# ESSAYS IN FINANCIAL LITERACY & DECISION MAKING

JÖRG WEBER

*Thesis submitted to The University of Nottingham*
*for the Degree of Doctor of Philosophy*

School of Economics

University of Nottingham

July 2015

Jörg Weber: *Essays in Financial Literacy & Decision Making*.
Supervised by Professor Robin Cubitt and Dr John Gathergood.

# ABSTRACT

Research in consumer financial decision making has received considerable attention in recent years. This thesis contributes to the literature on financial literacy and measuring underlying behavioural characteristics to explain individual choice, as well as the experimental literature on the certainty effect and robustness of experimental results.

The thesis is separated into three substantive chapters. The first two substantive chapters use individual level survey data of a representative sample of UK households to investigate the role of financial literacy and behavioural traits in (i) the simultaneous holding of consumer credit and liquid savings, i.e. the 'co-holding puzzle', and (ii) mortgage choice. My results show that underlying individual traits are important predictors for consumer choice. Households with self-control issues are significantly more likely to co-hold substantial amounts, consistent with the notion that co-holding is a form of self-control management to limit consumption. My results also show that individuals with low levels of financial literacy and an impulsive present bias for consumption are significantly more likely to hold alternative, non-amortising, mortgage products. This suggests that these mortgages may attract consumers who are less likely to sufficiently understand their features, and who put more weight on present consumption.

The third substantive chapter reports and discusses evidence from two experimental studies, motivated by evidence that people may prefer simple and/or certain options disproportionally. The first study investigates the certainty effect using a new laboratory design that goes beyond the pairwise-lottery choices typically used in the literature. The results provide little evidence of a certainty effect in this setting, where subjects can choose from eleven options. In the second study, I attempt to replicate the results of the original experiment that suggests that people are significantly more likely to prefer simple options when faced with larger choice sets. I follow the procedure of the original design, but my results provide no evidence for a disproportionate preference for simplicity. Instead, subjects choose according to their risk attitude.

# PUBLICATIONS

The main results of Chapter II have been published in the *Journal of Economic Behavior & Organization*, co-authored with John Gathergood:

GATHERGOOD, J. & WEBER, J. (2014). 'Self-Control, Financial Literacy & the Co-Holding Puzzle'. *Journal of Economic Behavior & Organization*, 107(Part B), pp. 455–469.

# ACKNOWLEDGEMENTS

A number of people have greatly contributed to the successful completion of this thesis. First and foremost, I would like to thank my thesis advisors, Professor Robin Cubitt and Dr John Gathergood, for their inspirational and dedicated mentoring. It was, and continues to be, a privilege to learn from them.

I have benefited greatly from guidance and support from various members of CeDEx and the School of Economics at the University of Nottingham. Also, many words of gratitude have to go to the fantastic support staff at the School of Economics. I would also like to thank my friends, old and new, and PhD colleagues for invaluable discussions, camaraderie and friendship.

This thesis would not exist without funding from the Economic and Social Research Council, which I gratefully acknowledge.

Finally, I thank my parents, my family and my partner Britta for their never-ending support.

# CONTENTS

# LIST OF TABLES

## CHAPTER II – THE CO-HOLDING PUZZLE



## CHAPTER III – MORTGAGE CHOICE

## CHAPTER IV – RISK, CERTAINTY & SIMPLE CHOICE

# LIST OF FIGURES

## CHAPTER IV – RISK, CERTAINTY & SIMPLE CHOICE

# CHAPTER I

# INTRODUCTION TO THE THESIS

# INTRODUCTION TO THE THESIS

RESEARCH IN CONSUMER FINANCIAL DECISION MAKING has received considerable attention in recent years. Consumers can now choose from a wide variety of financial products, be it credit cards, mortgages or investment plans. As the portfolio of products increased, so did the responsibility of the consumer to make good and informed decisions for the well-being of their household. But the recent economic crisis has highlighted that consumers may struggle to make sound financial decisions, with potentially devastating consequences for themselves, but also at an aggregate level for the economy.

Understanding suboptimal financial choice from the consumer's perspective is a young area of economic research: less than ten years ago, John Campbell, then president of the American Finance Association, noted that the field of household finance "has attracted much recent interest but still lacks definition and status within our profession" (Campbell, 2006, p. 1553).

One factor that has limited research in consumer financial choice is the low availability of individual level data. This has improved considerably over recent years: national household surveys have been extended to include more data on individual financial choice, for example the US 'Survey of Consumer Finances' (SCF), the UK's 'British Household Panel Survey' (BHPS) and 'Wealth and Assets Survey' (WAS), as well as the 'Household Finance and Consumption Survey' (HFCS) of the European Central Bank. Financial intermediaries and governments have also become more willing to provide access to individual level transaction data or tax records. At the same time, economic models focussing on individual financial choice have advanced considerably. Advances in theoretical and empirical research are both discussed in Campbell (2006) and Tufano (2009).

Consumer financial decision making can be investigated in many ways: theoretical models, randomised controlled trials, survey data or experiments. This thesis uses the last two methodologies to provide new insights into individual choice related to financial decision making. In particular, I focus on the role of individual behavioural characteristics and choice, as well as the role of behavioural biases, such as self-control problems.

This thesis is split into three independent chapters. I now introduce each chapter and report the main results.

## CHAPTERS II & III: FINANCIAL LITERACY

The first two substantive chapters investigate the role of financial literacy and behavioural characteristics in consumer choice, using individual level survey data. Financial literacy refers to the understanding of basic, but key, financial concepts required for informed consumer decisions. These include, for example, understanding of (compounding) interest rates or (non-)amortisation of debt. A growing body of evidence shows that understanding of these principles is strongly related to important consumer financial decisions, for example adequacy of savings, consumer credit portfolios, retirement planning and portfolio choice. A detailed review of the current state of the literature can be found in Lusardi & Mitchell (2014).

Chapter II investigates the simultaneous holding of debt and savings, known as 'the co-holding puzzle'. This puzzle was first documented in US data, where one third of credit card holders co-hold substantial amounts of consumer credit debt and liquid saving (Gross & Souleles, 2002). Households forego hundreds of dollars each year in interest payments, although they could pay off their outstanding consumer credit entirely by simply using their liquid savings (Telyukova, 2013).

The explanation which I explore in the chapter is that consumers co-hold due to particular behavioural biases in their decision making. I use a representative sample of UK consumers to show that 12% hold, on average, £3,800 of revolving credit on multiple credit products for which they incur interest charges even though they could immediately pay down all this debt using their liquid assets, and with a month's income in liquid assets to spare. By 'co-holding' credit and assets, these households incur around £650 to £1,000 in unnecessary interest charges per annum.

My analysis focusses on two individual characteristics: poor financial literacy and lack of self-control. To my knowledge, the research presented in the chapter is the first empirical evidence on the importance of these behavioural characteristics to co-holding. The results suggest that co-holding is not significantly associated with poor financial literacy or lack of education, but is associated with lack of self-control. Co-holders perform above-average when answering financial literacy questions, but self-report high rates of impulsive spending behaviour. Regression estimates show impulsiveness predicts co-holding in the majority of the estimated models. These findings are consistent with the suggestion that co-holding is a planned behaviour of the type modelled in Bertaut et al. (2009). This gives empirical support to the notion that co-holding arises as an activity undertaken by the household to manage impulsive spending tendencies.

Chapter III investigates mortgage choice among a representative sample of UK borrowers. Again, I focus on the role of financial literacy and self-control in a consumer's decision to choose an alternative (non-amortising) mortgage product (AMP) or a standard (repayment) mortgage (SMP), as well as to borrow via an adjustable or fixed rate mortgage (ARM vs FRM). AMPs are more flexible financial instruments compared with standard principal-repayment mortgages, but are also more complex as holders need to formulate and commit to their own repayment plans.

A rational consumer can use an AMP to smooth consumption over time when faced with expected income growth, but consumers that suffer behavioural biases or other shortcomings may choose an AMP by mistake or as a result of misunderstanding: if a consumer cannot accurately calculate the lifetime costs of a mortgage, then the consumer might misjudge the AMP as a better deal than a standard mortgage due to lower initial repayments. The lower initial payments on an AMP might also be tempting for a consumer with high discounting of the future and/or an impulsive present bias with respect to consumption.

The results of this chapter show that financial literacy and consumer behavioural characteristics are important determinants of mortgage choice. Results from multivariate econometric models show that high financial literacy significantly increases the likelihood of choosing an ARM. This result is suggestive of the notion that informed consumers are more willing and able to take on a mortgage product that requires reviewing mortgage options and performance more actively. Results also show that poor financial literacy significantly raises the likelihood of choosing an AMP. Both present bias and high discounting are further important predictors of mortgage choice, as both raise the likelihood of AMP holding significantly. This is evidence for the contention that consumers who place lower weight on the future are more likely to choose AMPs. Lower literacy and present bias suggest that one reason for the high default rates of AMPs may be that they attract consumers who are less likely to sufficiently understand their features and put more weight on present consumption.

## Survey Data

Both chapters use individual level data provided by the market research company YouGov. One of their regular surveys is the 'Debt Tracker', a cross-sectional survey representative of UK households, conducted quarterly. This survey covers household demographics and finances, including credit commitments and savings, in great detail. YouGov provided me with the opportunity to add specific questions

to the survey which allowed me to use specific measures for financial literacy.

In analysis of the relationship between financial literacy and financial choices it is essential that the measure of financial literacy is relevant for the financial choices modelled. My financial literacy questions follow the conceptual approach of using test-based measures in a multiple-choice format. For Chapter II, I used the September 2010 wave and added questions related to 'debt literacy', specifically aimed to test understanding of the cost of credit (Lusardi & Tufano, 2009). Chapter III used the August 2013 wave for which I developed a series a questions that aimed to measure understanding of key concepts of mortgages. The mathematical requirements for the test-based measures to answer correctly are low to avoid the financial literacy questions resembling a math test, or requiring infeasible calculations within the context of a consumer survey. Instead, these questions measure basic understanding of key financial concepts that are relevant for the respective choices, consumer credit and mortgages.

The survey data that I use offers several advantages. It allows to observe many important drivers of individual behaviour, such as financial literacy, as well as core behavioural traits, such as attitude to risk, time preferences and self-control. These are typically unobservable in national panel data sets (such as the SCF or WAS) or lender provided data (as in Gross & Souleles, 2002). But a drawback of survey data may be reliability: can households be trusted to report the truth when questioned about sensitive, personal and private information (Karlan & Zinman, 2008)? Research suggests that respondents in surveys are likely to under-report information that may be viewed as socially undesirable, for instance smoking (Means et al., 1992) or criminal activity (Wyner, 1980). With regards to financial activity, credit card borrowing is widely being viewed as undesirable (Durkin, 2000). Karlan & Zinman (2008) find that 50% of borrowers of expensive consumer credit in South Africa do not report this borrowing when surveyed. The authors attribute this behaviour to a clear stigmatisation of high-cost borrowing. Finding a similar bias, Zinman (2009) aggregates credit card use based on the SCF and industry data in 2004 and finds that the survey data yields a consistently lower estimate of revolving debt. The discrepancy estimated was $537 billion, half the amount of revolving credit card debt implied by industry data.

These studies highlight a considerable bias in self-reported survey data that may "confound inference on the relationship between credit card borrowing and outcomes of interest" (Zinman, 2009, p.249). With respect to co-holding, using survey data may lead to a considerable under-reporting of revolving credit and hence to an underestimation of the true prevalence of co-holding. This calls for better survey instruments and validation studies in order to cope with suggested unobserved heterogeneity in household characteristics. Nevertheless, for the

purpose of investigating the co-holding puzzle, if a similar bias towards under-reporting in UK data exists, this does not undermine my strategy or results because it implies that co-holding is more prevalent than actually implied by the data. With respect to mortgage choice, it seems unlikely that respondents would deliberately misreport mortgage characteristics because of image concerns. During the course of the analysis, I compare results from the data I use with results from other surveys, where applicable, in order to stress the quality of the data.

## CHAPTER IV: RISK, CERTAINTY & SIMPLE CHOICE

Chapter IV reports and discusses evidence of two experimental studies. These are motivated by evidence that individuals exhibit disproportionate preferences, or tendencies to choose, certain and/or simple options. Results provided by Iyengar & Kamenica (2010) suggest that certain options may be preferred *because* they are simpler, and vice versa.

My first study investigates the 'certainty effect', a well-established exhibit of the non-expected utility literature. It refers to the possibility that agents exhibit disproportionate preferences for risk-free, certain options. The second study investigates the robustness of the original findings by Iyengar & Kamenica (2010). These are concerned with 'choice overload' and 'simplicity seeking', that is that individuals may be more inclined towards simple options when they face larger choice sets.

These three concepts are important for individual consumer choice. Following an influential article by Thaler & Sunstein (2003) and a subsequent book (Thaler & Sunstein, 2008), policy makers and academics have engaged in a lively debate on 'liberal paternalism', i.e. trying to influence "the choices of affected parties in a way that will make those parties better off" (p. 175). The idea is that choice for consumers in a variety of domains, health or finance for example, has become more complicated due to the amount of information consumers have to process. A policy maker can 'nudge' consumers to make 'better' choice by, for example, rearranging the choice presentation, providing 'good' defaults or simplifying the choice set. Liberal paternalism has received considerable attention and several governments have established teams to create interventions to nudge people towards (what they consider to be) better choice, for example the 'Behavioural Insights Team' in the UK, the Government of New South Wales in Australia and the 'Social and Behavioral Sciences Team' in the US Government.

'Certainty' and 'simplicity' are thereby of particular interest for the study of

financial decision making. For instance, Wakker et al. (1997) find that consumers are willing to pay a considerable premium for certainty in the insurance market. They investigate probabilistic insurance, i.e. a policy that involves a small probability that the consumer will not be reimbursed. They find that consumers demand a 20% reduction in insurance premiums to compensate for a 1% default risk. In experimental settings, numerous studies have provided empirical evidence of a certainty effect in pairwise lottery choices. Examples include the well-known common ratio and common consequence effects (Allais, 1953; Kahneman & Tversky, 1979). But at the same time, a well-documented result is that the certainty effect disappears or reduces when certainty is substituted with an option that involves 'near-certain' probabilities. In other words, once all options involve risk, even when the risk is very small, the preference for certainty is no longer systematic. A detailed review of theory and empirical evidence of this literature can be found in Starmer (2000).

The objective of the experimental design in Study 1 is to investigate Iyengar & Kamenica's (2010) result of a strong preference for the certain option in one of their experiments. They find that nearly two thirds of subjects choose the certain payoff in a choice set where 10 other, risky gambles are included. In my experiment, I present subjects with this choice set. Alternatively, I offer subjects a choice set that contains the same 10 risky gambles, but I substitute for the certain option a 'near certain' gamble that has slightly higher risk. My design is also motivated by the observation above, i.e. that moving away from certainty reduces or eliminates the certainty effect. This design provides a test for the certainty effect, by observing behaviour when moving away from certainty to a slightly more risky option, but in an environment where several other options are present.

The results of this experiment suggest that subjects do not exhibit a disproportionate preference for certainty. I find no evidence to suggest that subjects prefer the certain or 'near-certain' option differently. One of the reasons for the absence of a treatment effect lies in the non-replication of the original result of Iyengar & Kamenica (2010). In my experiment, only 13%–16% of subjects choose the certain option, compared to 63% in the original experiment.

Study 2 is motivated by the importance of 'simplicity' and by Study 1's non-replication of the result of Iyengar & Kamenica (2010). Providing simpler options may be important to guide consumers when choice sets are large or complex. Supporting consumers is important because investor sophistication may have lagged behind the growing complexity of financial products, and financial institutions may have incentives to obfuscate product characteristics to increase profits (Carlin & Manso, 2010). In a large field experiment, Beshears et al. (2013) study enrolment into retirement plans. They offer a simple plan at a pre-selected

contribution rate and asset allocation, and consumers only have to make a binary choice between the status quo and the simple plan. They find that sign-up rates increased by 10 to 20 percentage points due to this simplification.

The results of Study 1 cast doubt on some of the findings of Iyengar & Kamenica (2010), but only in relation to one of the choice sets from one of their experiments. In Study 2, I replicate each treatment of both of their experiments using procedures very similar to theirs. In their two experiments, subjects have to choose one option from a set of 3 or 11 options. In the first experiment, the simple option is the certain one as in the choice set of my Study 1. The certain option is simpler relative to all risky, binary gambles because it has only one probable outcome, and computing the expected value is less time consuming. In Experiment 2, all options are risky, but the simple gamble is a binary gamble of either winning $0 or $10, whereas the remaining 10 options are more complex as they have six probable outcomes. Iyengar & Kamenica (2010) find that around 60% of subjects prefer the simple option when offered all 11 options, but only a fraction prefer the simple option when offered a subset of only 3 options.

The authors recruit subjects outside the laboratory by asking passers-by at a university campus to fill out a brief survey, and for compensation they complete the lottery-choice task. I replicate this experimental procedure, and also replicate the experiment in a controlled laboratory environment. The results of my replication suggest no special attractiveness for simplicity across treatments and experiments, neither in the laboratory nor in the field. Instead, my results suggest that subjects treat the choice task similar to an ordered lottery selection design (Harrison & Rutström, 2008) and choose according to their risk attitude.

# BIBLIOGRAPHY


ALLAIS, M. (1953). 'Le Comportement de l'Homme Rationnel devant le Risque: Critique des Postulats et Axiomes de l'Ecole Americaine'. *Econometrica*, 21(4), p. 503.

BERTAUT, C.C., HALIASSOS, M. & REITER, M. (2009). 'Credit Card Debt Puzzles and Debt Revolvers for Self Control'. *Review of Finance*, 13(4), pp. 657–692.

BESHEARS, J., CHOI, J.J., LAIBSON, D. & MADRIAN, B.C. (2013). 'Simplification and Saving.' *Journal of Economic Behavior & Organization*, 95, pp. 130–145.

CAMPBELL, J.Y. (2006). 'Household Finance'. *The Journal of Finance*, 61(4), pp. 1553–1604.

CARLIN, B.I. & MANSO, G. (2010). 'Obfuscation, Learning, and the Evolution of Investor Sophistication'. *The Review of Financial Studies*, 24(3), pp. 754–785.

DURKIN, T.A. (2000). 'Credit cards: use and consumer attitudes, 1970-2000'. *Federal Reserve Bulletin*, (Sep), pp. 623–634.

GROSS, D.B. & SOULELES, N.S. (2002). 'Do Liquidity Constraints and Interest Rates Matter for Consumer Behavior? Evidence from Credit Card Data'. *The Quarterly Journal of Economics*, 117(1), pp. 149–185.

HARRISON, G.W. & RUTSTRÖM, E.E. (2008). 'Risk Aversion in the Laboratory'. In: *Risk Aversion in Experiments (Research in Experimental Economics, Volume 12)*. Ed. by J.C. COX & G.W. HARRISON. Emerald Group Publishing Limited, pp. 41–196.

IYENGAR, S.S. & KAMENICA, E. (2010). 'Choice proliferation, simplicity seeking, and asset allocation'. *Journal of Public Economics*, 94(7-8), pp. 530–539.

KAHNEMAN, D. & TVERSKY, A. (1979). 'Prospect Theory: An Analysis of Decision under Risk'. *Econometrica*, 54(2), pp. 263–291.

KARLAN, D. & ZINMAN, J. (2008). 'Lying About Borrowing'. *Journal of the European Economic Association*, 6(2-3), pp. 510–521.

LUSARDI, A. & TUFANO, P. (2009). 'Debt Literacy, Financial Experiences, and Overindebtedness'. *NBER Working Paper*, 14808.

LUSARDI, A. & MITCHELL, O.S. (2014). 'The Economic Importance of Financial Literacy: Theory and Evidence'. *Journal of Economic Literature*, 52(1), pp. 5–44.

MEANS, B., HABINA, K., SWAN, G.E. & JACK, L. (1992). 'Cognitive Research on Response Error in Survey Questions on Smoking'. *Vital and Health Statistics*, 6(5).

STARMER, C. (2000). 'Developments in Non-Expected Utility Theory: The Hunt for a Descriptive Theory of Choice under Risk'. *Journal of Economic Literature*, 38(2), pp. 332–382.

TELYUKOVA, I.A. (2013). 'Household Need for Liquidity and the Credit Card Debt Puzzle'. *The Review of Economic Studies*, 80(3), pp. 1148–1177.

THALER, R.H. & SUNSTEIN, C.R. (2003). 'Libertarian Paternalism'. *American Economic Review*, 93(2), pp. 175–179.

— (2008). *Nudge: Improving Decisions about Health, Wealth and Happiness*. New Haven: Yale University Press.

TUFANO, P. (2009). 'Consumer Finance'. *Annual Review of Financial Economics*, 1(1), pp. 227–247.

WAKKER, P., THALER, R.H. & TVERSKY, A. (1997). 'Probabilistic Insurance'. *Journal of Risk and Uncertainty*, 15(1), pp. 7–28.

WYNER, G.A. (1980). 'Response Errors in Self-Reported Number of Arrests'. *Sociological Methods & Research*, 9(2), pp. 161–177.

ZINMAN, J. (2009). 'Where is the missing Credit Card Debt? Clues and Implications'. *Review of Income and Wealth*, 55(2), pp. 249–265.

CHAPTER II

# SELF-CONTROL, FINANCIAL LITERACY & THE CO-HOLDING PUZZLE

ABSTRACT

This chapter uses UK survey data to analyse the puzzling co-existence of high cost revolving consumer credit alongside low yield liquid savings in household balance sheets, which I name the 'co-holding puzzle'. Approximately 12% of households in the sample co-hold, on average, £3,800 of revolving consumer credit on which they incur interest charges, even though they could immediately pay down all this debt using their liquid assets. Co-holders are typically more financially literate, with above average income and education. In most estimates co-holding is also associated with impulsive spending behaviour on the part of the household. The results provide empirical support to theoretical models in which households co-hold as a means of managing self-control problems.

*Keywords*: consumer credit, self-control, financial literacy

# 1

# INTRODUCTION

WHY DO CONSUMERS simultaneously hold high cost consumer credit and low yield liquid savings? For around 10 years researchers have been investigating this puzzling co-existence as it appears to be a violation of simple arbitrage: households could make substantial savings in the cost of debt servicing, or pay off their outstanding consumer credit entirely, by simply using their liquid savings to pay down their debts. But around one third of US consumers co-hold substantial amount of credit card debt and liquid saving, foregoing hundreds of dollars each year in interest payments (Gross & Souleles, 2002; Telyukova, 2013; Fulford, 2014).

A number of explanations have been offered to rationalise this behaviour: households may simply prefer to hold liquidity because they anticipate the requirement of purchases for which consumer credit cannot be used (Telyukova & Wright, 2008), or because they do not want to rely on credit in the case of emergencies because credit may be withdrawn by the lender (Fulford, 2014).

The explanation which I explore in this chapter is that consumers co-hold due to particular behavioural biases in their decision making. I focus on two behavioural biases: poor financial literacy and lack of self-control. To the best of my knowledge, the research presented in this chapter is the first empirical evidence on the importance of these behavioural characteristics to co-holding, focusing on financial literacy, self-control and related behaviours in explaining levels of co-holding among a representative sample of UK households.

First, less financially literate individuals may not realise the existence of arbitrage opportunities and hence may not recognise that co-holding is a costly activity. Disney & Gathergood (2013) show poor financial literacy is associated with higher cost consumer credit portfolios, and recent studies have shown that lack of financial literacy leads to a range of other suboptimal financial outcomes, including under-saving and suboptimal portfolio allocations (Lusardi & Mitchell, 2007; Lusardi & Tufano, 2009; Van Rooij et al., 2011a,b).

Second, lack of self-control and impulsive spending behaviour might explain co-holding. 'Behavioural' concepts of self-control and associated impulsive spending behaviour have been subject to substantial research over the past decades and are typically associated with high amounts of debt or undersaving before

retirement (for instance, Thaler & Shefrin, 1981; Thaler, 1985; Laibson, 1997). The link to co-holding is that impulsive consumers may engage in spending mistakes at the point-of-sale (for example in shops or via online shopping) using their credit card, store card or mail order account while, at the same time, holding monies in savings accounts or other savings products not available at point of sale. Persistent co-holding might then actually be explained as a form of self-control management whereby consumers deliberately restrict their available-to-spend liquidity by holding high utilisation rates on consumer credit, so limiting the opportunity for impulsive spending mistakes.

This intuition is formalised in the dual-self model of Bertaut et al. (2009) in which one patient entity of the 'inner-self' controls a less patient entity by restricting access to credit via high utilisation so as to control credit liquidity. In this so-called 'accountant-shopper' framework, a patient 'accountant' self who manages the finances of the household and has sole access to liquid savings with which to pay down credit, decides to revolve debt in order to restrict the consumption opportunities of an impatient 'shopper' self who cannot access savings and is reliant on the credit decisions of the accountant. Thus, by making one's savings less accessible and non-spendable for immediate consumption, consumers minimise their vulnerability to impulsive spending by maintaining revolving consumer credit debt simultaneously with savings.

The data used in this chapter does not provide the opportunity for a causal interpretation, but allows me to control for a broad set of covariates regarding household demographic constitution and financial characteristics. In order to elicit behavioural characteristics of respondents, I use an indicator of financial literacy specifically related to the cost of credit. In addition, the survey provides self-assessed measures of behavioural traits, for example impatience.

I show that 12% of UK households hold, on average, £3,800 of revolving credit on multiple credit products for which they incur interest charges even though they could immediately pay down all this debt using their liquid assets (and with a month's income in liquid assets to spare). By 'co-holding' credit and assets, these households incur on average approximately £650 ($1,050) in unnecessary interest charges per annum. One-in-five 'co-holders' incur £1,000 ($1,600) in interest charges per annum due to co-holding.

The results suggests that co-holding is not significantly associated with poor financial literacy or lack of education, but is associated with lack of self-control. Co-holders perform above-average when answering financial literacy questions. Also, co-holders are mostly of working age and have above average levels of education, employment and household income. However, co-holders self-report high rates of impulsive spending behaviour. Multivariate probit estimates show

impulsiveness predicts co-holding in the majority of the estimated models. This result is robust to controls for time preference (i.e. patience), perceived income risk and alternative measures of the cost of co-holding. These findings are consistent with the suggestion that co-holding is a planned behaviour of the type modelled in Bertaut et al. (2009). This gives empirical support to the notion that co-holding arises as an activity undertaken by the household to manage impulsive spending tendencies.

The remainder of this chapter is structured as follows: in Section 2 I discuss the literature on the co-holding puzzle in detail. First I show the empirical evidence that has been presented over the past decade and discuss the methodologies of these studies. I continue by reviewing theoretical models and other explanations that aim to rationalise co-holding. Section 3 describes the dataset and in particular how I create measures of co-holding, financial literacy and behavioural traits. The remainder of that section presents the empirical strategy, which involves estimating a series of econometric models. In Section 4 I describe results and compare them with results from other surveys where applicable, first by presenting descriptive statistics to give an indication of sample characteristics and then by discussing econometric results. I show that results are robust to a number of specifications. Finally, in Section 5 I discuss and conclude the results and put them into context of the literature.

# 2

# CO-HOLDING IN THE LITERATURE

The co-holding puzzle was analysed by Gross & Souleles (2002) in their analysis of lender provided credit card data and this research offers a benchmark for the studies that will be discussed later. The authors use a US panel data set provided by bankcard issuers containing about 24,000 accounts. Accounts were followed for, on average, 24 months and the unbalanced sample extends from January 1995–1998.

The authors find 36% of the population co-hold some positive credit card debt and liquid savings. Credit card borrowers hold, on average, $5,500 in liquid assets such as checking and savings accounts which typically yield interest of 1–2%, compared to an average borrowing cost of 16.6% interest for credit cards. In their data, the authors cannot find an explanation for a puzzling portfolio of this kind and to further stress the issue the authors show that 95% of households have positive net worth, conditional on borrowing, and 69% have positive net housing equity and could have used cheaper home-equity debt, charging 7–9%, rather than expensive bankcards for their borrowing needs.

Some holding of liquid assets may be required for transaction purposes and the authors control for transaction needs by allowing for one month gross total income to be held in liquid assets. The results imply that, after accounting for one-month income, 33% of borrowers (which is equivalent to 12% of the full sample) still hold $1,671 in liquid assets, which could be easily used to pay off high cost debt. This is the 'real puzzle' group whose behaviour cannot be rationalised by conventional buffer-stock models.

## 2.1 CO-HOLDING IN SURVEY DATA

Telyukova & Wright (2008) and Telyukova (2013) use the 'US Survey of Consumer Finances' (SCF) 2001 and the US 'Consumer Expenditure Survey' (CEX) 2000–2002 for their analysis (both papers share the same data and methodology). The puzzle group of co-holders is defined as households revolving more than $500 in credit card debt and $500 in liquid savings. The definition of liquid savings includes checking-, savings- and brokerage accounts and the results imply that

27–29% of households co-hold. These households hold, on average, $5,766 of revolving credit card debt and $7,237 of liquid assets with an average cost of credit of 13.7–14.8% interest.

Next, Fulford (2014) uses the SCF 2007 which provides a sample of 4,400 US households. The author finds that 30% of households in the sample are co-holders, comparable to the previous studies. Co-holding households hold, on average, $1,600 credit card debt and $2,600 in liquid savings. Average credit card interest rates are reported as 14.2%, implying a carrying cost of extra debt amounting 0.6% of household income.[1]

Finally, Bertaut et al. (2009) combine waves of the SCF 1995, 1998, 2001 and 2004, 1995 being the earliest wave when the use of bankcards has been surveyed. Their dataset comprises 17,564 households. To account for short-term liquidity requirements, they include a threshold amount of one-half of average monthly income. Adhering to this definition, the fraction of households with revolving bank card balances and liquid savings in the sample is around 30%. In addition, more than two-thirds of this subgroup state that they do not usually pay off balances in full. The median interest rate charged for borrowing is around 14%. The median amount of revolving credit card debt is around $1,200 and for liquid assets the median amount is $8,500. The authors argue that, given the amount of debt and savings and that liquid savings in their data even excludes cash holdings, "it is difficult to argue that our puzzling households were systematically revolving credit card debt because they were unable to pay it off or because the interest benefits from doing so would be lower" (p.663).

Concluding this section, studies using US household survey data find that roughly one third of households in the population co-hold sizeable amounts of liquid savings, ranging between $2,600 and $8,500, and consumer credit, ranging between $1,200 and $5,700. The difference in these numbers can be attributed to different definitions of what constitutes 'revolving credit card debt', 'liquid savings' and how the studies attribute for short term liquidity requirements.

### 2.1.1 Characteristics of Co-Holders

Although information in their dataset is limited, Gross & Souleles (2002) are able to condition their analysis on income, age and education of the account holder. In

1 Fulford (2014) does not comment on the huge difference between the amounts of saving and borrowing in his results, using the SCF 2007, and the results of Telyukova & Wright (2008) and Telyukova (2013), using the SCF 2001. The difference in savings might occur because Fulford excludes brokerage accounts, and the difference in credit card debt might occur because the other two studies focus on households that revolve debt habitually.

their data, co-holding conditional on one-month income appears more prevalent among high income account holders (more than $50,000 per annum), where 17% co-hold, relative to 13% in the middle income group and 8% in the low income group. A similar pattern emerges with respect to education: those with college education are more likely to co-hold (16%), relative to account holders with a high school degree (13%) or below (7%). With regards to age, co-holding is occurring mostly in the middle bracket, age 35–62, where 15% co-hold relative to 10% each in the below 35 and above 62 age groups.

Telyukova (2013) reports statistics from both the SCF and the CEX about the puzzle group: co-holding occurs across all ages, with a slight hump between age 30–50. On average, co-holding is prevalent by around one-third in all age groups. Relative to borrowers and savers, co-holders are more likely to be white, be married, work full-time and have a white-collar profession. Co-holding and saving households are both less likely to have dependent children, compared to borrowers. With regards to education, savers and co-holders report similar statistics, and these groups are more educated compared to borrowers. Co-holders are also more likely to own a house with a mortgage and are least likely to rent. They are in the middle of the income distribution and have a mean total after-tax annual income of around $52,000, lower than savers ($64,331) but considerably above borrowers ($28,000). The results of Bertaut et al. (2009) are very similar to those mentioned above: co-holding occurs in around one third of all age profiles and is exhibited more by the higher educated: 27% of households with a high school degree are co-holders, compared to 45% of household with a college education.

Summarising the characteristics above, co-holders are typically in the middle age bracket, have a high level of education and have high annual income. Co-holding is not associated with young age, low levels of income or low education.

## 2.2 RATIONALISATIONS OF CO-HOLDING

### 2.2.1 The Failure of 'Conventional' Models

The first stream of research that aims to explain co-holding highlights that conventional consumption-saving models with exponential discount functions have difficulty predicting the incidence and level of revolving credit card debt and liquid savings (Angeletos et al., 2001; Laibson et al., 2003).

Simulations of life-cycle consumption models over-predict holdings of liquid assets by as much as 30 percentage points (pp) relative to observed data in the

SCF. At the same time, these models under-predict revolving credit card debt by as much as 50 pp relative to observed data ($900 simulated compared to $5000 observed). These models also fail to simulate the high frequency of credit card borrowing: at any point in the life-cycle of a simulated consumer, less than 20% hold credit card debt, which is much lower than real data suggests. Relating these results to co-holding, the simulated model cannot match frequencies of credit card borrowing and actual mid-life wealth accumulation: only 1% of simulated consumers in the top wealth quartile borrow. This is in stark contrast to empirical results, where 59–68% of these households borrow. Laibson et al. (2007) conclude that observed credit card borrowing over the life-cycle implies a constant discount rate of 16.7%, which is almost three times the value usually found by estimating time preferences calibrated by wealth and consumption data. However, a discount rate of this magnitude fails to account for observed wealth, and actually predicts negative wealth.

