Comparing Elicitation Methods of Risk Preferences in Personal Financial Planning: A Field Experiment among Working Adults in Malaysia

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Abstract: Risk preference is an important input in designing investment types or portfolios in personal finance. Although there are many reported risk elicitation methods, the risk preference measure obtained from these methods has not been associated with any behavioural or psychological reasons underlying the choices made. This association is important in providing the underlying theoretical understanding of risk preferences and establishing the robustness of a measure. The present paper attempted to test the consistency of risk preferences between two widely used elicitation methods: Grable and Lytton (1999, 2003) risk tolerance score and probability weighting function in prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992). The risk score captures the self-reported willingness to engage in risky investment, and the probability weighting function shows overweighting or underweighting of the probability. We conducted a series of field experiments involving working adults of three main ethnic groups in Malaysia. The results showed consistency in risk preferences between the two methods: high willingness to engage in risk was complemented by optimistic probability weighting, and respondents with low willingness to engage in risky investment evaluated high probability more favourably. The study is useful to financial professionals when implementing the questionnaire to measure risk preferences.

Keywords: Grable and Lytton risk tolerance score, probability weighting function, risk preferences, prospect theory, financial counselling and planning
JEL classification: C93, D91, G41

1. Introduction

The measurement and assessment of an individual's risk tolerance level have always been an important element in financial counselling and planning. However, there has not been a unanimously accepted method that can provide a comprehensive understanding and the behavioural mechanisms underlying risk preferences. For example,

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* This research is financed by the Ministry of Higher Education Malaysia under the Fundamental Research Grant Scheme with Project Code: FRGS/1/2020/SS0/USM/02/26.

Article Info: *Received* 22 September 2022; *Revised* 6 April 2023; *Accepted* 17 April 2023
https://doi.org/10.22452/MJES.vol60no1.2

in personal finance, there are many methods to measure one's willingness to engage in risky financial behaviours. Among them is the *Survey of Consumer Finances* by the Federal Reserve Board, negative net worth and the life cycle hypothesis (Chen & Finke, 1996), multidimensional risk measure (Barsky et al., 1997), estimates on willingness to engage in risky financial investments (Grable & Lytton, 2003; Hanna et al., 2001; Hanna & Lindamood, 2004). While researchers have examined the reliability and validity of these measures, the association between the risk tolerance levels revealed by the measures and the psychological traits underlying the risk preferences has not been well established. Investigating the potential association between risk tolerance measure and the underpinning psychological traits is important not only for determining the robustness of the measure, but it also aids in learning the reasons behind the risky choices made at the individual level. The present paper analyses two widely used risk elicitation methods: the Grable and Lytton (henceforth G&L) 13-item questionnaire (Grable & Lytton, 2003) and probability weighting function in prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992).

Measuring risk preferences has a long history in psychology and economics (Mata et al., 2018; Schildberg-Hörisch, 2018). The risk elicitation method is often categorised into two main techniques: survey questionnaire and incentivised experiment (Charness et al., 2013), both are not without weaknesses. The main concern of the survey method is that respondents do not have the incentive to truthfully self-report their perceptions and beliefs based on some hypothetical questions related to willingness to engage in certain risk choices such as risky investments or portfolios. Usually, the data are collected in an uncontrolled environment that involves many confounding matters and a lack of proper guidance in answering difficult abstract or hypothetical questions (Charness et al., 2013; Fehr et al., 2002; Sanou et al., 2018).

On the other hand, the experimental method used to elicit risk also has its weaknesses. The frequent criticisms are that the experiment is "artificial" and lacks external validity to represent the real world that is more complex (Lonati et al., 2018). It is often related to the type of subjects used in the experiment (usually college students) and the simulated environment in a laboratory that does not reflect real-world settings (Lonati et al., 2018). Thus, in the present paper, we recruited working adults as our respondents, and we conducted a field experiment instead of a laboratory experiment.

In this study, we aimed to compare the difference between risk preference measures obtained from an economic experiment with real monetary payoff and risk preference obtained from a survey about willingness to engage in a risky investment. The economic experiment is a series of lottery games with real monetary payoff and risk in the style of Holt and Laury (2002). From the lottery games, we derived the probability weighting functions that measure how respondents perceived or evaluated probability (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992). To investigate how individuals responded to probability, the lottery game is divided into: low probability to win (it is to reflect high-risk investment) and high probability to win (it is to reflect low-risk investment). As for the survey, the 13-item financial tolerance scale by Grable and Lytton (1999) was adopted. The financial tolerance scale has been widely used to gather client data related to risk preference such as in Grable (2022), Heo et al. (2021), Kuzniak et al. (2015) and Yao and Rabbani (2021). We then compared the risk tolerance

score obtained from a survey of those who self-reported on their willingness to engage in risky investment with the probability weighting function. Since the same respondents were recruited to play lottery games and answer the survey, the comparison could provide a glimpse of the association between risk tolerance and probability evaluation.

