Domain Effects and Financial Risk Attitudes

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We investigated whether financial risk preferences are dependent on the financial domain (i.e., the context) in which the risky choice options are presented. Previous studies have demonstrated that risk attitudes change when gambles are framed as gains, losses, or as insurance. Our study explores this directly by offering choices between identical gambles, framed in terms of seven financial domains. Three factors were extracted, explaining 68.6% of the variance: Factor 1 (Positive)—opportunity to win, pension provision, and job salary change; Factor 2 (Positive-Complex)—investments and mortgage buying; Factor 3 (Negative)—possibility of loss and insurance. Inspection of the solution revealed context effects on risk perceptions across the seven scenarios. We also found that the commonly accepted assumption that women are more risk averse cannot be confirmed with the context structure suggested in this research; however, it is acknowledged that in the students' population the variance across genders might be considerably less. These results suggest that our financial risk attitude measures may be tapping into a stable aspect of "context dependence" of relevance to real-world decision making.

KEY WORDS: Financial risk; framing effects; risk attitudes; risk perception

1. INTRODUCTION

A very important strand of research is the stability of various measures of risk aversion. There has been considerable research interest in investigating the structure of human risk preferences for various choice domains like economic, social, environmental, or health risks.[1–4] The seminal work of Kahneman and Tversky[5,6] and Thaler[7,8] gave birth to the whole new domain of behavior finance, and researchers concentrated particularly in studying choice behavior in various financial activities.[6,9–11] There is extensive evidence that risky decisions of this type are affected by various factors like framing,[12] the procedures used to elicit risk preferences,[13] or whether the risk is described as a gamble or as a mean and variance.[14] This evidence challenges most classical decision theories,[15] according to which choices made in different financial domains, and at a particular point in time (i.e., in identical circumstances), should be determined by the same stable and endogenous utility function.[16]

We can identify at least a few reasons why this normative prediction will fail in reality. First, this normative prediction presents a rather simplistic vision about how people understand financial risk, a view that assumes a coherent pattern of risk preferences. People's everyday conception of risk is likely

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to be much less precise, especially because risk arises not merely in finance, but also in areas like health, environment, and so on.[3,4,17] In line with this argument, Vlaev *et al.*[18] identified factors (e.g., perceived level of knowledge about an investment) that can affect people's perception and comprehension of information about the risks related to retirement investments.

Several other studies have also examined people's understanding of risk in the financial domain. Slovic[19] examined the implications of research on human judgment and decision making for investment decisions. He pointed to multiple conceptualizations of risk that people apply to risk-taking situations (such as selections of gambles) and he concluded that variance of returns, which are used in the standard approach to predicting risk taking, are not a consistent predictor of risk taking (e.g., Slovic found that other decision rules, such as maximizing possible gain or minimizing possible below-target return, also play a central role in decision making under uncertainty). Slovic[3,17] concluded that, as a result of such different conceptualizations of risk, people may be risk averse in one domain (e.g., nuclear waste) and risk seeking in another (e.g., health). Inspired by the diverse set of determinants of decisions under risk, Weber *et al.*[20] and Blais and Weber[21] developed a risk-taking scale, the domain-specific-risk-taking (DOSPERT) scale, that assesses both conventional risk attitudes (defined as the reported level of risk taking) and perceived risk attitudes (defined as the willingness to take risky activity as a function of its perceived riskiness) in five content domains: financial decisions (separately for investing versus gambling), health/safety, recreational, ethical, and social decisions. Weber *et al.* reported that respondents' degree of risk taking was highly domain specific rather than reflecting a stable attitude or trait. That is, people were not consistently risk averse or consistently risk seeking across all content domains. Also, Hanoch *et al.*[22] used the DOSPERT scale to show that individuals selected to exhibit high levels of risk taking in one content area (e.g., bungee jumpers taking recreational risks) can be quite risk averse in other risky domains (e.g., financial decisions). Although DOSPERT might be discovered in various real-life scenarios in choices under risk, in our approach, we focus exclusively on the role of financial context when decisionmakers contemplate various financial scenarios.

There is some reason to believe that people's choices about monetary gambles may not correspond with their tendency for risk taking in situations where they need to consider decisions regarding other kinds of financial risks. Several studies have reported increased attractiveness of decision prospects when framed as insurance decisions; specifically, there is evidence for a context effect in which prospects presented in an insurance context are judged with greater risk aversion than mathematically identical choices presented as standard gambles.[23–26] This finding has prompted the suggestion that people have a relatively favorable attitude toward insurance because, unlike gambling, insurance is viewed as an investment as well as a means of risk reduction.[27,28] In recent research Kusev *et al.*[29] found evidence that variation in decision content produces variation in preferences for financial risk. Because by the accessibility of events in memory people exaggerate the risk, the weighting function varies as a function of the accessibility of events. This suggests that people's experiences of events "leak" into decisions even when risk information is explicitly provided. The results in Kusev *et al.*[29] call into question the assumption that decisions made with monetary gambles can be used as a methodology for evaluating not only domain-independent risk preferences, but also preferences within the same domain (such as finances). The authors suggest that this, in turn, should prompt further exploration of what it is that people are deciding about produces variation in the risks people are prepared to take.

All these results imply that, for example, mortgage-related risk may be conceptualized differently from insurance type of risk, which goes against the idea that a stable utility function should determine risky behaviors in these domains.

