Risk tolerance and household financial behaviour: A test of the reflection effect

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Abstract An important proposition underlying prospect theory is the notion that when decision-makers must choose between options with gains and losses, their preference for positive outcomes often mirrors their preference for negative outcomes. This is called the reflection effect. This paper aimed to test the extent to which the reflection effect is associated with household finance outcomes. A secondary goal was to determine whether different risk preference groups, based on categorised reflection effect responses (i.e. risk avoiders, loss averse, loss tolerant and risk seekers), share common demographic characteristics. Findings, based on internet survey data from more than 40,000 individuals aged 35 or older, showed that individuals, on average, exhibit the reflection effect. The results also confirmed that there are differences in behaviour across risk categories, but that it is difficult to cluster decision-makers into a risk category using demographic characteristics.

Introduction

The independence axiom is a foundational concept imbedded in expected utility theory (Moscati, 2016). Independence refers to being indifferent between lotteries regardless of the way in which the lottery outcomes are framed or mixed (Cox, Sadiraj, & Schmidt, 2015). Nearly 40 years ago, Kahneman and Tversky (1979) tested the independence axiom. They concluded that a few of their test participants followed the independence axiom when making risky choices. Based on their experimental findings, the foundational propositions of prospect theory began to coalesce.

Two core propositions helped shape the development of prospect theory. The first is what Kahneman and Tversky (1979) called the certainty effect. This is a decision-maker's behavioural tendency to overweight outcomes that are thought to be certain or sure, relative to outcomes that are less certain. The second is what they called the reflection effect. This behavioural tendency occurs when test participants make mirrored choices for gains and losses. Consider the following example. Assume a test taker is asked to choose between Gamble A with a 100% chance of losing $3000 or Gamble B with an 80% chance of losing $4000 and a 20% chance of losing nothing. Further assume that the same test taker is then asked to select between Gamble C with a 100% chance of receiving $3000 and Gamble D with an 80% chance of receiving $4000 and a 20% chance of receiving nothing.

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Kahneman and Tversky (1979) reported that 92% of test takers, across a broad range of studies, chose Gamble B, whereas only 20% chose Gamble D. This phenomenon has been noted consistently in various other situations, even those with subtle expected payout differences. For example, mirroring has been found in gambles where a decision-maker has been asked to choose between a 20% chance to win $4000 versus a 25% chance to win $3000, and a 20% chance to lose $4000 versus a 25% chance to lose $3000. When given these choices, most decision-makers choose the 20% chance to win $4000 and the 25% chance to lose $3000. This reflection effect represents individuals' opposite preferences for gambles with inverse outcomes. Specifically, Kahneman and Tversky hypothesised – as a key element of prospect theory – that decision-makers will be risk seeking when faced with probable losses and risk averse when presented with likely gains (Tversky & Kahneman, 1992). This has important implications for use in categorizing decision-makers. Conceptually, if a decision-maker chooses sure options with no variance (i.e., no risk) regardless of gains or losses, this decision-maker can be classified as a risk avoider. Alternatively, a decision-maker who selects risky options, regardless of gains or losses, can be categorised as a risk seeker. Those who exhibit the reflection effect fall between these two classifications. The most common description of decision-makers who make mirrored choices is loss averse.

The reflection effect has been tested using experimental and clinical methodologies, real-world market settings, and survey data (e.g., Fisher & Montalto, 2011; Genesove & Mayer, 2001; Jianakoplos & Bernasek, 1998; Menkhoff, Schmidt, & Brozynski, 2006; Odean, 1998; Shefrin & Statman, 1985). While such research has confirmed the general reflection effect, the previous literature has been somewhat silent in further describing the risk preferences of individual decision-makers. At the household level, classifying and understanding individuals based on their risk preferences is important because a decision-maker's risk preference is one of the key inputs needed to make appropriate financial decisions.

As mentioned above, a majority of decision-makers fall between the classifications of risk avoiders and risk seekers. Among those who fall between risk avoiders and risk seekers, decision-makers can further be classified based on the degree of their risk preference. For example, some decision-makers have a preference for tolerating losses instead of avoiding losses. When investing his or her assets into risky investment options, some decision-makers may be willing to accept certain degrees of loss and tolerate some level of shortfall before they shift to avoiding losses. This helps explain the nomenclature often used by household finance researchers. Consider the terms 'tolerance' and 'avoidance' in the context of the reflection effect and the classification of decision-makers. Tolerance typically means the 'maximal duration or magnitude of a noxious stimulus endured before the organism withdraws from it' (Cipher & Fernandez, 1997, p. 439), while avoidance means 'the act of staying away from a noxious stimulus altogether' (Cipher & Fernandez, 1997, p. 439). Among household finance researchers, tolerance is most widely used in the description of financial risk attitudes (e.g., risk tolerance). Specifically, financial risk tolerance represents a person's willingness to engage in a financial behaviour in which the outcome is both unknown and potentially harmful (Grable, 2016). In this study, loss tolerance is introduced as a concept that means the willingness of a decision-maker to consistently accept some level of loss when making a financial decision under uncertainty.