Based on the prospect theory, risk seekers overweight low probability and risk averters underweight high probability (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992). There is a consistency of risk preferences to some extent, whereby respondents who chose medium and high willingness to engage in risky investment in the G&L questionnaire perceived low probability to win as highly probable, and those who expressed low willingness to engage in risky investment in G&L questionnaire evaluated high probability unfavourably. The present study hypothesised that respondents who exhibited high G&L risk scores should overweight small probability of winning and those with low G&L risk score should underweight large probability. This hypothesis has been used to predict four patterns of risk behaviour in Kahneman and Tversky (1979) and Tversky and Kahneman (1992).

2. Methodology

2.1 Study Design and Participants

A total of 300 working adults were recruited to participate in the survey and lottery game experiment. From this total, 131 or 46% of the subjects were Malays, 93 (32%) were Chinese and 65 (22%) were Indians. The subject pool consisted of 121 men and 168 women ranging from 20 to 64 years of age.

The subjects were recruited from their workplaces, such as factories, offices, banks and retail shops. Prior approval was obtained from the respective management to conduct the fieldwork during the lunch break to minimise work disruption. The subjects were randomly selected to participate in the study. Since the study is considered not invasive by the management and the university, the ethics committee approval is not required.

Six interviewers, who were undergraduates from a local public university, were recruited to conduct the survey and field experiment. The interviewers were given training on the procedures to ensure that the explanations given to the subjects during the fieldwork were standardised and well-understood.

The interviewers spent, on average, 30 minutes explaining and guiding each subject during the fieldwork. In the lottery games, every subject had the opportunity to receive a payoff ranging from RM10 (USD2.50) to RM30 (USD7.50), depending on his/her performance during the lottery games. At the end of approximately 6 weeks, only 289 subjects had completed the experiment (11 subjects were removed because of violations of certain rules in the lottery game).

2.2 Materials

2.2.1 Socio-Demographics

Participants were required to provide their socio-demographic information. The study collected information on gender, ethnicity (i.e., Malay, Chinese and Indian), age, marital

status (i.e., married, never married, separated or divorced and widowed), income and education level (i.e., high school, foundation, bachelor degree, masters degree and PhD).

2.2.2 Grable and Lytton (G&L) Risk Tolerance Score

G&L risk tolerance score (Grable & Lytton, 1999, 2003; Kuzniak et al., 2015) consists of 13-item measures to test different constructs namely investment risk, risk comfort and experience, and speculative risk. G&L risk tolerance score was adopted in this study because this instrument can measure more than one dimension of financial risk tolerance, and a summated scale consisting of the multidimensional items (i.e., the three factors) was determined to be the best measure of financial risk tolerance attitudes (Callan & Johnson, 2002). Scores are calculated based on self-reported responses to questions about their financial risk tolerance. A reliability test was performed to test the internal consistency and whether the scale is measuring risk. The reliability test was conducted based on Cronbach's alpha measure.

A validity test was conducted to examine whether the score could explain financial risk tolerance. The test should show the association between scores in cash holding and risky asset holding (such as equity ownership). This association is based on the modern portfolio theory, which predicts that higher risk tolerance results in greater equity ownership (Markowitz, 1952). We followed the method in Grable and Lytton (2003) to test the validity by looking into the association between the summated scores of the 13 items in the questionnaire to the asset allocation choices. In terms of scoring, a G&L risk tolerance score of 18 and below is considered low-risk tolerance or conservative investor, 19 to 22 is below average risk tolerance, 23 to 28 is moderate/average risk tolerance, 29 to 32 above average risk tolerance and 33 and above is high-risk tolerance or aggressive investor.

2.2.3 Probability Weighting Function

To understand the differences in risk preferences among the respondents, particularly differences in the weighting probability of a risky prospect, we implemented a two-choice lottery field experiment. Unlike methods used to elicit risk tolerance scores in Grable and Lytton (1999), the same respondents were faced with real monetary rewards and risks when making choices between a lottery and a guaranteed payoff.

Fifteen two-choice lottery games were designed to elicit the risk preferences of the subjects. In each lottery game, subjects could choose option A (lottery), which was a choice that involved risk, or option B, which was a choice with a guaranteed payoff. The lottery or option A was considered a risky choice as the potential gain or loss depended on probabilities that ranged from 5%, 20%, 50%, 80% and 95%. The low probabilities of winning 5% and 20% were considered high-risk investments, while the probabilities of winning 80% and 95%, reflected low-risk investments. Option A is referred to as the risky choice or lottery throughout the rest of the paper. Table 1 shows one of the lottery games in the gain domain that was used in the experiment.