Another argument why choices made in different financial "domains" (or subdomains) may not be determined by the same utility function is because the reference point may change depending on the domain. When I choose between monetary gambles, I may use as a benchmark my pocket money (instead of my total wealth as most normative theories predict), while when I choose my pension investment products, I may think about my total net wealth (including my house assets, stock investments, etc.). Such effects due to variable frames of references have been well documented in the literature (see Kahneman and Tversky[6] for a review). This interpretation implies lack of a stable risk personality, which also is implied by more recent work on risky choice. For example, Stewart *et al.*[30] demonstrated a closely related phenomenon, "prospect

relativity," by asking people to trade off risk and return by choosing a gamble (of the form "*p* chance of *x*") from a varying range of options. People chose based not on absolute risk-return level, but on the risk-return level relative to the other gamble options available (see Stewart *et al.*[31] for a model of risky choice that assumes relative judgments only). Other relational theories also have in common the idea that preferences are constructed (i.e., not elicited or revealed).[32–34]

The study presented in this article tested whether there is a variability of risk preferences depending on the financial domain. We do not aim to answer, however, exactly what causes different risk attitudes being expressed in different financial domains (i.e., we do not explicitly test to what extent variability in risk attitudes is due to changing reference points in each financial domain vs. different conceptualization of risk depending on the domain). Our goal was only to establish and measure the degree of such variability between human attitudes to risk in various financial choice domains. This is an important question because the extensive research in risky decision making discussed at the beginning has not directly addressed the degree to which our preference for financial risk is a stable trait of our "financial personality" or a by-product of the particular financial situation (domain) we are facing (each time we make a risky financial decision). For example, the Markets in Financial Instruments Directive (MiFID) requires that, where it applies, investment firms shall ask the client or potential client to provide information regarding his knowledge and experience in the investment field relevant to the specific type of product or service offered or demanded so as to enable the investment firm to assess whether the investment service or product envisaged is appropriate for the client (Directive 2004/39/EC of April 21, 2004 on Markets in Financial Instruments (MiFID), Article 19). In particular, regarding risk preferences, MiFID requires obtaining information about the investment objectives of the client, including information on his or her preferences regarding risk taking, his or her risk profile, and the purposes of the investment (Commission Directive 2006/73/EC of August 10, 2006, Article 35). In this respect, our study also has an obvious applied objective. If we establish that people have context-dependent risk attitudes across (some) financial domains, then this research seeks both to allow us to predict a particular individual's financial preferences for a particular, perhaps novel, product or combination of products. Moreover, it also should allow us to build a "psychometrics" of "financial personality." That is, it should allow us to develop measures of key aspects of people's domain-specific financial decision making (e.g., insurance, retirement investments, and mortgage) through a carefully crafted choice of queries (e.g., gambles in each financial domain).

In addition, we also aim to study gender differences in risk taking across different financial domains. One aspect of the natural variation in response to risk is a tendency for females and males to respond to risk differently. In numerous areas, including financial decisions, health/safety, recreation, and ethical decisions, females are found to be more risk averse than males.[20] Gender difference in perceived risk is also associated with alcohol and drug use,[35] environmental disasters,[36] and recreational activities.[37] Women also have less risky asset portfolios than men[38] and lower willingness to take financial risk.[39] We could not find publishable studies on how men and women differ across various financial behaviors. For example, are women more risk averse with mortgages because they tend to possess stronger values related to home, family security, and parenthood? Or are men more risk seeking with gambles due to a cultural image of gambling as adrenaline-driven entertainment for macho men? Or does the higher testosterone make men more aggressive risk-seeking investors in the stock market? Our study aimed to test for such gender differences at a behavioral level in the domain of risky financial choice (although we did not try to distinguish between various cultural and physiological explanations).

2. EXPERIMENT

Our test aimed to investigate whether financial risk preferences depend on the financial domain in which the risky choice option is presented (or framed). For example, previous studies showed that people change their risk attitudes if gambles are framed as gains, losses, or insurance.[6] In this study, we made a deeper dissection of the financial context and our test framed the most common financial contexts that an ordinary person faces in life nowadays. Such frames are cases of monetary gambles, hazard losses, investment, insurances, pension provision, job salary change, and mortgage buying. Appendix A presents the seven financial scenarios described as the following seven products:[7]

[7]In this respect, we would like to stress that we made sure that there were analogous real financial products on the market.

(1) "Gain" gambles asked the participants to imagine making choices between playing a gamble to receive an amount of money and taking a smaller amount for sure.
(2) "Investment" involved making choices between buying a company share with an uncertain profit and buying a bond offering a smaller profit for sure.
(3) "Mortgage" was a buying choice between two houses (one at a popular but cheap location, and another at an expensive but unpopular location) with the aim to rent part of the house to repay the mortgage.
(4) "Salary" involved a choice between two jobs: one offering low but certain income, and another with high but variable income.
(5) "Pension" offered a choice between two retirement investment plans: one investing in bonds offering a smaller pension for sure, or another investing in stocks offering bigger but variable pension.
(6) "Loss" gamble involved making choices between playing a gamble that can make you lose an amount of money and losing a smaller amount for sure.
(7) "Insurance" was a choice between buying insurance against a possible loss in a share's value, or not paying the fixed price and risking taking the loss (which is bigger than the insurance premium).

Our study was designed as a questionnaire, in which we used hypothetical measures of risk attitudes in these seven financial contexts. We used a self-report hypothetical measure of risk aversion—choice of abstract gambles (in the form presented in Appendix A).