### 2.2.2 Liquidity Management & Precautionary Saving

The second stream of research focuses on liquidity management and rationalises co-holding on the basis that households need to hold liquid balances to undertake transactions for which credit cards cannot be used. In two papers, Telyukova & Wright (2008) and Telyukova (2013) argue that the co-holding puzzle is simply a new form of the rate of return dominance puzzle (or *coexistence puzzle*) in monetary economics that has puzzled economists at least since Hicks (1935). The puzzle is why individuals hold cash that has a negative return due to inflation and no interest payments although they could earn a positive amount by purchasing securities that bear higher financial return.

The common explanation for the rate of return dominance puzzle is twofold: firstly, money is considered to be a special asset that provides liquidity services and makes it a superior method of payment. This is the concept behind any model where money enters the utility function to generate a demand for money or models that incorporate cash-in-advance constraints for some purchases (see, for instance, Lucas, 1982; Svensson, 1985; Lucas & Stokey, 1987). Secondly, uncertainty of security returns is suggested as a source for coexistence. Uncertainty may create negative nominal rate of returns of securities and consumers hold money as a form of 'hard currency' (Makinen & Woodward, 1986).

Telyukova & Wright (2008) and Telyukova (2013) use exactly these two explanations to motivate their model and to explain co-holding: consumers hold liquid savings because there are certain classes of consumption purchases for

which credit products cannot be used. Therefore, households hold liquid savings, possibly on a precautionary basis, to facilitate such transactions should they arise. The unpredictability of cash requirements advocates the holding of liquid balances although individuals hold consumer credit debt. The authors cite unanticipated household expenses such as automotive- or home repairs (Telyukova & Wright, 2008) and predicted expenses such as mortgage and rent payments, utilities, babysitting and day-care services (Telyukova, 2013) as examples of such expenditures which cannot be paid for using credit cards.

Using data from the SCF and the CEX, the results show that the calibrated model explains co-holding behaviour for roughly half of the households in the data, and explains the liquidity held by a median household in the co-holding puzzle group for all households. Telyukova & Wright (2008) conclude that their "liquidity-based explanation appears quantitatively relevant" (p.643) as it explains a large share of the puzzle group.

The liquidity management based story can be criticised in two ways: first, their explanation is dependent upon consumers facing sizeable volumes of purchases for which credit cards cannot be used and does not explicitly take into account other forms of consumer credit which may be even more costly. Although the explanation could be qualitatively extended to other forms of credit, it may become less compelling the higher the cost of credit, as the failure to realise arbitrage opportunities becomes more costly.

Secondly, as Fulford (2014) demonstrates, the share of co-holders in the US has remained almost constant since 1992, but the acceptance of credit cards for transactions has increased substantially and the share of non-cash transactions per person increased accordingly from 22% in 1995 to 67% in 2006, implying that cash transactions have decreased (Gerdes, 2008). Another issue is that cash advances seem to almost eliminate the requirement to keep cash for emergencies. Although expensive, Gerdes (2008) illustrates that cash advances are likely used exactly for short-term liquidity requirements during emergencies as mean cash advances withdrawals are considerably higher than ATM withdrawals.

Building on this criticism, Fulford (2014) develops another explanation: consumers co-hold for precautionary reasons because they fear variable credit limits. They do not want to rely on credit lines in emergencies that may be withdrawn by the lender. Cash acts as an insurance policy so that during bad times or when a credit company withdraws lines of credit the consumer still has disposable income left. In his words, "the risk of not being able to borrow when times are bad creates a reason to hold cash, even while carrying expensive debt, as a precaution against not being able to borrow" (p.2). With certain borrowing limits, the amount consumers can borrow adds to their buffer, hence the ability to borrow adds to the

consumers' self-insurance. However, with stochastic borrowing limits, consumers build up wealth to protect themselves from borrowing uncertainty. The optimising household never co-holds with a certain borrowing limit, but may co-hold with a stochastic borrowing limit. The notion that the debt limit can vary unexpectedly is the cornerstone of Fulford's model, and he argues that this modification can explain the credit card puzzle.

The author fits the model to the data using the SCF 2007. In the model the consumer faces the portfolio problem of how much to leave in liquid savings and how much credit to leave for the following period. He finds that by calibrating preferences, disposable income processes and the risk of losing access to borrowing, the model can explain co-holding behaviour in its entirety. The problem is that, when accounting for all these parameters, the model explains co-holding, but loses its ability to simulate consumers who revolve credit card debt but hold no liquid savings – around 20% of US households in 2007. By extending the model further by allowing preferences to vary and including consumers with different levels of risk aversion and time-discounting the model closely matches the joint distribution of savings and credit card debt of US households, but it also makes the model less tractable.

Both the liquidity-based explanation as well as the precautionary saving explanation provide comprehensible explanations why co-holding occurs. But they become complicated and less tractable when all extensions are included to explain the puzzle and the incidence and levels of borrowing and saving for households that only revolve debt or households that only save. Both models cannot account fully for observed accumulations of liquid assets which are typically much higher in survey data than the models suggest.

Two factors further question the relevance of these models in the UK, the context for this study: firstly, payment restrictions do not apply to either medical or housing expenses or any other sizeable purchases. Credit card payment options are ubiquitous, available for almost all payments of more than a few pounds in value. Secondly, there is no empirical evidence to suggest that UK consumer credit holders face a high probability of credit lines being withdrawn, hence there appears to be no foundation for the hypothesis that consumers co-hold for precautionary reasons. If anything, consumer credit demand and credit limits and have increased over the past years (Bank of England, 2012).

In summary, Telyukova & Wright (2008), Telyukova (2013), Fulford (2014) argue that co-holding is no real puzzle as people simply hold cash for liquidity or precautionary reasons. Impulsiveness should not play an important role as co-holding is undertaken as an exercise of financial management. In fact, the models rule out an association of self-control problems with co-holding explicitly

by assumption of rationality and implicitly by their motivation in developing the models. Financial capability does not enter the models as consumers are assumed to be time-consistent and show full financial awareness.

### 2.2.3 'Dual Self' Models

The third explanation relates co-holding to self-control issues that arise due to existence of a *dual-self* or *planner-doer* dichotomy, pioneered by Thaler and Shefrin's model of a farsighted planner and a myopic doer (Thaler & Shefrin, 1981). The model is built on the observation that an individual's plan for future behaviour is often more constant and foresighted than the actual myopic behaviour[2]. The myopic 'doer' selfishly cares only about his own immediate gratification, the 'planner' cares about the present and future equally.

Bertaut et al. (2009) develop a model in the spirit of the planner-doer model that aims to rationalise co-holding, which they brand *accountant-shopper* model. Here, "the separation of purchase from payment made possible by credit cards creates potential for differential impatience between the entities responsible for the two actions: the *shopper* and the *accountant*" (p.658). The (patient) accountant manages household finances and decides how much debt to revolve, the less patient shopper chooses consumption, taking the extent of unused credit determined by the accountant as given.

The shopper and the accountant are fully rational and are involved in a repeated dynamic game[3]: the accountant's objective is to maximise expected lifetime utility, which is a function of real consumption and when deciding the extent of debt repayments he takes all standard consumption-saving choices into account (precautionary savings, life-cycle behaviour, borrowing constraints etc.). He knows about the shopper's impatience and that the shopper adjusts his consumption to the size of unused but accessible credit. Revolving consumer credit implies less consumption choice for the shopper, and by choosing a particular amount to pay-off debt (i.e. the accountant uses not all liquid savings to clear the debt) the shopper faces a tighter borrowing constraint when maximising his utility.

The shopper's problem is based on the observation that the separation of

2 There are many examples of this kind of behaviour in the literature. Frederick et al. (2002) give the example of upholding a diet plan. Individuals often recognise that maintaining a diet is good for their long-term health, but they frequently violate their farsighted perspective for quick and instantaneous gratification.

3 In a previous paper, Haliassos & Reiter (2005) establish an 'accountant-shopper' model in which the shopper exhibits bounded rationality in the sense that he has limited awareness of the financial consequences of his spending actions. The accountant is fully sophisticated, the shopper is impulsive, i.e. discounts the future more heavily and ignores the consequences of today's spending on the payments into the account made by the accountant in the next period.

purchase from payment, which is facilitated by credit cards or other consumer credit products, tends to enable consumers to spend more impulsively relative to running down cash balances (Durkin, 2000). This is formalised by assuming a higher rate of time preferences of the shopper relative to the accountant, but otherwise the two entities share the same preferences and knowledge. The shopper is aware that the accountant can use the credit balance to restrain his spending and, when choosing consumption, he takes into account the response of the accountant in the next period.

The dynamic game corresponds to the payment cycle of a credit card account: firstly, the accountant pays the bill at the start of the period in part or in full; secondly, the shopper consumes. In order for credit cards to function as commitment devices, the model relies on the assumption that only the accountant has access to (liquid) savings, and the shopper relies solely on the available credit line for consumption. When increasing consumption, the shopper faces the consequence of a higher outstanding balance that the accountant may not clear at the beginning of the next period, depending on how much the balance deviates from the accountant's optimal allocation. This implies that the shopper faces some kind of reciprocal action from the accountant if he chooses to consume 'too much' in the current period and therefore leaves a fraction of the credit line unused.

The authors show that the separation into two entities with differential time preference is "sufficient to generate co-existence between credit card debt and substantial liquid assets, even if both entities are rational and financially sophisticated" (p.659). The model provides two interpretations: if the two entities are within one individual, the model has a self-control implication; if the entities are one household, the model simply departs from a unitary framework where all members of the households share the same time preference. In fact, the model is identical to a standard consumption model when the difference in time preference of the two entities is zero.

Simulated results show that their model matches data of the SCF closely: if there is no difference in time-preference between both entities, the consumer or household will not revolve any debt if there are sufficient savings to pay it off. But even small differences in time-preferences will lead to revolving significant amounts of consumer credit debt for a wide range of liquid asset levels.

Dual-self models have received their fair share of criticism. Telyukova & Wright (2008) and Telyukova (2013) argue that it is a costly kind of control, as there are much cheaper ways of controlling consumption, for instance by simply reducing one's credit card limit. But this criticism neglects that a voluntary reduction of available credit is reversible, which does not seem useful for a self-control device. It also ignores empirical evidence regarding credit line utilisation rates found

by Gross & Souleles (2002) and theoretical predictions from buffer stock saving models, for instance Carroll & Samwick (1997): credit lines are not fully exhausted because of a precautionary saving motive and reducing the credit card limit voluntarily would either cancel out the buffer or would force consumption to decline if the consumer would like to keep a buffer. Similarly, in the accountant-shopper model, the shopper has a 'precautionary saving' motive because he knows that the payments of the accountant are stochastic.

The contribution of Bertaut, Haliassos and Reiter's accountant-shopper model is to show that a simple deviation from a standard model, the introduction of differential time-preference, is sufficient to generate co-holding in simulated consumers for a wide range of assets and even modest differences in time-preference. The model does not rely on limited financial literacy, and co-holding is generated even though both entities are fully financially aware, which is consistent with the observation that overspending of credit card holders appears unrelated to financial ignorance (Durkin, 2000). Most crucially, "the accountant-shopper framework (...) could provide a useful tool for future attempts to match the quite heterogeneous and often puzzling debt-asset structure of modern household" (p.689).

### 2.2.4 Financial Ability

The idea behind financial literacy provides a far simpler deviation from the rationality and time-consistency assumptions of the canonical discounted utility than the dual-self model. Poor 'Financial literacy' refers to the notion that individuals misunderstand their budget constraint because they struggle to understand the workings of basic numerical and financial concepts. If they fail to understand the mathematical construct of the budget constraint, consumers may make suboptimal financial choices because they fail to understand the stochastic environment in which they live. If consumers are relatively financially illiterate they may be unaware of the consequences of their consumption-saving choices.

Within the context of co-holding, individuals may accrue more consumer credit debt because they are less literate and do not understand the terms of credit products which can be quite complex. The positive relationship between debt and illiteracy has been supported by research of Lusardi & Tufano (2009) for the US and Disney & Gathergood (2013) for the UK. At the same time, less literate individuals may be more likely to fail to realise the existence of arbitrage opportunities and hence do not recognise that co-holding is a costly activity.

Financial literacy has also been linked to individual time preferences: Jappelli

& Padula (2013) develop an inter-temporal consumption model of investment in financial literacy. The idea here is that higher financial literacy increases the returns on wealth. The model predicts that more impatient consumers invest less in financial literacy and accumulate less wealth as the investment has a cost in terms of current consumption. Putting this notion to the test, Meier & Sprenger (2013) present results of a field study that links individual decisions to acquire financial literacy to time preferences. They offered 870 individuals free short credit counselling sessions and find that participants (55% of the sample) have a significantly lower discount rate than non-participants (45%). In short, more patient individuals are more likely to acquire financial information and have higher pre-knowledge regarding financial matters. The authors conclude that "if becoming financially literate is an investment in human capital, individuals who heavily discount the future will be less likely to find the investment to be attractive, and so will remain financially illiterate" (p.18).

### 2.2.5 Other Explanations

There are a number of other potential explanations of the credit-card puzzle, some of which have been proposed in the literature, some of which evolve more naturally. In the latter category is the notion that co-holding is a mere accounting phenomenon, for instance due to (misunderstood) definitions in surveys with regards to 'consumer credit' and 'liquid savings'. Another issue is the correct accounting time, on which Fulford (2014) elaborates: if monthly income is deposited directly into the bank account immediately after the due date on a consumer credit bill, "there could be large balances for the entire month even though all available cash is used to pay down the credit balance every month" (p.6). The SCF asks for the bankcard balance after the last payment and for holdings of liquid assets at the time the survey was run, which could cause problems if it is interpreted as the amount of savings as of the last statement. But empirical evidence, for instance in Gross & Souleles (2002), shows that one third of consumers hold more than the amount required to pay off the bill in liquid savings, even when allowing for a month of household income, hence it is unlikely that co-holding is just an "accounting artefact" (Fulford, 2014, p.18).

Another natural explanation of the puzzle is portfolio management. For some consumers the cost incurred due to arbitrage failure is simply the opportunity cost of not managing their asset portfolio properly, i.e. these consumers are unconcerned by the monetary loss of co-holding. Telyukova (2013) calculate that a household in the puzzle group loses $734 per annum on average. It is possible that

households are untroubled by this loss, given that it is only 1.5% of total annual after-tax income or 0.6% in Fulford's data. However, we have to ask whether these households would be equally untroubled if they would be aware of the exact amount they forego each year. Hence, the issue here may be that of limited attention which is consistent with the observation of Corwin & Coughenour (2008), who show that investors pay more attention and allocate more effort towards the most active items in their portfolio. If the loss incurred by co-holding is not visible to the household, limited attention might provide a simple explanation.

Yet another popular explanation is the theory of mental accounting which refers to the cognitive operations used by consumers to manage their financial activities. This explanation has at its core that individuals "do not treat all money as fungible, but instead assign different types of expenditures to different *mental accounts*" (Frederick et al., 2002, p.373). This suggests that larger amounts of money are coded as 'savings' while smaller amounts are coded as 'consumption' with a higher to willingness to spend from the latter account (Thaler, 1985). Relating this idea directly to consumption choice, Prelec & Loewenstein (1998) argue that payments for consumption causes an immediate disutility, i.e. a 'pain of paying'. Their model suggests that different ways of paying for purchases, for instance by cash, credit cards or a consumer loan, can lead to different purchasing decisions even when holding net present value of payments constant. Within the context of co-holding, mental accounting has two implications: first, consumers may treat their 'liquid savings' and their 'consumer credit' differently and build up a reluctance to pay off credit as the mental 'savings account' has a very low willingness to spend. This implies that individuals build up revolving consumer credit due to a mental barrier that prevents them from accessing liquid savings that could be used to pay off debt. Second, consumers may roll-over debt because financing options allow individuals to disassociate consumption from the 'pain of paying'. As before, consumers are then reluctant to pay off the debt using their savings because of a low willingness to spend out of the savings account.

An alternative explanation has been proposed by Lehnert & Maki (2002) who analyse bankruptcy behaviour. The idea is that households at the verge of bankruptcy try to rescue part of their wealth which is made possible by 'generous' provisions of bankruptcy laws. Under Chapter 7 bankruptcy filing in the US, states offer different exemption level of assets and the authors find a positive relation between exemption levels and the amount of revolving credit card debt and holding liquid savings. The rationale is that households run up their debt as it would be written off during the bankruptcy proceedings, and keep their savings in liquid forms as they are easily converted into exemptible assets. While this idea might be a compelling explanation for a number of households, examination

of household balance sheets reveal that co-holding households typically hold substantial illiquid financial and non-financial wealth which would make strategic bankruptcy behaviour very expensive (Bertaut et al., 2009; Telyukova, 2013; my data). Furthermore, Telyukova & Wright (2008) comment that co-holders do not go bankrupt with particularly high probability and Bertaut et al. (2009) note that the "the widespread nature of co-existence (...) cast[s] doubt on the wide applicability of this explanation" (p. 660). Furthermore, Bertaut et al. control for strategic default considerations by including a dummy capturing declared bankruptcy in the past and find "behaviour that is not inconsistent with a strategic default motive" (p. 687).

# 3

# HYPOTHESES & METHODOLOGY

The analysis in this chapter aims to investigate the link and interplay between impulsiveness, financial literacy and co-holding. The available data does not provide the opportunity for a causal interpretation, as there is no direct test for causal inference, such as a natural or laboratory experiment, instruments or exclusion restriction. The identification in this analysis aims to relate measures of core behaviour to hypothesised explanations for co-holding. The data allows to include a broad range of controls, with income and education entering as higher order polynomials, together with measures of credit constraints, income and employment uncertainty, financial literacy, individual discount rates and impulsiveness.

The model that Bertaut et al. (2009) develop provides a framework for my analysis, as the model implies that impulsive consumers or households co-hold if they are sufficiently self-aware of their impulsive spending tendencies. Impulsiveness can be seen as the driving factor behind co-holding as sophisticated consumers, who are able to realise their shortcoming, wish to voluntarily restrict their liquidity so that they do not have the opportunity to exert impulsive spending behaviour. These consumers are sophisticated in the sense that they correctly predict that their future selves will not honour the preferences of their present selves: if consumers suffer from a dual-self dichotomy, hence are tempted to consume against their better financial judgement, and realise their inner-self conflict, they might deliberately hold outstanding consumer credit balances in order to limit their opportunity to consume impulsively.

In the UK, savings balances cannot be easily used for transaction purposes, i.e. there is typically a delay of at least a few hours to a few days until savings balances can be accessed. Thus, by making one's savings less accessible and perceiving savings as non-spendable for immediate consumption, consumers minimise their vulnerability of impulsive spending by maintaining revolving consumer credit debt simultaneously with savings. Following this argumentation co-holding is then a means of consumers protecting themselves against time-inconsistency in their own decision making and is actually a response of sophisticated consumers to the realisation of their dual-self dichotomy and their subsequent impulsive spending tendencies.

## 3.1 SURVEY DESIGN & DATA

The analysis is conducted by drawing data from the YouGov Debt Tracker survey of household finances from the September 2010 wave which is also used in Gathergood (2012) and Disney & Gathergood (2013). The Debt Tracker is a quarterly cross-sectional survey of a representative sample of approximately 2,500 UK households and is conducted via the internet. Interviewed households are randomly drawn from YouGov's panel of 350,000 households and each wave is repeated on a fresh cross-sectional sample. Households receive a small fee and YouGov makes special provisions for non-internet users to ensure the surveyed sample is representative of the population.

The survey includes approximately 85 question which cover topics in household finance with detailed financial product use, demographics, education, housing and labour market status. In addition to these the survey includes a series of financial literacy questions relating to concepts in consumers credit and financial behaviour. I compare results from the sample with results from other surveys, where applicable, in order to highlight the quality of the data.

I now describe data regarding the measures of financial literacy, liquid savings, consumer credit and self-control in more detail.

### 3.1.1 Measures of Financial Literacy

In order to measure financial literacy three test-based measures were introduced to the survey that aim to measure *debt literacy*, which is financial literacy specifically concerned with the cost of credit. The three questions in this survey are based on those used in a study of US consumers by Lusardi & Tufano (2009). These test respondents' ability to make a simple interest calculation, to understand interest compounding, and to evaluate the impact of minimum payments on a credit card contract.

The literature has documented that understanding of these concepts is typically low in the population. Lack of understanding is associated with lower participation in private retirement saving planning or stock market investments and with a higher likelihood of debt repayment problems (Lusardi & Mitchell, 2007; Van Rooij et al., 2011a,b; Gathergood, 2012; Disney & Gathergood, 2013).

The questions were constructed using a multiple-choice format. Only the first question requires a simple per cent calculation to discriminate between two choices, answers in the other questions can be derived via elimination.

The first question tests the understanding of interest rates:

1. 'Cheryl owes £1,000 on her bank overdraft and the interest rate she is charged is 15% per year. If she didn't pay anything off, at this interest rate, how much money would she owe on her overdraft after one year?'
   - £850
   - £1,000
   - £1,150
   - £1,500
   - Do not know

The second question examines the understanding of interest compounding:

2. 'Sarah owes £1,000 on her credit card and the interest rate she is charged is 20% per year compounded annually. If she didn't pay anything off, at this interest rate, how many years would it take for the amount she owes to double?'
   - Less than 5 years
   - Between 5 and 10 years
   - More than 10 years
   - Do not know

The third question asks to compare the monthly payments of credit with a fixed fee against an annual percentage rate:

3. 'David has a credit card debt of £3,000 at an Annual Percentage Rate of 12% (or 1% per month). He makes payments of £30 per month and does not gain any charges or additional spending on the card. How long will it take him to pay off this debt?'
   - Less than 5 years
   - Between 5 and 10 years
   - More than 10 years
   - None of the above, he will continue to be in debt
   - Do not know

The number of correct answers is used to create a score of financial literacy, ranging from 0–3.

### 3.1.2 Measures of Self-Control and Time Preference

Studies investigating time preferences in individual choice are typically concerned with whether individuals prefer small rewards now or large rewards in the future. Experimental economists use incentivised choice tasks where subjects are

presented with binary choices between sooner smaller amounts or later but larger amounts. This allows, for example, to construct $\delta$-$\beta$ parameters to distinguish between linear (time-consistent) discounting (the $\delta$ part) and present bias (time inconsistency, the $\beta$ part). See Frederick et al. (2002) for a review.

It is often not feasible to include these complex measures into representative surveys, hence the requirement for proxy instruments. The instrument I use to elicit self-control problems on the part of the respondent in the survey uses a Likert scale response by which individuals associate or disassociate themselves with a short statement which describes impulsive behaviour. This approach is dependent upon self-awareness on the part of the respondent. Self-awareness of self-control problems is central to the notion that individuals co-hold as a means of regulating their own behaviour as discussed in Section 2.2.3. Vischer et al. (2013) show that short survey instruments similar the one below, are able to predict behaviour. They validate these proxies by inviting a representative sub-sample of respondents to a large survey to participate in an inter-temporal choice experiment of the 'smaller-sooner' vs 'larger-later' type. Results indicate that the proxy statement is able to significantly predict behaviour in an incentive-compatible choice task.

The impulsiveness statement included in the survey was:

- 'I am impulsive and tend to buy things even when I can't really afford them'
  - (a) Agree strongly
  - (b) Tend to agree
  - (c) Neither agree nor disagree
  - (d) Tend to disagree
  - (e) Disagree strongly
  - (f) Do not know

To create a measure of impulsiveness, the Likert scale response is transformed to an indicator variable by assigning a value of one if the respondent answers 'agree strongly' or 'tend to agree' and a value of zero otherwise.

The assumption regarding self-awareness is supported by Ameriks et al. (2003) and Ameriks et al. (2007) who show that individuals are willing and able to self-identify traits related to suboptimal economic behaviour in hypothetical, scenario-based questions. In Ameriks et al. (2003), respondents are asked to associate themselves with hypothetical statements related to producing and adhering to financial planning, and the authors show that those that self-identify a higher 'propensity to plan' accumulate more wealth. In a similar fashion, Ameriks et al. (2007) measure self-control problems directly by asking respondents hypothetical scenario questions regarding their (personal) optimal allocation of restaurant vouchers over a 2 year period and asking them if they expect to depart from their ideal allocation. The authors find that subjects that are willing and able to self-identify self-control problems have more difficulty committing to consumption-saving choices, and that those with more self-control problems accumulate less

financial net worth.

The survey also contains a separate question on respondent spending behaviour relating to time preference for consumption. I use responses to this question to identify impulsive spending behaviour due to lack of self-control (time inconsistency) from a strong preference on near-term consumption (time preference). I label this question 'heavy discounter', again assigning a value of one if the respondent answers 'agree strongly' or 'tend to agree' and a value of zero otherwise:

Heavy discounter:

- 'I am prepared to spend now and let the future take care of itself'
  - (a) Agree strongly
  - (b) Tend to agree
  - (c) Neither agree nor disagree
  - (d) Tend to disagree
  - (e) Disagree strongly
  - (f) Do not know

### 3.1.3 Measures of Income Risk & Credit Constraints

In addition to these questions on behavioural characteristics I also make use of data from the survey on income risk to control for income risk which might induce the household to hold additional precautionary liquid savings. I measure income risk based on the self-reported likelihood of respondents facing unemployment in the near future. I label this question 'expects to be unemployed' and assign a value of one if the respondent answers 'very likely' or 'fairly likely' and a value of zero otherwise:

Unemployment risk:

- 'How likely or unlikely do you think it is that you will be made redundant or become unemployed over the next 6 months?'
  - (a) Very likely
  - (b) Fairly likely
  - (c) Neither likely nor unlikely
  - (d) Fairly unlikely
  - (e) Very unlikely
  - (f) Do not know

I also incorporate a self-reported measure of the likelihood of needing to draw upon credit in the near future, possible answers and the coding of which are the same as for the unemployment risk question above, which I label 'likely to borrow more in future':

Borrowing risk:

- 'In the near future how likely or unlikely is it that you will need to borrow any more money over the next 3 months?'

Finally, I create an indicator measuring the credit constraints a household faces in order to distinguish whether certain households are constrained in their

borrowing capacity, in other words whether they want to be borrowers or increase their borrowing but face external restrictions. This dummy takes the value 1 if respondents state either one of the following:

- 'Financial circumstances have got worse: can't get credit'.
- 'Credit card withdrawn' or 'credit limit reduced' or 'overdraft withdrawn'.
- Applied for a particular credit product and the outcome is either 'credit amount was less than wanted' or 'turned down'.

### 3.1.4 Measure of Co-Holding

The degree of co-holding among households in the survey is measured by combining data on balances on consumer credit products with data on liquid savings. The survey data contains individual balances on the full range of consumer credit products held by the household. Respondents were asked to state the value of outstanding debt for each product, excluding balances which would be repaid within the current payment period such as balances on credit and store cards which would be cleared before interest was due. I sum the value of individual balances on each consumer credit product to give a value for total outstanding consumer credit.

The measure of saving is a self-reported measure of liquid savings based on a specific survey question. I use this approach because, for the purpose of studying co-holding, the interest is in the level of liquid savings available to the household which could be used to pay down consumer credit balances. Detailed data on savings and investments by product is not available in the survey. The total value of liquid savings I use is derived from a survey question in which respondents were asked to state the value of their non-pension savings which could be accessed easily:

- 'How much do you [and your partner] have in liquid savings? These are savings that could easily be used in an emergency and are not tied up in a pension or long term savings product.'

This question is designed to identify revolving financial assets by the phrase 'savings' and not deposit- or current account balances held between salary/benefit payment periods. The value of liquid savings I use is based on the respondents' own judgment about the liquidity of their savings and investments. The use of 'emergency funds' as a measure of liquid savings has been conceptualised by Johnson & Widdows (1985), who define it as very liquid assets including money market funds, savings- and checking accounts. This definition is the basis for

liquid savings in household surveys such as the SCF. It is not an assumption that survey respondents are familiar with this definition, but it provides a concept of what can be viewed as liquid savings. The measure of liquid savings I use is therefore based on the respondents' own judgement about the liquidity of their savings and investments.

Co-holders are defined as households with a positive value of liquid savings who also hold a positive value of total consumer credit at the same time. To account for liquidity needs, following Gross & Souleles (2002), I allow for liquid savings to a value of one month's disposable income, which I calculate at the individual household level, and deduct this value from reported liquid savings when calculating co-holding balances. I do so because respondents may report within-period deposit account balances as savings, or because households might hold liquid savings against within-month liquidity needs or on a precautionary basis. I calculate the amount of co-holding for each household.

To calculate the interest cost of co-holding I first attach product-specific 'Annualised Percentage Interest Rates' (APR) to each product type held by households. The product-specific APRs are representative APRs derived from a monthly data series provided by the 'Financial and Leasing Association', the UK industry body for the consumer credit industry. Assuming that households would pay down their most expensive consumer credit products first, I can calculate the annualised interest cost of co-holding for each household.[4]

## 3.2 EMPIRICAL STRATEGY

I estimate a series of econometric models to analyse the relationship between self-control, financial literacy plus other covariates and the likelihood and magnitude of co-holding. The empirical strategy consists of three elements: firstly, I split the sample into groups of co-holders, borrowers (no liquid savings), savers (no consumer credit) and those that have neither savings nor borrowing. All households in the survey are classified as (exactly) one of these types based on values of consumer borrowing and liquid savings. This allows investigating the group of co-holders by estimating a series of models in which the dependent variable is an indicator for the extent of co-holding conditional on demographic and income-related covariates. I estimate two categories of co-holding models by binary probit using standard maximum likelihood procedure. In the first category, the dependent variables are 0/1 dummies of whether a household co-holds at

4 This is a conservative assumption as these are households who are known to incur 'unnecessary' costs. Hence, the estimates should be seen as a minimum.

least £1,000 or at least £2,000. In the second category, the dependent variables are indicators for the level of cost of co-holding, specifically incurring costs of at least £100, £500 or £1,000 per annum. These thresholds of co-holding are created in order to differentiate the results by the extent of co-holding.

The estimated equations are given as:

$$ch = \alpha_0 + \alpha_1 imp + \alpha_2 fl + \alpha_3 hd + \mathbf{W}'\beta + \mathbf{X}'\omega + u \tag{1}$$

where $ch$ denotes one of the five co-holding thresholds, $imp$ the impulsive spender dummy, $fl$ the financial literacy score ranging from 0–3 and $hd$ the heavy discounter dummy. $\mathbf{W}$ denotes a vector of the control for income risk and credit constraints, $\mathbf{X}$ denotes the vector of demographic and financial controls as shown in Table 2. $u$ denotes the error term which is assumed to be normally distributed with zero mean. This implies that the probit model allows for any degree of correlation between single error terms and can represent different substitution patterns (Greene, 2007) .

In probit regression, the probability of the dependent variable is not a linear function of any random variable $Z$, but follows a cumulative distribution function for which $Pr(Z \leq z)$ denoted $\Phi(z)$ as $N(0,1)$. Classifying $\mathbf{Z}$ as a vector of all explanatory variables used to estimate Equation 1, the model can then be written as:

$$Pr(ch = 0) = \Phi(-\alpha\mathbf{Z}) \tag{2}$$

$$Pr(ch = 1) = \Phi(\alpha\mathbf{Z}) \tag{3}$$

Probit models are estimated using maximum likelihood methods. The likelihood function is a joint probability density function for $ch_1, ..., ch_N$, evaluated at the actual observations. By assumption of normally distributed errors with zero mean, the likelihood function to estimate the model can be written as:

$$L(\alpha) = \prod_{i=1}^{N} p(ch_i) = \prod_{i=1}^{N} \Phi(\alpha\mathbf{Z})^{ch_i} \Phi(-\alpha\mathbf{Z})^{1-ch_i} \tag{4}$$

where $ch_i$ is either $ch_i = 0$ or $ch_i = 1$.

Due to the non-linearity, interpretation of the model requires estimation of marginal effects. I use average marginal effects (AME) to estimate the marginal effect of the independent variables. AME compute the average of discrete or partial changes over all observations. AME is now widely used to compute marginal effects, in particular when binary regressors are used. The advantage over MEM (marginal effects at the mean) is that it provides better estimates when the regressors include many zeros (see Bartus, 2005 and Greene, 2007 for discussion).

Secondly, I estimate two Tobit model where the dependent variable is first, the continuous level of co-holding with a lower limit of zero, and secondly the

continuous level of co-holding cost, again with a lower limit of zero. I do this for robustness for two reasons: firstly, in order to ensure that the arbitrary choice of co-holding thresholds above does not obscure the results. Secondly, as around 80% of the sample are not co-holders, this may be an important estimation bias which implies that ordinary least squares (OLS) estimation is not appropriate. Hence, censoring the dependent variable equal to zero is appropriate to account for this bias. Tobit regression assumes normal distribution of the errors with zero mean.

The estimated Tobit equation is:

$$coholding = \alpha_0 + \alpha_1 imp + \alpha_2 fl + \alpha_3 hd + \mathbf{W}'\beta + \mathbf{X}'\omega + u \tag{5}$$

where $coholding$ is either the continuous value of co-holding or the continuous level of co-holding cost, both with $coholding > 0$.

Thirdly, as a robustness check, I estimate these models with varying control groups and estimate a multinomial model to highlight differences across the groups of savers, borrowers, neither savers nor borrowers and co-holders. The multinomial probit model explicitly models assignment into each of the groups, in contrast to the estimates where the control groups are varied, which only model the bivariate relationship between co-holding and one of the other group categories. In the multinomial probit model the base is the co-holder group and I and present mean marginal effects for the evaluation of the results.

# 4

# RESULTS

## 4.1 SURVEY & SAMPLE CHARACTERISTICS

Summary statistics for the sample of households are provided in Table 1. Column 1 reports mean values for the whole sample of 2,584 households. Half of all respondents are male, two thirds married and one fifth have dependent children. 59% of households have a respondent in employment, with 43% having the respondent's partner in full-time employment. 70% of households are home-owners. Mean household income is £35,600 with median income at £30,000.