It was emphasised to the subjects that they were allowed to switch from option B to option A (or vice versa) only once. If a subject exhibited inconsistency and switched

Table 1. Sample lottery game when payoff = RM10 (USD2.50)

1	Option A (lottery)	Your choice		Option B (Guaranteed payoff) RM
		A	B	
1	Profit of RMX with probability y and profit of RM0 with probability (1-y)			10.00
2				9.50
3				9.00
4				8.50
5				8.00
6				7.50
7				7.00
8				6.50
9				6.00
10				5.50
11				5.00
12				4.50
13				4.00
14				3.50
15				3.00
16				2.50
17				2.00
18				1.50
19				1.00
20				0.50

Note: RMX refers to the amount of monetary reward; it ranges from RM10 (USD2.50), RM20 (USD5) and RM30 (USD7.50). The parameter y refers to probability, from 5%, 20%, 50%, 80% and 95%. Subjects were asked to play a lottery with three different rewards, with five different probability levels. Therefore, 3 monetary rewards x 5 probability levels = 15 lottery games.

between options A and B more than once, the subject was removed from the analysis. For example, if a subject chose option B at first, when the guaranteed payoff was RM10 and switched to option A when the guaranteed payoff was RM9, and then switched back to option B when the guaranteed payoff was RM4, the choice was considered illogical. This is because the subject showed a willingness to take a risk when the guaranteed payoff was RM9, but not when the guaranteed payoff was RM4. A subject willing to take a risk when the guaranteed payoff was RM9 should be willing to do so for all guaranteed payoffs lower than RM9. Furthermore, in a choice between the guaranteed payoff of RM10 (option B) and options A, which only held a 5% probability of winning, the logical choice would be the guaranteed payment of RM10 (option B),

instead of option A. Therefore, subjects who chose option A, instead of B, for the first choice were removed from the analysis. The choices of 11 subjects who violated these two requirements were removed from the analysis.

After the subjects had made choices for all 15 lottery games, one of the lottery games was randomly selected for the final payoff calculation. Three random numbers were generated: the first random number from 1 – 15 to decide on which lottery game, the second random number from 1 – 20 was generated to decide on which choice and the third random number 1 – 100 to decide on payment if the choice were option A. If the choice was option B, the respondents were paid the guaranteed amount. If the final payoff was less than RM10, the respondents were paid a minimum of RM10. On average, each respondent was paid RM25 (USD6.25).

The choices made in the lottery games were used to calculate CE (i.e., certainty equivalence) and EP (i.e., expected payoff) of a lottery game; a subject is classified as risk-seeking if CE > EP, risk-averse if CE < EP and risk-neutral if CE = EP. The value of CE was calculated using Equation (1) below:

$$CE = \frac{(x1 + x2)}{2} \tag{1}$$

CE was calculated when the subjects switched their options from A to B or vice versa. For example, using the lottery game in Table 1, if a subject chose option B from first choice and switched to option A (risky choice) in 12th choice, the CE of the subject is = $\frac{(RM5 + RM4.50)}{2} = RM4.75$. This means the value of the risky option or the lottery (option A) is less than RM5 but more than RM4.50. However, if a subject chose option B from the first choice until the last choice, the CE was 0. This is because the perceived value of the lottery (option A) is less than RM0.50. Therefore, subjects with higher CE values are considered more risk-seeking than subjects with lower CE values.

We calculate the expected payoff (EP) of every lottery game using the following Equation (2) below:

$$EP = p(X) + (1–p)\,(Y) \tag{2}$$

where p denotes the probability of payoff "X" occurring while $1–p$ denotes the probability of payoff "Y" occurring. For example, in a lottery with payoff RM10 with probability 0.05 and RM0 with probability 0.95, the EP = 0.05 (10) + 0.95 (0) = RM0.50.

In prospect theory, the weighting of probability is denoted as "w" and measures how people evaluate the probability of a prospect. Thus, in a gamble with a 0.5 probability of winning RM50, the person is said to evaluate (weight) the probability as 0.7, this is written as w (0.5) = 0.7. If another person weighs the probability as 0.4, this is indicated as w (0.5) = 0.4. We can then conclude that the first person puts more weight on the probability and therefore, evaluates the gamble as being more attractive, as compared to the second person. Note also that the theory assumes that the function exhibits diminishing sensitivity; that is, the marginal impact of probability diminishes with distance from a reference point.