By asking the same risky questions within each of the seven financial domains we were able to study whether the description of a problem can influence people's risky decisions and whether there are different risk preferences for each financial domain. In our experiment, we controlled for the effects of absolute wealth by offering similar monetary amounts across all risky financial scenarios. Therefore, according to a normative point of view, the different scenarios should highly correlate with each other because the monetary amounts represented similar portions of the participants' total wealth. However, as we discussed before, researchers have reported that what appears to be slight shifts in problem wording can have a pronounced effect on choice behavior: "Subtle differences in how risks are presented can have marked effects on how they are perceived" (Ref. 40, p. 483). It follows that financial domains can affect risk perceptions.

2.1. Method

2.1.1. Participants

Seventy-six respondents took part in the gamble test. The participants were recruited from the University of Warwick and the University College London student population. The respondents were paid £5 for their participation.

2.1.2. Design

There are two main strands of research on measuring risk aversion. Some use either hypothetical questions or experimental gambling data, and most such studies focus on forms of risk in which both gains and losses are possible.[41–44] Other researchers estimate the risk aversion parameter empirically for individual households using survey data on real financial behavior, like investment in risky assets or insurance purchases.[45–48]

Our study was designed as a survey (questionnaire), in which we used hypothetical measures of risk preferences. We used a measure of risk aversion (see Appendix A) to measure the contextual dependence of preferences across seven financial contexts. Each respondent was asked to make choices in all seven financial contexts.

In each context, participants made choices between a sure thing and a risky option (p chance of x). Each pair of options was presented as two pie charts. The two regions of the pie chart represented the risky bet indicating the two probabilities for gain versus nothing, respectively (see Appendix A). Such gambles are used to measure risk aversion in most laboratory settings. For example, Schubert *et al.*[49] used similar gambles to test whether women are more risk averse than men in financial decision making. The risky option was constructed by crossing four probabilities (20%, 40%, 60%, and 80%) with four amounts (£100, £200, £300, and £400) to create 16 choices. The accompanying sure thing was generated by using a power law utility function with power γ (gamma)—so that a person with power γ would be indifferent between the sure thing and the risk. In particular, we used the following equation:

$$y = xp^{1/\gamma}, \tag{1}$$

where y is the sure amount and the prospect is a "p chance of x." γ describes the curvature of a hypothetical power law utility function, $u(x) = x^{\gamma}$. Gamma is equal to one for a risk-neutral person. Smaller values of γ denote greater risk aversion. Four levels of γ were used (0.35, 0.50, 0.65, and 0.80) to generate some questions when even the most risk averse would select the gamble and some other questions when someone much less risk averse would select the sure thing. (For the population used in this study, we observed values of γ in this range in an unpublished study from our laboratory, in which the values of γ were deduced from choices between simple prospects and sure amounts.) The idea here was that a more risk-averse person will tend to choose the sure amounts in the "risky" gambles and the prospects in the "safe" gambles, while a more risk-seeking person will tend to choose also prospects in the "risky" gambles. Of course, very risk-averse individuals will choose only the sure amounts and very risk-seeking persons would choose only the prospects. The values of γ we used were intended to allow for participants in the middle of the risk-aversion continuum to choose a mixture of sure amounts and risky prospects.

Levels of γ were randomly assigned to gambles with the constraint that each level of γ occurred once for each amount and once for each probability. To map the whole surface of possible combinations between the four levels of probability, prospect amount, and γ, we needed a set of 64 gambles ($4 \times 4 \times 4$). Presenting all participants with all 64 gambles in each financial domain would have been a too demanding task. Therefore, we presented 16 gambles per financial domain—but made sure that, at least, each scenario presented all four levels of γ paired with every monetary amount and probability. We also used four different orders of the four γ levels across the 16 gambles. To avoid repeating the same four sequences of four γ levels (say, in two different financial domains), we created eight different 16-gamble sequences in combinatorial counterbalanced manner. Appendix B shows the eight sets of choices that were generated (which is the full list of 128 gambles). Because we had only seven financial domains, we randomly assigned the eight possible subsets to the seven financial domains in four random orders: Order 1: 8 6 2 1 7 3 4; Order 2: 5 2 3 8 4 6 1; Order 3: 6 8 4 7 3 1 2; and Order 4: 7 2 8 3 1 4 6. Thus, each financial domain (e.g., gain) was presented in the context of four different gamble sets (e.g., 8, 5, 6, 7), which controlled for possible interactions between each financial domain and a particular gamble set. We also had four different random orders between the seven scenarios (to control for sequence effects between the domains), and four random orders between the 16 gambles in each domain (so that the gambles were not always increasing in amount and probability as in Appendix B). This randomization scheme was embedded in four booklets (each containing the seven scenarios), which were given to four different groups of participants.

In our test, the indicator of risk aversion was the proportion of risky picks among the 16 gambles in each domain (each person answered 16 questions in each financial domain). Thus, we coded each risky choice as 1 and the safe option as 0, and the risk aversion indicator was the sum across all 16 choices divided by 16 (the total number of gamble choices per domain).

2.1.3. Procedure

Participants were given a booklet with the scenarios and the questions after each scenario. They received written instructions explaining that we were running a study to help improve the presentation of financial information and that we were interested in finding out how people make risky decisions. We stated that we were interested to know what the participant would do if he/she really needed to make these decisions at the moment; we instructed them to answer as they would answer if they were making these decisions for real. We also pointed out that there were no right and wrong answers and they were free to choose whatever most suited their preferences. The questions and the answer options were presented in the same way as the example question presented in Appendix A. The participants had to circle with a pen the preferred option(s) after each scenario as if this choice was made for real.