Table 1 also provides summary statistics for household borrowing and savings. For consumer borrowing the survey data contains individual balances on an exhaustive range of consumer credit products, including commonly held products such as credit cards, personal loans and store cards, but also less common forms of borrowing such as mail order and hire-purchase loans. The data include the value of outstanding debt for each product type; excluding non-revolving balances which would be repaid within the current payment period without incurring interest charges (such as within-month balances on credit and store cards). I sum the value of individual balances on each consumer credit product to give a value for total outstanding revolving consumer credit that incurs interest. This measure excludes mortgage debt. Among the whole sample (Column 1) the mean value of consumer credit debt is just above £2,000.

The mean value of liquid savings among the whole sample is £9,211. This compares with mean savings account balances reported by households in the UK 'Wealth and Assets Survey' (WAS, Office for National Statistics, 2014) of £8,700, comprising £5,900 held in standard savings accounts and £2,800 in tax-exempt 'Individual Savings Accounts'. The distribution of savings across age and income brackets in the data also matches the distribution in the WAS closely.

In addition, Table 1 provides summary statistics for four household types: 'borrower', 'saver', 'neither borrower nor saver' and 'co-holder'. In total, 350 households hold liquid savings and consumer credit at the same time. Net of one month's disposable income (on average 45% of gross income), this number falls to 299, which I define as the co-holding group.

TABLE 1 Sample Characteristics by Financial Market Participation

| | Sample | Borrower | Saver | Neither Borrower nor Saver | Co-Holder |
|---|---|---|---|---|---|
| *Age* | | | | | |
| 18–24 | 0.07 | 0.08 | 0.08 | 0.07 | 0.03 |
| 25–34 | 0.19 | 0.26 | 0.18 | 0.16 | 0.20 |
| 35–44 | 0.20 | 0.25 | 0.18 | 0.17 | 0.22 |
| 45–54 | 0.18 | 0.22 | 0.15 | 0.18 | 0.22 |
| 55+ | 0.36 | 0.19 | 0.41 | 0.43 | 0.33 |
| *Demographics* | | | | | |
| Male (= 1) | 0.50 | 0.43 | 0.53 | 0.50 | 0.54 |
| Married / living as married (= 1) | 0.67 | 0.69 | 0.64 | 0.67 | 0.77 |
| Dependent children (= 1) | 0.20 | 0.32 | 0.16 | 0.17 | 0.22 |
| Education leaving age | 18.92 | 18.71 | 19.32 | 18.59 | 18.99 |
| *Employment* | | | | | |
| Employed (= 1) | 0.59 | 0.71 | 0.55 | 0.51 | 0.70 |
| Unemployed (= 1) | 0.04 | 0.04 | 0.03 | 0.05 | 0.03 |
| Retired/Student/Housewife/Disabled | 0.37 | 0.25 | 0.42 | 0.43 | 0.27 |
| Spouse employed (= 1) | 0.43 | 0.52 | 0.37 | 0.41 | 0.55 |
| *Housing* | | | | | |
| Homeowner without mortgage (= 1) | 0.29 | 0.10 | 0.37 | 0.34 | 0.24 |
| Homeowner with mortgage (= 1) | 0.41 | 0.47 | 0.38 | 0.36 | 0.55 |
| *Household Finances* | | | | | |
| Household income (£) | 35579<br>(30000) | 35172<br>(32000) | 37973<br>(32000) | 30685<br>(28000) | 42869<br>(35000) |
| Disposable household income (£) | 15923<br>(13739) | 15179<br>(13212) | 18036<br>(15630) | 12881<br>(11400) | 19316<br>(16560) |
| Liquid savings (£) | 9211<br>(0) | 117<br>(0) | 21577<br>(10000) | 0<br>(0) | 12079<br>(6000) |
| Consumer credit debt (£) | 2036<br>(0) | 6943<br>(3100) | 0<br>(0) | 0<br>(0) | 6191<br>(4000) |
| Co-Holding (£) | 462<br>(0) | 105<br>(0) | 0<br>(0) | 0<br>(0) | 3821<br>(2500) |
| Credit constrained (= 1) | 0.09 | 0.22 | 0.04 | 0.07 | 0.10 |
| *Income and Expenditure Risk* | | | | | |
| Expects to be unemployed (= 1) | 0.08 | 0.09 | 0.08 | 0.07 | 0.09 |
| Likely to borrow more in future (= 1) | 0.09 | 0.20 | 0.04 | 0.07 | 0.10 |
| *Behavioural Characteristics* | | | | | |
| Literacy score (0–3) | 1.90 | 1.75 | 2.12 | 1.71 | 1.99 |
| Impulsive spender (= 1) | 0.13 | 0.26 | 0.07 | 0.10 | 0.22 |
| Heavy discounter (= 1) | 0.09 | 0.17 | 0.06 | 0.07 | 0.12 |
| Observations | 2584 | 491 | 933 | 861 | 299 |

*Note:* Mean values reported, medians in parentheses for financial variables.

*Source:* YouGov Debt Tracker September 2010.

Co-holders can be classified into two types based on the relative size of their liquid savings and consumer credit debt. Firstly, some co-holding households hold net liquid saving balances in excess of their consumer credit balances and so could pay down all their consumer credit balance with savings to spare. Secondly, other co-holding households hold net liquid savings balances below their consumer credit balances and so could only partly pay down their consumer credit balance if they used all of their liquid savings. In the data, 199 households are of the first type and 100 are of the second type. The mean value of co-holding within the co-holders group is £3,800 with the median value £2,500. I define the amount of co-holding as the minimum of positive consumer credit and positive liquid savings (minus one month's disposable income).

For the other groups, borrowers are defined as households with non-zero total consumer credit balances and liquid savings of less than one month's disposable income (51 of these hold savings above zero). Mean consumer credit debt among borrowers is £6,900 and the median is £3,100. Savers are defined as households with non-zero liquid savings and zero consumer credit balances. Mean savings among savers is £21,500 with median £10,000.

The group 'neither borrowers nor savers' is defined as households with zero reported liquid savings and zero reported consumer credit balances. Although these households report zero balances for both savings and debt, one might expect that they hold some form of savings whether in cash or in small values of revolving deposit account end-of-month surpluses. However, I choose not to combine this group with savers as their reported liquid savings are zero and among this group average income is 20% lower than that of savers. But, combining this group with savers in the econometric analysis does not change the results. I also report estimates from specifications which combine the two groups later in the analysis.

### 4.1.1 Financial Literacy, Behavioural Characteristics and Co-Holding

In this section I provide summary statistics on the relationship between household behavioural characteristics and co-holding. The main insight from these summary statistics is that, compared with other types, co-holders are more financially literate than borrowers, but they report similar, high rates of impulsive spending behaviour.

From Table 1, among co-holders the mean literacy score (number of financial literacy questions answered correctly) is 1.99, which is 5% higher than the sample average and approximately 15% higher than the mean scores for borrowers and the 'neither/nor' group. The socio-economic characteristics of co-holders are

in keeping with their higher literacy scores. Compared with the whole sample, co-holders are typically more likely to be married, in employment plus have a partner in employment and to be home-owners with mortgages.

Co-holders also have the highest mean income among the four groups (20% higher than the sample average and 22% higher than households who borrow but hold no liquid savings) and higher than average balances of both liquid savings and consumer credit. Also, co-holders are only slightly more likely to self-report that they are credit constrained (10%) compared with the whole sample (9%). Borrowers report much higher rates of being credit constrained (22%).

Among the co-holding group, 22% of respondents strongly agreed or agreed with the statement that they are impulsive spenders. This proportion of impulsive spenders among the co-holding group is 9 pp higher than the whole sample average and more than three times that among savers and twice that among 'neither/nor' respondents. Among borrowers, the proportion of respondents who report being impulsive spenders is 4 percentage points higher than among co-holders.

More detailed summary statistics for households broken down by the level of household co-holding are presented in Table 2. These reveal that higher levels of co-holding, and higher levels of more costly co-holding (which I define below) are associated with both better financial literacy but also higher likelihood of being an impulsive spender. The first two columns of Table 2 report summary statistics for co-holders by their amount of co-holding. Among the 299 co-holding households, 136 households co-hold between £250 and £2000 of consumer credit debt and liquid savings and 163 co-hold more than £2000. Among the larger co-holders, the mean literacy score is 0.21 points higher and the proportion of impulsive spenders 4 percentage points larger. Mean household income among that group is also 48% higher than among the smaller co-holders.

The second two columns of Table 2 separate co-holders by the financial cost of their co-holding. I estimate the financial cost of co-holding using household level credit portfolio data. Most households in the sample hold multiple consumer credit products. Table 3 provides summary statistics for consumer credit portfolios of co-holding households. Average balances for individual credit products among credit portfolios of co-holding households reveal much heterogeneity as they contain a wide variety of credit products, not just credit card debt. While credit card debt is on average the largest credit product type, personal loans and car loans also constitute sizeable amounts to the average portfolio.

The results of my calculations regarding the cost of co-holding show that 164 co-holding households in the sample incur interest costs between £100 and £500 per annum. 135 co-holding households incur annual interest costs in excess of

TABLE 2 Sample Characteristics by Amount of Co-Holding

| | (1) Co-Holding | | (2) Co-Holding Cost | |
|---|---|---|---|---|
| | £250–£2000 | > £2000 | £100–£500 | > £500 |
| *Age* | | | | |
| 18–24 | 0.05 | 0.01 | 0.04 | 0.01 |
| 25–34 | 0.21 | 0.19 | 0.22 | 0.18 |
| 35–44 | 0.15 | 0.28 | 0.15 | 0.30 |
| 45–54 | 0.24 | 0.20 | 0.23 | 0.21 |
| 55+ | 0.34 | 0.32 | 0.35 | 0.30 |
| *Demographics* | | | | |
| Male (= 1) | 0.47 | 0.60 | 0.49 | 0.59 |
| Married / living as married (= 1) | 0.74 | 0.80 | 0.76 | 0.78 |
| Dependent children (= 1) | 0.15 | 0.28 | 0.15 | 0.30 |
| Education leaving age | 18.74 | 19.21 | 18.80 | 19.23 |
| *Employment* | | | | |
| Employed (= 1) | 0.68 | 0.71 | 0.68 | 0.72 |
| Unemployed (= 1) | 0.03 | 0.03 | 0.03 | 0.03 |
| Retired/Student/Housewife/Disabled | 0.29 | 0.26 | 0.29 | 0.25 |
| Spouse employed (= 1) | 0.51 | 0.58 | 0.54 | 0.56 |
| *Housing* | | | | |
| Homeowner without mortgage (= 1) | 0.26 | 0.22 | 0.27 | 0.20 |
| Homeowner with mortgage (= 1) | 0.48 | 0.61 | 0.49 | 0.62 |
| *Household Finances* | | | | |
| Household income (£) | 34000<br>(30000) | 50269<br>(45000) | 36728<br>(32000) | 50329<br>(45000) |
| Disposable household income (£) | 15102<br>(13892) | 22833<br>(20314) | 16447<br>(14894) | 22802<br>(20314) |
| Liquid savings (£) | 8651<br>(5000) | 14938<br>(8000) | 10485<br>(5000) | 14014<br>(7500) |
| Consumer credit debt (£) | 2816<br>(1320) | 9006<br>(6830) | 3090<br>(1700) | 9958<br>(8000) |
| Co-Holding (£) | 1207<br>(1000) | 6001<br>(5000) | 1609<br>(1300) | 6507<br>(5000) |
| Credit constrained (= 1) | 0.10 | 0.10 | 0.08 | 0.13 |
| *Income and Expenditure Risk* | | | | |
| Expects to be unemployed (= 1) | 0.08 | 0.10 | 0.09 | 0.10 |
| Likely to borrow more in future (= 1) | 0.12 | 0.08 | 0.09 | 0.11 |
| *Behavioural Characteristics* | | | | |
| Literacy score (0–3) | 1.88 | 2.09 | 1.96 | 2.04 |
| Impulsive spender (= 1) | 0.20 | 0.24 | 0.20 | 0.25 |
| Heavy discounter (= 1) | 0.10 | 0.14 | 0.09 | 0.16 |
| Observations | 136 | 163 | 164 | 135 |

*Definitions:* (1) 'Co-Holding' is constructed as the minimum of liquid savings (minus one month's disposable income) and consumer credit. (2) 'Co-Holding Cost' is calculated as the incurred credit charge plus interest foregone by co-holding.

*Note:* Mean values reported, medians in parentheses for financial variables. *Source*: YouGov Debt Tracker September 2010.

TABLE 3 Consumer Credit Portfolios for Co-Holders

| | Co-Holding £250–£2000 | Co-Holding > £2000 |
|---|---|---|
| *Consumer credit debt (£)* | 2816 | 9006 |
| Credit Card (£) | 1472 | 2696 |
| Store Card (£) | 72 | 98 |
| Personal Loan (£) | 360 | 2820 |
| Overdraft (£) | 383 | 634 |
| Hire-Purchase Agreement (£) | 160 | 400 |
| Car Loan (£) | 257 | 2067 |
| Mail Order Catalogue (£) | 49 | 21 |
| Other Loan (£) | 50 | 260 |
| Observations | 136 | 163 |

*Note:* Mean values reported.
*Source:* YouGov Debt Tracker September 2010.

£500 per annum. Households in the higher-cost co-holding group have higher mean financial literacy scores (0.08 points difference) plus a 5% higher proportion of being impulsive spenders compared with the lower cost co-holding group. Higher-cost co-holders also have higher mean household income (37% higher) and higher rates of home ownership (6 pp).

## 4.2 ECONOMETRIC RESULTS

The summary statistics from the previous section indicate that co-holding households are more likely to report self-control problems and also exhibit higher levels of financial literacy, especially compared with borrowers. However, cross-group comparisons show households of the different types also differ in terms of demographic-, income- and other characteristics. I now present estimates from a series of multivariate econometric models which condition on these covariates.

### 4.2.1 Probit Estimates

The baseline estimates of Equation 1 are presented in Table 4, which shows estimates for two specifications. In the first, the dependent variable is a 1/0 dummy variable indicating co-holding of at least £1,000 (Column 1), in the second a 1/0 dummy variable indicating co-holding of at least £2,000 (Column 2).

Turning first to covariates, results show no strong relationship between co-

TABLE 4 Probit Model for Characteristics of Co-Holders

| | (1) Co-Holding > £1000 | | (2) Co-Holding > £2000 | |
|---|---|---|---|---|
| | $\beta$ / SE | Margin | $\beta$ / SE | Margin |
| *Age* | | | | |
| 18–24 | −0.481** | −0.075** | −0.716** | −0.081** |
| | (0.216) | | (0.308) | |
| 25–34 | −0.117 | −0.018 | −0.039 | −0.004 |
| | (0.120) | | (0.135) | |
| 35–44 | −0.055 | −0.009 | −0.006 | −0.001 |
| | (0.111) | | (0.123) | |
| 55+ | 0.090 | 0.014 | 0.223* | 0.025* |
| | (0.116) | | (0.131) | |
| *Employment* | | | | |
| Employed (= 1) | 0.104 | 0.016 | 0.121 | 0.014 |
| | (0.096) | | (0.108) | |
| Unemployed (= 1) | −0.136 | −0.021 | 0.024 | 0.003 |
| | (0.218) | | (0.237) | |
| *Housing* | | | | |
| Homeowner without mortgage (= 1) | 0.035 | 0.005 | 0.067 | 0.008 |
| | (0.121) | | (0.138) | |
| Homeowner with mortgage (= 1) | 0.237** | 0.037** | 0.248** | 0.028** |
| | (0.099) | | (0.113) | |
| *Household Finances* | | | | |
| Household income (£10,000s) | 0.447 | 0.070 | 0.631 | 0.071 |
| | (0.345) | | (0.403) | |
| Household income$^2$ | −0.142 | −0.022 | −0.179 | −0.020 |
| | (0.121) | | (0.137) | |
| *Income and Expenditure Risk* | | | | |
| Expects to be unemployed (= 1) | 0.003 | 0.000 | −0.070 | −0.008 |
| | (0.129) | | (0.146) | |
| Likely to borrow more in future (= 1) | −0.011 | −0.002 | 0.043 | 0.005 |
| | (0.128) | | (0.141) | |
| *Behavioural Characteristics* | | | | |
| Literacy score (0–3) | 0.038 | 0.006 | 0.055 | 0.006 |
| | (0.039) | | (0.044) | |
| Impulsive spender (= 1) | 0.435*** | 0.068*** | 0.430*** | 0.048*** |
| | (0.100) | | (0.111) | |
| Heavy discounter (= 1) | 0.110 | 0.017 | 0.085 | 0.010 |
| | (0.118) | | (0.131) | |
| Observations | 2584 | | 2584 | |
| Pseudo $R^2$ | 0.060 | | 0.084 | |
| LR chi2 | 98.947 | | 111.463 | |
| Prob > chi2 | 0.000 | | 0.000 | |
| Baseline predicted probability | 0.098 | | 0.072 | |

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses. Average marginal effects.

*Note:* Omitted reference groups are, for *Employment:* Renter/Student/Housewife/Disabled; for *Housing:* Private renter/Social renter. Further controls for spouse employment status, gender, marital status, dependent children and education leaving age.

*Source:* YouGov Debt Tracker September 2010.

holding and age. In Column 1 younger households aged 18–24 are 0.075 pp less likely to co-hold compared with the omitted age group (44–55). Against a baseline probability of 9.8% this equates to a 77% reduction in likelihood. However, in my cross-sectional data I cannot distinguish age from cohort effects, and young households may have less opportunity to co-hold because of potentially lower availability of credit.

Among other covariates, the indicator variable for being a mortgaged homeowner is positive and statistically significant, the marginal effect implying mortgaged home owners are 38% more likely to co-hold. Compared to renters and outright homeowners, co-holding of mortgage holders may in part be related to liquid savings needs for refinancing or precaution for mortgage repayments. This may be relevant in the sample period (October 2010), during which uncertainties in the mortgage refinancing market and over the future path of mortgage interest rates were raised. These patterns in covariates are very similar in Column 2.

The coefficient on the financial literacy score is positive in both specifications, but not statistically significant. This indicates that there is no evidence for co-holding being associated with financial ignorance. The coefficient on the impulsive spender indicator variable is positive and statistically significant at the 1% level in both specifications. The magnitude of the marginal effect evaluated against the baseline probability is 69% in Column 1, 67% in Column 2. The very similar coefficient in the Column 2 specification shows the relationship between impulsiveness and co-holding is also strong at high levels of co-holding.

The heavy discounter variable is not significant in either specification, implying that co-holding is not simply explained by time preference. The coefficients on the variables measuring unemployment expectations and expected future additional borrowing are also not statistically significant in both specifications. These results provide no evidence for perceived predictable labour income risk or predictable dependency on credit explaining co-holding. They do not, however, rule out the possibility that unpredictable idiosyncratic risks or expenditure risks give rise to co-holding behaviour.

Table 5 presents additional estimates in which the dependent variable is in each case an indicator variable for the level of cost of co-holding. Again, there is no strong and significant age profile (apart from the 18–24 age bracket) or education leaving age profile in co-holding. Co-holding at a cost of more than £100 increases in likelihood with employment in Column 1, but the coefficient on the employed dummy is not significant in either specification for higher-cost co-holding. The coefficient on the mortgaged homeownership dummy is positive and statistically significant for co-holding at a cost of more than £100 and at a cost of more than £500, but not for co-holding at a cost of more than £1,000.

TABLE 5 Probit Model for Characteristics of Costly Co-Holders

| | (1) Co-Holding Cost > £100 | | (2) Co-Holding Cost > £500 | | (3) Co-Holding Cost > £1000 | |
|---|---|---|---|---|---|---|
| | $\beta$ / SE | Margin | $\beta$ / SE | Margin | $\beta$ / SE | Margin |
| *Age* | | | | | | |
| 18–24 | −0.376** | −0.069** | −0.573* | −0.049* | −0.761* | −0.022* |
| | (0.191) | | (0.312) | | (0.440) | |
| 25–34 | −0.080 | −0.015 | −0.104 | −0.009 | −0.478** | −0.014** |
| | (0.113) | | (0.151) | | (0.239) | |
| 35–44 | −0.078 | −0.014 | 0.077 | 0.007 | 0.033 | 0.001 |
| | (0.106) | | (0.132) | | (0.189) | |
| 55+ | 0.006 | 0.001 | 0.153 | 0.013 | 0.174 | 0.005 |
| | (0.110) | | (0.148) | | (0.209) | |
| *Employment* | | | | | | |
| Employed (= 1) | 0.176* | 0.032* | 0.046 | 0.004 | 0.131 | 0.004 |
| | (0.091) | | (0.121) | | (0.178) | |
| Unemployed (= 1) | −0.041 | −0.007 | −0.091 | −0.008 | 0.267 | 0.008 |
| | (0.198) | | (0.271) | | (0.339) | |
| *Housing* | | | | | | |
| Homeowner without mortgage (= 1) | 0.022 | 0.004 | 0.028 | 0.002 | 0.001 | 0.000 |
| | (0.113) | | (0.156) | | (0.212) | |
| Homeowner with mortgage (= 1) | 0.206** | 0.038** | 0.219* | 0.019* | −0.101 | −0.003 |
| | (0.093) | | (0.124) | | (0.182) | |
| *Household Finances* | | | | | | |
| Household income (£10,000s) | 0.373 | 0.068 | 0.290 | 0.025 | −0.417 | −0.012 |
| | (0.322) | | (0.435) | | (0.701) | |
| Household income$^2$ | −0.143 | −0.026 | −0.062 | −0.005 | 0.183 | 0.005 |
| | (0.114) | | (0.148) | | (0.260) | |
| *Income and Expenditure Risk* | | | | | | |
| Expects to be unemployed (= 1) | −0.015 | −0.003 | −0.010 | −0.001 | −0.030 | −0.001 |
| | (0.123) | | (0.157) | | (0.229) | |
| Likely to borrow more in future (= 1) | 0.017 | 0.003 | 0.074 | 0.006 | 0.062 | 0.002 |
| | (0.121) | | (0.152) | | (0.218) | |
| *Behavioural Characteristics* | | | | | | |
| Literacy score (0–3) | 0.039 | 0.007 | 0.014 | 0.001 | −0.068 | −0.002 |
| | (0.037) | | (0.049) | | (0.069) | |
| Impulsive spender (= 1) | 0.409*** | 0.075*** | 0.389*** | 0.033*** | 0.636*** | 0.018*** |
| | (0.096) | | (0.120) | | (0.160) | |
| Heavy discounter (= 1) | 0.046 | 0.008 | 0.162 | 0.014 | −0.026 | −0.001 |
| | (0.115) | | (0.139) | | (0.209) | |
| Observations | 2584 | | 2584 | | 2584 | |
| Pseudo $R^2$ | 0.047 | | 0.092 | | 0.157 | |
| LR chi2 | 87.926 | | 96.976 | | 82.213 | |
| Prob > chi2 | 0.000 | | 0.000 | | 0.000 | |
| Baseline predicted probability | 0.116 | | 0.052 | | 0.021 | |

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses. Average marginal effects.

*Note:* Omitted reference groups are, for *Employment:* Renter/Student/Housewife/Disabled; for *Housing:* Private renter/Social renter. Further controls for spouse employment status, for gender, marital status, dependent children and education leaving age.

*Source:* YouGov Debt Tracker September 2010.

TABLE 6 Probit Model Sensitivity Check

| | (1) Co-Holding > £1000 | | (2) Co-Holding > £2000 | |
|---|---|---|---|---|
| | $\beta$ / SE | Margin | $\beta$ / SE | Margin |
| Literacy Score = 1 | −0.002 | −0.000 | 0.104 | 0.012 |
| | (0.143) | | (0.169) | |
| Literacy Score = 2 | 0.181 | 0.028 | 0.238 | 0.027 |
| | (0.140) | | (0.166) | |
| Literacy Score = 3 | 0.072 | 0.011 | 0.189 | 0.021 |
| | (0.144) | | (0.168) | |
| Impulsive = Agree | 0.441*** | 0.069*** | 0.404*** | 0.045*** |
| | (0.120) | | (0.132) | |
| Impulsive = Disagree | −0.037 | −0.006 | −0.068 | −0.008 |
| | (0.096) | | (0.107) | |

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses. Average marginal effects.

*Note:* Omitted groups are, for *Financial Literacy:* zero correct answers; for *Impulsiveness:* Neither disagree nor agree. Further controls as in Table 4.

*Source:* YouGov Debt Tracker September 2010.

The sign, magnitude and statistical significance of the behavioural characteristics variables are very similar to the previous results. The financial literacy score is not statistically significant in any of the specifications. Co-holding at all levels of cost increases in likelihood with impulsiveness. The magnitudes of the marginal effects on the impulsive spender dummy variable are again large: the implied effects are 65% in Column 1, 63% in Column 2 and 86% in Column 3. The coefficients on the heavy discounter variable are again not statistically significant. Also, neither the unemployment expectation variable nor the anticipated future borrowing variable are significant in these estimates.

For robustness, in Table 6 I also re-estimate the specifications from Table 4 to allow more flexibility in the relationship between financial literacy, impulsiveness and co-holding. I augment the specification by entering the financial literacy score as a series of dummy variables instead of one continuous 0–3 variable (literacy score = 1, literacy score = 2, literacy score =3, omitted group literacy score = 0). Similarly, the impulsive spender measure enters as two dummy variables (impulsive = agree and impulsive = disagree, omitted group = neither agree nor disagree) instead of one 1/0 dummy variable taking a value of one for agree and zero otherwise. As before, none of the literacy score variables are statistically significant. The impulsive = agree variable is statistically significant at the 1% level of significance in each of the specifications and the magnitude of the coefficients are very similar to before, whereas the impulsive = disagree variable is not significant in each specification. These results confirm the pattern seen in the coefficient estimates in Tables 4 and 5 that co-holding is unrelated to financial literacy, but increases in likelihood with self-reported impulsiveness.

### 4.2.2 Tobit Estimates

I now present results from estimated models which explain the extent of co-holding. Table 7 shows results from two Tobit models where the dependent variable is the continuous level of co-holding (Column 1) and the continuous cost incurred due to co-holding (Column 2). Households with no co-holding are assigned a value of zero. The co-holding value is the minimum value of consumer credit or liquid savings. The set of covariates included in the model is identical to that in the previous tables, as is the inclusion of the variables capturing behavioural characteristics.

Results from estimated models in both columns are very similar, and reveal the same pattern in the coefficients as those seen in the previous estimates. The level of co-holding is increasing in employment and mortgaged homeownership and decreasing with the youngest age group. The coefficient on the financial literacy score is positive but not statistically significant in either specification.

The coefficient on the impulsive spender indicator variable is positive and statistically significant at the 1% level. The coefficient value in Column 1 implies that impulsive spending, evaluated at the means of covariates, is associated with approximately £3,100 of co-holding. The coefficient value on the impulsive spender variable in Column 2, again evaluated at the means of covariates, implies impulsive spending is associated with approximately £550 of interest costs due to co-holding. As with the results in the previous tables, the coefficients on the unemployment expectation and credit use expectation variables are both statistically not significant.

For robustness, I again estimate all models where both literacy score and impulsiveness are included as dummies (Table 8). These alternative specifications do not alter the results: in the case of financial literacy answering one, two or three questions correctly is not statistically significant relative to the omitted group of zero questions answered correctly; in the case of impulsiveness, agreeing is significant at the one percent level and negative relative to the baseline of neither agreeing nor disagreeing.

### 4.2.3 Estimates for Alternative Comparison Groups

The results presented so far show that impulsiveness is positively and significantly associated with co-holding. However, these estimates do not allow me to conclude that impulsiveness is particularly associated with co-holding as distinct from borrowing. It could be argued that the relationship I observe is between

TABLE 7 Tobit Models of Amount of Co-Holding and Costly Co-Holding

| | (1) Amount of Co-Holding $\beta$ / SE | (2) High-Cost Co-Holding $\beta$ / SE |
|---|---|---|
| *Age* | | |
| 18–24 | −2094.408* | −410.025* |
| | (1184.930) | (217.459) |
| 25–34 | −524.499 | −77.198 |
| | (714.736) | (130.778) |
| 35–44 | −527.080 | −102.309 |
| | (672.894) | (123.671) |
| 55+ | 149.643 | 21.904 |
| | (713.826) | (131.001) |
| *Employment* | | |
| Employed (= 1) | 1306.946** | 243.322** |
| | (590.621) | (108.342) |
| Unemployed (= 1) | −173.968 | −49.392 |
| | (1273.566) | (234.672) |
| *Housing* | | |
| Homeowner without mortgage (= 1) | −88.624 | −33.466 |
| | (741.150) | (135.647) |
| Homeowner with mortgage (= 1) | 1343.101** | 211.109* |
| | (594.864) | (108.797) |
| *Household Finances* | | |
| Household income (£10,000s) | 2193.200 | 458.534 |
| | (2098.595) | (386.943) |
| Household income$^2$ | −721.241 | −157.487 |
| | (738.084) | (136.608) |
| *Income and Expenditure Risk* | | |
| Expects to be unemployed (= 1) | −632.520 | −112.658 |
| | (793.446) | (145.257) |
| Likely to borrow more in future (= 1) | −7.057 | −11.284 |
| | (763.864) | (139.996) |
| *Behavioural Characteristics* | | |
| Literacy score (0–3) | 264.091 | 38.502 |
| | (238.861) | (43.761) |
| Impulsive spender (= 1) | 3079.628*** | 548.851*** |
| | (611.085) | (111.971) |
| Heavy discounter (= 1) | 628.697 | 187.208 |
| | (719.285) | (130.676) |
| Observations | 2584 | 2584 |
| Pseudo $R^2$ | 0.019 | 0.021 |
| LR chi2 / F | 158.948 | 151.225 |
| Prob > chi2 / Prob > F | 0.000 | 0.000 |
| Baseline Co-Holding (£) | 462.148 | 82.613 |

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses.

*Dependent Variable:* (1) Minimum amount of co-Holding with lower limit of £0, (2) Amount of high-cost co-holding with lower limit of £0.

*Note:* Omitted reference groups are, for *Employment:* Renter/Student/Housewife/Disabled; for *Housing:* Private renter/Social renter. Further controls for spouse employment status, for gender, marital status, dependent children and education leaving age.

*Source:* YouGov Debt Tracker September 2010.

TABLE 8 Tobit Models Sensitivity Check

| | (1) Tobit $\beta$ / SE | (2) Tobit $\beta$ / SE |
|---|---|---|
| Literacy Score = 1 | 422.119 | 108.694 |
| | (870.572) | (159.658) |
| Literacy Score = 2 | 1156.981 | 234.611 |
| | (861.323) | (158.148) |
| Literacy Score = 3 | 775.261 | 136.708 |
| | (877.274) | (161.187) |
| Impulsive = Agree | 2750.776*** | 456.256*** |
| | (716.359) | (130.418) |
| Impulsive = Disagree | −695.649 | −195.341* |
| | (571.170) | (103.865) |

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses.

*Dependent Variable:* (1) Minimum amount of co-Holding with lower limit of £0, (2) Amount of high-cost co-holding with lower limit of £0.

*Note:* Omitted groups are, for *Financial Literacy:* zero correct answers; for *Impulsiveness:* Neither disagree nor agree. Further controls as in Table 7.

*Source:* YouGov Debt Tracker September 2010.

impulsiveness and borrowing and that, as borrowing is one aspect of co-holding, is what explains the positive association between impulsiveness and co-holding. The summary statistics show that both borrowers and co-holders have high levels of debt and are more likely to be impulsive.

To empirically distinguish the behavioural differences which are associated with co-holding distinct from borrowing I re-estimate a further series of probit models in which I reconfigure the control group of observations in the zero category to be borrowers only. The coefficient estimates in this revised specification predict the likelihood of a household co-holding compared with borrowing. I also estimate models for comparison with the controls groups set as the 'neither/nor' group and the savers group plus an additional comparison group which combines these groups (as the 'neither/nor' group are probably low-level savers).

Table 9 reports estimates from these additional specifications. In Column 1, where the control is borrowers, the coefficient on the financial literacy score is positive and statistically significant. The marginal effect on the literacy score implies a one-point increase in literacy raises the likelihood of co-holding by 10%. The coefficient on the 'expects to be unemployed' variable is statistically not significant and the coefficient on the 'likely to borrow more in future' variable is negative and statistically significant. These imply that co-holding versus borrowing does not arise due to an expectation of unemployment and is negatively related to the expectation of requiring additional borrowing in future. The result that co-holding is predicted by better financial literacy lends some support to the

notion that co-holding arises as a planned behaviour.

Columns 2 and 3 present results where the comparison groups are savers and the 'neither/nor' group, respectively. Results in Column 2 show that impulsiveness strongly predicts co-holding compared with saving alone. Importantly, impulsiveness predicts co-holding when I include a measure of impatience in the form of the 'heavy discounter' variable. The coefficient on the literacy score in statistically not significant implying co-holding compared with saving is not predicted by poor financial literacy. In contrast, results in Column 3 show co-holding compared with 'neither/'nor' is predicted by both financial literacy and impulsiveness. In additional estimates not shown, when I combine the 'neither/nor' and savers groups, I find almost identical patterns to the 'standard' savers groups: the coefficient on the financial literacy variable is positive, but not statistically significant and the coefficient on the impulsive spender dummy is positive and statistically significant at the 1% level, the marginal effect indicating impulsiveness is associated with a 86% probability of being a co-holder.

I also report estimates from an unordered multinomial probit model shown in Table 10. The multinomial probit model explicitly models assignment into each of the groups, in contrast to the estimates in Table 9 which only model the bivariate relationship between co-holding and one of the other group categories. In the multinomial probit model the base is the co-holder group. Results confirm the pattern in the earlier models for financial literacy and impulsiveness. Compared with being a co-holder, financial literacy is positively associated with being a saver and negatively related to being a borrower or 'neither/nor'. Being an impulsive spender is negatively related to being a saver or 'neither/nor' but positively related to being a borrower. When I combine the 'neither/nor' and savers groups I again find the same pattern in the coefficient estimates with similar magnitudes.