The property that people are more sensitive near the reference points (i.e., 0 and 1), and therefore overweight a small probability and underweight a large probability

explains the fourfold risk pattern. People are sensitive to the change of probability from 0 to 0.05 and overweight the chances of winning. This causes risk-seeking. But when the probability is large, people are sensitive to changes from 1 to 0.95 and underweight the chances of winning. This results in people being risk-averse when the probability is large. This implies that the probability weighting function "w" has an inverted S-shape – the first concave when the probability is small and convex when the probability is large.

Such psychological reactions to the probability are captured by two parameters: one parameter measures the sensitivity (γ) and another parameter captures the attractiveness (δ). The functional form of the model can be given in Equations (3) and (4) as follows:

$$\log\frac{w(p)}{1-w(p)} = \gamma \log\frac{p}{1-p} + \log\delta \tag{3}$$

solving for $w(p)$:

$$w(p) = \frac{\delta p^{\gamma}}{\delta p^{\gamma} + (1-p)^{\gamma}} \tag{4}$$

with the two end points bounded by w (0) = 0 and w (1) = 1, and if $\gamma = \delta = 1$, then $w(p) = p$. The function in Equation (4) has been widely used to model the probability weighting of a risky prospect, such as by Abdellaoui et al. (2008), Lattimore et al. (1992), Tversky and Fox (1995), among others.

3. Results

3.1 Grable and Lytton Risk Tolerance Score

To investigate whether there is a significant difference between the risk tolerance scores obtained and demographics, analysis of variance (ANOVA) tests were computed. Findings showed that the risk tolerance scores are significantly different between genders (F = 5.66, p = 0.0186), ethnic groups (F = 3.21, p = 0.0838) and different age groups (F = 2.15, p = 0.0781) (see Table 2). However, there were no significant differences between risk tolerance scores among different income levels, marital status and education levels (see Table 2).

Figure 1 depicts the frequency distribution of risk scores with the lowest score of 13 and the highest score of 35. According to the scoring of the risk tolerance scale, findings showed that 135 or 46% of the respondents are in the moderate/average risk tolerance category (see Figure 1). The reliability measure for the risk tolerance scale was acceptable (Cronbach's α = 0.76) and is in line with Grable and Lytton's (1999) reliability score.

Based on Gilliam et al. (2010) and Grable and Schumm (2008), the risk tolerance scores should exhibit real investing behaviour. It should show a positive association with equity ownership and a negative association with fixed income and cash ownership (Kuzniak et al., 2015; Yang, 2004). Table 3 shows the reported willingness of the respondents to take on more risks by investing in high-risk assets. We test the association of the scores and risk level, and the different risk scores according to genders, ethnicities and age groups.

Table 2. Risk scores according to demographic details

Variable	Respondents		Risk scores		
	Frequency	Percentage	Mean	Std. dev.	Cronbach's alpha
Risk tolerance score			26.5600	4.2654	0.76
Gender					
Female	168	58.1315	27.8750	4.3728	0.78
Male	121	41.8685	25.5300	3.9411	0.73
Ethnicity					
Malay	131	45.3287	24.7600	3.9892	0.79
Chinese	93	32.1799	23.9375	4.5307	0.82
Indian	65	22.4913	25.0294	4.4414	0.72
Age					
Under 25	144	49.8270	24.7333	3.9364	0.78
25–34	42	14.5329	26.2381	5.2048	0.79
35–44	34	11.7647	24.5555	3.4338	0.76
45–54	46	15.9170	22.6250	4.3819	0.83
55–64	23	7.9585	24.4167	4.5618	0.79
Marital status					
Married	95	32.8720	23.7959	3.9422	0.81
Never married	184	63.6678	25.0000	4.2944	0.78
Separated or divorced	8	2.7682	24.2500	3.6723	0.72
Widowed	2	0.6920	21.0000	4.3928	0.82
Income					
Less than RM20,000	163	56.4014	24.7529	3.9487	0.78
RM20,001 to RM35,000	31	10.7266	25.0625	4.9324	0.79
RM35,001 to RM50,000	12	4.1522	23.5000	4.0892	0.80
RM50,001 to RM70,000	29	10.0346	26.3333	4.3369	0.77
RM70,001 to RM100,000	38	13.1488	22.7500	4.7669	0.75
More than 100,000	16	5.5363	23.5000	3.2952	0.79
Education					
SPM	13	4.4983	24.5714	4.7559	0.81
STPM/Matric/Diploma	73	25.2595	24.8684	3.4809	0.79
Bachelor degree	166	57.4394	24.6976	4.4828	0.73
Master degree	33	11.4187	23.2941	4.8187	0.77
PhD	4	1.3841	23.5000	3.5355	0.72