2.2. Results and Discussion

We conducted a consistency test to check whether participants responded randomly across the 16 gambles in each scenario (e.g., lack of correlation between the domains can result from such random answering due to lack of interest, care, attention, or incentives). A reliability analysis was run and returned a Cronbach's $\alpha = 0.59$, denoting satisfactory internal consistency, especially considering the

Table I. Three-Factor PCA Solution: Communalities, Loadings of Variables on Factors, and Percentage of Variance Explained

Scenarios	Communalities	Factor 1 ("Positive")	Factor 2 ("Positive-Complex")	Factor 3 ("Negative")
Pension	0.74	0.94		
Gain	0.66	0.62		
Salary	0.58	0.60		
Mortgage	0.72		0.89	
Investment	0.64		0.71	
Insurance	0.79			0.83
Loss	0.68			0.77
	Percentage of variance	35.4	21.9	11.3

Notes: Loadings of variables on factors are obtained from the pattern matrix to ease interpretation (as shared variance is omitted). Inspection of structure matrix revealed cross-loadings between variables in Factors 1 and 2; this is expected as the two factors correlate and "the correlations between variables and factors are inflated by any overlap between factors."[53] Variables are ordered and grouped by size of loadings to facilitate interpretation. For the same reason, loadings under 0.45 (i.e., 20% of variance) are omitted.

low number of items.[8] However, if the domain of loss (low item-total correlation, $r = -0.08$) was excluded from the analysis, internal consistency rose to $\alpha = 0.70$; this seems to suggest that the way the participants responded to the scenarios in the loss domain departed to some extent when compared to the remaining six scenarios. In any case, the relatively high levels of α refute the possibility that our data are the results of random and careless responses.

A principal component analysis (PCA)[9] was run with oblique rotation (Promax, $\kappa = 4$)[10] to summarize the correlations pattern. Two factors were initially extracted and explained 57.3% of the variance. However, upon inspection of the communality values it was ascertained that such solution poorly explained some items (e.g., pension, communality = 0.45 and mortgage = 0.46).

When three factors were retained, the solution explained a satisfactory 68.6% of the variance; moreover, communalities were considerably higher and ranged from 0.58 (salary) to 0.79 (insurance; see Table I). Inspection of the solution revealed context effects on risk perceptions. The three factors depict financial situations that seem perceived differently by participants. Gains, pensions, and salaries ("Positive" factor) are situations in which the "positive utility" of the scenario is most easily brought to mind. Investments and mortgages ("Positive-Complex" factor) represent more sophisticated "gain" financial situations, possibly associated with the relatively higher complexity of the financial products. Finally, in line with previous research, losses and insurances ("Negative" factor) were perceived as similar scenarios by participants, possibly because of their "disutility" connotation.

Interestingly, the Negative factor did not correlate with either factor (both $r = -0.01$)—while Positive and Positive-Complex factors strongly correlated ($r = 0.51$, $p < 0.001$)—as it could be expected. Overall, some consistency was observed for participants' responses to the five domains framed as "gain" (Positive and Positive-Complex factors)—which, however, seemed relatively independent from how they responded to the two negative scenarios (i.e., loss and insurance).

A 2 × 3 mixed ANOVA was run on the proportion of risk taken, with gender (male vs. female) as the between-subjects factor and Factor (Positive, Positive-Complex, and Negative) as the within-subject variable. Table II represents the mean risk taken in each of the three grouped financial frames (Factors) and separately for males and females. Participants' gender did not affect risk preferences, as (1) overall, males ($M = 0.52$, $SD = 0.14$) and females ($M = 0.48$, $SD = 0.11$) did not differ in the

[8]When run separately for males and females, Cronbach's α revealed slightly higher consistency for males ($\alpha = 0.62$) than for females ($\alpha = 0.53$).

[9]An inspection of the distributions revealed no major departures from normality (largest absolute skewness value = −0.48, $SE = 0.28$; largest kurtosis = 0.82, $SE = 0.55$). Moreover, the Kaiser-Meyer-Olkin measure of sampling adequacy revealed a satisfactory value of 0.70. Finally, the Bartlett's test of sphericity was significant, $\chi^2 = 95.8$, $p < 0.001$—and revealed how the correlation matrix was not an identity matrix.

[10]Oblique rotation was used so to allow the underlying factors to correlate.

Table II. Mean Risk Taken (and *SD*) as a Function of Financial Frame and Participants' Gender

Financial Frame (Factor)	Risk Taken		
	All	Males	Females
Positive	0.52	0.56	0.49
	(0.18)	(0.20)	(0.16)
Positive-Complex	0.54	0.57	0.51
	(0.18)	(0.21)	(0.15)
Negative	0.42	0.42	0.43
	(0.20)	(0.22)	(0.19)
Overall	0.50	0.52	0.48
	(0.13)	(0.14)	(0.11)

proportion of risk taken, $F(1, 73) = 2.2$, $p = 0.14$ and (2) factor did not interact with gender, $F(2, 146) = 1.0$, $p = 0.36$. This result demonstrates that the commonly accepted assumption that women are more risk averse might not apply with these factors; however, it is acknowledged that in the students' population the variance across genders might be considerably less. On the other hand, the main effect of Factor was significant, $F(1.6, 120.2) = 9.7, p < .001$.[11] Post-hoc tests with Bonferroni adjustment revealed that the risk taken in the Negative domain ($M = 0.42$, $SD = 0.20$) was significantly lower than for Positive ($M = 0.52$, $SD = 0.18$) and Positive-Complex domains ($M = 0.54$, $SD = 0.18$; both ps < 0.01).