The purpose of the current study was to test the reflection effect with a large multi-year dataset, and to isolate different risk preferences between being risk avoiding and risk seeking. This paper advances the literature in several ways. First, findings provide additional support for the proposition imbedded within prospect theory that decision-makers systematically, on average, violate the independence axiom. Results provide evidence that what Tversky and Kahneman (1992) and others (e.g., Genesove & Mayer, 2001) have noted in relation to the reflection effect is present in the context of investing behaviour outside of experimental and clinical environments. Second, the findings suggest that while loss aversion is, as described by prospect theory, an important factor shaping behavioural choices, some decision-makers also exhibit, what is termed in this study, loss tolerance characteristics. Third, findings illustrate how being loss averse and loss tolerant are related to portfolio composition choices and gambling preferences.

Theoretical perspective

Prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992) is a descriptive theory that explains, but does not explicitly predict, financial behaviour. The theory describes how decision-makers make probabilistic choices that entail risk. A key assumption within the theory is that outcome probabilities are known prior to the decision task.

A core proposition underlying the theory is that decision-makers undertake two tasks when deciding between risky choice alternatives. The first task is called editing. During editing, a decision-maker relies on heuristics, or general rules that simplify choice options, that help the decision-maker make the two alternatives comparable. This means that the decision-maker begins by setting a reference point, which is a starting value. At that point, reduced or smaller outcomes are defined as losses, whereas greater or larger outcomes are considered gains. The second task involves an evaluation of the choice alternatives. During this stage of the evaluation process, decision-makers subjectively compute the value of the choices. This is akin to a utility estimation. The evaluation is based on each decision-maker's estimate of potential outcomes based on known probabilities. The classic formula for the evaluation phase is as follows:

$$U = \sum_{i=i}^{n} w(p_i) v(x_i)$$

where U is the overall satisfaction associated with the outcomes, w is the probability weighting function, x_1, x_2, $x_3 \ldots x_n$ are potential outcomes, $p_1, p_2, p_3 \ldots p_n$ are the outcome probabilities, and v is a function used to value an outcome. Essentially, the core takeaway from prospect theory is the notion that decision-makers tend to be loss averse, not merely risk averse. That is, the average decision-maker feels the negative effect of a loss more acutely than the positive effect of a gain. Specifically, the value function is steeper for losses than for gains. This contrasts with traditional expected utility theory that is premised on the assumption that individuals make decisions based on their evaluation of

the final state of the choice dilemma and choose the option that provides the maximum absolute utility.

Prior to prospect theory being fully developed, it was difficult for researchers to describe when individuals would exhibit a reversal of choice preferences when faced with gain and loss information. After the introduction and acceptance of prospect theory, researchers were better able to describe when someone's preference for risk taking would shift. For example, it is now widely believed that a decision-maker's decision choice when faced with a gain generally mirrors the choice taken when the decision choice involves a loss (Newell, Lagnado, & Shanks, 2015). When viewed this way, a decision-maker can be classified as a risk avoider if her or his choices are risk avoiding regardless of framing. One can be categorised as a risk seeker if her or his choices are consistently risky without regard to framing. Those who exhibit the reflection effect fall between these two extremes. The mirrored effect is not perfect because, as stated earlier, the value function is steeper for losses than for gains. In other words, prospect theory shows that, on average, decision-makers are risk averse when faced with choices that only entail gains but risk seeking when similar choices involve only losses.

Numerous studies have been conducted to test the reflection effect. The majority of these studies have been experimental and clinical tests. Kühberger, Schulte-Mecklenbeck, and Perner (1999) conducted a meta-analysis and found relationships between the gain domain and risk aversion and the loss domain and risk seeking. They also found risk preferences to be related to stated probabilities, the size of payoffs, and the type of goods in question (whether it is money, property or human capital). Generally, higher probabilities have a stronger influence on risk aversion when outcomes are described as gains. Decision-makers tend to be risk seeking when outcomes are described as losses. The influence of probabilities on risk preferences was also noted in Tversky and Kahneman's (1992) cumulative prospect theory where they categorised fourfold risk preferences for decision-makers. Later, the reflection effect was deconstructed by Bosch-Domènech and Silverstre (2006) as a translation effect and a switch effect. In Bosch-Domènech and Silverstre's study, the reflection effect was confirmed for high probabilities; however, the reflection effect was observed less frequently in low probability situations. Baucells and Villasis (2010) also found, in accordance with prospect theory, that most decision-makers are risk averse for gains and risk seeking for losses. They reported that the majority of those in their study exhibited mirrored choices. That is, participants not only changed their response patterns based on the way in which choices were framed (i.e., worded as a gain or loss), but they also fell into a pattern of mirroring their previous choice. Baucells and Villasis did note that about a quarter of their participants behaved differently, with most being loss averse in both the gain and loss domains.

A few researchers have noted that individual risk preferences might be unstable. For example, Ng, Luce, and Marley (2009) and Luce (2010) argued that an individual's value function could be bounded or unbounded. Malul, Rosenboim, and Shavit (2013) proposed that the S-shape value function in prospect theory can differ based on unique circumstances. As earlier researchers have

suggested, the value function might vary based on the size of the stated probabilities and the payoff. Malul et al. (2013) reported that in some cases less than one half of decision-makers behave in accordance with prospect or cumulative prospect theory descriptions. Based on a series of experiments for pricing and allocation, both in outcomes and pre-payment situations, Malul et al. (2013) also noted that decision-maker's risk attitudes may not be consistent.