TABLE 9 Probit Models of Co-Holders vs Different Comparison Groups

| | (1) Control: Borrower | | (2) Control: Saver | | (3) Control: Neither-Nor | |
|---|---|---|---|---|---|---|
| | $\beta$ / SE | Margin | $\beta$ / SE | Margin | $\beta$ / SE | Margin |
| *Age* | | | | | | |
| 18–24 | −0.452* | −0.167* | −0.458* | −0.133* | −0.377 | −0.116 |
| | (0.266) | | (0.245) | | (0.245) | |
| 25–34 | −0.142 | −0.052 | −0.042 | −0.012 | −0.000 | −0.000 |
| | (0.157) | | (0.146) | | (0.147) | |
| 35–44 | −0.013 | −0.005 | −0.007 | −0.002 | −0.025 | −0.008 |
| | (0.147) | | (0.137) | | (0.139) | |
| 55+ | 0.195 | 0.072 | 0.015 | 0.004 | 0.049 | 0.015 |
| | (0.164) | | (0.141) | | (0.141) | |
| *Employment* | | | | | | |
| Employed (= 1) | −0.159 | −0.059 | 0.220* | 0.064* | 0.185 | 0.057 |
| | (0.139) | | (0.115) | | (0.114) | |
| Unemployed (= 1) | −0.310 | −0.115 | 0.052 | 0.015 | −0.279 | −0.086 |
| | (0.292) | | (0.271) | | (0.245) | |
| *Housing* | | | | | | |
| Homeowner without mortgage (= 1) | 0.713*** | 0.263*** | −0.228 | −0.066 | −0.026 | −0.008 |
| | (0.176) | | (0.142) | | (0.140) | |
| Homeowner with mortgage (= 1) | 0.382*** | 0.141*** | 0.132 | 0.038 | 0.194 | 0.060 |
| | (0.129) | | (0.118) | | (0.119) | |
| *Household Finances* | | | | | | |
| Household income (£10,000s) | 0.444 | 0.164 | 0.603 | 0.175 | 1.588** | 0.487** |
| | (0.624) | | (0.397) | | (0.682) | |
| Household income$^2$ | −0.119 | −0.044 | −0.217 | −0.063 | −0.758** | −0.233** |
| | (0.242) | | (0.140) | | (0.304) | |
| *Income and Expenditure Risk* | | | | | | |
| Expects to be unemployed (= 1) | 0.192 | 0.071 | −0.079 | −0.023 | 0.093 | 0.028 |
| | (0.175) | | (0.154) | | (0.160) | |
| Likely to borrow more in future (= 1) | −0.366** | −0.135** | 0.303* | 0.088* | 0.094 | 0.029 |
| | (0.148) | | (0.174) | | (0.159) | |
| *Behavioural Characteristics* | | | | | | |
| Literacy score (0–3) | 0.120** | 0.044** | −0.058 | −0.017 | 0.137*** | 0.042*** |
| | (0.055) | | (0.049) | | (0.046) | |
| Impulsive spender (= 1) | 0.069 | 0.026 | 0.745*** | 0.216*** | 0.579*** | 0.178*** |
| | (0.123) | | (0.131) | | (0.127) | |
| Heavy discounter (= 1) | −0.115 | −0.043 | 0.305* | 0.088* | 0.060 | 0.018 |
| | (0.146) | | (0.156) | | (0.153) | |
| Observations | 790 | | 1232 | | 1160 | |
| Pseudo $R^2$ | 0.120 | | 0.094 | | 0.105 | |
| LR chi2 | 124.315 | | 126.088 | | 136.744 | |
| Prob > chi2 | 0.000 | | 0.000 | | 0.000 | |
| Baseline predicted probability | 0.427 | | 0.254 | | 0.260 | |

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses. Average marginal effects.

*Dependent Variable:* Binary co-holder variable.

*Note:* Omitted reference groups are, for *Employment:* Renter/Student/Housewife/Disabled; for *Housing:* Private renter/Social renter. Further controls for spouse employment status, for gender, marital status, dependent children and education leaving age.

*Source:* YouGov Debt Tracker September 2010.

TABLE 10 Multinomial Probit Model (Marginal Effects)

| | (1) Outcome: Borrower Margin / SE | (2) Outcome: Saver Margin / SE | (3) Outcome: Neither-Nor Margin / SE |
|---|---|---|---|
| *Age* | | | |
| 18–24 | −0.011 | 0.065 | 0.008 |
| | (0.035) | (0.050) | (0.048) |
| 25–34 | 0.000 | 0.047 | −0.040 |
| | (0.024) | (0.036) | (0.034) |
| 35–44 | −0.009 | 0.018 | 0.007 |
| | (0.023) | (0.035) | (0.033) |
| 55+ | −0.038 | 0.040 | 0.002 |
| | (0.025) | (0.034) | (0.032) |
| *Employment* | | | |
| Employed (= 1) | 0.075*** | −0.072*** | −0.047* |
| | (0.020) | (0.027) | (0.025) |
| Unemployed (= 1) | 0.047 | −0.133** | 0.097* |
| | (0.039) | (0.057) | (0.051) |
| *Housing* | | | |
| Homeowner without mortgage (= 1) | −0.167*** | 0.154*** | 0.018 |
| | (0.025) | (0.033) | (0.031) |
| Homeowner with mortgage (= 1) | −0.071*** | 0.042 | −0.018 |
| | (0.019) | (0.029) | (0.027) |
| *Household Finances* | | | |
| Household income (£10,000s) | 0.037 | −0.043 | −0.159 |
| | (0.074) | (0.108) | (0.147) |
| Household income$^2$ | −0.031 | −0.008 | 0.108 |
| | (0.030) | (0.046) | (0.070) |
| *Income and Expenditure Risk* | | | |
| Expects to be unemployed (= 1) | −0.045 | 0.069* | −0.008 |
| | (0.028) | (0.040) | (0.038) |
| Likely to borrow more in future (= 1) | 0.134*** | −0.154*** | −0.004 |
| | (0.024) | (0.042) | (0.037) |
| *Behavioural Characteristics* | | | |
| Literacy score (0–3) | −0.016** | 0.068*** | −0.061*** |
| | (0.008) | (0.011) | (0.011) |
| Impulsive spender (= 1) | 0.093*** | −0.153*** | −0.055* |
| | (0.021) | (0.035) | (0.032) |
| Heavy discounter (= 1) | 0.073*** | −0.092** | −0.007 |
| | (0.024) | (0.039) | (0.036) |
| Observations | 2584 | 2584 | 2584 |
| Baseline predicted probability | 0.170 | 0.362 | 0.333 |

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. Average marginal effects.

*Base Group:* Outcome 'Co-holder'.

*Note:* Omitted reference groups are, for *Employment:* Renter/Student/Housewife/Disabled; for *Housing:* Private renter/Social renter. Further controls for spouse employment status, for gender, marital status, dependent children and education leaving age.

*Source:* YouGov Debt Tracker September 2010.

# 5

# DISCUSSION & CONCLUSION

Co-holding is a violation of a simple arbitrage opportunity between liquid assets and debt on the part of households in their consumer finances. It has given rise to a puzzle in the household finance literature: why does a subset of households hold high cost consumer credit and low yield liquid savings simultaneously? Various explanations have been suggested as to why consumers engage in this behaviour. In this chapter, I have provided new empirical evidence on the role of financial literacy and lack of self-control (or impulsiveness) in co-holding. The following paragraphs discuss the main contributions of the chapter and set the results into the context of the literature.

Firstly, I provide new evidence on the characteristics of co-holders. I find that co-holding is prevalent among 12% of the households in the sample, many of whom hold many thousands of pounds of liquid savings and consumer credit simultaneously, costing the household hundreds of pounds each year. Co-holding households have relatively complex portfolios of consumer credit, including credit cards, instalment loans and flexible options such as overdrafts. Co-holding households hold a range of credit items which could be repaid or pre-paid without incurring financial charges.

Secondly, I estimate a series of econometric models which relate the measures of financial literacy and impulsiveness to the likelihood and magnitude of co-holding and control for a broad set of covariates and test the sensitivity of the analysis to different levels of co-holding. The results show that impulsiveness positively predicts co-holding. In the sample, in which approximately one quarter of co-holding households report impulsive spending behaviour, estimates imply that a household which exhibits impulsiveness in spending decisions is approximately 70% more likely to co-hold at least £1,000 of consumer credit. Estimates also imply that among co-holders impulsiveness is associated with co-holding approximately £3,100, on average, equivalent to foregoing £550 in interest payments per annum. I test the robustness of my findings to a variety of specifications.

Thirdly, by splitting the sample into four different groups depending on their saving-borrowing behaviour, I find that households in the co-holding group are typically more educated, more likely to have both household head and their spouse employed, have higher incomes and are more likely to be home-owners.

Co-holders are on average better at answering the financial literacy questions used to measure financial literacy. However, they are also much more likely to report being impulsive in their spending decisions. By varying control groups and estimating a multinomial model I show that these differences across groups are significant: self-control positively predicts co-holding compared with saving or holding neither assets nor debt. Self-control does not predict co-holding compared with borrowing, but financial literacy does raise the likelihood of co-holding. Savers and co-holders are indistinct with regards to financial literacy, but co-holders exhibit significantly less self-control.

Fourthly, I incorporate self-reported measures of income risk into the analysis and show that co-holding is not explained by anticipated future income variability which might induce precautionary saving behaviour on the part of the household in the face of perceived income risk. Co-holders, on average, self-report rates of expected unemployment similar to non-co-holders and average rates of expected future additional credit use below those of borrowers, who do not co-hold liquid savings. The econometric analysis finds no evidence for future income- or expenditure risk increasing the likelihood of co-holding. I also incorporate measures of credit constraints which do not alter the results.

How should we understand these results on the role of behavioural characteristics in co-holding? The results show co-holding is positively associated with self-reported impulsive spending on the part of respondents, which increases the probability of co-holding by between two thirds and more than three quarters. However, there is no evidence that respondents who report co-holding significantly misunderstand interest rates, interest compounding and (non-amortisation), some of the central tenets of consumer finance. Poor financial literacy does not predict co-holding and estimates show financial literacy increases the likelihood of co-holding as an alternative to borrowing.

This gives empirical support for the notion that co-holding arises as an activity undertaken by financially aware households who tend to be impulsive in their spending, but have financial understanding such that they hold consumer credit balances as a means of controlling their behaviour. This lends some support to the accountant-shopper explanation for co-holding suggested by Bertaut et al. (2009). In their model co-holding is a rational response to the realisation of impulsive spending tendencies and is dependent on consumers being able to correctly predict that their future selves will not conform the preferences of their present selves. This is consistent with the results that show the strong predictive power of self-assessed impulsiveness on co-holding. At the same time, their model does not depend on limited financial ability as the co-holding equilibrium is generated even though both entities of the dual-self are fully financially aware, which again

is consistent with the findings that poor financial literacy does not predict co-holding.

However, support from my results for the accountant-shopper explanation for co-holding should be offered with caveats. Firstly, in the sample only one quarter of co-holding households report impulsive spending, so an explanation for co-holding based on impulsiveness can only explain some of the observed co-holding in the data. Secondly, although my estimates include measures of perceived predictable unemployment- and income risk and I account for liquidity- and precautionary needs by allowing for a buffer of one-month's income, I cannot rule out the possibility that unpredictable idiosyncratic risk contributes to co-holding. Thirdly, financial literacy is measured by testing understanding of interest rates and amortisation. This is related to cost of credit, but does not provide a measurement of the type of sophistication required to use co-holding as a deliberate self-control device.

Furthermore, my cross-sectional data does not allow me to observe whether co-holding among sample households is a temporary or persistent phenomenon. This distinction is important for understanding whether impulsiveness is a short-term or long-term driver of co-holding and whether it occurs as a planned behaviour or short-term financial mistake. Panel data would allow for additional insight into the dynamics of co-holding. Finally, I cannot rule out the possibility that other explanations for co-holding (such as precautionary liquidity management) might interact with financial literacy and/or impulsiveness.

However, the results on the relationship between financial literacy and co-holding do provide an example of how the observed relationship between financial literacy and financial behaviour might create surprising counter-intuitive results. The financial literacy literature typically finds that better financial literacy is associated with better financial outcomes such as more adequate preparation for retirement, portfolio diversification and use of lower-cost credit. In my analysis, among borrowers, better financial literacy is associated with co-holding behaviour which appears suboptimal, but which may actually be beneficial for consumers.

The results do not provide a complete explanation for co-holding or unambiguous support for the Bertaut et al. (2009) accountant-shopper model. Instead, they show that behavioural characteristics are important in explaining some of the observed prevalence of co-holding in the data. In doing so, this chapter contributes to the existing literature on whether consumers behave rationally in credit markets (Bernheim, 1995; Agarwal et al., 2006; Campbell, 2006; Agarwal et al., 2009).

The results are also relevant to the literature on financial literacy and individual behaviour (Bernheim, 1998; Lusardi, 2008; Jappelli, 2010) and more generally to

the literature on the role of self-control problems in shaping individual behaviour related to financial decision making (Strotz, 1955; Thaler & Shefrin, 1981; Laibson, 1997; Gul & Pesendorfer, 2001; Benhabib & Bisin, 2005; Fudenberg & Levine, 2006; Heidhues & Kőszegi, 2010).

# BIBLIOGRAPHY


AGARWAL, S., CHOMSISENGPHET, S., LIU, C. & SOULELES, N.S. (2006). 'Do Consumers Choose the Right Credit Contracts?' *Federal Reserve Bank of Chicago Working Paper*.

AGARWAL, S., DRISCOLL, J., GABAIX, X. & LAIBSON, D. (2009). 'The Age of Reason: Financial Decisions over the Life Cycle and Implications for Regulation'. *Brookings Papers on Economic Activity*, 2009(2), pp. 51–117.

AMERIKS, J., CAPLIN, A. & LEAHY, J. (2003). 'Wealth Accumulation and the Propensity to Plan'. *The Quarterly Journal of Economics*, 118(3), pp. 1007–1047.

AMERIKS, J., CAPLIN, A., LEAHY, J. & TYLER, T. (2007). 'Measuring Self-Control Problems'. *American Economic Review*, 97(3), pp. 966–972.

ANGELETOS, G.-M., LAIBSON, D., REPETTO, A., TOBACMAN, J. & WEINBERG, S. (2001). 'The Hyperbolic Consumption Model: Calibration, Simulation, and Empirical Evaluation'. *Journal of Economic Perspectives*, 15(3), pp. 47–68.

BANK OF ENGLAND (2012). 'Lending to Individuals - September 2012'. *Statistical Release*.

BARTUS, T. (2005). 'Estimation of marginal effects using margeff'. *The Stata Journal*, 5(3), pp. 309–329.

BENHABIB, J. & BISIN, A. (2005). 'Modeling internal commitment mechanisms and self-control: A neuroeconomics approach to consumption-saving decisions'. *Games and Economic Behavior*, 52(2), pp. 460–492.

BERNHEIM, B. (1995). 'Do Households Appreciate Their Financial Vulnerabilities? An Analysis of Actions, Perceptions, and Public Policy'. In: *Tax Policy and Economic Growth*. Washington, DC: American Council for Capital Formation, pp. 1–30.

— (1998). 'Financial illiteracy, education, and retirement saving'. In: *Living with Defined Contribution Pensions*. Ed. by O.S. MITCHELL & S.J. SCHIEBER. Philadelphia: University of Pennsylvania Press, pp. 36–68.

BERTAUT, C.C., HALIASSOS, M. & REITER, M. (2009). 'Credit Card Debt Puzzles and Debt Revolvers for Self Control'. *Review of Finance*, 13(4), pp. 657–692.

CAMPBELL, J.Y. (2006). 'Household Finance'. *The Journal of Finance*, 61(4), pp. 1553–1604.

CARROLL, C.D. & SAMWICK, A.A. (1997). 'The nature of precautionary wealth'. *Journal of Monetary Economics*, 40(1), pp. 41–71.

CORWIN, S.A. & COUGHENOUR, J.F. (2008). 'Limited Attention and the Allocation of Effort in Securities Trading'. *The Journal of Finance*, 63(6), pp. 3031–3067.

DISNEY, R. & GATHERGOOD, J. (2013). 'Financial literacy and consumer credit portfolios'. *Journal of Banking & Finance*, 37(7), pp. 2246–2254.

DURKIN, T.A. (2000). 'Credit cards: use and consumer attitudes, 1970-2000'. *Federal Reserve Bulletin*, (Sep), pp. 623–634.

FREDERICK, S., LOEWENSTEIN, G. & O'DONOGHUE, T. (2002). 'Time Discounting and Time Preference: A Critical Review'. *Journal of Economic Literature*, 40(2), pp. 351–401.

FUDENBERG, D. & LEVINE, D.K. (2006). 'A Dual-Self Model of Impulse Control'. *American Economic Review*, 96(5), pp. 1449–1476.

FULFORD, S. (2014). 'How important is variability in consumer credit limits?' *Federal Reserve Bank of Boston Working Paper*, 14(8).

GATHERGOOD, J. (2012). 'Self-control, financial literacy and consumer overindebtedness'. *Journal of Economic Psychology*, 33(3), pp. 590–602.

GERDES, G. (2008). 'Recent payment trends in the United States'. *Federal Reserve Bulletin*, 94(October), A75–A106.

GREENE, W.H. (2007). *Econometric Analysis*. 6th ed. Upper Saddle River, New Jersey: Pearson Prentice Hall.

GROSS, D.B. & SOULELES, N.S. (2002). 'Do Liquidity Constraints and Interest Rates Matter for Consumer Behavior? Evidence from Credit Card Data'. *The Quarterly Journal of Economics*, 117(1), pp. 149–185.

GUL, F. & PESENDORFER, W. (2001). 'Temptation and Self-Control'. *Econometrica*, 69(6), pp. 1403–1435.

HALIASSOS, M. & REITER, M. (2005). 'Credit card debt puzzles'. *CFS Working Paper*, 2005(26).

HEIDHUES, P. & KŐSZEGI, B. (2010). 'Exploiting Naïvete about Self-Control in the Credit Market'. *American Economic Review*, 100(5), pp. 2279–2303.

HICKS, J. (1935). 'A suggestion for simplifying the theory of money'. *Economica*, 2(5), pp. 1–19.

JAPPELLI, T. (2010). 'Economic Literacy: An International Comparison'. *The Economic Journal*, 120(548), pp. 429–451.

JAPPELLI, T. & PADULA, M. (2013). 'Investment in financial literacy and saving decisions'. *Journal of Banking & Finance*, 37(8), pp. 2779–2792.

JOHNSON, D.P. & WIDDOWS, R. (1985). 'Emergency fund levels of households'. In: *Proceedings of the 31th Annual Conference of the American Council on Consumer Interest*. Ed. by K.P. SCHNITTGRUND. Columbia, Missouri: American Council on Consumer Interests, pp. 235–241.

LAIBSON, D. (1997). 'Golden Eggs and Hyperbolic Discounting'. *The Quarterly Journal of Economics*, 112(2), pp. 443–478.

LAIBSON, D., REPETTO, A. & TOBACMAN, J. (2003). 'A Debt Puzzle'. In: *Knowledge, Information, and Expectations in Modern Economics: In Honor of Edmund S. Phelps*. Ed. by P. AGHION, R. FRYDMAN, J. STIGLITZ & M. WOODFORD. Princeton: Pinceton University Press, pp. 228–266.

— (2007). 'Estimating Discount Functions with Consumption Choices over the Lifecycle'. *NBER Working Paper*, 13314.

LEHNERT, A. & MAKI, D. (2002). 'Consumption, debt and portfolio choice: testing the effect of bankruptcy law'. *Federal Reserve Board Finance and Economics Discussion Series*, 2002(14).

LUCAS, R.E. (1982). 'Interest rates and currency prices in a two-country world'. *Journal of Monetary Economics*, 10(3), pp. 335–359.

LUCAS, R.E. & STOKEY, N.L. (1987). 'Money and Interest in a Cash-in-Advance Economy'. *Econometrica*, 55(3), pp. 491–513.

LUSARDI, A. & MITCHELL, O.S. (2007). 'Financial Literacy and Retirement Preparedness: Evidence and Implications for Financial Education'. *Business Economics*, 42(1), pp. 35–44.

LUSARDI, A. (2008). 'Financial Literacy: An Essential Tool for Informed Consumer Choice?' *NBER Working Paper*, 14084.

LUSARDI, A. & TUFANO, P. (2009). 'Debt Literacy, Financial Experiences, and Overindebtedness'. *NBER Working Paper*, 14808.

MAKINEN, G. & WOODWARD, G. (1986). 'Some anecdotal evidence relating to the legal restrictions theory of the demand for money'. *The Journal of Political Economy*, 94(2), pp. 260–265.

MEIER, S. & SPRENGER, C.D. (2013). 'Discounting financial literacy: Time preferences and participation in financial education programs'. *Journal of Economic Behavior & Organization*, 95, pp. 159–174.

OFFICE FOR NATIONAL STATISTICS (2014). 'Wealth in Great Britain Wave 3, 2010-2012'. *Wealth and Assets Survey*.

PRELEC, D. & LOEWENSTEIN, G. (1998). 'The Red and the Black: Mental Accounting of Savings and Debt'. *Marketing Science*, 17(1), pp. 4–28.

STROTZ, R.H. (1955). 'Myopia and Inconsistency in Dynamic Utility Maximization'. *The Review of Economic Studies*, 23(3), pp. 165–180.

SVENSSON, L. (1985). 'Money and asset prices in a cash-in-advance economy'. *The Journal of Political Economy*, 93(5), pp. 919–944.

TELYUKOVA, I.A. & WRIGHT, R. (2008). 'A Model of Money and Credit, with Application to the Credit Card Debt Puzzle'. *The Review of Economic Studies*, 75(2), pp. 629–647.

TELYUKOVA, I.A. (2013). 'Household Need for Liquidity and the Credit Card Debt Puzzle'. *The Review of Economic Studies*, 80(3), pp. 1148–1177.

THALER, R.H. & SHEFRIN, H.M. (1981). 'An Economic Theory of Self-Control'. *Journal of Political Economy*, 89(2), pp. 392–406.

THALER, R.H. (1985). 'Mental Accounting and Consumer Choice'. *Marketing Science*, 4(3), pp. 199–214.

ROOIJ, M. VAN, LUSARDI, A. & ALESSIE, R.J. (2011a). 'Financial literacy and retirement planning in the Netherlands'. *Journal of Economic Psychology*, 32(4), pp. 593–608.

— (2011b). 'Financial literacy and stock market participation'. *Journal of Financial Economics*, 101(2), pp. 449–472.

VISCHER, T., DOHMEN, T., FALK, A., HUFFMAN, D., SCHUPP, J., SUNDE, U. & WAGNER, G.G. (2013). 'Validating an ultra-short survey measure of patience'. *Economics Letters*, 120(2), pp. 142–145.

CHAPTER III

# FINANCIAL LITERACY, BEHAVIOURAL CHARACTERISTICS & MORTGAGE CHOICE

## ABSTRACT

I estimate the impact of financial literacy on the decision of a household to borrow via an alternative (non-amortising) mortgage product (AMP) or a standard (repayment) mortgage (SMP), as well as via an adjustable or fixed rate mortgage (ARM vs FRM). I use a representative survey of UK borrowers into which I add a set of test-based measures of financial literacy, specifically developed to test ability of respondents to understand key features of mortgage contracts, as well as measures of key behavioural characteristics. I show that financial literacy and behavioural characteristics are important determinants of mortgage choice. Financially literate households are significantly more likely to hold ARMs, supporting the contention that informed individuals are more willing and able to take on mortgages that involve reviewing options and performance more actively. I find poor literacy households are significantly more likely to use AMPs. I also show that individuals with present bias and high discounting of the future are significantly more likely to hold AMPs. These results are consistent with the notion that AMP holding may be the result of misunderstanding features of mortgage contracts or the result of present bias for consumption and associated self-control issues.



*Keywords*: financial literacy, mortgage choice, present bias, self-control, alternative mortgage products

# 1

# INTRODUCTION

MUCH CONTROVERSY HAS SURROUNDED non-amortising or semi-amortising mortgage loans, known as 'Interest Only Mortgages' or 'Alternative Mortgage Products' (AMPs). This has especially been the case since the financial crisis during which AMPs were cited as the major market failure in the US mortgage market (Mayer et al., 2009; Bernanke, 2010). In the UK, the context of this study, AMPs constitute around one third of the entire mortgage stock, but at the same time default rates are substantially higher for households with AMPs, and a sizeable proportion of AMP holders may not be able to repay their mortgage under their current mortgage terms (Financial Conduct Authority, 2013).

AMPs are a more flexible financial instrument compared with a standard principal-repayment mortgage, but are also more complex because holders need to formulate and commit to a plan for repayment of the principal. The popular perception is that many holders of AMPs have not understood how the products work, or have been tempted into taking AMPs due to their lower initial payments, and have made mistakes as a consequence.

Financial innovation, such as the introduction of AMPs in the mortgage market, can work for good or bad depending upon how the instrument is used by consumers and sold by firms. While a rational consumer can use an AMP to smooth consumption over time when faced with expected income growth, consumers that suffer behavioural biases or other shortcomings may choose an AMP by mistake or as a result of misunderstanding. If a consumer cannot accurately calculate the lifetime costs of a mortgage, then the consumer might misjudge the AMP as a better deal than a standard mortgage due to lower initial repayments. The lower initial payments on an AMP might also be tempting for a consumer with high discounting of the future and/or an impulsive present bias with respect to consumption.

I investigate these individual characteristics and their relationship to mortgage choice using individual level data for a representative sample of UK borrowers. My focus lies on the role of financial literacy and self-control in a consumer's decision to choose an AMP over a Standard Mortgage Product (SMP), and the choice between an Adjustable Rate Mortgage (ARM) and Fixed Rate Mortgage (FRM). Is there evidence that behavioural characteristics are relevant for choices made by

mortgage holders? Do holders of AMPs understand the true financial costs and features of their products? Are individuals with a present bias for consumption or high discounting drawn to the lower initial payments offered by AMPs? These are the questions I explore in this chapter.

The benefit of an AMP compared with a standard amortising mortgage in the context of consumer lifetime utility maximisation is that it offers greater consumption smoothing opportunities. If a consumer faces higher future income and liquidity constraints an AMP allows higher current consumption by delaying mortgage principal repayments. Cocco (2013) uses UK data and demonstrates that AMP holders typically exhibit higher expected future income and work in occupations with higher expected lifetime earnings growth. This evidence is consistent with AMPs being used to fulfil a consumption smoothing function.

But AMPs are more complex than SMPs due to the deferral or non-amortisation of the principal, which requires borrowers to plan ahead for the significant increases in payments after the interest-only period. Greater complexity means that AMPs are open to being mis-chosen by consumers who may misunderstand the product or choose the product due to high discounting of the future or present bias and associated self-control problems. Cocco (2013) suggests the greater complexity of AMPs together with low financial literacy may lead some consumers to "fail to recognise that the lower initial mortgage payments imply larger future loan balances outstanding" (p. 1667). A large literature now exists that documents individual shortcomings with regards to understanding central tenets of consumer finance (see, Lusardi & Mitchell, 2014 for a review.). At the same time, for many years, economists have discussed individual (lack of) self-control both theoretically (for example, Strotz, 1955; Thaler & Shefrin, 1981; Gul & Pesendorfer, 2001, 2004) as well as empirically (for example, DellaVigna & Malmendier, 2004; Ameriks et al., 2007; Busse et al., 2013).

Cocco (2013) argues that financial literacy and present bias may both contribute to the attractiveness of AMPs for some borrowers: lower initial payments may be particularly attractive for myopic consumers who put little weight on the future. Simultaneously, AMP holders may not fully understand their nature, which may lead to suboptimal household financing decisions. A further problem is the potential incentive of mortgage providers to obfuscate or suppress information that ought to be relevant for consumers that are unsophisticated in the sense of being uninformed or present-biased (Gabaix & Laibson, 2006; Carlin, 2009; Carlin & Manso, 2010). By offering consumers greater flexibility in their repayment schedule, AMPs place increased financial responsibility on the mortgage holder to form and commit to a repayment plan or vehicle. However, as I show, consumers with poor financial literacy typically under-estimate the cost of loan

repayments. They may see AMPs as attractive because they perceive the lifetime costs of an AMP to be lower. Consumers with present bias tendencies may be tempted by the higher initial consumption available under an AMP. For example, Atlas et al. (2014) and Agarwal et al. (2014) show that borrowers with greater self-control problems and discounting are more likely to choose mortgages that minimise up-front costs.

It is widely accepted that consumer unsophistication may have been at play in mortgage decisions in the sub-prime mortgage market in the US (see, for example, Einav et al., 2012; Gerardi et al., 2013; Ghent, 2013). But how common are biases that may lead to unsophistication, and how important are they in consumer mortgage decisions? Understanding of financial concepts, forward-looking behaviour and self-awareness of own shortcoming are all important properties for making informed financial choices, but so far there is little evidence that distinguishes between these individual characteristics in the domain of mortgages.

I examine these issues. The environment for my research is an extensive individual level consumer survey run by a large UK market research organisation which provides detailed information on individual loan characteristics, payments and terms together with a broad range of socio-economic control variables. I incorporate a series of questions designed to measure financial literacy which I configure to focus on mortgage choices to test respondents understanding of core concepts related to mortgage vehicles: the accrual of interest over time, simple interest calculations, interest compounding and the absence of principal repayments in an AMP. These questions do not require complex calculations but do require a sound understanding of the core concepts embodied within each question. From these I discover that over two thirds of respondents understand that longer mortgages involve greater accrued interest and can make a simple interest calculation. But I also find only half can make a simple compound interest calculation and less than 40% can correctly identify an AMP from a SMP.

I also insert a series of questions which have been developed in the recent applied behavioural economics literature to measure risk attitude, self-control problems and time preferences in survey settings. These traits may be important for understanding mortgage choices in themselves, but also important control variables when modelling the impact of financial literacy of the choice of an AMP vs SMP and ARM vs FRM. Attitude to risk may also be important for both choices: LaCour-Little & Yang (2010) show households with more tolerance for risk are more likely to choose non-amortising mortgages. More risk averse households may prefer fixed-rate mortgages because of the uncertainty associated with adjustable rate mortgages Campbell & Cocco (2003) and Piskorski & Tchistyi (2010).

Of particular importance are time preferences as they may co-determine both

financial literacy and use of an AMP. A more impatient individual will be less willing to invest to the acquisition of financial literacy (Meier & Sprenger, 2013). They are also more likely to face binding liquidity constraints as they desire higher current consumption. The lower initial payments under an AMP will therefore be more attractive than a SMP by allowing higher current consumption. Hence, in this example, failing to control for time preference, the underlying determinant of both financial literacy and the choice of an AMP, will bias estimates of the relationship between financial literacy and mortgage choice. But in assessing consumer sophistication it is important to distinguish high discounting of the future from present bias: in the case of present bias, the preference for an AMP may arise because of an underlying self-control issue (Laibson, 1997). In the case of high discounting, a consumer can be perfectly rational without any self-control issue, but still prefer AMPs because of putting a higher weight on present consumption.

My results show that financial literacy and consumer behavioural characteristics are important determinants of mortgage choices. In my data, poor financial literacy raises the likelihood of choosing an AMP. A one point increase in financial literacy, i.e. answering one more question correctly, lowers the likelihood of an individual holding an AMP by around 50%. I show that this result does not arise due to reverse causality or simultaneity by using an instrumental variable method based on early life performance in mathematics. Results also show financial literacy increase the likelihood of choosing an ARM. A unit increase in literacy increases the likelihood of holding an ARM by around 25%. This result is suggestive of the notion that informed consumers are more willing and able to take on a mortgage product that requires reviewing mortgage options and performance more actively (Miles, 2004).

Results also suggest that both present bias and high discounting are important predictors of mortgage choice, as both raise the likelihood of AMP holding significantly. This is evidence for the contention of Cocco (2013) that consumers who place lower weight on the future are more likely to choose AMPs. However, my results show that present bias contributes more to AMP holding than high, but exponential discounting. Together, lower literacy and present bias suggest that one reason for the poor performance of AMPs may be that they attract consumers who are less likely to sufficiently understand their features and put more weight on present consumption.

These results contribute to the literature that exists on the determinants of mortgage choice, in particular the choice between ARMs and FRMs (Stanton & Wallace, 1999; Campbell & Cocco, 2003; Koijen et al., 2009), but also the choice between AMPs and SMPs (LaCour-Little & Yang, 2010; Piskorski & Tchistyi, 2010). My results also contribute to the expanding literature on investigating behavioural

characteristics in representative surveys (Ameriks et al., 2007; Dohmen et al., 2011; Burks et al., 2012), and the literature on financial literacy by developing a unique set of questions that measure literacy with respect to understanding central features of mortgage contracts (Lusardi & Mitchell, 2014).

The remainder of the chapter proceeds as follows. In Section 2 I describe the evolution of AMPs in the UK mortgage market and in Section 2.1 the motivation behind my survey design plus the survey instruments that I use. Section 3 describes the features of my survey data and initial results on characteristics of individuals by mortgage type choice. Following that, Section 4 presents econometric results from a variety of econometric models which reveal the impact of financial literacy and behavioural traits on mortgage choice. I discuss my results and conclude in Section 5.

# 2

# THE UK CONTEXT & SURVEY DESIGN

THE FOCUS OF ATTENTION around AMPs has centred upon the US mortgage market. Within the US, AMPs developed during the early 2000s and incorporated products with limited or no amortisation, or in some cases negative amortisation up to specific loan-to-value (LTV) limits, i.e. initial mortgage payments were insufficient to cover interest charges for some period. In the latter case, AMPs were coupled with a 'teaser' interest rate, implicitly assuming house price growth would exceed negative amortisation ahead of the next mortgage refinancing point. The wide variety of AMP products offered in the US market is reviewed in Mayer et al. (2009).