3. GENERAL DISCUSSION

In this work, we have found that estimates of risk attitudes highly depend on the financial scenario at hand. How far do the risk-aversion estimates thus derived meet criteria of stability and real-world applicability? Some results from the present study indicate that the risk attitude measures do appear to be influenced by the context in which the hypothetical gamble is framed. People may understand (conceptualize) the financial risk differently in each of these domains. Similar questions were prompted by Erb *et al.*[50] where participants were given lists of words to prime risk attitudes (affective prime). In the risk tasks, the list contained adjectives with positive and negative connotations for risk seeking/avoidance and additional distracting adjectives. Using this prime procedure, Erb *et al.*[50] were able (1) to induce risk-seeking or risk-averse preferences across a range of decision scenarios using this priming procedure and (2) showed that these priming effects can be reversed by drawing participants' attention to the priming event. Accordingly, we found evidence that participants were highly influenced by the context in which the hypothetical financial scenario was formulated. This suggests that such risk attitude estimates reflect some aspect of the "interface" with which they are dealing, rather than people's underlying decision processes. This context makes certain mental representations more accessible and available in the decision-making process (see Kahneman[51] for an in-depth discussion of the key concept of mental "accessibility" and how it could explain choice behavior). Thus, people's (past and remembered) experiences of events "leak" into decisions even when risk information is explicitly provided—an integration of experience and description of risks on preferences. Kusev *et al.*[29] demonstrate greater risk-averse behavior for more accessible risks (hazards), which suggests that, even when outcome values and probabilities are known, human risk preferences are affected by the accessibility of domain-specific events and their frequencies in memory. Thus, people do not seem to have underlying preferences for risk—instead, context and experience determine preferences even when the utilities (risk and reward) of alternative options are known.

3.1. Possible Applications

The financial choices that people make have substantial implications for their future well-being. But these decisions also have large implications for social policy and the economy. For example, the degree to which people discount the future with respect to the present will influence their preferences regarding pensions and insurance with consequent implications for welfare policy. And the degree to which individuals are risk averse may be an important determinant of the cost of capital and the valuation of the stock market.

It is known that people make financial choices in ways that depart substantially from the recommendations of normative economic models.[6] In our study, people's decisions appear to be sensitive to the financial domain of options presented. Despite a vast theoretical and empirical literature on the topic of financial choices in the literatures on psychology, economics, and business, the nature of these influences is still poorly understood. These issues are likely to be of central importance in the development of

[11] Degrees of freedom were adjusted according to Greenhouse-Geisser estimates of sphericity, as the Mauchly's test was significant ($p < 0.001$).

the next generation of financial services. Our study also demonstrated that different financial frames also prompt, more or less, different risk attitudes (indicated by multifactor PCA solution). From an applied point of view, these framing effects demonstrate the large influence that the specific financial domain has on peoples' judgments concerning risky choices. An understanding of domain-specific effects is important for two reasons. First, such effects will need to be partialed out or controlled for to reveal stable underlying parameters (e.g., γ coefficient of risk aversion). Second, as financial decisions rarely occur in isolation from other financial decisions, and also rarely concern a single product, establishing the locus of these domain-specific effects is an important step toward adapting an existing (e.g., γ-based) model to account for performance in realistic decision scenarios. Future research should investigate the extent to which an individual's sensitivity to the specific financial domain can be parameterized and incorporated into a cognitive decision model. Creating such cognitive models, and understanding of domain effects, will only provide an insight of potential commercial value to the extent that their predictions generalize to real-world financial decisions in specific target populations.

Another strand of future research should aim to discover how risky behavior generalizes from laboratory experiments to real financial decisions (e.g., investing in different shares, or how to divide savings between high risk–high return products like stocks and fixed-interest products like a building society account). This would require the development of a scale measuring risk in financial investments. Note that actual financial decisions are also assumed to be influenced by accessibility/availability of more risky investment options (e.g., how easy it is to buy shares) and therefore an additional scale may need to be designed to measure this—the prediction being that the accessibility/availability of higher risk options will interact with risk attitude measures to predict actual financial behavior.

3.2. Concluding Remarks

We believe that the goal of the cognitive system is to adapt flexibly to the dynamic environment. Such an "adaptionist" approach to decision making would require adaptive, efficient, robust, context-specific, domain-specific, species-specific behavior. This approach is contrasted to the traditional rational approach that demands consistency, transitivity, and content-independence for the resulting decisions. There is enough evidence already that most of human decision making is context-dependent.[52] The study described in this article presents evidence that, also in the financial domains, risk preferences are specific to the context in which they are formulated.