As noted, the existing literature is relatively silent in describing how decision-makers who exhibit the reflection effect, but in opposite ways, compare with each other. For example, it is common for decision-makers to display a strong preference for risk avoidance when a choice dilemma is associated with a gain (van Raaij, 2016). The same decision-makers can be expected to exhibit risk-seeking preferences when a similar scenario is associated with a loss. This is a fundamental proposition of prospect theory. It is important to note, however, that it is possible for decision-makers to also exhibit the reflection effect such that they are risk seeking in the gain domain and risk avoiding in the loss domain. Further, if a decision-maker follows this pattern, she or he is generally willing to tolerate some degree of loss. In this study, those that fit this profile are called loss tolerant. What proportion of the population follows this pattern of decision-making is not widely known or reported in the literature. Further, little is known about how similar those who are loss averse are when compared to those who are loss tolerant. Overall, the concept of loss tolerance is relatively undefined in the academic literature. This study adds to the existing literature by addressing these particular issues.

Demographic and risk-taking correlates

The number of analyses designed to identify the demographic characteristics associated with risk attitudes and risk-taking preferences is quite large (van Raaij, 2016). Within the household finance domain, these research efforts have tended to be focussed on identifying individual characteristics that can be used to classify and predict investor behaviour (Grable, 2016). Factors such as education, marital status, income, age and gender have traditionally been identified as being particularly important in these classification attempts (Grable & Joo, 2004; Kannadhasan, 2015; Mazzoli, Marinelli, & Palmucci, 2017).

Consider the association between attained education and risk attitudes. Individuals with more formal education are generally thought to be more sophisticated in their ability to distinguish between risky choices. This may be a result of enhanced cognitive skills or more knowledge obtained from socialisation with others who have faced similar risky choices (Hallahan, Faff, & McKenzie, 2004). Marital status is another variable thought to be associated with risk taking preferences. It is worth noting that the relationship is, at best, fragmented. Some have argued that married individuals and those in a committed relationship are better able to handle the risks involved with some financial behaviours (Christiansen, Joensen, & Rangvid, 2015; McNeil, 1998; Waite & Gallagher, 2000). This hypothesis is based on the notion that a cohabitating individual has a greater risk capacity and can diversify income and wealth risk, whereas

a single decision-maker's risk capacity tends to be lower. Others have argued, on the other hand, that singles should prefer more risk because decisions made have limited impact on others, such as a partner or other financial dependents (Sulaiman, 2012; Sunden & Surette, 1998).

The association between income and risk-taking attitudes and behaviours is less ambiguous. Generally, those with higher personal and household incomes exhibit a tendency to hold riskier assets and to be willing to take above-average financial risk (Grable, 2000; Kannadhasan, 2015). Age is a commonly used demographic characteristic among those wishing to classify decision-makers into risk categories. Financial advisors once used a simple age-based rule to guide asset allocation recommendations (see Marsh, 2015). They would subtract a client's current age from 100 and use the result as the percent allocated to equities and other risky assets. In effect, age was used as a proxy for an investor's time horizon. The most recent literature suggests that using age as an indicator of risk tolerance is problematic because a decision-maker's willingness to take on a financial risk is shaped by more than the individual's time horizon. Even so, many researchers have noted an inverse relationship between age and willingness to take risk (Deaves, Veit, Bhandari, & Cheney, 2007; Gilliam, Chatterjee, & Zhu, 2010; Nairn, 2005), although others have documented an increased willingness among older investors to take risks (Ardehali, Paradi, & Asmild, 2005; Wang & Hanna, 1997). Besides income, gender is the one demographic factor that shows the most consistency in classification models. In general, men tend to exhibit a greater preference for risk compared to women (Gilliam, Chatterjee, & Grable, 2010, 2010; Mazzoli et al., 2017; Moreschi, 2004). It is important to note, however, that gender effects are thought to be temporary. That is, when women receive equivalent information and education regarding investing and personal finance topics, most gender-based risk differences disappear (Cupples, Rasure, & Grable, 2013; Grable & Joo, 1999; Magendans, Gutteling, & Zebel, 2017).

To summarise, there have been numerous attempts to categorise individuals into risk classifications using demographic factors. Overall, these attempts have been less than fruitful (Grable & Lytton, 1999; Grable, Lytton, & O'Neill, 2003), although there is some evidence that those who take fewer financial risks share some common characteristics, such as being female and having a lower income and education profile (Grable, 2016). High risk-takers are often thought to be males with more income and education. It gets more difficult to classify individuals into risk categories between these two extremes. An expected outcome from the current study was to provide additional insight into the usefulness of demographic characteristics as classification factors.