The UK mortgage market also includes a significant share of AMP products and is particularly interesting for the study of consumer mortgage choice for a number of reasons. Cocco (2013) examines the use of AMPs by individual mortgage holders in a sample of UK consumers beginning in 1993. AMPs have been common in the UK since the early 1990s and were widely chosen by consumers. In the UK market, where AMPs are used, they are typically used to finance the entire mortgage balance over the term of the mortgage. There are no conforming loan limits that dictate loan size, loan characteristics or a relation between the two in the UK mortgage market. That means that, in the UK, AMPs are typically available under similar conditions as SMPs, e.g. with respect to minimum deposits or leverage.

Historically, AMPs were commonly sold alongside investment vehicles designed to accrue the principal due at the conclusion of the mortgage to which the mortgage holder would make monthly contributions alongside their AMP payment. These were known as 'endowment mortgages'. Alleged mis-selling of endowment mortgages resulted in the regulator demanding endowment mortgage providers to provide compensation to holders of endowment-linked mortgages in the early 2000s (see Severn, 2008 for a detailed review). Insurance companies selling endowment products were adjudged to have mis-sold on the basis of unrealistic returns from equity investments and/or provision of poor financial advice to investors whose endowments underperformed. The regulator imposed compensation payments to make up for projected shortfalls in the value of accrued endowments.

One impact of the mis-selling episode has been that mortgage providers no

longer recommend endowment products and instead sell interest-only mortgages with no associated investment vehicle. In my dataset, two thirds of AMP holders report they have no linked investment product or other investment which they intend to use to repay the outstanding principal due at maturity.

There is previous evidence that many holders of AMPs did not understand the key features of their products. In the US, the aforementioned controversy surrounding AMPs has been highlighted by Ben Bernanke in a speech in 2010, then chairman of the Federal Reserve. He argues that the complexity and "availability of these alternative mortgage products proved to be quite important and, as many have recognised, is likely a key explanation of the housing bubble" (Bernanke, 2010, p. 16).

In the UK, the aspect of market failure due to misunderstanding of mortgage properties has been highlighted by David Miles, former member of the UK monetary policy committee, in his report to the UK Government (Miles, 2004). The 'Miles Report' chronicles the innovation and features of the UK market but also raises concerns about consumer misunderstanding of products. In particular, following evidence brought forward by survey and interviews with borrowers, the report raises the concern that many consumers based their mortgage choice on initial payments only and not the longer-term horizon. But understanding the lifetime cost of a mortgage is particularly important in the choice of repayment type: as discussed above, by offering consumers greater flexibility in their repayment schedule, AMPs place increased financial responsibility on the mortgage holder to form and commit to a repayment plan or vehicle. Consumers with poor financial literacy who, as I show, typically under-estimate the cost of loan repayments may see AMPs as attractive because they perceive the lifetime costs of an AMP to be lower. Consumers with self-control issues or high discounting of the future may be tempted by the higher initial consumption available under an AMP.

The Miles Report also highlights that borrowers, in their choice of interest-rate type, tend to focus on initial cost, but not on expectations of future interest movements. The report shows that borrowers appear very sensitive to interest rate differentials, i.e. loan take ups of FRMs are higher when they are cheaper relative to ARMs and vice versa. But at the same time there appears to be no relationship between the take up of fixed-rate mortgages and the differential between the fixed rate and the expected variable rate over the length of the fixed period, where expectations are based on bond prices (Miles, 2004, p. 27). Informed and forward-looking customers should factor in the likely future cost of different mortgages when making their borrowing decision. But, according to Miles (2004), many borrowers appear to pay little attention to the likely levels of future interest rates.

## 2.1 SURVEY DESIGN

To investigate the role of behavioural traits, financial literacy and mortgage choice I commissioned a special survey module in a large scale survey of UK consumers. My survey is the YouGov Debt Tracker, a cross-sectional survey of UK households, conducted quarterly by the UK market research company YouGov. I use the August 2013 wave which surveys a representative sample of 2,000 UK households who have been drawn from YouGov's panel of 350,000 households. The survey is conducted via the internet and special provisions for non-internet users are made. The core Debt Tracker survey comprises 84 questions that cover demographics, finances, labour market situation, education, financial product use and housing. In addition, YouGov provided me with the opportunity to add specific questions to the survey. I now describe these measures in more detail.

### 2.1.1 Mortgage Literacy Questions

I now describe the design of my survey questions of financial literacy. To my knowledge, my study is the first to measure financial literacy specifically related to mortgage choices, using objective questions applied to a representative sample of households. In analysis of the relationship between financial literacy and financial choices it is essential that the measure of financial literacy used by the researcher is relevant for the financial choices modelled. For example, financial literacy questions framed within the context of retirement saving decisions (focusing on the concepts of interest compounding, real vs nominal returns and annuity returns) are not appropriate for analysing decisions relating to consumer credit and debt for which those concepts are not integral. It is also essential that the measure of financial literacy allows the researcher to judge better and worse levels of financial understanding in an objective way.

In designing these questions I seek to achieve two objectives. First, to construct an objective measure of the extent to which an individual understands the key concepts in finance relevant for mortgage choice and, second, to do so in a design which is not mathematically complex. The literature has documented that basic or 'core' financial literacy varies within the population and that variation in correct responses to relatively simple questions about finance can explain significant heterogeneity in observed choices relating to consumer credit and debt (Lusardi & Tufano, 2009; Disney & Gathergood, 2013), retirement saving (Lusardi & Mitchell, 2007a,b; Van Rooij et al., 2011a) and stock market participation (Guiso & Jappelli, 2005; Van Rooij et al., 2011b). These studies typically use test-based

measures to measure individual understanding of, for example, compounding or minimum payments on a credit product. Multiple-choice questions with relatively low mathematical requirements are used to avoid the financial literacy questions resembling a math test or requiring infeasible calculations within the context of a consumer survey.

Alternative approaches have included using objective measures of core numeracy and/or understanding of probability and uncertainty. For example, Gerardi et al. (2013) investigate the role of numeracy on subprime mortgage delinquency in the US. They use a set of questions to measure several aspects of numeracy and economic understanding. Another alternative approach is to use self-reported financial understanding. Cox et al. (2014) use Dutch panel data to investigate the impact of financial literacy on mortgage choice. Their measure of 'financial literacy' is a joint measure of self-reported financial knowledge ("How knowledgeable do you consider yourself with respect to financial matters?") and financial activity with regards to holding financial products.

I adopt the conceptual approach of test-based measures for the design of my financial literacy questions. I include four questions to the survey that aim to measure respondent's ability to make informed decisions specifically with regards to mortgage choice, which I brand 'mortgage literacy'. Each question was framed in the context of a particular dimension of typical mortgage contracts and constructed using a multiple-choice format.

The four questions are:

1. Suppose a 15 year mortgage and a 30 year mortgage have the same Annual Percentage Rate and the same amount borrowed. The total amount repaid will be:
   - Higher for the 15 year mortgage
   - Higher for the 30 year mortgage
   - The total amount repaid on both mortgages will be the same
   - Do not know

2. Suppose you owe £50,000 on a mortgage at an Annual Percentage Rate of 6%. If you didn't make any payments on this mortgage how much would you owe in total after one year?
   - Less than £50,000
   - £50,000 - £54,999
   - £55,000 - £59,999
   - £60,000 - £64,999
   - More than £65,000
   - Do not know

3. Suppose you owe £100,000 on a mortgage at an Annual Percentage Rate of 5%. If you didn't make any payments on this mortgage how much would you owe in total after five years?
   - Less than £120,000
   - Between £120,000 and £125,000
   - More than £125,000
   - Do not know
4. Suppose you owe £200,000 on a mortgage with at an Annual Percentage Rate of 5%. If you made annual payments of £10,000 per year how long would it take to repay the whole mortgage?
   - Less than 20 years
   - Between 20 and 30 years
   - Between 30 and 40 years
   - The mortgage would never be repaid
   - Do not know

The questions are (arguably) increasing in difficulty. The first two questions are designed to measure fundamental understanding of interest rates crucial for making borrowing choices: an understanding that interest costs increase with the length of the loan and an ability to make a very simple interest calculation. Failure to answer these questions would demonstrate a significant misunderstanding of the terms of a mortgage product. They are designed to establish whether a sub-sample of respondents do not have even a fundamental understanding of the operation of a credit product.

The third and fourth questions, while still quite basic, test more advanced concepts in finance. The third question tests whether the individual understands compound interest. The question itself does not require a specific compound interest calculation, but instead requires the respondent to know that interest compounds, not multiplies, so the accrued interest on a £100,000 mortgage at 5% APR over 5 years with no payments would be more than £25,000. The fourth question tests whether the individual can recognise a non-amortising mortgage example. The question describes a scenario in which mortgage payments only cover the interest cost – the essence of an AMP in my data – and requires the respondent to realise that in this example the principal will never be repaid.

I analyse responses to these questions in two ways. First, I create a series of 1/0 dummy variables for which a value of one denotes a correct answer and zero otherwise. Second, I sum the number of questions answered correctly to create a five-point financial literacy score ranging from zero to four. I show results from econometric models in which the financial literacy variables enter in index form

and as individual dummy variables denoting correct responses to each question.

In my econometric analysis I subsequently relate an individual's performance on these questions and their mortgage choices. However, an individual's financial literacy score may be endogenous to mortgage choices or confounded by other factors related to mortgage choices. Financial literacy may be correlated with individual characteristics (such as human capital and time preferences) and other elements individuals may control (such as assets). Plus, reverse causality may be at play whereby an individual's mortgage choice affects their subsequent financial literacy. For example, the choice of taking a SMP may lead to consumers acquiring information on mortgage amortisation through their mortgage statements.

Lusardi & Mitchell (2007a,b), Christiansen et al. (2008) and Behrman et al. (2012) all show that estimations that do not control for correlated standard errors typically underestimate the effect of financial literacy on wealth accumulation. Following these studies, I resolve the potential endogeneity problem by adopting an Instrumental Variable (IV) strategy. My strategy exploits a source of variation in financial literacy at the individual level which pre-dates mortgage market exposure, and hence self-selection, and also pre-dates the acquisition of labour market and financial market experience. The instrument that I use has been suggested by Jappelli & Padula (2013). They develop an intertemporal consumption model of consumer investment in financial literacy and demonstrate that financial literacy and wealth are jointly determined and positively correlated over the life-cycle. In empirical analysis they show that pre-labour market entry literacy endowment is a valid instrument in the regressions of wealth and financial literacy. Based on this, I include a question in the survey that measures the self-assessed level of mathematics whilst in primary school:

- When you were at primary school aged 10 how did you perform in maths compared to other children in your class?
    - Much better than average
    - Better than average
    - About the same as average
    - Worse than average
    - Much worse than average

From answers to this question I create a primary-school math level score ranging from one to five.

### 2.1.2 Behavioural Characteristics

In addition to the literacy questions, I include survey instruments to proxy impulsive present bias, discount rates and risk attitude of the respondents. In prior studies researchers seeking to measure behavioural traits such as attitude to risk have tended to use incentivised laboratory experiments involving choices for money. However, a laboratory setting necessarily limits the available subject pool. Consequently, researchers have developed a series of survey instruments which have been shown to correlate very closely with those obtained in laboratory studies, as discussed below.

First, I elicit impulsiveness using Likert scale responses by which respondents associate or dissociate themselves with a short statement describing impulsive consumption behaviour on a five point scale from 'agree strongly' to 'disagree strongly'. The statement is:

- I am impulsive and tend to buy things even when I can't really afford them
  - (a) Agree strongly
  - (b) Tend to agree
  - (c) Neither agree nor disagree
  - (d) Tend to disagree
  - (e) Disagree strongly
  - (f) Do not know

This question proxies self-control issues in the sense of 'present bias', which I also use in Gathergood & Weber (2014): respondents are asked by how much they can see themselves preferring instantaneous gratification even when it is sub-optimal, conceptually similar to the self-control measure developed by Ameriks et al. (2007). I create a binary variable that I label 'Impulsive Spender', taking the value of one if the respondent answers 'tend to agree' or 'agree strongly' and zero otherwise to this statement.

To proxy exponential discount rates I adopt the widely used approach proposed by Dohmen et al. (2010, 2011). They use a short, self-assessed measure that can be easily included in surveys, where respondents are asked to rate their patience on an eleven point scale. Vischer et al. (2013) show that this measure is able to proxy exponential time preferences well compared with laboratory experiments. The statement reads:

- How do you see yourself: are you generally an impatient person, or someone who always shows great patience? Answers are coded on an 11-point scale, with 0 referring to 'very impatient' and 10 'very patient'.

From respondents' answers of the statement above I create a binary variable that I name 'Heavy Discounter' and takes the value of one if the respondent answers on the eleven point scale between zero and two (i.e. impatience) and takes a value of zero otherwise. A measure of time preference is particularly important for

my analysis, because it allows to distinguish self-control issues in the form of present bias from high discount rates. Both present-biased consumers as well as consumers with high discount rates may prefer AMPs because of the minimal up-front costs. But in the case of present bias this preference arises because of an overweighing of the present and underlying self-control issues (Laibson, 1997). In the case of high discounting, a consumer can be perfectly rational without any self-control issue, but still prefer AMPs because of lower present payments.

Another important factor is the potential inter-relation between financial literacy and time preferences: individuals may stay illiterate because they discount the future more. Meier & Sprenger (2013) show that patient individuals are significantly more likely to take up an offered credit counselling program, and have higher pre-counselling financial knowledge. Furthermore, Dohmen et al. (2010) highlight that individuals with lower cognitive ability are typically less patient and might therefore be unwilling or unable to invest time in order to make fully informed mortgage choices. Hence a measure of time preference is an important control variable in my analysis.

I also include a measure of risk attitude in my analysis. More risk averse households may prefer fixed-rate mortgages because of the uncertainty associated with adjustable rate mortgages (Campbell & Cocco, 2003). Individuals with greater risk averseness may also shy away from AMPs due to the underlying uncertainty of repaying the principal. Alternatively, risk averse households may exhibit a preference for AMPs if they are concerned with future income streams and the higher present repayments of SMPs. To my knowledge, only one study relates risk attitude to mortgage choice empirically: Cox et al. (2014) create a risk averseness measure depending on whether households invest in riskier assets. They find that households that invest in less risky assets are also less likely to choose interest-only mortgages. However, an inverse relation might also be expected when considering the impact of cognitive ability on risk aversion: Dohmen et al. (2010) show that individuals with lower ability are less likely to choose riskier payoffs compared to individuals with higher ability, indicating a higher degree of risk aversion.

My measure of risk attitude is again based on a question developed by Dohmen et al. (2010, 2011):

- How do you see yourself: are you generally a person who is fully prepared to take risks or do you try to avoid taking risks? Please tick a box on the scale, where the value 0 means: 'unwilling to take risks' and the value 10 means: 'fully prepared to take risk'.

From respondent answers I create a binary variable that I name 'Risk Averse' that takes the value of one if the respondent answers between zero and two (i.e. risk averse), and takes a value of zero otherwise.

# 3

# SURVEY SUMMARY DATA

## 3.1 SAMPLE CHARACTERISTICS

SUMMARY STATISTICS for the survey sample are presented in Table 1. It total there are 1,974 households in my sample, 32% of which are mortgage holders, 32% of which are outright homeowners and 36% are renters[1]. This distribution is representative of the UK population found in large panel data sets (BHPS and WAS). Homeownership groups within the sample exhibit expected demographics and financial characteristics. Mortgage holders are typically in mid-life, better educated, more likely to be in work and have higher household incomes. Renters are typically younger than mortgage holders and outright owners are typically older (79% of outright owners are aged over 55). Compared with whole sample characteristics, mortgage holders are more likely to be married (77% compared to 64% in the sample), have dependent children (36% to 20%) and to be in employment (85% to 59%). Mortgage holders report, on average, the highest mean and median incomes of all subgroups.

The level of financial literacy is, on average, much better among mortgage holders compared with outright owners and renters. Renters report the lowest average literacy score, answering 1.64 out of 4 questions correctly, relative to a sample mean of 2 questions answered correctly. Outright home holders are very close to the sample mean, whereas mortgage holders are substantially better in answering my questions correctly (2.35 questions).

Other behavioural characteristics also differ between homeownership groups. On average, mortgage holders show medium rates of future discounting and present bias: 9% of mortgage holders are 'heavy discounters' and 13% 'impulsive spenders', compared with the whole sample means of 10% and 12% respectively. For the remainder of the analysis, it is important to verify that respondents can distinguish between these two concepts. Among mortgage holders, 3% are both 'heavy discounters' and 'impulsive spenders'. The basic correlation between the two variables is 0.20 (phi-coefficient). Hence, there is relatively little overlap between the two questions, suggesting that they pick up different behavioural traits.

1 'Renters' include 'social renters', e.g. living rent-free in their parents' home

TABLE 1 Sample Characteristics

| | (1) Sample | (2) Mortgage Holder | (3) Outright Homeowner | (4) Renter |
|---|---|---|---|---|
| *Age* | | | | |
| 18–34 | 0.23 | 0.22 | 0.02 | 0.43 |
| 35–44 | 0.18 | 0.30 | 0.05 | 0.19 |
| 45–54 | 0.18 | 0.27 | 0.13 | 0.15 |
| 55+ | 0.41 | 0.21 | 0.79 | 0.23 |
| *Demographics* | | | | |
| Male (= 1) | 0.50 | 0.53 | 0.53 | 0.46 |
| Married / living as married (= 1) | 0.64 | 0.77 | 0.78 | 0.40 |
| Dependent children (= 1) | 0.20 | 0.36 | 0.05 | 0.19 |
| Education leaving age | 18.44 | 18.95 | 17.74 | 18.63 |
| Math Level in School (1–5) | 3.59 | 3.69 | 3.54 | 3.53 |
| *Employment* | | | | |
| Employed (= 1) | 0.59 | 0.85 | 0.31 | 0.60 |
| Unemployed (= 1) | 0.02 | 0.01 | 0.01 | 0.05 |
| Retired/Student/Housewife/Disabled | 0.39 | 0.14 | 0.69 | 0.35 |
| Spouse employed (= 1) | 0.37 | 0.62 | 0.26 | 0.24 |
| *Household Finances* | | | | |
| Household income (£) | 32900 (28000) | 43600 (39000) | 29400 (24400) | 26400 (23000) |
| *Behavioural Characteristics* | | | | |
| Literacy score (0–4) | 1.98 | 2.35 | 1.99 | 1.64 |
| Heavy discounter (= 1) | 0.10 | 0.09 | 0.07 | 0.14 |
| Impulsive spender (= 1) | 0.12 | 0.13 | 0.05 | 0.16 |
| Risk averse (= 1) | 0.30 | 0.33 | 0.34 | 0.24 |
| Observations | 1974 | 632 | 634 | 708 |

*Note:* Table shows summary statistics for all individuals in the dataset (Column 1), plus for all individuals divided into three mutually exclusive and exhaustive groups: those owning a home via a mortgage (Column 2), those who are outright home owners i.e. with no mortgage (Column 3), and those renting (Column 4). The variable 'education leaving age' is the age at which the individual finished full-time education. The variable 'math level in school' is the individual's self-reported mathematical ability at school on a scale from 1 to 5. The variable 'literacy score' is the number of financial literacy questions the individual answered correctly on a scale from 0 to 4. The variables 'heavy discounter' and 'impulsive spender' are 1/0 dummy variables constructed from Likert scale answers. 'Risk averse' is a 1/0 dummy for risk averse individuals constructed from a self-reported attitude to risk question.

Mean values reported, medians in parentheses for financial variables.

*Source:* YouGov Debt Tracker August 2013.

Differences in socio-economic composition of the homeownership groups described above suggest these differences in financial literacy and behavioural characteristics across groups may be due to life-cycle characteristics and the varying economic circumstance of households in different groups.

## 3.2 CHARACTERISTICS BY MORTGAGE TYPE

The sample summary statistics reveal much heterogeneity between house-ownership types and renters, and mortgage holders are, on average, at the top end of the distribution with respect to income, education and financial ability. But now I focus on the sub-sample of 632 mortgage holders, which is the basis for all further analysis. Tables 2 and 3 separates this sub-sample into mutually exclusive and exhaustive divisions by mortgage repayment type (AMP or SMP) and interest rate type (ARM or FRM). Column 1 of Table 2 shows characteristics by repayment type. Among mortgage holders, 78% hold a SMP and the remaining 22% hold an AMP. Holders of SMPs are typically younger, while those with AMPs are typically older (almost 40% of households with an alternative mortgage are above 55). Holders of AMPs have left education at a younger age (18.23 years compared to 19.15) and had a lower self-assessed math ability in school (3.49 compared to 3.75 on a 1–5 scale). Their household income is lower (mean £40,700 relative to £44,400).

Table 3 shows holders of AMPs typically have slightly lower mortgage interest rates, higher loan-to-income rations (LTIs) and slightly lower loan-to-value ratio (LTVs). These results also reveals large differences in behavioural characteristics between holders of AMPs and SMPs. Particularly striking is the difference in literacy: holders of AMPs do substantially worse in answering my questions, with an average of only 1.56 out of 4 questions answered correctly. In contrast, holders of SMPs answer, on average, 2.57 questions correctly. Holders of AMPs are also more likely to have higher discount rates (12% relative to 8%) and be impulsive spenders (19% relative to 11%). But they report a greater degree of risk averseness (3.99 relative to 4.39 on a 0–10 scale).

Column 2 compares mortgage holders by interest rate type. The two groups are of comparable size: 53% of mortgage holders hold an ARM, 47% hold a FRM. Overall, comparison between FRM and ARM groups does not reveal the same degree of heterogeneity as the comparison between AMP holders and SMP holders. Younger households are typically more likely to hold a fixed rate mortgage – 27% of households aged 18–34 hold an FRM, compared to 17% holding an ARM in that age bracket. Employment levels, math level in school and household composition are comparable. Unsurprisingly, Table 3 shows a substantial difference in the mortgage

TABLE 2 Demographic Characteristics of Mortgage Holders

| | (1) Repayment Type | | (2) Interest Rate Type | |
|---|---|---|---|---|
| | Standard Mortgage | Alternative Mortgage | Adjustable Rate (ARM) | Fixed Rate (FRM) |
| *Age* | | | | |
| 18–34 | 0.24 | 0.14 | 0.17 | 0.27 |
| 35–44 | 0.32 | 0.23 | 0.32 | 0.28 |
| 45–54 | 0.28 | 0.25 | 0.26 | 0.28 |
| 55+ | 0.16 | 0.39 | 0.25 | 0.17 |
| *Demographics* | | | | |
| Male (= 1) | 0.54 | 0.46 | 0.57 | 0.48 |
| Married / living as married (= 1) | 0.77 | 0.76 | 0.80 | 0.73 |
| Dependent children (= 1) | 0.37 | 0.32 | 0.39 | 0.33 |
| Education leaving age | 19.15 | 18.23 | 18.74 | 19.19 |
| Math Level in School (1–5) | 3.75 | 3.49 | 3.77 | 3.60 |
| *Employment* | | | | |
| Employed (= 1) | 0.89 | 0.73 | 0.83 | 0.88 |
| Unemployed (= 1) | 0.01 | 0.01 | 0.01 | 0.00 |
| Retired/Student/Housewife/Disabled | 0.11 | 0.26 | 0.16 | 0.12 |
| Spouse employed (= 1) | 0.64 | 0.54 | 0.59 | 0.64 |
| *Household Finances* | | | | |
| Household income (£) | 44400 (40000) | 40700 (34000) | 43200 (38000) | 44000 (40000) |
| Observations | 492 | 140 | 338 | 294 |

*Note:* Table shows summary statistics for the 632 mortgage holders in the sample. Columns 1 divides the sample by mortgage repayment type. Column 2 divides the sample by mortgage interest rate type. 'Standard Mortgage' is a capital repayment mortgage in which mortgage payments include payment of the principal which declines to zero over the term of the mortgage. 'Alternative Mortgage' is a mortgage in which mortgage payments meet the interest on the principal only and may or may not be linked to an investment held by the individual such as an endowment fund or pension (otherwise known as 'interest only mortgages'). 'Adjustable Rate' mortgage is a mortgage for which the interest rate varies over the mortgage term, in the majority of cases the interest rate is linked to the Bank of England repo rate. 'Fixed Rate' mortgage is a mortgage in which the nominal interest rate is fixed for some or all of the mortgage term.

Mean values reported, medians in parentheses for financial variables.

*Source:* YouGov Debt Tracker August 2013.

TABLE 3 Housing and Behavioural Characteristics of Mortgage Holders

| | (1) Repayment Type | | (2) Interest Rate Type | |
|---|---|---|---|---|
| | Standard Mortgage | Alternative Mortgage | Adjustable Rate (ARM) | Fixed Rate (FRM) |
| *Housing* | | | | |
| Property value (£) | 202600 (165000) | 212800 (177500) | 205600 (165000) | 204100 (172500) |
| Mortgage outstanding amount (£) | 91500 (80000) | 92500 (77900) | 88300 (77000) | 95600 (82000) |
| Mortgage Interest Rate | 3.59 | 3.37 | 3.14 | 4.00 |
| Loan to Income Ratio | 2.35 | 2.61 | 2.34 | 2.48 |
| Loan to Value Ratio | 0.56 | 0.52 | 0.57 | 0.53 |
| Alternative Mortgage Product | 0.00 | 1.00 | 0.28 | 0.16 |
| Standard Mortgage | 1.00 | 0.00 | 0.72 | 0.84 |
| Adjustable Rate (ARM) | 0.50 | 0.67 | 1.00 | 0.00 |
| Fixed Interest Rate (FRM) | 0.50 | 0.33 | 0.00 | 1.00 |
| *Behavioural Characteristics* | | | | |
| Literacy score (0–4) | 2.57 | 1.56 | 2.45 | 2.23 |
| Heavy discounter (= 1) | 0.08 | 0.12 | 0.09 | 0.09 |
| Impulsive spender (= 1) | 0.11 | 0.19 | 0.13 | 0.13 |
| Risk averse (= 1) | 0.31 | 0.38 | 0.37 | 0.28 |
| Observations | 492 | 140 | 338 | 294 |

*Note:* Mean values reported, medians in parentheses for financial variables. See note of Table 2 for details.
*Source:* YouGov Debt Tracker August 2013.

interest rate, with FRMs on average showing an 86 basis points premium over ARMs.

In contrast with differences in behavioural characteristics for those with AMPs compared to those with SMPs, holders of ARMs and FRMs do not differ substantially in their behavioural characteristics. ARM holders perform slightly better on my literacy assessment, and answer, on average, 2.45 questions correctly, relative to 2.23 questions of FRM holders. ARM holders also show on average slightly higher risk aversion by my measure. Other behavioural characteristics are on average identical between the two groups.

## 3.3 SUMMARY DATA FOR MORTGAGE LITERACY

A detailed breakdown of characteristics by mortgage literacy score is provided in Table 4. The table shows that mortgage literacy score strongly correlates with choice of repayment type. Among the 138 individuals with a score of 4/4, only 12% hold an AMP compared with 67% among the 63 individuals with a score of 0/4. The simple correlation between mortgage literacy score and the likelihood of holding an AMP is −0.88. As might be expected, individuals with better mortgage literacy scores typically have a higher education leaving age, higher household income and larger property values. There is no clear relationship between mortgage literacy score and mortgage interest rate, LTI or LTV.

A detailed breakdown of individual question scores by group is provided in Table 5. The table reveals two main patterns in the data. First, for each question a substantial fraction of mortgage holders provide incorrect answers. The proportion of 'don't know' responses among mortgage holders is low: 8% for the first question, then 13%, 13% and 21% for the subsequent questions. Consequently, most non-correct answers are not due to choosing 'don't know', but are due to mistakes: 11% for the first question, then 21%, 36% and 31% for subsequent questions.

Second, holders of AMPs do strikingly worse than holders of SMPs on all questions. Only 60% of AMP holders correctly answer the first question by identifying that a 30 year mortgage will result in higher total repayments compared with a 15 year mortgage. For SMP holders close to 90% answer this question correctly. For the second question, a simple interest rate calculation, less than half of AMP holders provide a correct answer. Less than one third of AMP holders answer the interest compounding question correctly and only one quarter answer the final 'never repay' question correctly. The 'never repay' question involves the respondent correctly identifying that a mortgage repayment is only sufficient to cover interest costs and the loan principal does not amortise – the essence of an AMP. Yet very

TABLE 4 Characteristics of Mortgage Holders by Mortgage Literacy

| | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| *Age* | | | | | |
| 18–34 | 0.33 | 0.19 | 0.21 | 0.18 | 0.24 |
| 35–44 | 0.21 | 0.27 | 0.30 | 0.29 | 0.36 |
| 45–54 | 0.32 | 0.27 | 0.26 | 0.31 | 0.23 |
| 55+ | 0.14 | 0.28 | 0.23 | 0.22 | 0.17 |
| *Demographics* | | | | | |
| Male (= 1) | 0.27 | 0.48 | 0.48 | 0.58 | 0.67 |
| Married / living as married (= 1) | 0.78 | 0.73 | 0.72 | 0.77 | 0.83 |
| Dependent children (= 1) | 0.33 | 0.33 | 0.33 | 0.37 | 0.42 |
| Education leaving age | 18.42 | 18.18 | 18.73 | 19.38 | 19.47 |
| Math Level in School (1–5) | 2.92 | 3.37 | 3.68 | 3.93 | 3.99 |
| *Employment* | | | | | |
| Employed (= 1) | 0.79 | 0.85 | 0.85 | 0.88 | 0.85 |
| Unemployed (= 1) | 0.00 | 0.00 | 0.02 | 0.00 | 0.01 |
| Retired/Student/Housewife/Disabled | 0.21 | 0.15 | 0.13 | 0.12 | 0.14 |
| Spouse employed (= 1) | 0.71 | 0.59 | 0.61 | 0.66 | 0.54 |
| *Household Finances* | | | | | |
| Household income (£) | 37400 (33000) | 38400 (35000) | 41500 (36500) | 47600 (45000) | 47800 (40100) |
| *Housing* | | | | | |
| Property value (£) | 167800 (153000) | 188600 (158400) | 198900 (160000) | 214700 (180000) | 228800 (180000) |
| Mortgage outstanding amount (£) | 82300 (75000) | 89900 (74800) | 91600 (81500) | 86900 (80000) | 103100 (97000) |
| Mortgage Interest Rate | 3.60 | 3.95 | 3.38 | 3.37 | 3.63 |
| Loan to Income Ratio | 2.32 | 2.89 | 2.37 | 2.08 | 2.54 |
| Loan to Value Ratio | 0.55 | 0.58 | 0.53 | 0.46 | 0.66 |
| Alternative Mortgage Product | 0.67 | 0.32 | 0.18 | 0.13 | 0.12 |
| Standard Mortgage | 0.33 | 0.68 | 0.82 | 0.87 | 0.88 |
| Adjustable Rate (ARM) | 0.44 | 0.51 | 0.52 | 0.53 | 0.61 |
| Fixed Interest Rate (FRM) | 0.56 | 0.49 | 0.48 | 0.47 | 0.39 |
| *Behavioural Characteristics* | | | | | |
| Heavy discounter (= 1) | 0.11 | 0.14 | 0.08 | 0.05 | 0.09 |
| Impulsive spender (= 1) | 0.19 | 0.17 | 0.14 | 0.07 | 0.12 |
| Risk averse (= 1) | 0.35 | 0.22 | 0.32 | 0.34 | 0.38 |
| Observations | 63 | 94 | 174 | 163 | 138 |

*Note:* Table shows summary statistics for mortgage holders by their financial literacy score (number of financial literacy questions answered correctly).

Mean values reported, medians in parentheses for financial variables.

*Source:* YouGov Debt Tracker August 2013.

TABLE 5 Mortgage Literacy Performance

| | (1) Sample | | (2) Repayment Type | | (3) Interest Rate Type | |
|---|---|---|---|---|---|---|
| | Full Sample | Mortgage Holders | Alternative Mortgage | Standard | Adjustable-Rate | Fixed-Rate |
| 1. Suppose a 15 year mortgage and a 30 year mortgage have the same Annual Percentage Rate and the same amount borrowed. The total amount repaid will be: | | | | | | |
| Higher for the 15 year mortgage | 0.05 | 0.04 | 0.09 | 0.03 | 0.03 | 0.06 |
| *Higher for the 30 year mortgage* | 0.70 | 0.81 | 0.59 | 0.87 | 0.83 | 0.78 |
| The total amount repaid on both mortgages will be the same | 0.09 | 0.07 | 0.16 | 0.05 | 0.07 | 0.08 |
| Do not know | 0.16 | 0.08 | 0.17 | 0.05 | 0.07 | 0.09 |
| 2. Suppose you owe £50,000 on a mortgage at an Annual Percentage Rate of 6%. If you didn't make any payments on this mortgage how much would you owe in total after one year? | | | | | | |
| Less than £50,000 | 0.03 | 0.02 | 0.04 | 0.01 | 0.03 | 0.01 |
| *£50,000 – £54,999* | 0.55 | 0.66 | 0.44 | 0.72 | 0.67 | 0.64 |
| £55,000 – £59,999 | 0.14 | 0.13 | 0.17 | 0.12 | 0.13 | 0.13 |
| £60,000 – £64,999 | 0.02 | 0.02 | 0.04 | 0.01 | 0.01 | 0.02 |
| More than £65,000 | 0.03 | 0.04 | 0.04 | 0.05 | 0.04 | 0.05 |
| Do not know | 0.23 | 0.13 | 0.27 | 0.09 | 0.12 | 0.15 |
| 3. Suppose you owe £100,000 on a mortgage at an Annual Percentage Rate of 5%. If you didn't make any payments on this mortgage how much would you owe in total after five years? | | | | | | |
| Less than £120,000 | 0.14 | 0.13 | 0.13 | 0.14 | 0.14 | 0.13 |
| Between £120,000 and £125,000 | 0.22 | 0.23 | 0.31 | 0.20 | 0.22 | 0.24 |
| *More than £125,000* | 0.42 | 0.51 | 0.28 | 0.58 | 0.53 | 0.49 |
| Do not know | 0.22 | 0.13 | 0.28 | 0.08 | 0.11 | 0.15 |
| 4. Suppose you owe £200,000 on a mortgage with at an Annual Percentage Rate of 5%. If you made annual payments of £10,000 per year how long would it take to repay the whole mortgage? | | | | | | |
| Less than 20 years | 0.02 | 0.02 | 0.04 | 0.01 | 0.01 | 0.03 |
| Between 20 and 30 years | 0.26 | 0.29 | 0.26 | 0.30 | 0.30 | 0.29 |
| Between 30 and 40 years | 0.11 | 0.10 | 0.07 | 0.11 | 0.10 | 0.10 |
| *The mortgage would never be repaid* | 0.30 | 0.37 | 0.26 | 0.41 | 0.41 | 0.33 |
| Do not know | 0.30 | 0.21 | 0.37 | 0.17 | 0.17 | 0.26 |
| Observations | 1974 | 632 | 140 | 492 | 338 | 294 |

*Note:* Table shows breakdown of answers to financial literacy questions. Column 1 shows statistics for the full sample and for mortgage holders only. Columns 2 and 3 show statistics for all mortgage holders by their mortgage repayment type and mortgage interest rate type.