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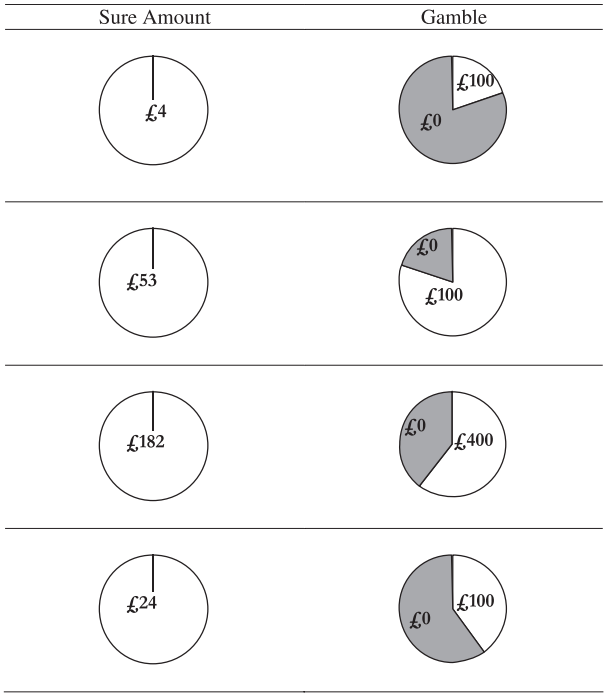
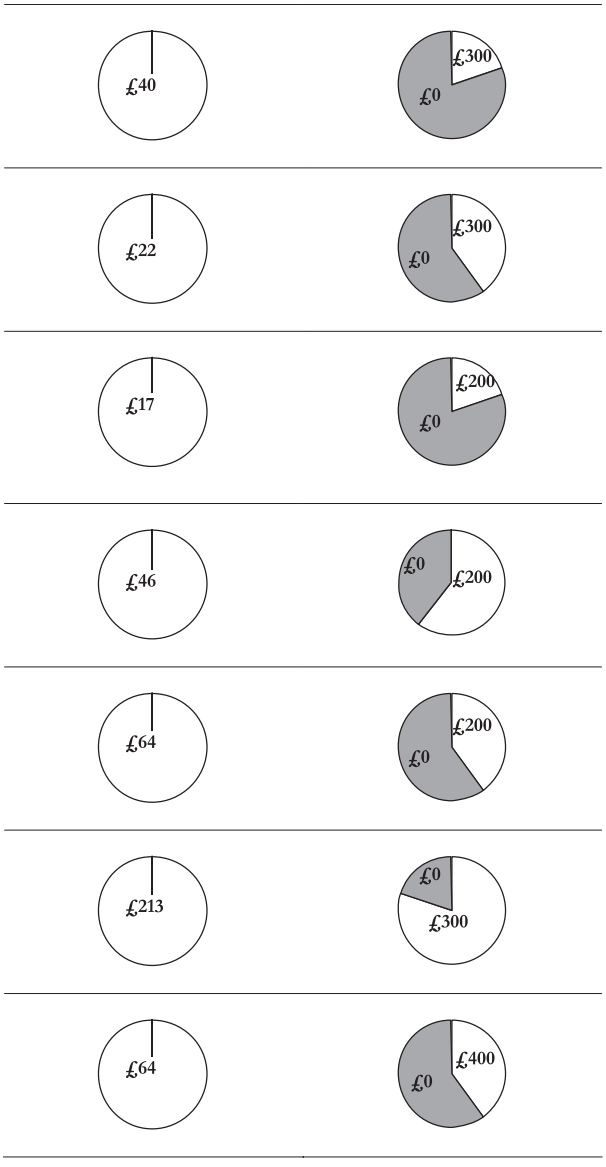
APPENDIX A: GAMBLES TEST

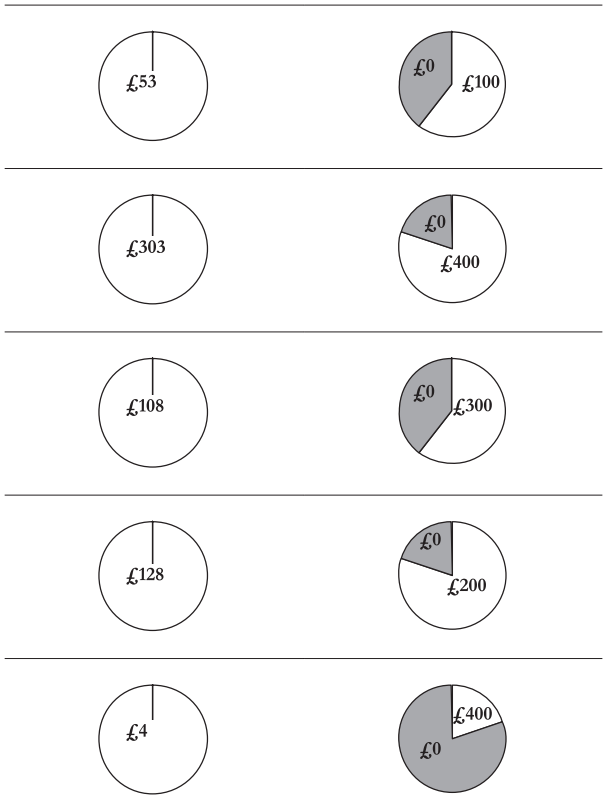
(1) Gambles with gain

Imagine choosing between "receiving £30 for certain" or a "50% chance of winning £100." Which option would you choose? Here you would have to imagine making choices between playing a gamble to receive an amount of money and taking a smaller amount for sure. Each pair of options is presented as two pie charts. Imagine that a spinner is attached to the center of the pie chart and after the spinner is spun you will receive the money written in the





region where and the pointer lands. As you can see, the pie charts representing "Sure Amount" will always give you a certain amount while the pie charts representing "Gamble" offer either a bigger amount or zero (the two regions of these pie charts represent the probabilities for each amount, respectively). Please circle the pie chart you would prefer (the Sure Amount or the Gamble) in each pair. Note that there are no correct answers and your choice is a matter of personal preference, but try to choose which option (Sure Amount or a Gamble) you would prefer if this choice was made for real.



(2) Investment

Imagine that you want to make an investment decision and you are offered a choice between buying either a bond that gives you £30 profit for certain per year or buying a company share that has a 50% chance of bringing you £100 profit per year. Which option would you choose? Here you would have to imagine making choices between buying a company share with an uncertain profit and buying a bond offering a smaller profit for sure. Each pair of options (bond vs. share) is presented here as two pie charts. Imagine that a spinner is attached to the center of each pie chart and after the spinner is spun you will receive the money written in the region where the pointer lands. As you can see, the pie charts representing "Bonds" will always give you a certain profit while the pie charts representing "Shares" offer either a bigger profit or zero (the two regions of these pie charts represent the probabilities for each profit, respectively). Please circle the pie chart you would prefer (bond or share) in each pair. Note that there are no correct answers and your choice is a matter of personal preference, but try to choose which option

(bond or share) you would prefer if this choice was made for real.