Methodology

This study was designed to answer three questions: (a) to what extent does the reflection effect exist outside of experimental and clinical situations? (b) to what extent do those who are risk avoiders, loss averse, loss tolerant and risk seekers differ in their engagement in household financial behaviour? And, (c) to what extent are there demographic differences among these four risk groups? Data to test these questions were obtained from an ongoing survey conducted online between late 2007 and 2013. The survey was open to anyone with internet access. The survey was widely advertised in trade publications, books and by land grant university extension services in the United States. The questionnaire was designed to assess the risk-taking attitudes of participants. The questions asked in the survey were similar to those published by Grable and Lytton (1999). The following are two examples of questions asked in the survey:

(1) When you think of the word 'risk' which of the following words comes to mind first?
    (a) Loss
    (b) Uncertainty
    (c) Opportunity
    (d) Thrill
(2) Suppose a relative left you an inheritance of $100,000, stipulating in the will that you invest all the money in one of the following choices. Which one would you select?
    (a) A savings account or money market mutual fund
    (b) A mutual fund that owns stocks and bonds
    (c) A portfolio of 15 common stocks
    (d) Commodities like gold, silver and oil

Given the objectives of this study, the sample was delimited to include only those participants who were 35 years of age or older. This choice was made to ensure that participants in the study fit the profile of investors rather than students or early career individuals. Given this delimitation, the final sample size was 44,636. Nearly all participants were from the United States and Canada. While the survey was not designed to be representative of any one country, the final sample was most representative of individuals with current investment holdings living in North America (Kuzniak, Rabbani, Heo, Ruiz-Menjivar, & Grable, 2015).

Outcome variable

The reflection effect was estimated by classifying participants into one of four risk categories by their choices to the following two questions:

(1) In addition to whatever you own, you have been given $1000. You are now asked to choose between:

    A: A sure gain of $500
    B: A 50% chance to gain $1000 and a 50% chance to gain nothing

(2) In addition to whatever you own, you have been given $2000. You are now asked to choose between:

    C: A sure loss of $500
    D: A 50% chance to lose $1000 and a 50% chance to lose nothing

Participants who chose A and C were classified as risk avoiders. Those who chose A and D were categorised as loss

averse. Participants who selected B and C were classified as loss tolerant. Finally, those who chose B and D were categorised as risk seekers. Traditionally, those who selected A and D or B and C have been described simply as exhibiting the reflection effect. A choice was made to use the nomenclature of Cipher and Fernandez (1997) to further separate this category of decision-makers into loss averse and loss tolerant groups. In this study, those who were classified as loss tolerant exhibited risk seeking when faced with a sure gain and risk avoiding when faced with a sure loss. This fits well with the definition of tolerance presented by Cipher and Fernandez: 'maximal duration or magnitude of a noxious stimulus endured before the organism withdraws from it' (p. 439). Overall, 20%, 45%, 6% and 29% of participants fell into each of the risk categories (i.e. risk avoiders, loss averse, loss tolerant and risk seekers), respectively.

Household financial behaviours

Household financial behaviours were measured using portfolio composition indicators and participant choices to a gambling scenario item. As an element of the survey, participants were asked to indicate approximately what percentage of your personal and retirement savings and investments are in the following categories: (a) cash, such as savings accounts, CDs, or money market mutual funds; (b) fixed income investments, such as corporate bonds, government bonds, or bond mutual funds; and (c) equities, such as stocks, stock mutual funds, direct business ownership or investment real estate (not your personal residence). Responses to (a) and (b) were combined to create a fixed-income variable. Participants reported holding approximately 51% (SD = 32%) of their investments in these assets. Equities comprised almost 45% (SD = 32%) of participant portfolios. Other assets, such as gold and collectibles (not evaluated in this study), comprised the remainder. An equity to fixed-income variable was created by dividing equity holdings by fixed-income assets. The mean and standard deviation for the equity to fixed-income ratio was 2.71 and 7.87, respectively.

Gambling preference was assessed by asking the following question: 'You are on a TV game show and can choose one of the following. Which would you take? (a) $1000 in cash, (b) a 50% chance of winning $5000, (c) a 25% chance of winning $10,000, or (d) a 5% chance of winning $100,000.' Approximately 23%, 49%, 17% and 11% of participants selected categories (a), (b), (c) and (d), respectively. The median selection was the 50% chance of winning $5000 category.

Demographic factors

Five demographic variables were assessed as an element of the survey. Females were coded 1, whereas males were coded 0. In this study, 39% of participants were females. Age was measured categorically as follows: (a) 35–44 years, (b) 45–54 years, (c) 55–64 years, (d) 65–74 years and (e) 75 or older. The sample was distributed among these categories as follows: 32%, 31%, 26%, 9% and 3%, respectively. Education was assessed categorically: (a) some high school or less, (b) high school, (c) some college, (d) Associate's degree, (e) Bachelor's degree or (f) graduate degree. The median

category was a Bachelor's degree. The percentage of participants in each category was 2%, 6%, 17%, 9%, 32% and 34%, respectively. Household income was measured categorically as follows: (a) less than $25,000, (b) $25,000-$49,999, (c) $50,000–$74,999, (d) $75,000–$99,999 and (e) $100,000 or more. Participant incomes skewed higher in the dataset, with 5%, 14%, 19%, 18% and 44% of participants reporting incomes in each category, respectively. Marital status was coded using the following six categories: (a) never married, (b) living with significant other, (c) married, (d) separated/ divorced, (e) widowed and (f) shared living arrangement. Approximately 11%, 4%, 68%, 13%, 3% and 1% of participants fell into each category, respectively. Table 1 provides a descriptive summary of the characteristics of those who participated in the study.