*Source*: YouGov Debt Tracker August 2013.

few AMP holders answer this question correctly. There are no similar differences in question performance between ARM and FRM holders.

Overall, these summary data suggest that individual behavioural characteristics are important determinants of repayment type choice: there is a strong contrast in the mortgage literacy scores of AMP holders compared to SMP holders. Other behavioural measures show AMP holders are also more likely to be impulsive spenders. However, a comparison of summary data does not imply a causal relationship between these characteristics and choice of an AMP. AMP and SMP holders differ in other characteristics related to consumer financial sophistication including age, income and employment and education level. At the same time, differences in individual characteristics are far less pronounced when comparing mortgage holders by their interest-type. ARM holders appear to be more literate than FRM holders and to be more risk seeking. The latter may appear counter-intuitive, as ARMs are more risky with respect to the uncertainty of future interest movements.

But the summary statistics only allow us to inspect correlations, but tell us very little regarding the significance of the impact of behavioural traits when controlling for demographic- and financial characteristics. Financial literacy may also arise endogenously with mortgage choice, as discussed earlier. Therefore, in the next section, I turn to multivariate regression models to control for these related characteristics and use IV methods to estimate the causality between behavioural characteristics and mortgage choice.

# 4

# ECONOMETRIC ANALYSIS

In this section I present econometric analysis of the relationship between individual characteristics and mortgage choices. The summary statistics suggest financial literacy and present bias are related to the choice of AMP vs SMP. My econometric analysis proceeds in three stages. Firstly, I show that behavioural characteristics are unrelated to other dimensions of mortgage choice – LTV, LTI and the mortgage interest rate, which may be related to the choice of AMP vs SMP. Secondly, I show baseline econometric estimates from multivariate models. These estimates show poor financial literacy and present bias strongly predict the choice of an AMP. However, financial literacy in particular may be endogenous to mortgage choice. Therefore, thirdly, I show IV estimates which exploit pre-market mathematical ability as an instrument for contemporaneous financial literacy.

## 4.1 BEHAVIOURAL- & MORTGAGE CHARACTERISTICS

Before presenting estimates of the relationship between behavioural characteristics and the choices between AMP vs SMP and FRM vs ARM, I first analyse the relationship between these characteristics and other dimensions of mortgage choice – LTV, LTI and the mortgage interest rate. I do so for the following reason: If choices of AMP vs SMP and FRM vs ARM are related to or arise from choices over other aspects of an individual's mortgage, then my estimates for the former may arise mechanically due to these other choices. Behavioural characteristics may drive consumers to, say, opt for a high LTI which could hypothetically only be offered as an AMP by the lender.

I am confident from institutional features of the UK mortgage market and for empirical reasons that these mechanisms are not at work in my data. As discussed earlier, there are no conforming limits in the UK mortgage market and mortgage lenders have offered AMPs and SMPs, ARM and FRM products at equivalent LTIs and LTV and AMPs and SMPs also at equivalent interest rates. Nevertheless, even if mortgage providers do not tie other mortgage features to their product offerings consumer choices may imply correlation in these features. For example, if individuals who wish to borrow at high LTI ratios, say, due to present bias in

the preference for consumption can only afford to do so using an AMP then the underlying economic mechanism is between present bias and LTI – the choice of an AMP is ancillary to the choice of LTI.

Econometric estimates also show these mechanisms are not at work in my data. There is no significant relationship between behavioural characteristics and LTV, LTI or the mortgage interest rate. To show this, Table 6 presents estimates from a series of multivariate models in which the dependent variables are the mortgagees' LTV ratio (Column 1), LTI ratio (Column 2) and mortgage interest rate (Column 3). Models are estimated by ordinary least squares (OLS). Coefficient estimates on the behavioural characteristics variables are in all cases statistically not significant at the 10% level. For most estimates, the standard error is larger than the coefficient estimate.

The econometric estimates do reveal, as expected, life-cycle drivers of these mortgage metrics. The positive coefficient on the dummy variable capturing individuals aged 18–34 in all estimates indicates younger individuals with mortgages are more highly leveraged and geared and pay higher interest costs; this life-cycle pattern is also reflected in the positive coefficient on the married/living as married dummy variable and the dummy variable capturing whether the individual has dependent children. Estimates also reveal a broadly negative relationship between income and LTI and the mortgage interest rate.

## 4.2 BASELINE ESTIMATES FOR MORTGAGE CHOICE

Next, I present baseline estimates for the relationship between behavioural characteristics and mortgage type. These are reported in Table 7. For the two choices I model choice of AMP vs SMP and choice of FRM vs ARM using probit models. The estimated equations are given as:

$$Pr(\text{AMP} = 1) = \Phi(\alpha_0 + \alpha_1 fl + \alpha_2 imp + \alpha_3 hd + \alpha_4 risk + \mathbf{X}'\beta) \quad (1)$$

$$Pr(\text{ARM} = 1) = \Phi(\alpha_0 + \alpha_1 fl + \alpha_2 imp + \alpha_3 hd + \alpha_4 risk + \mathbf{X}'\beta) \quad (2)$$

where $\Phi$ is the cumulative normal distribution.

In Equation 1 the dependent variable is a dummy variable which takes a value of 1 if the mortgage is an AMP and 0 if the mortgage is a SMP. In Equation 2, the dependent variable is a dummy variable which takes a value of 1 if the mortgage is an ARM and 0 if the mortgage is an FRM. As I estimate probit models I also report average marginal effects (see, Section 3.2 of Chapter II for more details).

Independent variables include the financial literacy score $fl$, ranging from zero to four, a dummy variable for present bias ($imp$), a dummy for high discounters

TABLE 6 Financial Literacy and Mortgage Characteristics

| | (1) Loan-to-Value $\beta$ / SE | (2) Loan-to-Income $\beta$ / SE | (3) Interest Rate $\beta$ / SE |
|---|---|---|---|
| Literacy score (0–4) | −0.021 | 0.023 | −0.039 |
| | (0.015) | (0.065) | (0.113) |
| *Age* | | | |
| 18–34 | 0.483*** | 1.193*** | 1.634*** |
| | (0.060) | (0.262) | (0.455) |
| 35–44 | 0.200*** | 0.830*** | 0.545 |
| | (0.059) | (0.260) | (0.451) |
| 45–54 | −0.019 | 0.162 | 0.505 |
| | (0.056) | (0.246) | (0.426) |
| *Demographics* | | | |
| Male (= 1) | 0.075** | −0.278* | 0.823*** |
| | (0.038) | (0.165) | (0.286) |
| Married / living as married (= 1) | 0.474*** | 0.869*** | 1.663*** |
| | (0.076) | (0.334) | (0.579) |
| Dependent children (= 1) | 0.109** | 0.332* | −0.207 |
| | (0.042) | (0.184) | (0.319) |
| *Employment* | | | |
| Employed (= 1) | 0.057 | −0.098 | 0.183 |
| | (0.058) | (0.255) | (0.442) |
| Unemployed (= 1) | 0.032 | 0.365 | −1.991 |
| | (0.189) | (0.829) | (1.436) |
| *Household Finances* | | | |
| Household income < £15000 | −0.080 | 2.376*** | 1.683*** |
| | (0.076) | (0.333) | (0.578) |
| Household income £15,000–£30,000 | −0.096* | 0.379* | 0.798** |
| | (0.051) | (0.222) | (0.386) |
| Household income £45,000–£60,000 | −0.077 | −0.454** | −0.083 |
| | (0.051) | (0.224) | (0.388) |
| Household income £60,000–£75,000 | −0.006 | −0.546* | −0.900* |
| | (0.069) | (0.303) | (0.525) |
| Household income > £75,000 | −0.075 | −0.779** | −0.200 |
| | (0.073) | (0.318) | (0.550) |
| *Behavioural Characteristics* | | | |
| Heavy discounter (= 1) | 0.003 | 0.046 | 0.014 |
| | (0.067) | (0.293) | (0.508) |
| Impulsive spender (= 1) | 0.016 | 0.358 | 0.595 |
| | (0.057) | (0.248) | (0.431) |
| Risk averse (= 1) | 0.050 | −0.170 | 0.195 |
| | (0.039) | (0.169) | (0.294) |
| Observations | 632 | 632 | 632 |
| $R^2$ | 0.283 | 0.171 | 0.053 |
| LR chi2 | 13.481 | 7.530 | 2.750 |
| Prob > chi2 | 0.000 | 0.000 | 0.000 |
| Baseline predicted probability | 0.500 | 2.760 | 3.673 |

*Note:* Table shows OLS estimates and robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Sample is mortgage holders only. In Column 1 the dependent variable is the loan-to-value ratio constructed by dividing the total outstanding principal on the mortgage by the house value. In Column 2 the dependent variable is the loan-to-income ratio constructed by dividing the total outstanding principal on the mortgage by gross household income. In Column 3 the dependent variable is the current mortgage interest rate (fixed or adjustable).

*Source:* YouGov Debt Tracker August 2013.

(*hd*) and a control for risk averse individuals (*risk*). Both probit models also include a number of control variables, the vector **X**, for financial and demographic covariates. I show coefficient estimates for age, household income, housing and mortgage characteristics. Additional controls include educational leaving age, 1/0 dummies for own- and spouse employment status, gender, marital status and a 1/0 dummy for whether the mortgage holder has dependent children. I enter the age variable as a series of four dummy variables for the age band of the individual respondent – 18–34, 35–44, 45–54 and 55 or over (which is omitted from the regression as the baseline group). Similarly, household income is included as bands, where income of £30,000–£45,000 (the median of the income distribution) is the omitted baseline group. I do so to allow for a high degree of non-linearity in the model fit between age, household income and the dependent variable outcomes.

For both models the sample comprises the 632 mortgage holders in my dataset. Econometric estimates reveal many of the control variables are economically important. As described in the summary data, holders of AMPs are typically older than holders of SMPs due to the popularity of AMPs during the late 1990s and 2000s. Estimated coefficients on the age dummy variables are negative and statistically significant at the 1% level, confirming the expected positive relation between age and AMP holding. Estimates in Column 2 also suggest a positive relationship between age and the likelihood of an individual holding an ARM[2]. There is no clear relationship between income and either holding an AMP or an ARM.

Coefficient estimates for the behavioural characteristics are related to holding an AMP, but are unrelated to holding an ARM. The probit estimates shown in Column 2 reveal that the coefficients estimated on the literacy score, heavy discounter dummy, impulsive spender dummy and risk averse dummy variables are all statistically not significant at the 10% level. These imply no relationship between the behavioural characteristics and choice of ARM compared with FRM in the baseline specification.

In Column 1, modelling the choice of AMP vs SMP, the coefficient on the literacy score is negative and statistically significant at the 1% level. The average marginal effect returns a value of −0.112, implying that a 1 unit increase in the financial literacy score is associated with an 11 percentage point (pp) decrease in the likelihood of holding an AMP. The baseline predicted probability from the

2 As robustness check, I include age linearly and as higher order polynomial terms. In the AMP model, the linear term is significant at the 1% level and the squared term significant at the 5% level, suggesting some non-linearity in the relationship between age and AMP holding. In the ARM model, the linear term is significant at the 5% level, but higher order polynomial terms are not statistically significant.

TABLE 7 Baseline Probit Model: Repayment Type & Interest Type

| | (1) Repayment Type (Alternative Mortgage = 1) | | (2) Interest Rate Type (Adjustable Rate = 1) | |
|---|---|---|---|---|
| | $\beta$ / SE | Margin | $\beta$ / SE | Margin |
| *Age* | | | | |
| 18–34 | −1.089*** | −0.266*** | −0.527*** | −0.209*** |
| | (0.233) | | (0.191) | |
| 35–44 | −0.808*** | −0.197*** | −0.163 | −0.065 |
| | (0.215) | | (0.180) | |
| 45–54 | −0.627*** | −0.153*** | −0.266 | −0.105 |
| | (0.193) | | (0.167) | |
| *Household Finances* | | | | |
| Household income < £15000 | 0.195 | 0.048 | 0.652** | 0.259** |
| | (0.311) | | (0.284) | |
| Household income £15,000–£30,000 | 0.387** | 0.095** | 0.002 | 0.001 |
| | (0.189) | | (0.158) | |
| Household income £45,000–£60,000 | 0.246 | 0.060 | 0.166 | 0.066 |
| | (0.200) | | (0.157) | |
| Household income £60,000–£75,000 | 0.396 | 0.097 | 0.127 | 0.051 |
| | (0.274) | | (0.219) | |
| Household income > £75,000 | −0.295 | −0.072 | 0.140 | 0.056 |
| | (0.355) | | (0.261) | |
| *Housing* | | | | |
| Mortgage Debt (£10,000s) | 0.043** | 0.011** | −0.019 | −0.008 |
| | (0.018) | | (0.014) | |
| Loan to Value Ratio | −0.078 | −0.019 | 0.465*** | 0.185*** |
| | (0.197) | | (0.170) | |
| Loan to Income Ratio | −0.059 | −0.014 | −0.050 | −0.020 |
| | (0.059) | | (0.042) | |
| Mortgage Interest Rate | −0.014 | −0.003 | −0.070*** | −0.028*** |
| | (0.021) | | (0.017) | |
| *Behavioural Characteristics* | | | | |
| Literacy score (0–4) | −0.459*** | −0.112*** | 0.055 | 0.022 |
| | (0.057) | | (0.044) | |
| Heavy discounter (= 1) | 0.402* | 0.098* | 0.077 | 0.031 |
| | (0.224) | | (0.198) | |
| Impulsive spender (= 1) | 0.448** | 0.109** | 0.178 | 0.071 |
| | (0.192) | | (0.173) | |
| Risk averse (= 1) | 0.289** | 0.071** | 0.176 | 0.070 |
| | (0.141) | | (0.118) | |
| Observations | 632 | | 632 | |
| Pseudo $R^2$ | 0.235 | | 0.087 | |
| LR chi2 | 157.134 | | 75.716 | |
| Prob > chi2 | 0.000 | | 0.000 | |
| Baseline predicted probability | 0.220 | | 0.536 | |

*Note:* Table shows probit model estimates and average marginal effects. * p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses. Sample is mortgage holders only. In Column 1 the dependent variable is a 1/0 dummy for which a value of 1 denotes the individual holds an alternative mortgage and a value of 0 denotes the individual holds a standard mortgage. In Column 2 the dependent variable is a 1/0 dummy variable for which a value of 1 denotes the individual holds an adjustable rate mortgage and a value of 0 denotes the individual holds a fixed rate mortgage. Baseline predicted probability is the average predicted likelihood from the model.

Omitted reference groups are , for *Age:* > 54; for *Household Income:* £30,000–£45,000. Further controls for education leaving age, (spouse) employment status, gender, marital status and dependent children.

*Source:* YouGov Debt Tracker August 2013.

probit model is 22%. Hence, the 11 pp decrease is a 50% decrease on the baseline predicted probability.

The estimated coefficients for the measures of present bias and time preferences are both positive: the impulsive spender dummy is statistically significant at the 5% level. The average marginal effect implies an individual who is an impulsive spender is 11 pp more likely to hold an AMP, a 50% increase on the baseline predicted probability. The heavy discounter dummy is significant at the 10% level and implies an individual captured by this dummy variable is 10 pp or 45% more likely to hold an AMP. The variable capturing risk averseness is positive and statistically significant at the 5% level. An individual who is risk averse is 7 percentage points more likely to hold an AMP, a 32% increase on the baseline predicted probability (I will discuss this result further in Section 5).

The financial literacy score variable used in the baseline regression sums answers to four questions. Are some of these questions more important than others for the decision to hold an AMP? To investigate this, in Table 8 I re-estimate the probit models from Table 7 but include separate 1/0 dummy variables denoting correct/incorrect answers to each of the four questions. Coefficient estimates in Column 1 reveal that each of the first three questions return statistically significant and negative coefficients with similar coefficient magnitudes and average marginal effect magnitudes.

The coefficient on the Question 4 dummy variable is statistically not significant at the 10% level. This is perhaps unsurprising as answers to the preceding questions are correlated and the additional of the fourth question dummy may be collinear with the earlier questions. However, these estimates show that no one single concept captured by my financial literacy questions alone explains the choice between an AMP and SMP. Instead, a range of concepts tested by the questions are relevant to the mortgage choice decision.

## 4.3 INSTRUMENTAL VARIABLE ESTIMATES

My baseline probit estimates suggest a strong role for financial literacy and related behavioural characteristics for the choice of the repayment type of a mortgage, but not for the choice of the interest rate type. However, my baseline estimates should be interpreted with caution. As discussed before, this is because an individual's financial literacy score may be endogenous to mortgage choices or confounded by other factors related to mortgage choices. Financial literacy may be correlated with individual characteristics I do not directly observe and other elements of an individual's financial situation.

TABLE 8 Baseline Probit Model: Financial Literacy Questions

| | (1) Repayment Type (Alternative Mortgage = 1) | | (2) Interest Rate Type (Adjustable Rate = 1) | |
|---|---|---|---|---|
| | $\beta$ / SE | Margin | $\beta$ / SE | Margin |
| *Mortgage Literacy Question answered correctly* | | | | |
| Question 1 (=1) | −0.649*** | −0.161*** | 0.200 | 0.079 |
| | (0.157) | | (0.145) | |
| Question 2 (=1) | −0.498*** | −0.123*** | 0.007 | 0.003 |
| | (0.146) | | (0.122) | |
| Question 3 (=1) | −0.599*** | −0.149*** | −0.073 | −0.029 |
| | (0.142) | | (0.113) | |
| Question 4 (=1) | −0.072 | −0.018 | 0.101 | 0.040 |
| | (0.152) | | (0.117) | |
| *Behavioural Characteristics* | | | | |
| Heavy discounter (= 1) | 0.366* | 0.091* | 0.073 | 0.029 |
| | (0.222) | | (0.197) | |
| Impulsive spender (= 1) | 0.434** | 0.108** | 0.104 | 0.041 |
| | (0.193) | | (0.170) | |
| Risk averse (= 1) | 0.262* | 0.065* | 0.197* | 0.078* |
| | (0.141) | | (0.115) | |
| Observations | 632 | | 632 | |
| Pseudo $R^2$ | 0.235 | | 0.060 | |
| LR chi2 | 157.028 | | 52.065 | |
| Prob > chi2 | 0.000 | | 0.000 | |
| Baseline predicted probability | 0.350 | | 0.539 | |

*Note:* Table shows probit model estimates and average marginal effects. Specifications identical to those in Table 7 except the financial literacy score enters as 1/0 dummy variables to indicate 1, 2, 3 or 4 questions answered correctly (omitted dummy for 0 questions answered correctly).

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses.

*Source:* YouGov Debt Tracker August 2013.

Also, a potential reverse causality may be at play whereby an individual's mortgage choices affect their subsequent financial literacy. The causality may run from mortgage holding to financial literacy if mortgage holding choices affect the subsequent learning and information acquisition behaviours of the mortgage holders. This mechanism may be at play in my data. For example, the choice of taking a SMP as opposed to an AMP may lead to consumers acquiring information on mortgage amortisation through their mortgage statements which they would not receive had they taken an AMP.

Mortgagees who take a SMP will receive information on the amortisation of their mortgage – such as bank statements which show the monthly interest charges, monthly payments on account and decline in principal. Reading this information on mortgage statements may be a source of learning about the concepts I examine including compound interest calculation and duration features of a mortgage. By contrast, the holder of an AMP would receive a mortgage statement simply illustrating that their monthly payment on account is equal to the monthly interest charges with the principal unchanged. This potential route of endogeneity should be controlled for.

To overcome this potential reverse causality issue, I now present results of Instrumental Variable Probit (IV probit) models. The candidate instrumental variable should be correlated with the instrumented variable (the financial literacy score) but exogenous to mortgage choice and unrelated to the unobservable characteristics which may be related to mortgage choice. My choice of instrument is an individual's self-reported mathematical ability aged 10, as suggested by Jappelli & Padula (2013). In the UK education system, 10 is the age before high school entry and hence before students are able to self-select into subjects of interest. Mathematical ability is recorded on a five-point scale.

The linear equation that estimates mathematical ability as instrument for financial literacy is given as

$$fl = \alpha_0 + \alpha_1 math + \alpha_2 imp + \alpha_3 hd + \alpha_4 risk + \mathbf{X}'\beta + u \tag{3}$$

which includes all behavioural characteristics and control variables. The IV probit approach jointly estimates Equation 3 together with Equation 1 and Equation 2, respectively, using the maximum likelihood estimator.

Estimates from the Equation 3 are shown in Table 9. I estimate this model for the identical sample of 632 mortgage holders used in my baseline estimates. The dependent variable is the financial literacy score and the set of independent variables is identical to that used in the baseline regression plus the inclusion of the instrument. Estimates show a positive coefficient on the math level in school index which is statistically significant at the 1% level. The coefficient value of 0.432

implies a 1 unit increase in mathematical ability at school leads to a .43 increase in the financial literacy score. The average financial literacy score among mortgage holders in the sample is 2.35; hence a 1 unit increase in self-assessed mathematical ability causes an 18% increase in later life financial literacy score.

Estimates from the IV probit model are shown in Table 10. Again, I report average marginal effects to investigate the magnitude of the economic relationship. I describe estimates in Column 1 for AMP vs SMP and then estimates in Column 2 for ARM vs FRM. The estimates in Column 1 are very similar to those from the baseline model. The coefficient on the financial literacy score of −0.446, statistically significant at the 1% level, is very close to the coefficient estimate of −0.459 in Table 7. The marginal effect implies a one unit increase in the instrumented financial literacy score raises the probability of the individual holding an AMP by 10 pp. Evaluated against the baseline probability of 21.9% this represents a 46% increase in likelihood – very similar to the 50% increase in likelihood from the equivalent calculation for the baseline model.

Coefficients on the other behavioural characteristics variables are also very similar to before. The coefficients on the impulsive spender dummy and risk averse dummy are both statistically significant at the 5% level and imply an individual captured by the impulsive spender dummy variable is 9.9 pp (45%) more likely to hold an AMP and an individual captured by the risk averse dummy is 6.5 pp (30%) more likely to hold an AMP. The previous equivalent estimates from Table 7 were very similar at 45% and 32% respectively. Overall, my results are virtually unchanged in the IV model, suggesting endogeneity does not affect my baseline results. The Wald test of exogeneity confirms this as the test statistics fails to reject the null hypothesis of no endogeneity ($p = 0.895$).

However, estimates from Column 2 reveal a very different coefficient estimate for the instrumented financial literacy score compared with the baseline specification. In this model the financial literacy score is positive and statistically significant at the 1% level. The average marginal effect value of 0.12 implies a one unit increase in the financial literacy score causes a 12 pp increases in the likelihood of an individual holding an ARM. Evaluated against a baseline likelihood of holding an ARM of 53%, this value equates to a 23% increase in likelihood. The difference between this result and the baseline probit estimates suggests that the impact of financial literacy is underestimated in the baseline model. The Wald test confirms that we can reject the null of no endogeneity ($p = 0.010$). Coefficient estimates for the other behavioural characteristics variables are, as previously, statistically not significant at the 10% level of significance.

TABLE 9 First Stage of Instrumental Variable Approach

| | (1)<br>Literacy score (0–4)<br>$\beta$ / SE |
|---|---|
| *Instrument* | |
| Math Level in School (1–5) | 0.431*** |
| | (0.049) |
| *Age* | |
| 18–34 | 0.025 |
| | (0.163) |
| 35–44 | 0.230 |
| | (0.154) |
| 45–54 | 0.029 |
| | (0.144) |
| *Demographics* | |
| Male (= 1) | 0.456*** |
| | (0.097) |
| Married / living as married (= 1) | 0.423** |
| | (0.202) |
| Dependent children (= 1) | −0.050 |
| | (0.108) |
| *Employment* | |
| Employed (= 1) | −0.009 |
| | (0.151) |
| Unemployed (= 1) | 0.667 |
| | (0.484) |
| *Household Finances* | |
| Household income < £15000 | −0.608*** |
| | (0.230) |
| Household income £15,000–£30,000 | −0.629*** |
| | (0.133) |
| Household income £45,000–£60,000 | −0.052 |
| | (0.136) |
| Household income £60,000–£75,000 | 0.400** |
| | (0.188) |
| Household income > £75,000 | −0.050 |
| | (0.228) |
| *Housing* | |
| Mortgage Debt (£10,000s) | −0.007 |
| | (0.012) |
| Loan to Value Ratio | −0.186 |
| | (0.130) |
| Loan to Income Ratio | 0.046 |
| | (0.036) |
| Mortgage Interest Rate | −0.003 |
| | (0.014) |
| *Behavioural Characteristics* | |
| Heavy discounter (= 1) | −0.137 |
| | (0.171) |
| Impulsive spender (= 1) | −0.198 |
| | (0.146) |
| Risk averse (= 1) | 0.266*** |
| | (0.099) |
| Observations | 632 |
| F-Statistic | 7.768 |
| t-Statistic of Instrument | 9.762 |
| $R^2$ | 0.243 |
| Baseline predicted probability | 2.347 |

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses.

*Source:* YouGov Debt Tracker August 2013.

TABLE 10 IV Probit Model: Repayment Type & Interest Type

| | (1) Repayment Type (Alternative Mortgage = 1) | | (2) Interest Rate Type (Adjustable Rate = 1) | |
|---|---|---|---|---|
| | $\beta$ / SE | Margin | $\beta$ / SE | Margin |
| *Instrumented Variable* | | | | |
| Literacy score (0–4) | −0.446*** | −0.100*** | 0.353*** | 0.120*** |
| | (0.159) | | (0.109) | |
| *Age* | | | | |
| 18–34 | −1.073*** | −0.242*** | −0.536*** | −0.183*** |
| | (0.216) | | (0.191) | |
| 35–44 | −0.804*** | −0.181*** | −0.233 | −0.079 |
| | (0.215) | | (0.179) | |
| 45–54 | −0.615*** | −0.138*** | −0.265 | −0.090 |
| | (0.189) | | (0.168) | |
| *Demographics* | | | | |
| Male (= 1) | 0.002 | 0.000 | −0.037 | −0.013 |
| | (0.158) | | (0.125) | |
| Married / living as married (= 1) | −0.034 | −0.008 | 0.704*** | 0.240*** |
| | (0.291) | | (0.272) | |
| Dependent children (= 1) | 0.300** | 0.068** | 0.082 | 0.028 |
| | (0.150) | | (0.125) | |
| *Employment* | | | | |
| Employed (= 1) | −0.285 | −0.064 | −0.155 | −0.053 |
| | (0.191) | | (0.177) | |
| Unemployed (= 1) | −0.228 | −0.051 | −0.015 | −0.005 |
| | (0.570) | | (0.566) | |
| *Household Finances* | | | | |
| Household income < £15000 | 0.215 | 0.048 | 0.804*** | 0.274*** |
| | (0.334) | | (0.282) | |
| Household income £15,000–£30,000 | 0.405* | 0.091* | 0.197 | 0.067 |
| | (0.217) | | (0.170) | |
| Household income £45,000–£60,000 | 0.247 | 0.056 | 0.179 | 0.061 |
| | (0.195) | | (0.156) | |
| Household income £60,000–£75,000 | 0.390 | 0.088 | −0.030 | −0.010 |
| | (0.296) | | (0.221) | |
| Household income > £75,000 | −0.313 | −0.070 | 0.117 | 0.040 |
| | (0.365) | | (0.277) | |
| *Housing* | | | | |
| Mortgage Debt (£10,000s) | 0.043** | 0.010** | −0.016 | −0.006 |
| | (0.019) | | (0.016) | |
| Loan to Value Ratio | −0.065 | −0.015 | 0.483*** | 0.165*** |
| | (0.189) | | (0.151) | |
| Loan to Income Ratio | −0.059 | −0.013 | −0.060 | −0.020 |
| | (0.060) | | (0.044) | |
| Mortgage Interest Rate | −0.014 | −0.003 | −0.065*** | −0.022*** |
| | (0.020) | | (0.019) | |
| *Behavioural Characteristics* | | | | |
| Heavy discounter (= 1) | 0.409* | 0.092* | 0.124 | 0.042 |
| | (0.249) | | (0.194) | |
| Impulsive spender (= 1) | 0.439** | 0.099** | 0.238 | 0.081 |
| | (0.195) | | (0.156) | |
| Risk averse (= 1) | 0.287** | 0.065** | 0.104 | 0.035 |
| | (0.141) | | (0.118) | |
| Observations | 632 | | 632 | |
| LR chi2 | 98.684 | | 90.767 | |
| Prob > chi2 | 0.000 | | 0.000 | |
| Wald test of exogeneity | 0.895 | | 0.010 | |
| Baseline predicted probability | 0.219 | | 0.533 | |

*Note:* Table shows Instrumental Variable Probit model estimates and average marginal effects. Literacy score is the instrumented variable. Instrument is the variable 'math level at school' which is a categorical variable taking a value between 0 and 5 where 0 is lowest math level at school and 5 is highest. Additional control variables as in Table 7. * p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses.

*Source:* YouGov Debt Tracker August 2013.

# 5

# DISCUSSION & CONCLUSION

This chapter estimates the impact of financial literacy and behavioural traits on mortgage choice. The study of mortgage choice, in particular the use of alternative mortgage types has become of much interest in light of the US sub-prime crisis which proceeded the recent severe economic recession, and in the UK where default rates among alternative mortgages are high. I use household survey data in which I measure financial literacy through a set of questions particularly concerned with testing understanding of central features of mortgage contracts. I analyse the impact of financial literacy on the choice between standard and alternative mortgage products plus the choice between adjustable and fixed rate mortgages.

The analysis highlights several key results: first, I show that financial literacy, but not other behavioural traits, are related to the choice of the type of interest rate of a mortgage. Summary statistics reveal little heterogeneity between holders of ARMs and FRMs with respect to financial literacy. But econometric estimates reveal the importance of financial literacy. These are obtained using an IV strategy which addresses the potential endogeneity of financial literacy to mortgage market experience by exploiting early life variation in financial literacy which arises before experience of the mortgage market. Results show that a unit increase in literacy increases the likelihood of holding an ARM by around 25%.

Results also reveal that there is no evidence that risk aversion, present bias and time preference are significant in the choice of ARM or FRM. An important point is that the significant relation between financial literacy and ARM holding arises endogenously, as financial literacy is not significant in my baseline specification. This shows that controlling for unobserved heterogeneity and reverse causality is important in the study of financial literacy, and to my knowledge this is the first study to provide empirical evidence of a significant relationship between interest type choice and literacy.

These results give support to the notion that informed and forward-looking borrowers are more concerned with choosing a suitable contract (Miles, 2004). Campbell & Cocco (2003) develop a model of 'optimal mortgage choice' and show that these are typically ARMs for the majority of households, but less so for risk averse households with large mortgages. My results show no significant relation

between mortgage debt, risk attitude and interest rate type choice, but a significant relation between financial literacy and ARM holding. My data does not allow to provide judgment whether choice was ex-ante optimal for a household, but I interpret this result as indicating that more financially literate households are willing to take on a mortgage product which will involve them reviewing mortgage options and performance more actively, as suggested by Miles (2004).

Second, I show financial literacy is poor among those holding AMPs. I find that holders of AMPs do worse at my financial literacy questions than do renters. In the whole sample, comprising mortgage holders and non-mortgage holders, individuals answer on average two of the four multiple-choice financial literacy questions correctly. Among mortgagees, holders of SMPs answer 2.5 questions correctly, but holders of AMPs answer only 1.5 questions correctly. Renters do a little better at answering my mortgage-focused questions than do AMP holders, on average answering 1.7 questions correctly. Econometric results show that these differences in financial literacy among mortgagees give rise to large and statistically significant effects on the choice of AMP vs SMP in multivariate regression models. Results show a one point increase in financial literacy lowers the likelihood of an individual holding an AMP by around 50%.

Third, I show that impulsive present bias for consumption and discount rates are important predictors for the choice of AMPs. Among my whole sample 10% have a strong time preference for current consumption in the form of heavily discounting future consumption, 12% have an impulsive present bias for consumption and 30% are risk averse. Holders of AMPs are much more likely to have an impulsive present bias for consumption (20% among AMP holders compared with 10% among SMP holders) and are more likely to heavily discount future consumption (12% compared with 8%). I find present bias is greater among AMP holders compared with renters. Among renters, 16% of respondents exhibit impulsive present bias.