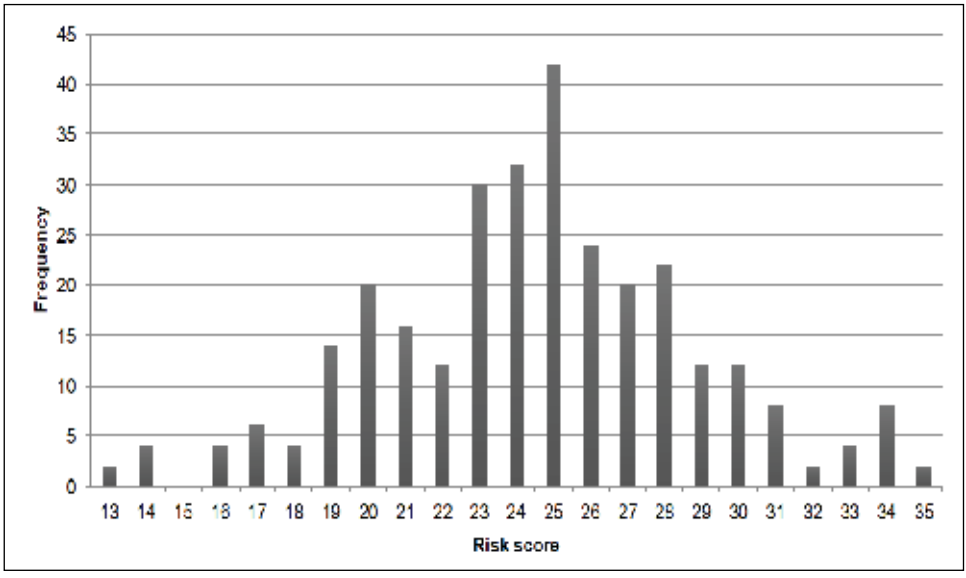

Figure 1. Frequency distribution of risk scores
Note: Histogram showing the frequency distribution of risk scores from the lowest at 13 to the highest at 35.

Table 3. Risk tolerance scores and standard deviations based on willingness to take on risk

Item	Low risk (SD)	Medium risk (SD)	High risk (SD)
Gender			
Male	23.93 (3.94)	27.17 (3.45)	25.67 (2.08)
Female	22.29 (3.83)	26.65 (3.38)	28.75 (2.29)
Ethnicity			
Malay	23.11 (4.27)	26.77 (3.57)	29.16 (4.58)
Chinese	23.57 (3.74)	27.20 (3.30)	28.36 (4.39)
Indian	21.61 (3.81)	26.77 (3.49)	26.25 (4.79)
Age group			
<25	23.30 (3.65)	26.28 (3.23)	31.68 (3.43)
25–34	24.00 (5.70)	29.00 (3.71)	32.38 (4.24)
35–44	23.08 (3.03)	27.50 (2.07)	31.90 (3.13)
45–54	20.88 (3.39)	26.86 (3.67)	28.65 (2.19)
55–64	23.5 (4.54)	26.25 (4.65)	29.16 (4.17)

Note: Participants were asked to rate their willingness to take on risk on a scale of 1 (low risk) to 3 (high risk). Respondents could choose different contextual questions which are related to taking on more risks in investment.

Table 3 shows the overall risk tolerance scores on willingness to take on risks according to gender, ethnicity and age groups. For the validity test, the scores should be low to depict cash holding and high to depict equity ownership. ANOVA test showed that the risk scores are significantly higher when respondents answered their willingness to take on the highest risk than the willingness to take on the lowest risk (i.e., cash holdings) across genders, ethnicities and different age groups.

When comparing risk scores between genders, the results show risk scores for females are significantly higher than their male counterparts when asked about allocating money to invest in highly risky assets ($F = 4.59$, $p = 0.0851$) but significantly less than males in low-risk assets holding ($F = 3.55$, $p = 0.0628$). Significant differences can be seen also among different ethnic groups, with the Chinese ethnic group exhibiting higher risk scores in low-risk asset holding than their Malay and Indian counterparts ($F = 2.38$, $p = 0.0987$) but Malay and Chinese ethnic groups show higher risk scores when coming to the willingness to take on more risks by investing in equity than their Indian counterparts ($F = 3.57$, $p = 0.1074$). In terms of risk scores among different age groups, we find respondents in the age group 25–34 scores significantly higher than other age groups ($F = 3.45$, $p = 0.0725$).