Data analysis methods

The research questions were evaluated using a combination of statistics, including ANOVA, chi-square and multinomial logistic regression. Each technique was chosen based on the coding of the variables of interest. Given the nominal measurement of the risk categories and the continuous nature of the portfolio composition variables, ANOVA was used for the first research question. Chi-square was employed to estimate category differences in the gambling question. Finally, a multinomial regression technique was used to identify differences among the four categories of risk using the risk-seeking group as the reference category. This approach was chosen over an ordinal regression procedure because the intent was to capture differences among possible group pairs. Nonetheless, a confirmatory polytomous universal model was estimated. While the results are not shown here, the multinomial findings were confirmed. The following variables were used as the omitted categories within the model: (a) married, (b) graduate degree, (c) over age 75 and (d) income greater than $100,000. Results from each test are described next.

Results

This first question of interest in this study was to investigate the extent to which the reflection effect exists outside of experimental and clinical environments. Some support for the notion that decision-makers systematically violate the independence axiom by exhibiting the reflection effect was found in this study. It was determined that 45% of participants exhibited loss aversion by selecting the sure gain option in the presence of gains and the gamble when faced with a sure loss. This result matched findings reported by Baucells and Villasis (2010). Another aspect of the reflection effect was noted with 6% of participants exhibiting what was termed loss tolerance in this study. While the reflection effect dominated the four categories of risk, it is worth noting that approximately 49% of participants made choices that were consistent in terms of risk avoidance (20%) or risk seeking (29%).

The second question presented in this study was to find out the extent to which those who were risk avoiders, loss averse, loss tolerant and risk seekers differed when making household financial choices. Results from Table 2 show that,

Table 1 Sample characteristics.

Characteristic	N	%	Mean	Median	SD
Gender					
Male	27,129	60.9			
Female	17,449	39.1			
Marital status					
Married	30,545	68.4			
Never married	4655	10.4			
Living with significant other	1736	3.9			
Separated/Divorced	5593	12.5			
Widowed	1231	2.8			
Shared living arrangement	515	1.2			
Education					
Some high school	634	1.4			
High school	2483	5.6			
Some college	7752	17.4			
Associate's degree	4227	9.5			
Bachelor's degree	14,028	31.4			
Graduate degree	15,162	34.0			
Age					
35 to 44	14,294	32.0			
45 to 54	13,684	30.7			
55 to 54	11,652	26.1			
65 to 74	3817	8.6			
75 or older	1190	2.7			
Income					
Less than $25,000	2088	4.8			
$25,000 to $49,999	5960	13.6			
$50,000 to $74,999	8493	19.4			
$75,000 to $99,999	7953	18.2			
More than $100,000	19,292	44.1			
Investment holdings					
Cash			32.83	20.0	32.60
Bonds			18.42	10.0	21.51
Equities			44.71	50.0	31.78

in general, portfolio composition varied based on these categories. Overall, risk avoiders were (a) more likely to hold fixed-income securities, (b) less willing to own equities and (c) more likely to hold a greater proportion of their assets in fixed-income assets. Risk seekers exhibited an opposite pattern of portfolio composition. Those who demonstrated the reflection effect were more similar than might have been expected. Post-hoc Bonferroni tests showed that those who were loss averse were similar to those who were loss tolerant in each of the portfolio composition situations. This implies that the reflection effect, regardless of whether the effect leads to aversion or tolerance, is associated with a similar pattern of portfolio composition.

Whether those who were risk avoiders, loss averse, loss tolerant or risk seekers differed in terms of gambling preference was tested with a chi-square test. An overall association was noted among the categories of risk and gambling, χ^2 (9) = 3212.65, $p < 0.001$. Table 3 provides a summary of the chi-square test.

As illustrated in Table 3, risk avoiders were more likely to choose the low risk guaranteed outcome. Similarly, those who were loss averse selected the low to lower-middle risk

options compared to the high gamble choices. Participants who were loss tolerant were more likely to choose the lower-middle to upper-middle choice gambles. Risk seekers were found to be significantly less inclined to choose the low risk gamble, and significantly more likely to choose the higher risk options.

Whether there were demographic differences among the four risk groups was tested using a multinomial logistic regression. Table 4 shows the results from this analysis. Using risk seekers as the reference category, the following characteristics were noted:

- Compared to those who were married, risk avoiders were more likely to be widowed but less likely to be in a shared living arrangement. An educational dichotomy was noted. A participant with less than a high school level of education or a Bachelor's degree, compared to a graduate degree, was more likely to belong to the risk avoider category than someone in the risk seeker category. Compared to the oldest participants, risk avoiders (compared to risk seekers) were grouped between age 35 and 54. Finally, compared to risk seekers, those who

Table 2 ANOVA results of portfolio composition measurements.