Econometric results reveal that present bias is strongly associated with holding an AMP: those with impulsive present bias for consumption are almost 50% more likely to holding an AMP. This marginal effect is equivalent to a one point increase in financial literacy. Being a heavy discounter is also positively related to holding an AMP with a comparable marginal effect, but this is only weakly significant. This is suggestive that present-bias and associated self-control issues are a stronger predictor of AMP holding than high, but exponential discounting of the future. At the same time I find no evidence, for example, that individuals with poor financial literacy hold more mortgage debt relative to the value of their property or relative to their income. These results show that AMPs have particular features which are highlighted in the choices of those with poor literacy or present bias.

Fourth, I find that risk averseness positively predicts holding of AMPs. Being risk averse implies a 30% increased probability in AMP holding. On first glance this result may be puzzling, because AMPs can be seen as riskier by design because of their non-amortisation property, which may explain the negative relation between risk averseness and AMP holding in Cox et al. (2014). If liquidity constraints and/or potential future repayment problems are at work and refinancing of a mortgage may be difficult, then risk averse individuals should be less willing to take out an AMP. But the positive relation in my results suggests that a different mechanism is at work in my data: research in psychology and behavioural economics suggests that individuals with lower cognitive ability are more risk averse (Dohmen et al., 2010). Hence, risk aversion may act as a proxy for low cognitive ability in my results.

The data used in this chapter does not provide me with the opportunity to interpret mortgage choice in the sense of (sub)optimal individual choice, as I am not able to follow households after the survey. However, my results suggest that poor financial literacy may, in part, explain the greater default rate of AMP holders in the UK (Financial Conduct Authority, 2013). Previous papers have shown how poor consumer understanding affects management of mortgages and mortgage default. Duca & Kumar (2014) show individuals with poor understanding of portfolio risk are more likely to withdraw housing equity. Fornero et al. (2011) show consumers with better general financial understanding are more likely to 'shop around' for mortgages and other products. Gerardi et al. (2013) find poor numerical ability in math tests predicts the likelihood of mortgage default. Indeed, Bucks & Pence (2008) show many borrowers with AMPs misunderstand basic financial features of their mortgages. Cox et al. (2014) and Van Ooijen & Van Rooij (2014) use Dutch data and find financial literacy is related to whether an individual chooses a mortgage contract which optimises tax deductibility.

The results are also consistent with the broader financial literacy literature which shows the effects of poor financial literacy on a broad range of financial choices, including retirement saving, stock market participation and use of consumer credit (for example, Guiso & Jappelli, 2005; Lusardi & Mitchell, 2007a,b; Van Rooij et al., 2011a,b; Disney & Gathergood, 2013. See Lusardi & Mitchell, 2014 for a review). They also confirm the contention of Cocco (2013) that for some consumers the choice of an AMP may be the result of misunderstanding features of the mortgage product.

# BIBLIOGRAPHY


AGARWAL, S., DENG, Y. & HE, J. (2014). 'Time Preferences, Mortgage Choice and Mortgage Default'. *SSRN Electronic Journal (Working Paper)*.

AMERIKS, J., CAPLIN, A., LEAHY, J. & TYLER, T. (2007). 'Measuring Self-Control Problems'. *American Economic Review*, 97(3), pp. 966–972.

ATLAS, S.A., JOHNSON, E.J. & PAYNE, J.W. (2014). 'Time Preferences and Mortgage Choice'. *Working Paper*.

BEHRMAN, J.R., MITCHELL, O.S., SOO, C.K. & BRAVO, D. (2012). 'How Financial Literacy Affects Household Wealth Accumulation'. *American Economic Review*, 102(3), pp. 300–304.

BERNANKE, B. (2010). 'Monetary policy and the housing bubble: Speech at the Annual Meeting of the American Economic Association'. *Speech from Board of Governors of the Federal Reserve System*, 499.

BUCKS, B. & PENCE, K. (2008). 'Do borrowers know their mortgage terms?' *Journal of Urban Economics*, 64(2), pp. 218–233.

BURKS, S., CARPENTER, J., GÖTTE, L. & RUSTICHINI, A. (2012). 'Which measures of time preference best predict outcomes: Evidence from a large-scale field experiment'. *Journal of Economic Behavior & Organization*, 84(1), pp. 308–320.

BUSSE, M.R., KNITTEL, C.R. & ZETTELMEYER, F. (2013). 'Are Consumers Myopic? Evidence from New and Used Car Purchases'. *American Economic Review*, 103(1), pp. 220–256.

CAMPBELL, J.Y. & COCCO, J.F. (2003). 'Household Risk Management and Optimal Mortgage Choice'. *The Quarterly Journal of Economics*, 118(4), pp. 1449–1494.

CARLIN, B.I. (2009). 'Strategic price complexity in retail financial markets'. *Journal of Financial Economics*, 91(3), pp. 278–287.

CARLIN, B.I. & MANSO, G. (2010). 'Obfuscation, Learning, and the Evolution of Investor Sophistication'. *The Review of Financial Studies*, 24(3), pp. 754–785.

CHRISTIANSEN, C., JOENSEN, J.S. & RANGVID, J. (2008). 'Are Economists More Likely to Hold Stocks?' *Review of Finance*, 12(3), pp. 465–496.

COCCO, J.F. (2013). 'Evidence on the Benefits of Alternative Mortgage Products'. *The Journal of Finance*, 68(4), pp. 1663–1690.

COX, R., BROUNEN, D. & NEUTEBOOM, P. (2014). 'Financial Literacy, Risk Aversion and Choice of Mortgage Type by Households'. *The Journal of Real Estate Finance and Economics*, (forthcoming).

DELLAVIGNA, S. & MALMENDIER, U. (2004). 'Contract Design and Self-Control: Theory and Evidence'. *The Quarterly Journal of Economics*, 119(2), pp. 353–402.

DISNEY, R. & GATHERGOOD, J. (2013). 'Financial literacy and consumer credit portfolios'. *Journal of Banking & Finance*, 37(7), pp. 2246–2254.

DOHMEN, T., FALK, A., HUFFMAN, D. & SUNDE, U. (2010). 'Are Risk Aversion and Impatience Related to Cognitive Ability?' *American Economic Review*, 100(3), pp. 1238–1260.

DOHMEN, T., FALK, A., HUFFMAN, D., SUNDE, U., SCHUPP, J. & WAGNER, G.G. (2011). 'Individual Risk Attitudes: Measurement, Determinants, and Behavioral Consequences'. *Journal of the European Economic Association*, 9(3), pp. 522–550.

DUCA, J.V. & KUMAR, A. (2014). 'Financial literacy and mortgage equity withdrawals'. *Journal of Urban Economics*, 80, pp. 62–75.

EINAV, L., JENKINS, M. & LEVIN, J. (2012). 'Contract Pricing in Consumer Credit Markets'. *Econometrica*, 80(4), pp. 1387–1432.

FINANCIAL CONDUCT AUTHORITY (2013). 'Dealing fairly with interest-only mortgage customers who risk being unable to repay their loan'. *FCA Guidance Reports*, FG13/7.

FORNERO, E., MONTICONE, C. & TRUCCHI, S. (2011). 'The effect of financial literacy on mortgage choices'. *CERP Working Paper*, 121(11).

GABAIX, X. & LAIBSON, D. (2006). 'Shrouded Attributes, Consumer Myopia, and Information Suppression in Competitive Markets'. *The Quarterly Journal of Economics*, 121(2), pp. 505–540.

GATHERGOOD, J. & WEBER, J. (2014). 'Self-Control, Financial Literacy & the Co-Holding Puzzle'. *Journal of Economic Behavior & Organization*, 107(Part B), pp. 455–469.

GERARDI, K., GOETTE, L. & MEIER, S. (2013). 'Numerical ability predicts mortgage default.' *Proceedings of the National Academy of Sciences of the United States of America*, 110(28), pp. 11267–71.

GHENT, A. (2013). 'Home Ownership, Household Leverage, and Hyperbolic Discounting'. *Real Estate Economics*, (forthcoming).

GUISO, L. & JAPPELLI, T. (2005). 'Awareness and Stock Market Participation'. *Review of Finance*, 9(4), pp. 537–567.

GUL, F. & PESENDORFER, W. (2001). 'Temptation and Self-Control'. *Econometrica*, 69(6), pp. 1403–1435.

— (2004). 'Self-Control and the Theory of Consumption'. *Econometrica*, 72(1), pp. 119–158.

JAPPELLI, T. & PADULA, M. (2013). 'Investment in financial literacy and saving decisions'. *Journal of Banking & Finance*, 37(8), pp. 2779–2792.

KOIJEN, R.S., HEMERT, O.V. & NIEUWERBURGH, S.V. (2009). 'Mortgage timing'. *Journal of Financial Economics*, 93(2), pp. 292–324.

LACOUR-LITTLE, M. & YANG, J. (2010). 'Pay Me Now or Pay Me Later: Alternative Mortgage Products and the Mortgage Crisis'. *Real Estate Economics*, 38(4), pp. 687–732.

LAIBSON, D. (1997). 'Golden Eggs and Hyperbolic Discounting'. *The Quarterly Journal of Economics*, 112(2), pp. 443–478.

LUSARDI, A. & MITCHELL, O.S. (2007a). 'Financial Literacy and Retirement Preparedness: Evidence and Implications for Financial Education'. *Business Economics*, 42(1), pp. 35–44.

— (2007b). 'Baby Boomer retirement security: The roles of planning, financial literacy, and housing wealth'. *Journal of Monetary Economics*, 54(1), pp. 205–224.

LUSARDI, A. & TUFANO, P. (2009). 'Debt Literacy, Financial Experiences, and Overindebtedness'. *NBER Working Paper*, 14808.

LUSARDI, A. & MITCHELL, O.S. (2014). 'The Economic Importance of Financial Literacy: Theory and Evidence'. *Journal of Economic Literature*, 52(1), pp. 5–44.

MAYER, C., PENCE, K. & SHERLUND, S.M. (2009). 'The Rise in Mortgage Defaults'. *Journal of Economic Perspectives*, 23(1), pp. 27–50.

MEIER, S. & SPRENGER, C.D. (2013). 'Discounting financial literacy: Time preferences and participation in financial education programs'. *Journal of Economic Behavior & Organization*, 95, pp. 159–174.

MILES, D. (2004). *The UK Mortgage Market: Taking a Longer-Term View - Final Report and Recommendations*. London: Her Majesty's Stationery Office.

PISKORSKI, T. & TCHISTYI, A. (2010). 'Optimal Mortgage Design'. *The Review of Financial Studies*, 23(8), pp. 3098–3140.

SEVERN, D. (2008). 'The Financial Ombudsman Service and mortgage endowment complaints'. *Report to the Board of the Financial Ombudsman Service*.

STANTON, R. & WALLACE, N. (1999). 'Anatomy of an ARM: The interest-rate risk of adjustable-rate mortgages'. *The Journal of Real Estate Finance and Economics*, 19(1), pp. 49–67.

STROTZ, R.H. (1955). 'Myopia and Inconsistency in Dynamic Utility Maximization'. *The Review of Economic Studies*, 23(3), pp. 165–180.

THALER, R.H. & SHEFRIN, H.M. (1981). 'An Economic Theory of Self-Control'. *Journal of Political Economy*, 89(2), pp. 392–406.

OOIJEN, R. VAN & ROOIJ, M. VAN (2014). 'Mortgage Risks, Debt Literacy and Financial Advice'. *De Nederlandsche Bank Working Paper*, (449).

ROOIJ, M. VAN, LUSARDI, A. & ALESSIE, R.J. (2011a). 'Financial literacy and retirement planning in the Netherlands'. *Journal of Economic Psychology*, 32(4), pp. 593–608.

ROOIJ, M. VAN, LUSARDI, A. & ALESSIE, R.J. (2011b). 'Financial literacy and stock market participation'. *Journal of Financial Economics*, 101(2), pp. 449–472.

VISCHER, T., DOHMEN, T., FALK, A., HUFFMAN, D., SCHUPP, J., SUNDE, U. & WAGNER, G.G. (2013). 'Validating an ultra-short survey measure of patience'. *Economics Letters*, 120(2), pp. 142–145.

CHAPTER IV

# RISK, CERTAINTY & SIMPLE CHOICE

ABSTRACT

Recent evidence from two experiments by Iyengar & Kamenica (2010) suggests that subjects choose simple options in a large choice set 3.5–4 times as frequently compared to a smaller choice set. In the first experiment, the simple option is certain; in the second experiment the simple option is risky. These results are striking because they contrast sharply with very basic principles of choice theory, and because they relate to two substantial concerns in economics and psychology: choice overload and the relationship between certainty and uncertainty. This chapter reports two studies motivated by this result. Study 1 investigates the claim that the strong preference for the simple option in the larger choice set is a type of certainty effect. Study 2 is a general replication attempt of the experimental components of the original study by Iyengar & Kamenica (2010). My results suggest no systematic evidence for a certainty effect in an environment with eleven options to choose from, as subjects do not exhibit a disproportionate preference for certainty across treatments. The absence of a treatment effect can partly be attributed to the non-replication of the original experiment. Study 2 focusses on the robustness of the original experimental result and investigates subjects' behaviour in the field and in the laboratory. Results show that subjects exhibit no special attraction to simple options, but instead choose according to their self-assessed risk attitude.

*Keywords*: certainty effect, preferences under risk, individual choice, choice overload, simplicity seeking, experimental replication

# 1

# INTRODUCTION

A LARGE AMOUNT OF RESEARCH is concerned with whether individuals exhibit disproportionate preferences for, or tendencies to choose, certain and/or simple options. Recent empirical evidence suggests that these two concepts are related, and that certain options may be preferred *because* they are simpler, and vice versa. In two incentivised experiments, Iyengar & Kamenica (2010, IK henceforth) find that people's preference for simple options increase drastically as the choice set grows, and call this behaviour 'simplicity seeking'.

The concept of the experiments is that subjects select one gamble from a menu of either 3 or 11 options. All menus contain a 'simple' option and some other gambles. In Experiment 1, gambles are dyadic, but the 'simple' option is a certainty and simpler in the sense of requiring less time to compute the expected value and having fewer outcomes. In Experiment 2, all options are risky, but the 'simple' option is a dyadic gamble of either winning $0 or $10, whereas the remaining options are more complex as they hexadic, i.e. have six probable outcomes[1]. Again, the simple option is considered simpler, by IK, because it requires less time to compute expected values.

The treatment variation of IK is that one group of subjects is offered a subset of the 11 gambles. This subset includes only 3 options, one of which is the certain gamble in their Experiment 1 or the dyadic gamble in their Experiment 2. Between the two treatments, IK find a substantial difference in the preference for the simple option. IK's results show that when facing the small choice set, only 16% of subjects prefer the simple options. But when facing the large choice set, around 60% subjects prefer the simple options. This result has received considerable interest as it appears to generate applicability to public policy, for example regarding the options of retirement or health care plans offered to consumers. In the UK, for instance, new regulation requires energy providers to use only one 'simple' structure for all price plans (Ofgem, 2014).

IK's results are striking because they contrast sharply with very basic principles of choice theory, and because they relate to two substantial concerns in economics

I gratefully acknowledge funding for Study 1 provided by Christian Thöni (formerly University of Vienna, now University of Lausanne) from Grant No. 135166 of the Swiss National Science Foundation.

1 In order to make the contrast with 'hexadic', I use 'dyadic' in place of the more usual 'binary'.

and psychology: choice overload and the relationship between certainty and uncertainty.

In standard economic theory, an expanding choice set cannot make a consumer worse off. When the choice set expands, the consumer can either remain at the old bundle or choose one of the newly available options and attain a higher utility level by doing so. Either way, on the standard account, the consumer cannot lose. But, what they should not do is reselect among the originally available options, and it is this restriction which is cast into doubt by IK's finding.

Choice overload refers to the notion that too large a choice set may be unmanageable for a decision maker. When faced with many options, consumers may feel regret or disappointment over their choices, they may make poor decisions, or they may avoid making choice altogether (see Botti & Iyengar, 2006). IK's finding relates to choice overload by demonstrating that large(r) choice sets drive the agent to select one particular option, in their case the simple one.

The certainty effect is a long standing exhibit of the non-expected utility literature (see Starmer, 2000). It refers to the possibility that agents exhibit a disproportionate preference for a risk-free, certain option. Clearly, IK's Experiment 1 relates directly to this finding. This result suggests that a certain option may act as a primarily salient option even when the number of alternatives is increased.

The purpose of this chapter is to report two studies motivated by IK: Study 1 investigates the claim that the strong preference for the simple option in the larger choice set of IK's first experiment derives from it being a certainty, and hence constitutes a type of certainty effect. Study 2 is a more general replication attempt of the experimental components of IK's paper. The latter is warranted because of the importance of IK's findings indicated above and, especially, in the light of the findings of Study 1.

Study 1 uses the same menu of ten risky lotteries and one certain option as IK's first experiment. As a treatment variation, I offer subjects a menu of choices that contains the same risky gambles as the original choice set, but I substitute for the certain option an uncertain gamble that has markedly lower variance than the remaining gambles. The treatment variation allows me to investigate the impact of certainty, so providing new insights into the structure of preferences when certainty is contrasted with near certainty.

This experiment contributes to the literature in a number of ways: firstly, I use an environment where IK have documented that subjects exhibit a preference for certainty and that goes beyond pairwise lottery choice typically used in the literature. Numerous studies have provided empirical evidence of a certainty effect, see for example Ballinger & Wilcox (1997) or Loomes & Sugden (1998). These studies have in common that they focus on pairwise lottery choice, similar

to the famous common ratio effect (see the discussion in Section 2.2). But the evidence provided by IK suggests that a preference for certainty may also be apparent in a more complex setting. This provides new insights with respect to the occurrence of the certainty effect in more complex environments, but also with respect to the impact of certainty in individual choice, for example for methods of risk elicitation that include certainty such as 'Ordered Lottery Selection Designs' (OLSD) as in Binswanger (1980).

Secondly, the experiment contributes to the literature that finds that the certainty effect disappears when certainty is substituted with an option that involves 'near-certain' probabilities (Conlisk, 1989; Harless, 1992; Sopher & Gigliotti, 1993; Harless & Camerer, 1994; Andreoni & Sprenger, 2010). My experimental design is conceptually similar to studies studying the effect of 'near certainty' cited above, but differs in some important ways. For example, Conlisk (1989) does not compare 'certainty' with 'near-certainty', but instead compares lotteries where the probability of winning is 98% to lotteries that offer winning with probability 88%. Other studies provide survey based experiments with very high hypothetical payoffs (Andreoni & Sprenger, 2010). To the best of my knowledge, my experiment is the first that compares 'certainty' with 'near certainty' (in the sense of substituting certainty with a low-variance gamble) in an incentivised and controlled laboratory setting *and* that goes beyond the lottery-pair common ratio examples.

Thirdly, this adds to the recent discussion on 'discontinuous preferences', so-called *u–v* models. These refer to the notion that certain and uncertain outcomes are evaluated with two distinct utility functions (Neilson, 1992; Schmidt, 1998; Diecidue et al., 2004). Recent empirical evidence suggests utility maybe different when certainty and uncertainty are involved (Gneezy et al., 2006; Simonsohn, 2009; Andreoni & Sprenger, 2012). Based on this, Andreoni & Sprenger (2010) suggest that the certainty effect should be treated less like a general violation of Expected Utility Theory (EUT), but instead a local violation when a particular outcome becomes close to certain. Hence, this experiment provides further insights into whether preferences may be seen as 'discontinuous' over certain and uncertain utility.

The results of Study 1 suggest that subjects do not exhibit a disproportionate preference for certainty. I find no evidence to suggest that subjects prefer the certain or 'near-certain' option differently. The majority of subjects choose consistently between rounds. One of the reasons for the absence of a treatment effect lies in the non-replication of IK's original result. In my experiment, only 13%–16% of subjects choose the certain option, compared to 63% in IK's experiment. This provides me only with a handful of subjects to analyse the impact of certain vs near-certainty.

This strong difference in results leads to Study 2 of this chapter. One important difference between my Study 1 and IK's experimental procedure was the environment in which the experiments were conducted: IK approached subjects in the field, i.e. they stopped passers-by at a University campus to participate in the choice task, while I invited subjects to participate in an experiment in 'economic decision making' in a controlled laboratory environment. Study 1 only uses one of the four choice sets studied by IK, but the result cast some doubt on the replicability of at least one of their experiments. But the difference between 'field' and the controlled laboratory environment in my Study 1 might explain some of the differences.[2]

In Study 2, I replicate all of IK's experiments to investigate the robustness of their results. I replicate the experimental procedure of IK in the field and compare the results to choice behaviour in an incentivised laboratory environment. The results of my replication suggest no special attractiveness for simplicity across treatments and experiments, neither in the laboratory nor in the field. Instead, my results suggest that subjects treat the choice task similar to an ordered lottery selection design (Harrison & Rutström, 2008) and choose according to their risk attitude.

The remainder of this chapter is structured as follows. Section 2 gives a brief overview of empirical evidence of choice overload, and a more detailed review of the theory and evidence regarding the certainty effect. Study 1 is presented in Section 3. The theoretical framework and hypotheses are discussed in Section 3.2, results are presented in Section 3.3. A critical discussion of these results is provided in Section 3.4. Section 4 introduces Study 2. Section 4.1 discusses both IK's original experimental design as well as the design of the replication. The results are presented and discussed in Section 4.2. Section 4.3 briefly discusses the results of Study 2. Section 5 concludes the chapter.

2 In their paper, Iyengar & Kamenica (2010) present two studies. The first is the experimental study discussed above, where they recruit subjects 'in the field'. The second study is an econometric analysis of simplicity seeking within 401(k) pension plans. IK refer to their first study as a 'laboratory experiment' (albeit not being performed in a laboratory), and to their second study as using 'field data'. In my chapter, 'field' implies performing IK's experiments outside the laboratory, and 'laboratory' implies performing them in a controlled laboratory environment.

# 2

# LITERATURE REVIEW

This section discusses the literature relevant to choice overload and the certainty effect in some detail. Section 1 has provided the precise motivations of the two studies reported in this chapter, in terms of their relationships to Iyengar & Kamenica (2010). I now describe the wider literature that provides the background which motivates interest in IK's claims among behavioural economists, and, by implication, my analyses of their robustness.

## 2.1 CHOICE OVERLOAD

Choice overload, the notion that agents may be better off with a strictly smaller choice set, has received considerable attention in recent research in economics and psychology. One of the most cited instances is reported in a field experiment by Iyengar & Lepper (2000). They show results from an experiment where they setup a tasting booth in a supermarket with either 6 or 24 different jams on display. Customers were invited to sample these jams and were given a discount coupon for purchases from that range. Although more customers approached the tasting booth with the larger variety, customers exposed to the smaller set were subsequently more likely to buy jams. Iyengar & Lepper (2000) provide more evidence from similar experiments, and interpret their findings as evidence that a large(r) choice set may "undermine chooser's subsequent satisfaction and motivation" (p. 1003).

Evidence that demand may be dependent on choice set size has been discussed in numerous studies, see the reviews of Scheibehenne et al. (2010) and Chernev et al. (2014). For example, Tversky & Shafir (1992) show that the tendency to not choose at all is greater from choice sets where neither alternative clearly dominates other prospects. Their results suggest that consumers may decide not to choose in order to avoid making difficult trade-offs. Greenleaf & Lehmann (1995) show that the difficulty of selecting a single alternative is one of the most important causes for delaying a number of purchase decisions. Dhar (1997) tests the hypothesis that preference uncertainty may lead to choice deferral when no single alternative is dominant and finds that deferral by the absolute difference in attractiveness

among options. Dean (2008) and Ren (2014) find that larger choice sets lead to a stronger preference for the default. Evidence that the number of options has a detrimental effect on subsequent purchases also comes from retirement planning: Iyengar et al. (2004) report that a larger number of funds available in a 401(k) savings plan is negatively correlated with participation in the plan. Occurrence of choice overload has also been documented in a large-scale field experiment in the consumer credit market: Bertrand et al. (2010) find that showing one example loan instead of four in a direct mail advertising campaign has the same effect on demand as reducing the interest rate by 25%.

But it may be difficult to reconcile instances of choice overload with the changes and trends in consumer retail markets: Mehta & Sugden (2013) argue that the range of choices in a supermarket is far greater than 24 jams in Iyengar & Lepper (2000) and the success of modern retailers such as Amazon and Wal-Mart can to a large extend be attributed to the large amount of choices they offer. Hence, the lower propensity to purchase in the larger choice set that Iyengar & Lepper (2000) find is not easily reconcilable with the actual structure of retail markets. Greifeneder et al. (2010) conduct a series of experiments that aim to assess the robustness of Iyengar & Lepper's (2000) claim and find evidence of choice overload only when alternatives are differentiated by many attributes, but not when differentiated by few attributes such as jam-flavours. Scheibehenne et al. (2010) conduct a meta-analysis of 50 published and unpublished experiments and find that the mean effect of assortment size on choice overload is non-significant. Similarly, Chernev et al. (2014) conduct a meta-analysis with more observations and find a 'choice overload effect' only when decision tasks are sufficiently difficult and choice sets sufficiently complex.

Choice overload has generated considerable scientific, public policy and media interest. This interest is perhaps not surprising given that consumers are confronted with a multitude of different choices in many daily situations, and it is a concept that most individuals can easily relate to. If choice overload decreases personal well-being, the organisation of information becomes important for people to make informed decisions. This connects to the recent debate on 'liberal paternalism' in public policy, e.g. trying to influence "the choices of affected parties in a way that will make those parties better off" (Thaler & Sunstein, 2003, p. 175).

The idea behind liberal paternalism is that consumers are prone to choice overload in a variety of domains, for example health or finance, as choice has become more complicated due to the amount of information consumers have to process. A policy maker can 'nudge' consumers to make 'better' choice by, for example, rearranging the choice presentation, providing 'good' defaults or simplifying the choice set. Within the context of choice overload and simplicity seeking, 'choice

architecture' plays an important role, i.e. how choices are presented to consumers. Thaler & Sunstein (2003) argue for creative use of choice architecture, for example presenting healthier food more prominently or highlighting a 'good' default, using 'libertarian paternalist' principles to help decision makers without reducing the choice set. Several governments have established teams to create interventions to nudge people towards better choice or simplify choice, for example the 'Behavioural Insights Team' in the UK, the Government of New South Wales in Australia and the 'Social and Behavioral Sciences Team' in the US Government.

## 2.2 THE CERTAINTY EFFECT: THEORY & EVIDENCE

The certainty effect has triggered substantial interest in economic research. I use two broad classifications to discuss the theoretical contributions: firstly, the *standard* approach in behavioural economics, exemplified by (cumulative) prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992, henceforth CPT[3]), and secondly, the *discontinuous* approach, exemplified by Neilson (1992).

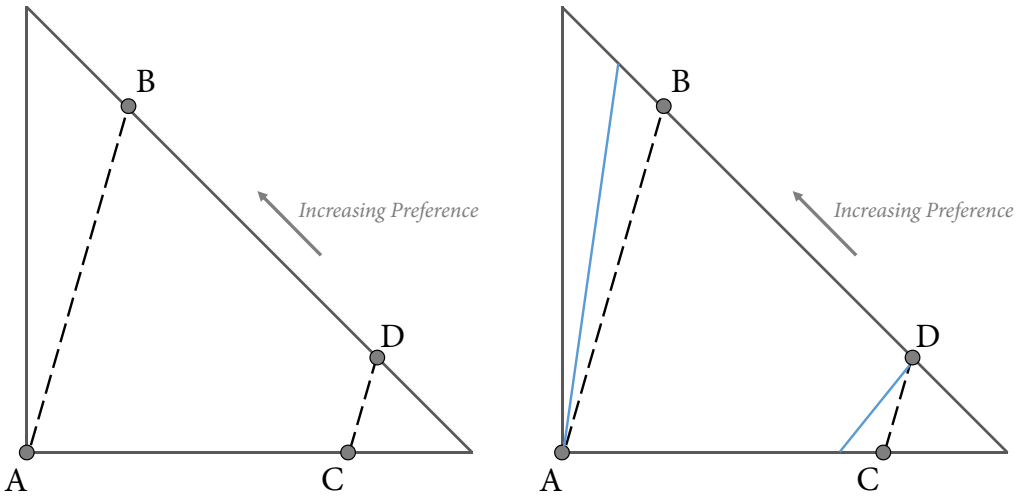
The standard approach has at its heart the relaxation of the independence axiom of EUT and its associated non-linearity in probabilities. A common demonstration of the certainty effect in the standard approach is the 'common ratio effect' (Kahneman & Tversky, 1979), in which agents face the choice between certainty, and a risky lottery and then a scaled version of the original options in two sequential choices:

| | Situation 1 | | Situation 2 |
|---|---|---|---|
| A | 100% chance of £3,000 | C | 25% chance of £3,000<br>75% chance of nothing |
| B | 80% chance of £4,000<br>20% chance of nothing | D | 20% chance of £4,000<br>80% chance of nothing |

The probabilities of Situation 1 are scaled by a common factor of four to create Situation 2. Under EUT, agents that prefer $A > B$ should also prefer $C > D$. Kahneman & Tversky (1979) find that the majority of subjects in an experimental task violate EUT and prefer $A > B$, i.e. the certain option, but $D > C$. Apparently, the reduction in probabilities from 100% to 25% has a greater effect than the reduction from 80% to 20%. Based on this observation, Kahneman & Tversky (1979) argue that people have a tendency to "overweigh outcomes that are considered certain, relative to outcomes which are merely probable" (p. 265).

3 References to 'Prospect theory' refer to CPT for the remainder of this chapter.

FIGURE 1 Common ratio effect in the probability triangle




(a) Linear indifference curves. (b) *Fanning-out* of indifference curves.

The crucial implication of independence in EUT is linearity in probabilities. As a consequence, indifference curves generated by EUT must be straight and parallel in the unit probability triangle. To see why the certainty effect in the form of a common ratio effect violates EUT consider Figure 1. For each of the triangles, the vertical axis is the probability of £4,000, and the horizontal axis is the probability of "nothing". The probability of £3,000 is then defined implicitly, by these two probabilities.

Panel (a) shows the common ratio example with linear indifference curves. All of the dotted lines connecting the points in the choice pairs are parallel, so an EUT agent must either choose the first element of each choice pair, or the second. The blue lines in panel (b) show the slope of the indifference curves required to accommodate for the certainty effect. Clearly, the blue curves are different to the linearity and parallelity required by EUT, and consequently EUT cannot explain the certainty effect while upholding independence.

In two seminal papers, Kahneman & Tversky (1979) and Tversky & Kahneman (1992) show a pattern that explains the common ratio effect consistently: 'fanning-out' of indifference curves for the domain of gains. They start out flat in the southeast region and get steeper to the northwest, as shown in panel (b) of Figure 1. CPT accounts for these EUT violations by postulating an inverse *S*-shaped probability weighting function which is concave for low probabilities and convex for high probabilities. This is based on the psychological reasoning that individuals become less sensitive to changes in probability as they move away from two natural reference points: impossibility and certainty. As a consequence, people underweight outcomes that are merely probable in comparison with outcomes that are certain.

CPT interprets the certainty effect (in the guise of the common ratio effect) as a particular instance of the more general phenomenon of probability weighting. But further evidence, discussed below, suggests that probability weighting may fail to account for the systematic preference for certainty, particularly when considering near certain options. An alternative to explaining the certainty effect is to interpret it as a more fundamental preference for certainty. Gilboa (1988) suggests the following thought experiment: consider lottery $A$ which pays \$4,000,000 with $p = 1 - \alpha$ and \$0 with $p = \alpha$, and lottery $B$ which pays \$3,000,000 with $p = 1$. Gilboa (1988) argues that, when the sums are so large, lottery $B$ is so attractive and the possibility of the zero prize in $A$ so unattractive, that even a minuscule value of $\alpha$ would imply a reversal of the preference ordering that would be held if $\alpha$ were exactly zero.

As this thought experiment suggests, a challenge for CPT may be the near infinite minimisation of changes in probabilities which may be sufficient to generate a certainty effect. But under CPT the inverse-$S$ probability function is not supposed to jump. Diecidue et al. (2004) point out that the special preference for certainty in CPT is 'smooth', but there is no categorical difference between 'riskless' and 'risky' options, only a gradual transition. Consequently, evaluation *at* certainty or *very near* certainty is very similar. To further stress this point consider the following example, provided by Andreoni & Sprenger (2010):

1. Situation $P$: Certainty of receiving 10 million.
   Situation $Q$: 99% chance of 50 million; 1% chance of nothing.
2. Situation $P'$: 99% chance of 10 million; 1% chance of nothing.
   Situation $Q'$: 98% chance of 50 million; 2% chance of nothing.
3. Situation $P''$: 98% chance of 10 million; 2% chance of nothing.
   Situation $Q''$: 97% chance of 50 million; 3% chance of nothing.

These situations are a scaled version of the classic common ratio effect (subject to rounding), and an EU-agent who reveals $P \succ Q$ should also $P' \succ Q'$ and $P'' \succ Q''$. Andreoni & Sprenger (2010) argue that violations of EUT are less frequent further away from certainty, i.e. a substantial proportion of individuals will violate expected utility by $P \succ Q$ and $Q' \succ P'$ due to the unattractiveness of the zero prize. But, as Andreoni & Sprenger (2010) show, once the zero prize is included in all evaluations, i.e. comparing Situation 2 to Situation 3, the relevance of the zero prize is not as important as when evaluating it with certainty. And indeed, the authors find a statistically significant violation of EUT between Situations 1 and 2, but not between Situations 2 and 3, indicating that EUT violations are less prevalent away from certainty.