3.2 Probability weighting functions

Next, we investigated the risk preference focusing on the probability weighting function between genders, ethnic groups and age groups. Prospect theory stipulates that people misinterpret probability by overweighting low probability and underweighting high probability (Kahneman & Tversky, 1979). Cases in the former are categorised as risk-seeking and the latter are categorised as risk aversion (Kahneman & Tversky, 1979; Laury & Holt, 2008).

We analyse the probability weighting functions of respondents who self-reported medium and high willingness to take on high-risk investments and those who reported low willingness to assume risk. We then compare the functions between genders from the former category followed by functions from the latter category. Figure 2 shows that in all lotteries (lotteries with payoff RM10, RM20 and RM30), on average, females are more optimistic when evaluating the chances to win the lotteries. For example, when the probabilities to win the lotteries were 0.1 and 0.2, female respondents weighted the chances significantly higher (at 0.25 and 0.37 respectively) than their male counterparts (at 0.22 and 0.34 respectively). But when the probabilities were high at 0.8 and 0.95, male respondents were more optimistic than female respondents.

We then check the consistency of risk preference by looking into the risk scores of those respondents. Findings from an ANOVA test showed that the average G&L risk tolerance score of female respondents in the low probability region is 28.35 which is significantly more than the risk score of their male counterparts ($F = 3.47$, $p = 0.0347$). The risk score in the high probability region is 23.78 for males, significantly higher than 21.93 for females ($F = 2.98$, $p = 0.04883$). In summary, the results show that female respondents with high-risk scores tend to evaluate low probability to win more favourably than their male counterparts but less favourably when evaluating high probability.

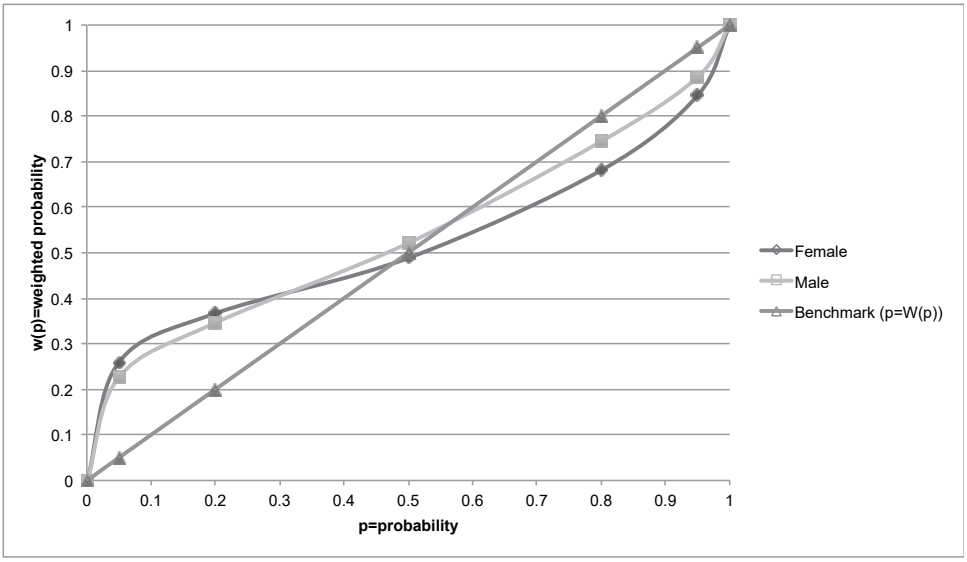

Figure 2. Probability weighting functions based on genders

Note: Line graphs show probability weighting between genders. Female respondents weigh a low probability of winning more favourably than their male counterparts and weigh a high probability of winning less favourably than male respondents.

Next, we investigated weighting functions based on ethnic groups. Based on Figure 3, the Malay ethnic group was the most optimistic when evaluating the lottery with small probabilities (i.e., 0.05 and 0.2) compared to the other two groups followed by Chinese and Indian ethnic groups. But when the probability of winning became larger (i.e., when it exceeds 0.5), Malays weighted the chances of winning to be lower than the other two groups. The risk tolerance score of the Malay ethnic group is also significantly higher than the other two ethnic groups ($F = 4.98$, $p = 0.0007$) and the risk tolerance score of the Chinese ethnic group is significantly larger than their Indian counterparts ($F = 3.28$, $p = 0.0083$). When in the region with a high probability to win, the risk score of the Chinese ethnic group is higher than the other two groups.

Figure 4 presents the probability weighting functions based on different age groups. Respondents under the age group 25–34 were most optimistic in terms of evaluating a small probability to win compared to other groups, followed by respondents from 35–44 and under 25. When the probability to win is high, respondents from the age group 25–34 were most optimistic followed by 55–64 and under 25. The result also shows the age group 25–34 has the highest risk score compared to other age groups in both low and high probability to win regions.