(3) Mortgage

Here you are offered pairs of houses and you have to choose which house to buy with a mortgage. However, to repay for the mortgage, you need to rent part of the house because your salary is not enough. One of the houses in each pair is always in a location within the town, which will give you a stable moderate average profit per week because it is on a road that is desirable, has similar houses and therefore has a stable regular market of interested tenants. The other house could bring you a bigger profit with certain probability because of its specific location that makes it desirable to only a smaller number of tenants who will be prepared to pay over the odds for it (and you can save for future mortgage payments). However, there is also a chance of not making any profit from this house because you might not be able to find tenants for the whole year (and you would have borrow money to repay the mortgage). Each pair of houses is presented as two pie charts. Imagine that a spinner is attached to the center of the pie chart and after the spinner is spun you will receive the profit written in the region where the pointer lands (which is the average weekly profit throughout the year). The pie charts representing "Guaranteed Profit House" will always give you a certain profit. The pie charts representing "Variable Profit House" offer either a bigger profit or a zero profit, and the two regions of these pie charts represent the probabilities for each profit, respectively. Please circle the pie chart (house) you would prefer in each pair. Note that there are no correct answers and your choice is a matter of personal preference, but try to choose which house you would prefer if this choice was made for real.

(4) Salary

Imagine that you are the only income earner in the family and you are searching for a job and you are offered to choose between two jobs. One job is offering £30 daily payment for certain while the other job is offering you variable payment scheme with a 50% chance of receiving salary of £100 per day because the payment depends on the company's performance for each day. Which option would you choose? Here you would have to imagine making choices between taking a job that offers you variable daily payment (salary) and taking job offering a smaller payment for sure. Each pair of jobs (payment schemes) is presented as two pie charts. Imagine that a spinner is attached to the center of the pie chart and after the spinner is spun you will receive the daily salary written in the region where the pointer lands. As you can see, the pie charts representing "Fixed Salary (per day)" will always give you a certain amount while the pie charts representing "Variable Salary (per day)" offer either a bigger daily salary or zero (the two regions of these pie charts represent the probabilities for each salary respectively). Please circle the pie chart (job) you would prefer (the fixed salary or the variable salary) in each pair. Note that there are no correct answers and your choice is a matter of personal preference, but try to choose which job you would prefer if this choice was made for real.

(5) Pension

Imagine you are saving for a pension (retirement income) and you are offered to choose between two pension investment plans. You can either invest your money safely in bonds with a fixed interest rate, thus offering a smaller pension for sure, or make a riskier stock market investment in company shares that could make you more money (bigger pension) but might also lose your savings if the stock market fails. For example, imagine choosing between receiving pension of £30 per day for certain or a 50% chance of receiving £100 pension per day. Which option would you choose? Here each pair of expected pensions (per day) is presented as two pie charts. Imagine that a spinner is attached to the center of the pie chart and after the spinner is spun you will receive the pension written in the region where and the pointer lands. As you can see, the pie charts representing "Sure Pension (per day)" will always give you a certain pension, while the pie charts representing "Variable Pension (per day)" offer either a bigger pension or zero (the two regions of these pie charts represent the probabilities for each pension, respectively). Please circle the pie chart you would prefer (sure pension or variable pension) in each pair. Note that there are no correct answers and your choice is a matter of personal preference, but try to choose which pension investment plan you would prefer if this choice was made for real.

(6) Gambles with loss

Imagine choosing between "losing £30 for certain" or a "50% chance of losing £100" (and hence there is a 50% chance of not losing anything). Which option would you choose? Here you would have to imagine making choices between playing a gamble that can make you lose an amount of money and losing a smaller amount for sure. Each pair of

options is again presented as two pie charts. Imagine that a spinner is attached to the center of the pie chart and after the spinner is spun you will lose the money written in the region where the pointer lands. As you can see, the pie charts representing "Sure Loss" will always make you lose a certain amount while the pie charts representing "Loss Gamble" can make you lose either a bigger amount or zero (the two regions of these pie charts represent the probabilities for each loss, respectively). Please circle the pie chart you would prefer (Sure Loss or Gamble) in each pair. Note that there are no correct answers and your choice is a matter of personal preference, but try to choose which option (Sure Loss or Gamble) you would prefer if this choice was made for real.

(7) Insurance

Imagine that you possess 16 shares of different companies, which are worth now £100, £200, £300, or £400 respectively. The value of each of these shares is however in danger of shrinking due to a fall in its popularity. The extent of this loss in value depends on how much the popularity of the share (company) decreases and is measured by the probability of each asset losing its total value (going to zero). This could be determined by the general economic and market conditions or because the particular company underperforms. You have the possibility of insuring yourself against the possible loss in each share's value. If you insure yourself, you will be compensated for any loss in value. To insure yourself you must pay the price of an insurance premium. Each share's probability of losing its value and the corresponding insurance cost are presented here as two pie charts. Thus, one pie chart is the "Insurance Cost," which is fixed for each share and in the first example below it is £4. The other pie chart represents the "Probability of Value Loss" (the probability that the share will lose its value) and in the first example below there is a 20% chance that the first share worth £100 will lose its value (the two regions of these pie charts represent the probabilities for each value loss, respectively). Imagine that a spinner is attached to the center of the pie chart and after the spinner is spun your share will lose the value written in the region where the pointer lands. Please circle the pie chart you would prefer in each pair (pay insurance or accept the chance). Note that there are no correct answers and your choice is a matter of personal preference, but try to choose which option (pay insurance or accept the chance) you would prefer if this choice was made for real.