Comparison	N	Mean	SD	F
Fixed income				
Risk avoider	8942	56.80	31.30	138.84***
Loss averse	20,064	52.01	31.81	
Loss tolerant	2561	52.19	31.19	
Risk seeker	13,069	46.12	31.78	
Equities				
Risk avoider	8942	39.09	32.11	177.64***
Loss averse	20,064	44.51	31.35	
Loss tolerant	2561	43.67	31.63	
Risk seeker	13,069	49.05	31.61	
Ratio of equities to fixed income				
Risk avoider	8652	2.39	7.19	25.19***
Loss averse	19,454	2.80	8.10	
Loss tolerant	2492	2.73	7.43	
Risk seeker	12,451	2.87	8.39	

Note: ***$p < 0.001$.

had lower incomes were more likely to be classified as a risk avoider.

- Participants classified as loss averse (i.e., those who exhibited a traditional reflection effect), compared to risk seekers, were more likely to be male. Compared to those who were married, loss averse participants reported living with a significant other or living in a shared living arrangement. As compared to those with a graduate degree level of education, loss averse participants were more likely to report having less than a high school education, an Associate's degree, or a bachelor's degree. Like those who were risk avoiders, incomes of loss averse participants were lower than those classified as risk seekers.

- Compared to risk seekers, those classified as loss tolerant were also more likely to be male. This finding was not surprising given the ANOVA results showing that those in the loss averse and loss tolerant groups were similar. Additionally, loss tolerant participants were more likely to report holding a Bachelor's degree compared to a graduate degree. Those in this category were also significantly less likely to report having income less than $25,000.

- In a model using risk avoiders as the reference category (model not shown here), risk seekers were generally found to represent middle age high-income households.

While the profiles shown in Table 4 provide an interesting demographic snapshot of those in each category, it is important to note that the overall amount of explained variance in the model was quite small. The only clear linear pattern to emerge from the analysis was that the income profile of risk avoiders and loss averse participants was generally lower than incomes reported by risk seekers. In nearly every case, the demographic profile of the categorisations was mixed. This means that household finance researchers should assume that the use of demographic clustering solutions could result in somewhat problematic outcomes. It may not be as easy as once thought to categorise risk takers based on demographic profiles.

Table 3 Cross tabulation table showing differences in gambling choice and risk category.

Risk category	Gambling choice			
	1 (Risk averse)	2	3	4 (Risk seeking)
Risk avoider				
Count	3365	3850	884	843
%	37.6%	43.1%	9.9%	9.4%
Expected	2039	4351	1533	1018
Standardised residual	29.4**	−7.6***	−16.6**	−5.5**
Loss Averse				
Count	5059	10,208	2936	1861
%	25.2%	50.9%	14.6%	9.3%
Expected	4576	9763	3441	2284
Standardised residual	7.1**	4.5***	−8.6**	−8.9**
Loss tolerant				
Count	426	1341	548	246
%	16.6%	52.4%	21.4%	9.6%
Expected	584	1246	439	292
Standardised residual	−6.5**	2.7***	5.2**	−2.7**
Risk seeker				
Count	1330	6321	3286	2132
%	10.2%	48.4%	25.1%	16.3%
Expected	2981	6359	2241	1488
Standardised residual	−30.2**	−0.5	22.1**	16.7**

**$p < 0.01$.
***$p < 0.001$.

Table 4 Multinomial regression showing demographic profile of those who are risk avoiders, loss averse, and loss tolerant.

Reference Category = Risk Seeker	Risk Avoider		Loss Averse		Loss Tolerant	
	B (SE)	Odds Ratio	B (SE)	Odds Ratio	B (SE)	Odds Ratio
Intercept	.22 (0.38)	.95	−0.30 (0.33)		−0.89 (0.66)	
Gender (1 = Female)	−0.05 (0.03)		−0.14 (0.02)**	.87	−0.09 (0.05)*	.91
Marital Status (Married = 0)						
Never Married	−0.03 (0.05)	.97	.02 (0.04)	1.02	−0.07 (0.07)	.93
Living with	.10 (0.07)	1.11	.17 (0.06)**	1.18	−0.04 (0.11)	.96
Significant Other						
Separated/Divorced	.03 (0.05)	1.04	.03 (0.04)	1.03	−0.07 (0.07)	.93
Widowed	.19 (0.09)*	1.22	−0.02 (0.07)	.98	−0.05 (0.15)	.95
Shared Living Arrangement	−0.24 (0.12)*	.79	.40 (0.11)**	1.50	.10 (0.21)	1.11
Education (Graduate School = 0)						
Some High School	.27 (0.11)*	1.31	.75 (0.10)**	2.11	.28 (0.18)	1.32
High School	−0.07 (0.06)	.93	.07 (0.05)	1.07	−0.04 (0.10)	.96
Some College	.05 (0.04)	1.05	.06 (0.03)	1.06	.07 (0.07)	1.08
Associate's Degree	.01 (0.05)	1.01	.10 (0.04)*	1.11	.11 (0.08)	1.12
Bachelor's Degree	.08 (0.03)*	1.09	.06 (0.03)*	1.06	.11 (0.05)*	1.12
Age (Over Age 75 = 0)						
35 to 44	.31 (0.09)**	1.36	.18 (0.08)*	1.20	−0.33 (0.16)*	.72
45 to 54	.17 (0.09)*	1.19	.02 (0.08)	1.02	−0.20 (0.16)	.82
55 to 54	.01 (0.09)	1.00	−0.19 (0.08)**	.83	−0.16 (0.16)	.85
65 to 74	−0.12 (0.10)	.89	−0.28 (0.08)**	.76	−0.05 (0.17)	.95
Income (More than $100,000 = 0)						
Less than $25,000	−0.59 (0.07)**	.44	−0.19 (0.08)**	.83	−0.28 (0.11)	.76
$25,000 to $49,999	−0.39 (0.05)**	.68	−0.20 (0.04)**	.82	−0.10 (0.08)**	.90
$50,000 to $74,999	−0.23 (0.04)**	.80	−0.12 (0.03)**	.89	−0.09 (0.06)	.91
$75,000 to $99,999	−0.08 (0.04)*	.93	−0.04 (0.03)	.96	−0.12 (0.06)	.89