Overall, the results suggest that there is a consistency of risk preferences between the two risk elicitation methods. A consistent pattern is observed when comparing risk preferences between genders, ethnicity and age groups, but not among different income levels, education levels and marital statuses.

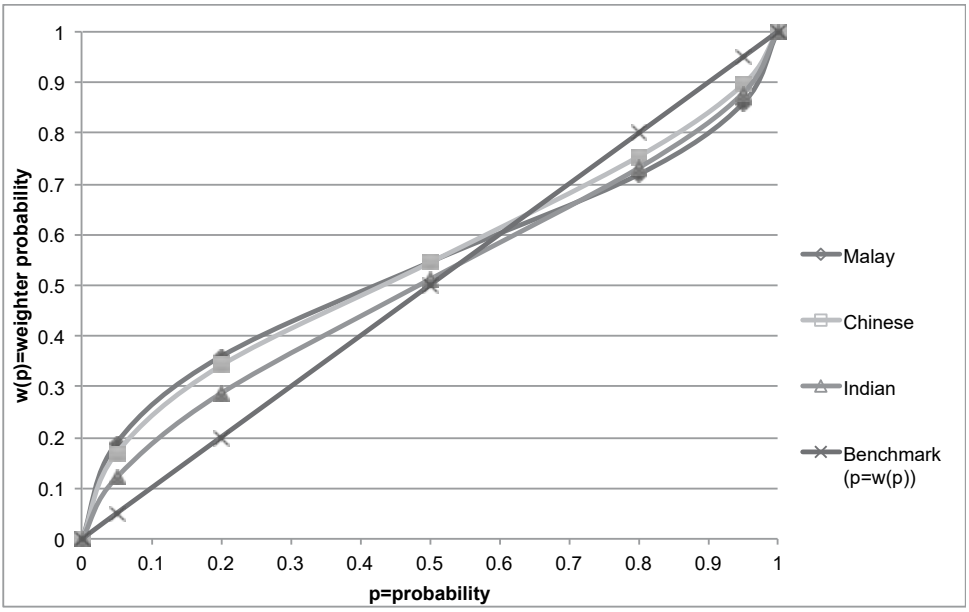

Figure 3. Probability weighting functions based on ethnicities

Note: Line graphs show probability weighting among three ethnic groups: Malay, Chinese and Indian respondents. Malay respondents weigh a low probability of winning more favourably than the other two counterparts but weigh a high probability of winning less favourably than the other two groups.

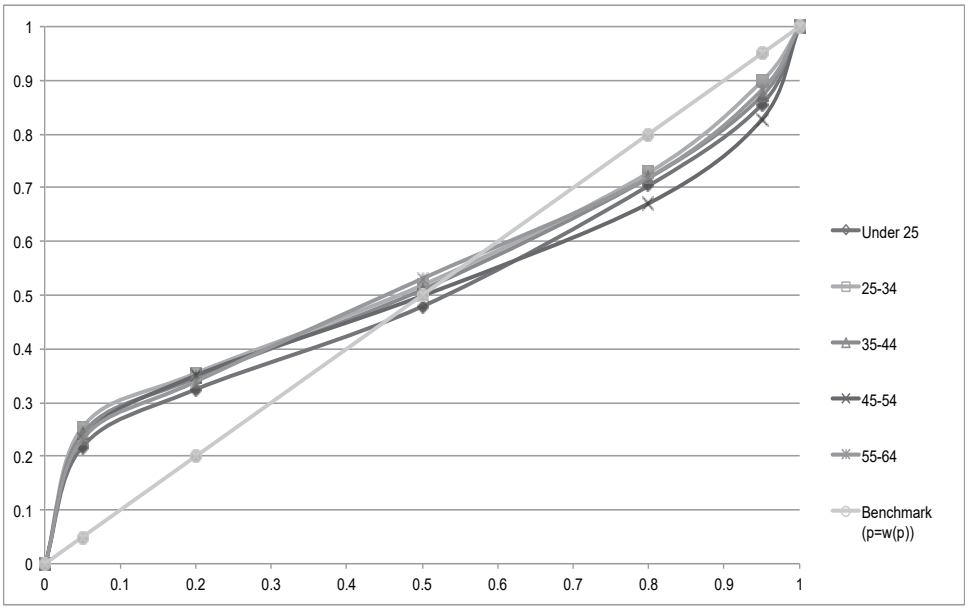

Figure 4. Probability weighting functions based on age groups

Note: Line graphs show probability weighting among different age groups: under 25, 25–34, 35–44, 45–54 and 55–64. Young respondents from the age group 25–34 weigh both low and high probability of winning more favourably than the other age groups. Those from the age group 45–54 weighs low and high probability of winning least favourably compared to other groups.