APPENDIX B: LIST OF 64 GAMBLES USED FOR THE FOUR VERSIONS OF GAMBLES TEST

Version	Gamble	£x	p	£y	γ
1	1	1	0.2	100	0.35
	2	16	0.4	100	0.50
	3	46	0.6	100	0.65
	4	76	0.8	100	0.80
	5	27	0.2	200	0.80
	6	15	0.4	200	0.35
	7	72	0.6	200	0.50
	8	142	0.8	200	0.65
	9	25	0.2	300	0.65
	10	95	0.4	300	0.80
	11	70	0.6	300	0.35
	12	192	0.8	300	0.50
	13	16	0.2	400	0.50
	14	98	0.4	400	0.65
	15	211	0.6	400	0.80
	16	211	0.8	400	0.35
2	1	13	0.2	100	0.80
	2	7	0.4	100	0.35
	3	36	0.6	100	0.50
	4	71	0.8	100	0.65
	5	17	0.2	200	0.65
	6	64	0.4	200	0.80
	7	46	0.6	200	0.35
	8	128	0.8	200	0.50
	9	12	0.2	300	0.50
	10	73	0.4	300	0.65
	11	158	0.6	300	0.80
	12	159	0.8	300	0.35
	13	4	0.2	400	0.35
	14	64	0.4	400	0.50
	15	182	0.6	400	0.65
	16	303	0.8	400	0.80
3	1	8	0.2	100	0.65
	2	32	0.4	100	0.80
	3	23	0.6	100	0.35
	4	64	0.8	100	0.50
	5	8	0.2	200	0.50
	6	49	0.4	200	0.65
	7	106	0.6	200	0.80
	8	106	0.8	200	0.35
	9	3	0.2	300	0.35
	10	48	0.4	300	0.50
	11	137	0.6	300	0.65
	12	227	0.8	300	0.80
	13	53	0.2	400	0.80
	14	29	0.4	400	0.35
	15	144	0.6	400	0.50
	16	284	0.8	400	0.65
4	1	4	0.2	100	0.50
	2	24	0.4	100	0.65
	3	53	0.6	100	0.80
	4	53	0.8	100	0.35

(*Continued*)

APPENDIX B. (*Continued*)

Version	Gamble	£x	p	£y	γ
	5	2	0.2	200	0.35
	6	32	0.4	200	0.50
	7	91	0.6	200	0.65
	8	151	0.8	200	0.80
	9	40	0.2	300	0.80
	10	22	0.4	300	0.35
	11	108	0.6	300	0.50
	12	213	0.8	300	0.65
	13	34	0.2	400	0.65
	14	127	0.4	400	0.80
	15	93	0.6	400	0.35
	16	256	0.8	400	0.50
5	1	1	0.2	100	0.35
	2	16	0.4	100	0.50
	3	46	0.6	100	0.65
	4	76	0.8	100	0.80
	5	8	0.2	200	0.50
	6	49	0.4	200	0.65
	7	106	0.6	200	0.80
	8	106	0.8	200	0.35
	9	25	0.2	300	0.65
	10	95	0.4	300	0.80
	11	70	0.6	300	0.35
	12	192	0.8	300	0.50
	13	53	0.2	400	0.80
	14	29	0.4	400	0.35
	15	144	0.6	400	0.50
	16	284	0.8	400	0.65
6	1	8	0.2	100	0.65
	2	32	0.4	100	0.80
	3	23	0.6	100	0.35
	4	64	0.8	100	0.50
	5	27	0.2	200	0.80
	6	15	0.4	200	0.35
	7	72	0.6	200	0.50
	8	142	0.8	200	0.65
	9	3	0.2	300	0.35
	10	48	0.4	300	0.50
	11	137	0.6	300	0.65
	12	227	0.8	300	0.80
	13	16	0.2	400	0.50
	14	98	0.4	400	0.65
	15	211	0.6	400	0.80
	16	211	0.8	400	0.35
7	1	13	0.2	100	0.80
	2	7	0.4	100	0.35
	3	36	0.6	100	0.50
	4	71	0.8	100	0.65
	5	2	0.2	200	0.35
	6	32	0.4	200	0.50
	7	91	0.6	200	0.65
	8	151	0.8	200	0.80
	9	12	0.2	300	0.50
	10	73	0.4	300	0.65
	11	158	0.6	300	0.80
	12	159	0.8	300	0.35

(*Continued*)

APPENDIX B. (*Continued*)

Version	Gamble	£x	p	£y	γ
	13	34	0.2	400	0.65
	14	127	0.4	400	0.80
	15	93	0.6	400	0.35
	16	256	0.8	400	0.50
8	1	4	0.2	100	0.50
	2	24	0.4	100	0.65
	3	53	0.6	100	0.80
	4	53	0.8	100	0.35
	5	17	0.2	200	0.65
	6	64	0.4	200	0.80
	7	46	0.6	200	0.35
	8	128	0.8	200	0.50
	9	40	0.2	300	0.80
	10	22	0.4	300	0.35
	11	108	0.6	300	0.50
	12	213	0.8	300	0.65
	13	4	0.2	400	0.35
	14	64	0.4	400	0.50
	15	182	0.6	400	0.65
	16	303	0.8	400	0.80

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