Note: Reference Category: Risk Seekers. R^2 = 0.01 (Cox and Snell), 0.02 (Nagelkerke). Model χ^2 (57) = 648.80, $p < 0.001$.
*$p < 0.05$.
**$p < 0.01$.

Discussion

It has been well established in the literature that individuals systematically violate core propositions rooted in expected utility theory. Allais (1953) was among the first to document, for example, that decision-makers often violate the independence axiom. Kahneman and Tversky (1979) provided examples of other ways how investors systematically exhibit biases when making financial decisions. Two of their most important observations were that, on average, decision-makers overweight outcomes with sure probabilities, and that when decision-makers must choose between options with gains and losses, their preference for a positive outcome often mirrors their preference for a negative result. This has come to be known as the reflection effect, or the tendency of individuals to exhibit risk aversion when choices are in the gain domain and risk seeking when outcomes are in the loss domain.

This study was undertaken to examine household financial behaviour associated with the reflection effect. The following research questions were tested: (a) to what extent does the reflection effect exist outside of experimental and clinical environments? (b) to what extent do those who are risk avoiders, loss averse, loss tolerant and risk seekers differ in the engagement in household financial behaviour?

And, (c) to what extent are there demographic differences among these four risk groups?

The answer to the first question is that the reflection effect, to some extent, is apparent outside of a controlled laboratory environment. Over 40,000 individuals aged 35 years of age or older participated in this study over a multiple year period. Among this group, 45% made risky choices that matched what is predicted in prospect theory. Another 6% made choices that matched the reflection effect; however, these choices were risk seeking in the face of losses and risk averse with sure gains. It is worth noting that although many participants did exhibit the reflection effect when making a risky choice, a sizable portion of the sample was consistent in either avoiding risks or seeking risks. The percent of those exhibiting a non-mirrored choice was larger in this study than what Kahneman and Tversky (1979) and Tversky and Kahneman (1992) reported. This may be due to the type of questions used in this analysis. The two questions measured the reference point and framing effect. The difference in results may also be attributable to the sample used in this study. Specifically, the sample used in this study represented a relatively technologically perceptive group of internet users who were more likely to have an interest in household finance topics compared to typical experimental or clinical study participants.
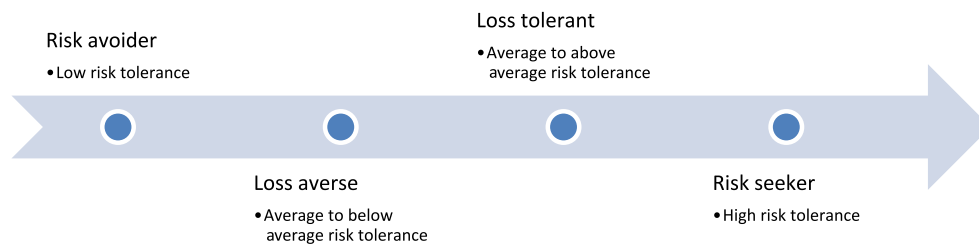
Fig. 1 The continuum of risk preference.

The answer to the second question turns out to be more nuanced than might otherwise be expected. Distinct portfolio differences were noted based on which category of risk a participant was classified. At the extremes, risk avoiders preferred fixed-income assets. The general preference among risk seekers was equities. These findings are not necessarily surprising. From a household level financial planning point of view, these insights illustrate the importance of accurately assessing a decision-maker's risk tolerance prior to formulating investment recommendations. The two risk questions used in this study provide a parsimonious way for financial service professionals to evaluate the risk preference of their clientele. Clients who answer A and C can confidently be classified as risk avoiders. These clients can be expected to, on average, hold and prefer holding a greater percent of their investment portfolio in lower risk securities. On the other hand, those who answer B and D can be categorised as risk seekers. Decision-makers fitting this profile can be described as those preferring to hold a greater proportion of their portfolio in riskier assets. A key takeaway from this study is that a decision-maker's risk profile falls on a risk continuum. While some decision-makers may be risk avoiders and others are risk seekers, many decision-makers will fall somewhere between these extremes.

With respect to the question regarding differences in household financial behaviour among the risk preference categories of risk taking, those who exhibited the reflection effect were found to be similar. It did not matter whether a participant made choices that were consistent with prospect theory or whether the reflection effect resembled loss tolerance. For example, those who were loss averse (i.e., they selected the A and D choices) held approximately 52% of their portfolio in fixed-income securities. This was almost the same percentage as those classified as loss tolerant (i.e., participants who selected B and C). A similar allocation pattern was noted for equities. Even the ratio of equities to fixed-income assets was similar. This means that exhibiting a mirrored choice is more important than the actual classification of the decision-maker who made the choice. In other words, it seems to matter little if a decision-maker is loss averse or loss tolerant; the decision-maker's portfolio allocation will fall between those who are risk avoiders and risk seekers.