4. Discussion

The main objective of the current study is to compare two methods of measuring risk tolerance preferences, namely, the probability weighting function in the prospect theory and the Grable and Lytton 13-item risk tolerance score. The overall reliability of the score in this study (0.76) was consistent with the estimates reported in the literature (Gilliam et al., 2010; Grable & Lytton, 1999, 2003; Yang, 2004). We further tested the reliability based on the level of willingness to hold on to different risk levels, high-risk investment, medium-risk investment and low-risk investment. The risk scores showed consistent results, a high-risk score for high-risk investment, a medium-risk score for medium-risk investment and a low-risk score for low-risk investment.

Our findings showed that when measuring risk tolerance based on demographic indicators – gender, ethnicity and age groups – showed significant differences in risk tolerance scores. The results reported females, Malay ethnic group and those from the 25–34 age group scored significantly higher risk tolerance than other demographic categories. In terms of gender, when measuring willingness to invest in medium and high-risk investments, female respondents scored significantly higher G&L risk tolerance scores than their male counterparts. But in a low-risk investment, male respondents displayed higher risk tolerance scores. The current study's findings are inconsistent with past studies as men were found to take higher risks by trading more frequently than women (Chin, 2021; Tauni et al., 2017). The contradictory results from these studies may be due to the different contexts each study has.

Our findings also showed that the Malay ethnic group and respondents between the ages 25–34 years old had higher risk tolerance scores in medium and high-risk investments but Malays showed lower risk tolerance scores compared to the Chinese ethnic group when the risk of investment was low. In terms of ethnicity, Ch'ng and Narayanan (2019) confirmed that Malays are more willing to take greater risks to reduce possible loss than to settle for a sure gain, compared to the other ethnic groups.

In terms of the younger age group, reporting higher risk tolerance scores is consistent with past studies such as Chin (2021) and Mak and Ip (2017). Their findings show that the younger age group tends to be more risk-taking by holding more shares (Mak & Ip, 2017), and trading more frequently (Chin, 2021). Studies have also revealed that younger people and those with higher levels of self-efficacy may have chosen a more heuristic approach to decision-making as opposed to an analytical one, resulting in a less "logical" behavioural outcome and thus having a higher risk tolerance (Law et al., 2022).

In weighting probability function analysis, we observed that respondents who weighted low probability as highly probable (i.e., those who were risk-seeking), had higher G&L risk tolerance scores. On average, the female respondents in the risk-seeking category had a score of 28.35 compared to their male counterparts (25.19). Malay ethnic groups and those from the 25–34 age group, who weighted low probability more favourably than other groups, were also found to have higher risk scores.

The results reported the consistency of risk preferences in the two risk elicitation mechanisms. The results from the weighting probability function analysis were consistent with the results from the G&L risk tolerance score in measuring risk tolerance

behaviour. The overall pattern highlighted the association between a high G&L risk score and favourable probability evaluation. The consistency of the risk preferences between the two mechanisms indicated that respondents with high-risk scores evaluated a low probability of winning (at 0.05 and 0.2) favourably and those with low-risk scores tended to evaluate a high probability more optimistically.

This study is not without some limitations. The results of females having higher risk tolerance warrant further investigation since the results are not consistent with past studies. Additionally, the risk tolerance measure was based on a single question on participants' willingness to take on risk. Perhaps looking into the participants' personality traits such as risk-averse and risk-seeking behaviour may add to the understanding of the differences seen between genders in the current study (De Bortoli et al., 2019; Pavlíček et al., 2021). Besides that, there were three specific investment-related scenarios in the willingness to take on risk questions. Cross-cultural studies in economics have shown that culture influences economic decision-making behaviour (Czerwonka, 2019; Fan & Xiao, 2006). As the current study involves various ethnic groups, the cultural context of the scenarios used should be taken into account.

5. Implications and Conclusion

The study can add to the body of research in several ways. First, the study made a direct comparison and therefore cross-verification between two different methods of measuring risk: risk tolerance based on the self-reported answers to abstract questions and risk tolerance behaviours elicited from a series of lottery games when real monetary payoff and risk were involved. Second, the robustness of each method in measuring risk tolerance was established when the same respondents were used to answer abstract risk questions and played the lottery game. The results from the comparison would be particularly useful to consumers as well as financial planning professionals. Third, this study provides insights to financial institutions such as insurance companies and investment firms on their customers' characteristics. A better strategy can be developed when a company has a different customer base. For example, when introducing insurance or investment plans for younger age groups, companies can introduce plans with higher risk levels.

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