Results from the chi-square analysis provided additional insights into the differences among those who were risk avoiders, loss averse, loss tolerant and risk seekers. As already noted, risk avoiders were much more likely to make choices that minimised the possibility of loss. Risk seekers were more inclined to make choices that provided high potential returns even if the probability of a gain was low. A slight difference was found to exist between those who

were loss averse and those who were loss tolerant. Loss averse decision-makers preferred low to middle-low risk alternatives. On the other hand, loss tolerant decision-makers preferred choices that provided middle-low or middle-high outcomes. Again, both loss averse and loss tolerant participants fell between risk avoiders and risk seekers when faced with a risky choice. The differences between those who were loss averse and loss tolerant, however, were not particularly strong.

Fig. 1 illustrates how the risk preference categories help explain financial decision-making among individuals. At the far left of the figure are the risk avoiders. These individuals prefer low risk outcomes, and as such, can be categorised as having a low tolerance for risk. Moving to the right, those who are loss averse are willing to accept more risk, but their preference is to stay in the lower-middle range of choice options. Loss averse decision-makers can be classified as having an average to below-average risk tolerance. Moving to the right again are loss tolerant individuals. These decision-makers prefer choices squarely in the middle of a choice dilemma. Loss tolerant individuals can be thought of as having an average to slightly above-average risk tolerance. At the far end of the figure, risk seekers prefer, on average, choices that provide high payoffs, regardless of the risk. These individuals can be classified as having a high tolerance for risk.

It was determined that the use of demographic factors as descriptors of risk categories was rather weak. From a financial services perspective, it would be ideal if a demographic profile could be developed to explain who or what type of decision-maker would most likely fall into one of the four risk preference categories, as shown in Fig. 1. If clean clusters could be identified it would make categorisation of individuals much easier. Clustering would also allow for a cleaner link between a risk assessment and the development of asset and portfolio recommendations. In this study, however, the amount of explained variance in the model that was used to estimate category composition was small, even though statistical significance was noted across groups. With this in mind, some general patterns of group membership did emerge. For example, those who were classified as risk avoiders and loss averse were more likely to be females with less education and lower household income. Those who were classified as loss tolerant or risk seeking were more likely to be younger and married with higher income.

As described in the financial planning literature, classification of decision-makers based on their risk preference is an important input that investors use when making investment decisions. This research presents an alternative way of categorising decision-makers into different risk preference groups. This method is based on a theoretically grounded

methodology. Using the reflection effect and the concept of risk preference, it was determined that individuals can be classified as risk avoiders, loss averse, loss tolerant and risk seekers. While the loss averse and loss tolerant groups exhibit the reflection effect, choices made by those in each group often differ, which suggests that risk preference for those exhibiting the reflection effect also differs. As suggested in prospect theory, generally a decision-maker feels losses more severely than gains, however, the magnitude of the difference between disutility from a loss and utility from a gain is different. The difference depends on whether a decision-maker is classified as loss averse or loss tolerant.[1] The questions that were used to measure the reflection effect, and the resulting classification of decision-makers into one of the four risk preference groups is relatively easy. This method of classification can aid in the development of future research and practice.

While the results from this study advance the literature is several ways, it is important to account for certain limitations. For example, while the sample is large, there is no way to confirm the generalisability of the findings to one specific country, other than to say that the results are most appropriately generalisable to investors living in the United States. It is possible that systematic response bias was present given the open access nature of the survey. Additionally, the portfolio composition data were based on multiple period measures. The periods of data collection included both the global financial crisis and the post-recession recovery in the United States. While the use of multiple periods of data adds to the robustness of the test results, it could be speculated whether one period had an undue influence on results. Future studies should attempt to confirm the results from this research by looking at each year independently to see if behaviours might be influenced by macroeconomic and/or market conditions. Lastly, the scope of household financial behaviours was limited to the questions asked in the survey. While this study provides baseline data on classifying decision-makers based on their risk preferences, further studies are needed to ascertain if the reflection effect influences other types of decisions that are encountered daily in the household finance environment. For example, it would be useful to know if those who are risk avoiders, loss averse, loss tolerant and risk seekers differ in mortgage choices, credit and debt choices, consumer purchases, and daily household spending decisions. This type of information can be useful for financial service professionals who work with clients making risky financial decisions, as well as policymakers who need applied information to inform legislative action.

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[1] Even though the findings from this research show that these two groups (i.e., loss averse and loss tolerant) are more similar to each other compared to those classified as risk averse or risk seeking, the evidence from this study suggests that the loss averse and loss tolerant groups have different value functions. This is especially true in the loss domain where generally the slope of those who are loss averse is steeper than the slope for those who are loss tolerant. In this study, the loss tolerant decision makers selected the risk seeking choice in the gain domain and the risk avoiding choice in the loss domain. The risk avoiding choice in the loss domain is a sure loss, not a probable loss.

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