The *discontinuous* approach is based on the above observations and accounts

for the certainty effect by allowing for distinct utility functions for certainty and uncertainty. These are collectively known as $u$–$v$ models. Under $u$–$v$ preferences, certainty *per se* yields higher utility. $u$–$v$ models capture the intuition of Allais (1953) that when all options are far from certain, individuals act effectively as EU maximisers, but, when certain options are available, certainty is disproportionately preferred. Diecidue et al. (2004) argue that such a discontinuity is psychologically plausible because we perceive 'risk' and 'certainty' as categorically differently: "as soon as a sure outcome is changed into a risky gamble, no matter how small the risk, new emotions are triggered, and people turn to a different evaluation procedure, the one for risky choices" (p. 243).

Conlisk (1989) interprets the certainty effect as a 'boundary effect'. In the triangle diagram, certainties involve only one consequence and hence lie on a 'double-boundary' point. This causes certainties to be more attractive relative to risky options as these are 'single-boundary' points. Certainty is disproportionally preferred because of the simplicity of a single-outcome choice. But when all outcomes are risky, i.e. all choices lie on 'single-boundary' points and have more than one outcome, agents behave according to EUT.

A model of 'boundary effects' that builds on Conlisk's hypothesis is presented by Neilson (1992). His model assumes the existence of a sequence of utility functions $u_i(\cdot)_{i=1}^{m}$, where $u_i(\cdot)$ is the utility function that is used in the evaluation of lotteries with $i$ different outcomes. To account for the certainty effect, the generalised preference ordering is then stated as $u_1(x) \geq u_2(x) \ldots \geq u_m(x)$ for all $x > 0$, $u_1(0) = \ldots = u_m(0)$, and $u_1(x) < \ldots < u_m(x)$ for all $x < 0$. EUT behaviour occurs when $u_1(x) = \ldots = u_m(x)$. This implies that when all choices contain the same number of outcomes, utility is evaluated with the same 'risky' utility function. But when a certain option is included as well, utility is evaluated with two utility functions – one for certainties and the other for uncertainties.

Several studies provide evidence for the 'boundary effects' hypothesis. Conlisk (1989) alters the lottery structure of lotteries similar to the common ratio example so that they lie marginally inside the triangle boundary. In hypothetical choice scenarios, 68% of subjects behave consistently with EUT when all lotteries are off the boundaries, but this falls to 50% when all lotteries are on the boundaries. Similar results have been obtained by Sopher & Gigliotti (1993, 42% consistent EUT behaviour off boundaries, 22% on boundaries), Harless (1992, 50%–75% consistent off boundaries) and Harless & Camerer (1994), who conclude that EUT violations diminish when lotteries contain an identical number of probable outcomes.

Assuming distinct utility functions for certain and uncertain utility is non-standard in decision making under risk. Only a handful of models besides Neilson (1992) have been proposed in the literature (e.g. Gilboa, 1988; Schmidt, 1998;

Diecidue et al., 2004). One of the reasons for the low number of theories is the implied violation of first-order stochastic dominance of $u$–$v$ models, which is "considered undesirable because they seem to be implausible" (Diecidue et al., 2004, p. 242). However, recent empirical evidence discussed in the next section shows that violations of stochastic dominance are not as unsystematic as previously thought, which has revived the interest in $u$–$v$ models.[4]

## 2.3 MORE EVIDENCE OF (UN)CERTAIN UTILITY

One of the motivations for Neilson's (1992) model, and the underlying reason for preference discontinuity, was the notion of preferences for simple options. Evidence consistent with this hypothesis has been presented by Huck & Weizsäcker (1999), who demonstrate in an incentivised experiment with binary lottery choices that subjects are more likely to deviate from EUT when the number of possible prizes increases. Subjects also reveal a tendency to choose the least complex option, i.e. the lottery with the smallest number of probable outcomes. Similar findings have been reported by Sonsino et al. (2002) in a multi-period setting, who find that subjects prefer simpler lotteries with fewer probable outcomes, particularly when the simpler option involves certainty.

Further evidence for the certainty effect has been found by studies focussing on cognitive processes. Arkes (1991) argues that choices involving a salient reference point, i.e. certainty, save cognitive effort. Certainty may be seen as a natural reference point, as it cannot be exceeded (Li & Chapman, 2009). Dickhaut et al. (2003) find that subject's response times and brain activity showed less computation and evaluation processing when certainty was present in a binary choice problem. Interestingly, actual choice did not change significantly, but their findings suggest that just the inclusion of a certain option may promote different decision processes, even if the differences among lotteries are not big enough to trigger different choices.

A series of recent empirical studies tested more directly whether preferences should be considered discontinuous when certainty is involved. One of these is the 'uncertainty effect', discovered by Gneezy et al. (2006). They find in an incentivised experiment that participants were willing to pay \$38 for a gift voucher, but were only willing to pay \$28 for a lottery ticket that offered winning the same voucher or \$100 with equal probability. Simonsohn (2009) successfully replicates the uncertainty effect using a similar setting, but he also provides further robustness

4 Diecidue et al. (2004) provide an insightful discussion on the 'utility of gambling' and argue that even Neumann and Morgenstern foresaw a violation of stochastic dominance.

analysis and rules out that subjects misunderstood the instructions.

The uncertainty effect cannot be explained by EUT or CPT: theories of decision making such as these impose that the value of a risky prospect is evaluated by a weighted-average principle, i.e. it must lie between the value of that prospect's highest and lowest outcome. The uncertainty effect is not only a violation of first order stochastic dominance, but also a violation of this weighted-average principle. But the uncertainty effect can be seen as further evidence for discontinuous preferences. For example, Neilson's (1992) model can readily account for it, since it would imply that the voucher itself is evaluated by a different utility function than the lottery in which the voucher is one of two prizes; and that certainty per se is valued. Thus, the voucher is worth more to a subject when it is not part of a lottery than when it is. Neilson's (1992) model can also rectify the occurrence of first order stochastic dominance violations.

Building on this observation, Andreoni & Sprenger (2012) provide further evidence of a direct preference for certainty by eliciting both certainty -and uncertainty equivalents in an incentivised laboratory experiment[5]. The results of their experiment show that EUT performs well away from certainty, but performs poorly when $p > 0.95$. They also show that Prospect theoretic models do not support the data: with certainty equivalents, $S$-shaped probability weighting summarises behaviour well, i.e. overweighting of small probabilities and underweighting of large probabilities. But with uncertainty equivalents, the results imply that individuals grow more risk averse at certainty of a low outcome, not less-so, as expected under CPT. Furthermore, nearly 40% of their subjects violate first-order stochastic dominance by preferring certainty of a low outcome to a near-certain, dominant lottery. This is both contrary to EUT and probability weighting of Prospect theory, but gives support to models that treat certain and uncertain utility differently.

## 2.4 IMPLICATIONS FOR RISK ELICITATION

The evidence discussed above suggests that agents behave differently when a menu of risky lotteries contains a certain option. This may have direct implications for two widely used methods of risk elicitation: certainty equivalents (CE) and ordered

5 The uncertainty equivalent method is based on eliciting the probability mixture that generates indifference between a gamble's best outcome and zero (see also Cubitt et al., 2004 and Butler & Loomes, 2007). In contrast, the certainty equivalent (CE) method asks for the certain amount that generates indifference to a given gamble. For example, consider gamble $(p, 1-p)$ over \$10 and \$30 $(p; 10, 30)$. The 'uncertainty equivalent' asks which $(q, 1-q)$ gamble over \$30 and \$0 $(q; 30, 0)$ generates indifference. Under EUT, the relationship between $q$ and $p$ must be linear; under probability weighting, $q$ should be a concave function of $p$ with the relationship growing more negative as $p$ approaches 1 (see Andreoni & Sprenger, 2012, Section 2.1 for details). This implies risk aversion at high probabilities and risk tolerance at low probabilities.

lottery selection design (OLSD)[6].

Firstly, CEs assess the certain amount that makes an agent indifferent to a given assessment gamble, i.e. the utility of the two are equal. McCord & De Neufville (1986) argue that for agents who value certainty disproportionally, the utility of the assessment gamble should be weighted higher than the utility of the certainty equivalent, otherwise the elicited utility function may be distorted. CE-variants that impose probability weighting have been proposed by Wakker & Deneffe (1996) and Abdellaoui et al. (2007). They take violations of EUT due to probability weighting into consideration, but fail to account for the evidence suggesting discontinuity of preferences. Andreoni & Sprenger (2012) highlight that CEs produce different results than predicted by standard theories of decision making under risk if certainty or near-certainty is present.

Secondly, in the OLSD subjects select one preferred option from an ordered menu of gambles, and the selected option determines risk attitude. Examples include Eckel & Grossman (2002, 2008) and Dave et al. (2010), using an ordered set where the first choice is a certain payment. Similarly, in the 'risk game' of Binswanger (1980) individuals select one gamble out of six, where the first gamble is a certain payoff (this method is popular in the field with less literate populations, e.g. Barr & Genicot, 2008). If just the existence of a certain option impacts choice, results generated by these methods may be confounded, even when certainty is not the preferred option.

These two risk elicitation procedures may be perfectly valid, provided the researcher is genuinely interested in attitude to certainty, e.g. if they want to know CEs for their own sake, or as indicators of prices at which agents would be willing to trade uncertain assets for certain cash. But, they are potentially misleading in the presence of certainty effects, if they are used to calibrate models that are then used to analyse decisions that do not involve certainties.

6 Other common methods include multiple price lists, random lottery pairs and the 'Becker-DeGroot-Marschak' method. See Harrison & Rutström (2008) for a review.

# 3

# STUDY 1: THE CERTAINTY EFFECT

## 3.1 EXPERIMENTAL DESIGN

Study 1 investigates whether it makes a crucial difference to subjects if a certainty in some choice set is replaced by a non-certain, but otherwise, similar gamble. In this sense, it investigates whether there is something 'special' about certainty. I investigate this in an incentivised laboratory experiment, where subjects are asked to select one option from a set of eleven options.

I use two choice sets, shown in Table 1. Options are presented as 50:50 gambles, determined by a coin flip. Choice set A contains a certain gamble of €5, which I call 'gamble 1'. This choice set is identical to the large choice set of Iyengar & Kamenica (2010), Experiment 1. I use the same nominal values, i.e. converting US-$ to € 1:1. In choice set B, 'gamble 1' is substituted with 'gamble 1.5' that offers a payoff of either €4.75 or €6.25 with equal probability. This gamble is intermediate between lottery 1 and lottery 2, both in terms of expected value and risk. The 'rank' of gamble 1.5 can be seen in Figure 2, which plots expected value as a function of risk and shows that gamble 1.5 lies between 1 and 2.

Options are presented in fixed order, i.e. increasing in risk (measured as increasing variance) and (weakly) increasing in expected value. Every subject faces both choice sets, and the order of choice sets is randomised between subjects. At the start of the experiment, subjects see the general instructions of the experiment, but these only set out the basic procedure (that they participate in an experiment in decision making and can earn money). They also know that the experiment consists of two separate rounds and that instructions are shown on screen before each round. The instructions for each lottery choice task read (translated from German):

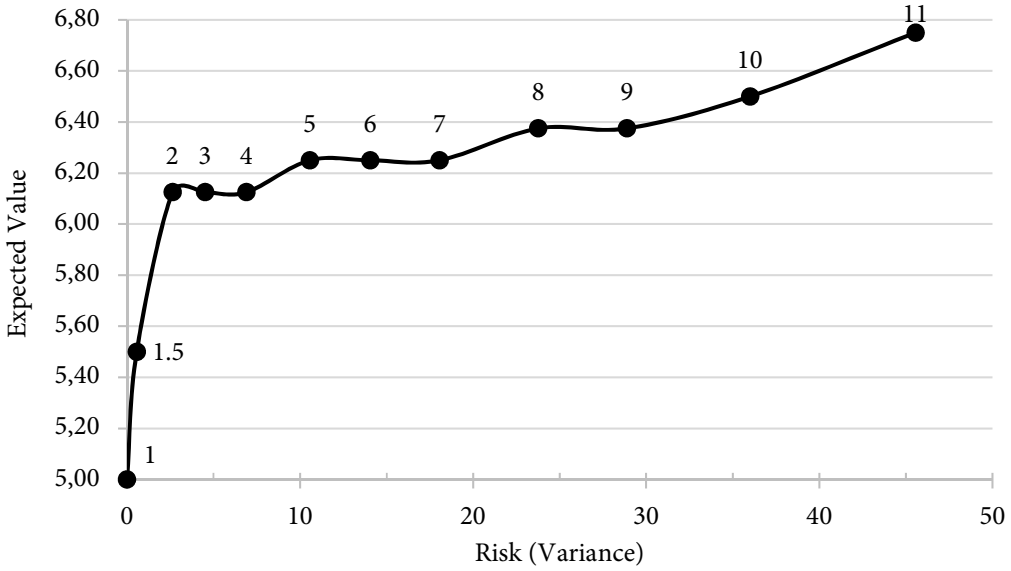
> "In this study, you can choose one option from a set of lotteries. One lottery consists of two possible payoffs: with 50% chance you can get a lower payoff (heads), and with 50% chance you can get a higher payoff (tails)."

Subjects know that only one of the rounds is randomly selected for payment at the end of the experiment. In addition, the two rounds are separated by an IQ test that lasts for approximately 15 minutes. The experiment is programmed with

TABLE 1 Set of Gambles

| Choice Set A | | | Choice Set B | | |
|---|---|---|---|---|---|
| Gamble # | If heads | If tails | Gamble # | If heads | If tails |
| 1 | 5.00 | 5.00 | 1.5 | 4.75 | 6.25 |
| 2 | 4.50 | 7.75 | 2 | 4.50 | 7.75 |
| 3 | 4.00 | 8.25 | 3 | 4.00 | 8.25 |
| 4 | 3.50 | 8.75 | 4 | 3.50 | 8.75 |
| 5 | 3.00 | 9.50 | 5 | 3.00 | 9.50 |
| 6 | 2.50 | 10.00 | 6 | 2.50 | 10.00 |
| 7 | 2.00 | 10.50 | 7 | 2.00 | 10.50 |
| 8 | 1.50 | 11.25 | 8 | 1.50 | 11.25 |
| 9 | 1.00 | 11.75 | 9 | 1.00 | 11.75 |
| 10 | 0.50 | 12.50 | 10 | 0.50 | 12.50 |
| 11 | 0.00 | 13.50 | 11 | 0.00 | 13.50 |

FIGURE 2 Expected Value as a Function of Risk



z-Tree (Fischbacher, 2007).

The objective of these design choices is that subjects treat the two lottery choices independently. The random lottery incentive mechanism rules out income effects. It creates an environment in which subjects could conceivably evaluate choices as contributions to compound lotteries, but empirical evidence from a number of studies suggests that this is not the case (see, for example, Starmer & Sugden, 1991; Cubitt et al., 1998; Hey & Lee, 2005).

Overall, the experiment followed the sequence shown below. Some subjects faced the order in which choice set A was faced at step 1 and choice set B at step 3, whereas other subjects faced the converse order.

1. Subjects see choice set A (B) and select one option.
2. Subjects complete an IQ test.
3. Subjects see choice set B (A) and select one option.
4. One choice is randomly determined.
5. The chosen lottery is played out and subjects get paid.

The objective of this experimental design is to investigate IK's result of a strong preference for the certain option in their Experiment 1, by observing subjects' behaviour when the certain option is substituted with a near certain option. My design provides a test for the certainty effect, by moving away from certainty to a slightly more risky option, but in an environment where several other options are present.

## 3.2 THEORETICAL FRAMEWORK

This subsection develops a simple theoretical framework for considering the choices of a single subject faced with choice sets A and B from Table 1.

Let $A = \{l_1, l_2, ..., l_{11}\}$ and
$B = \{l_{1.5}, l_2, ..., l_{11}\}$,

where the elements of these sets are the lotteries in choice sets A and B defined in Table 1. Let $L = A \cup B$ and, for any $l \in L$, $v(l)$ denote the variance, and $E(l)$ denote the expected value of $l$.

Note that $v(l_1) < v(l_{1.5}) < v(l_2) < ... < v(l_{11})$ and
$E(l_1) \leq E(l_{1.5}) \leq E(l_2) \leq ... \leq E(l_{11})$

I define a choice function $C(\cdot)$ such that for any $S \subseteq L$, $C(S)$ is the unique element of $S$ chosen by the decision maker when the choice-set faced is $S$. Uniqueness is imposed because I wish to model the choices made by subjects in the

experiment. In the experiment, one and only one option must be chosen from any choice-set faced.

For any $S \subseteq L$, any $l \in S$, and any strict ordering[7] $\succ$ of $L$, $l$ is *top-ranked* by $\succ$ in $S$ if, for all $l' \in S$, if $l' \neq l$ then $l \succ l'$. The definition of a strict ordering guarantees that there is exactly one top-ranked element in each $S$. A strict ordering $\succ$ of $L$ is *single-peaked with respect to variance* (henceforth, single-peaked) if, for all $l'$, $l'' \in L$, and letting $l$ be the element top-ranked by $\succ$ in $L$,

(i) if $v(l'), v(l'') > v(l)$ then $l' \succ l''$ if, and only if, $v(l') < v(l'')$;
(ii) if $v(l'), v(l'') < v(l)$ then $l' \succ l''$ if, and only if, $v(l') > v(l'')$.

By way of interpretation, note that, for any $l$, $l' \in L$, $v(l) < v(l')$ implies $E(l) \leq E(l')$. Thus, $L$ represents a risk-return trade-off (as Figure 2 shows) and, for any $l \in L$, $v(l)$ is a sufficient statistic for the position of $l$ on this trade-off. Being single-peaked with respect to variance proxies for being single-peaked in position on the trade-off.

I now consider two possible postulates concerning the choice function $C(\cdot)$:

POSTULATE 1 (ordering):
$C(\cdot)$ is rationalised by a strict ordering $\succ$ of $L$.

POSTULATE 2 (single-peakedness):
$C(\cdot)$ is rationalised by a strict ordering $\succ$ of $L$ that is single-peaked.

Postulate 1 states the most basic standard requirement of consistency of choice across opportunity sets, namely that it is rationalised by an underlying well-behaved preference ordering. Postulate 2 imposes an additional regularity condition. It is perfectly possible for a choice function to satisfy Postulate 1, but not Postulate 2. For example, Neilson's (1992) model would impose Postulate 1, but allow sharp violations of single-peakedness because the utility function used to evaluate $l_1$ would be different from that used to evaluate all the other lotteries. Hence, there would be no implication under that model that preference for certainty implies preference for low risk over high risk dyadic gambles[8].

The implications of ordering and single-peakedness are clarified by the following conditions:

CONDITION 1: If $C(A) \neq l_1$ and $C(B) \neq l_{1.5}$, then $C(A) = C(B)$.

CONDITION 2: (a) If $C(A) = l_1$ then $C(B) = l_{1.5}$.
(b) If $C(B) = l_{1.5}$ then $C(A) \in \{l_1, l_2\}$.

7 By a 'strict ordering' I mean a complete, transitive, but non-symmetric, strict preference relation.

8 In contrast, CPT would rule out major violations of single-peakedness because it represents a case where preference for certainty is associated with a more general preference for low risk (though, strictly, CPT does allow some minor 'local' violations of single-peakedness because of some distinctive features of IK's exact selection of gambles).

The following result, proved in Appendix A, encapsulates the implications of Postulates 1 and 2 for the relationship between choice from choice set A and choice from choice set B, and thus for the main experimental manipulation of the design.

PROPOSITION: If Postulate 1 holds then $C(\cdot)$ satisfies Condition 1.
If Postulate 2 holds then $C(\cdot)$ satisfies Conditions 1 and 2.

A simple intuition is as follows. Recall that $L$ is the set of all lotteries in Table 1. We may ask: What is the agent's preferred lottery from this set? One possibility is that the answer is some element of $\{l_2, ..., l_{11}\}$. Then, this lottery is available both in set A and in set B, and so must be chosen in both cases, if ordering is to be satisfied. Alternatively, the preferred lottery from $L$ might be $l_1$. Then, according to ordering, $l_1$ must be chosen when it is available (i.e. in set A); and, if preferences are single-peaked, the nearest alternative to $l_1$ in Figure 2 (i.e. $l_{1.5}$) must be chosen from set B. The final possibility is that the preferred lottery in $L$ is $l_{1.5}$. Then, according to ordering, $l_{1.5}$ must be chosen when it is available (i.e. in set B); and, if preferences are also single-peaked, the nearest alternative to $l_{1.5}$ in Figure 2, which might be either $l_1$ or $l_2$, must be chosen in set A.

I define the following two behaviours as 'certainty effects':

(i) *Strict Certainty Effect*: $C(A) = l_1$ and $C(B) \neq l_{1.5}$.
(ii) *Weak Certainty Effect*: $v(C(A)) < v(C(B))$.

A strict certainty effect is a case where the certainty is chosen when available, even though the nearest alternative gamble to certainty is *not* chosen in the absence of the certainty. A weak certainty effect refers to the chosen element of set B being further to the right in Figure 2 than the chosen element from set A, reflecting a case where the presence of certainty in the available set induces a more cautious choice, even though the certainty itself is not chosen.

A strict certainty effect is a violation of Condition 2. Evidence of a certainty effect in its strict form would, for example, be choosing gamble 1 in choice set A and gamble 8 in choice set B. This would be evidence of a special attractiveness for certainty. Neilson's (1992) model would be consistent with a strict certainty effect of this form: his model would impose ordering, but allow dramatic violations of the single-peakedness property and hence of Condition 2.

A weak certainty effect violates Condition 1 (unless $C(A) = l_1$, in which case Condition 1 does not apply). If Postulate 2 holds, there can be no certainty effects except for weak ones in which both $C(A) = l_1$ and $C(B) = l_{1.5}$. In contrast, if Postulate 1 holds but Postulate 2 does not, there can be certainty effects, strict or weak, as long as $C(A) = l_1$.

A certainty effect that is weak, but not strong, does not suggest a special tendency to choose certainty, but rather a more subtle effect. This captures the notion that the presence of a certain option in itself may affect choice, even when the certain option is not chosen (Dickhaut et al., 2003). 'Weak' certainty effects can for example be investigated by comparing choice behaviour of all subjects in the first round only. Choice in round one is not influenced by the options presented in the second lottery task, as subjects are unaware that they face a second round with a very similar choice task. This allows me to investigate the impact of a certain option vs a slightly less certain option on the entire choice distribution. Evidence of a certainty effect in its weak form may then be seen as a distributional shift towards lower variance lotteries in choice set A.

## 3.3 RESULTS

All experiments were conducted at the University of Vienna during 2012 and 2013. The two rounds of the experiment allow me to analyse within- and between subject behaviour. 71 subjects completed both rounds of the experiment. This provides me with 71 choice-pairs to analyse within-subject behaviour, i.e. comparing choice behaviour between both rounds. For the 'between' condition, i.e. comparing choice behaviour of the first round only, an additional 42 subjects completed only the first round, adding up to a total of 113 subjects for the 'between' condition.[9]

Subjects earned a €5 show-up fee plus the earnings of one lottery, on average around €10. Subjects were students of the University of Vienna and, on average, 24.3 years old. The gender split was almost equal, with 47% being female.

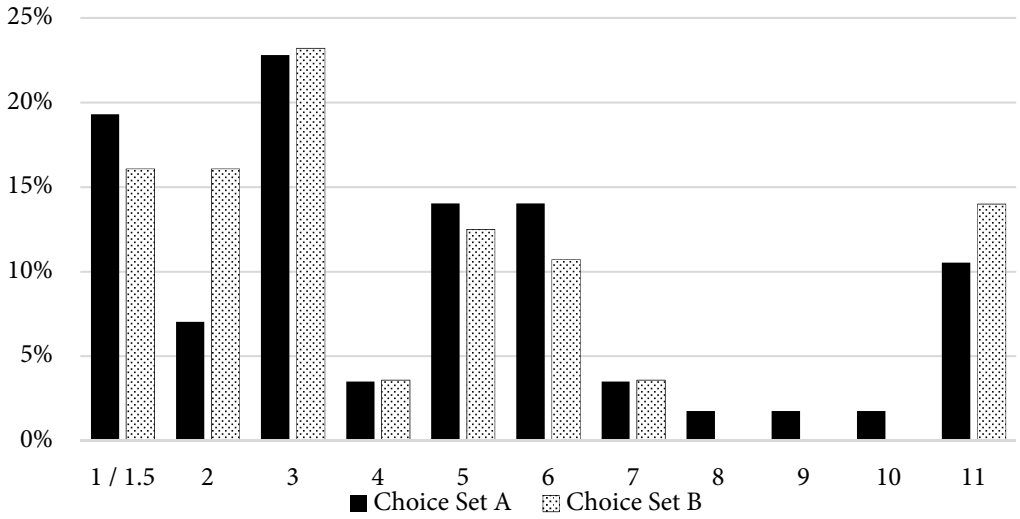
### 3.3.1 Between-Subject Choice

I first discuss the results between subjects, i.e. choice in round 1. Results are shown in Figure 3. Out of 113 subjects, 57 faced choice set A in the first round and 56 subjects faced choice set B. Overall, only 19% chose the certain gamble 1 in choice set A, which is comparable to 16% out of 56 subjects choosing gamble 1.5. I test the significance of the probability of choosing gamble 1/1.5 relative to other gambles in the choice set. A Fisher's exact test cannot reject the null of equal relative proportions among choices ($p = 0.34$).

I also test whether the entire distribution of the two samples is significantly different from each other. The kernel density estimates of choice in choice set A

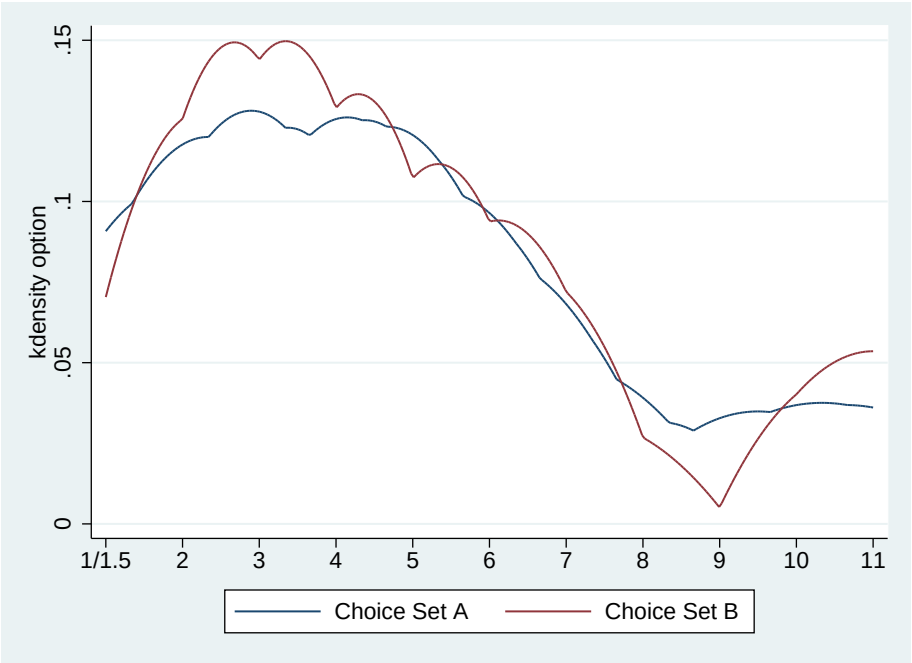
9 These additional observations were generated in an experimental session where choice in the second round was not recorded.

FIGURE 3 Choice of the 'between'-Subjects Sample




*Note:* Figure shows choice for round 1 only. The sample size is 113 subjects, 57 subjects face choice set A and 56 subjects choice set B in round 1.

FIGURE 4 Kernel Density of Subject Choice of the 'between'-Sample



and choice set B are shown in Figure 4. Using the Kolmogorov-Smirnov test it is not surprising that I cannot reject the null of equality of distributions at $p = 0.64$. Hence, I find no evidence that exchanging a certain option with a slightly less certain option significantly changes the choice distribution and I consequently find no evidence of a significant 'weak' certainty effect between subjects.

### 3.3.2 Within-Subject Choice

I will now compare choice from set A with choice from set B using within-subjects tests. As there is no evidence to suggest that subjects who faced choice set A first behaved differently to those who faced choice set B first ($p = 0.78$ in the Kolmogorov-Smirnov test), I pool the choices subjects made in round 1 and round 2 together (for all 71 subjects that made choices in both rounds).

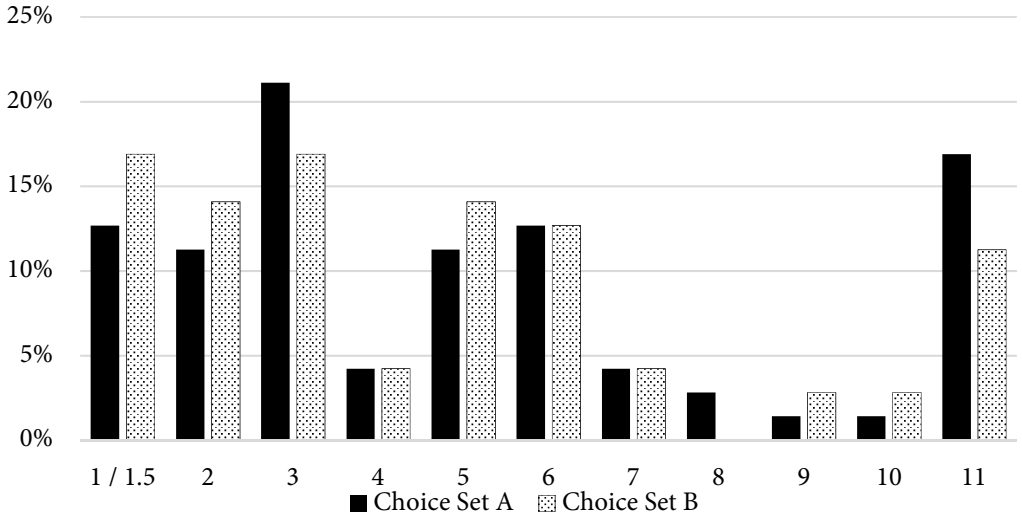
Figure 5 further highlights that the certain gamble 1 is not particularly attractive. Of all 71 subjects only 13% chose the certain gamble in choice set A. Gamble 1.5 of choice set B is slightly more attractive at 17%. A Fisher's exact test again does not allow me to reject the null of equal relative proportions among choices ($p = 0.28$), demonstrating that there is no evidence here of a greater attraction for certainty than for near-certainty. Figure 6 shows the kernel density estimates for both choice set. Again, these two distributions are near identical, confirmed by $p = 0.92$ of the Kolmogorov-Smirnov test, suggesting no evidence of weak certainty effects within subjects.

To further analyse within-subject behaviour, Table 2 plots a contingency table where the rows correspond to choice in set A and the columns to choice in set B, visualising the predictions of the theoretical framework. These predictions and the proportions of subjects conforming to them are summarised in Table 3.

The 'strict' certainty effect can directly be tested by observing subjects who have chosen the certain option in choice set A. Only 9 subjects chose certainty, and hence I cannot provide a relevant statistical test, only descriptive data. Of those 9 subjects, 4 chose gamble 1.5 and the remaining 5 a gamble further away. If we look at those who selected gamble 1.5 (12 subjects) 8 of those select either gamble 1 or gamble 2, and the remaining 4 an option further away. Consequently, only 5 subjects (7%) show a strict certainty effect. Another way of looking at this is to observe how subjects chose depending on their first round behaviour (which, as mentioned before, is not statistically significantly different from second round behaviour). Only 13 subjects (18%) chose gamble 1/1.5 in the first round. Of those, 4 subjects remained at gamble 1/1.5 and 4 subjects chose gamble 2. Again, this provides no evidence for a certainty effect.

To further interrogate these results, I analyse the overall consistency of subjects'

FIGURE 5 Choice of the 'within'-Subjects Sample




*Note:* Figure shows choice for round 1 and round 2 pooled together. The sample size is 71 subjects per choice set.

FIGURE 6 Kernel Density of Subject Choice of the 'within'-Sample

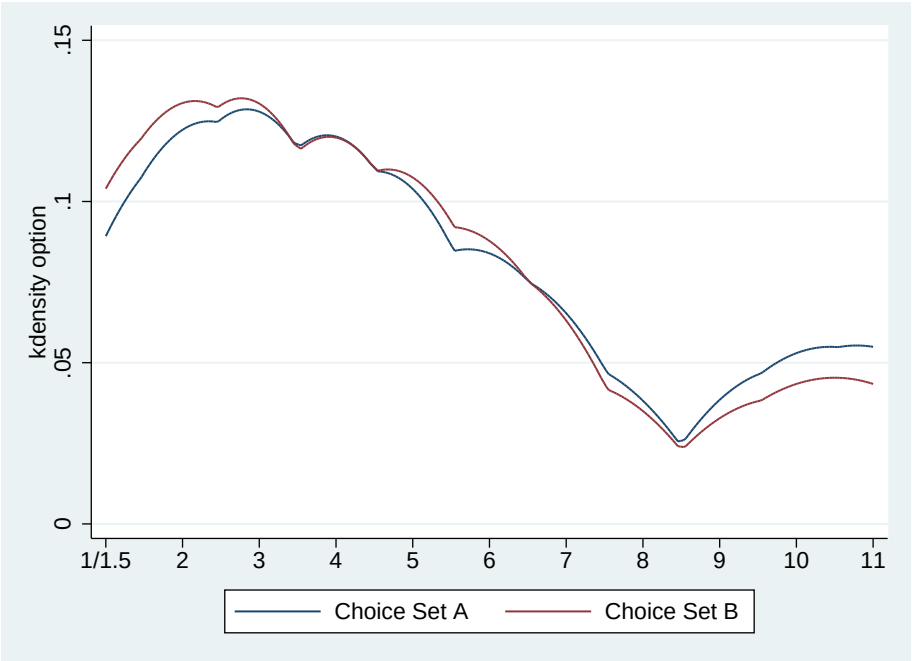


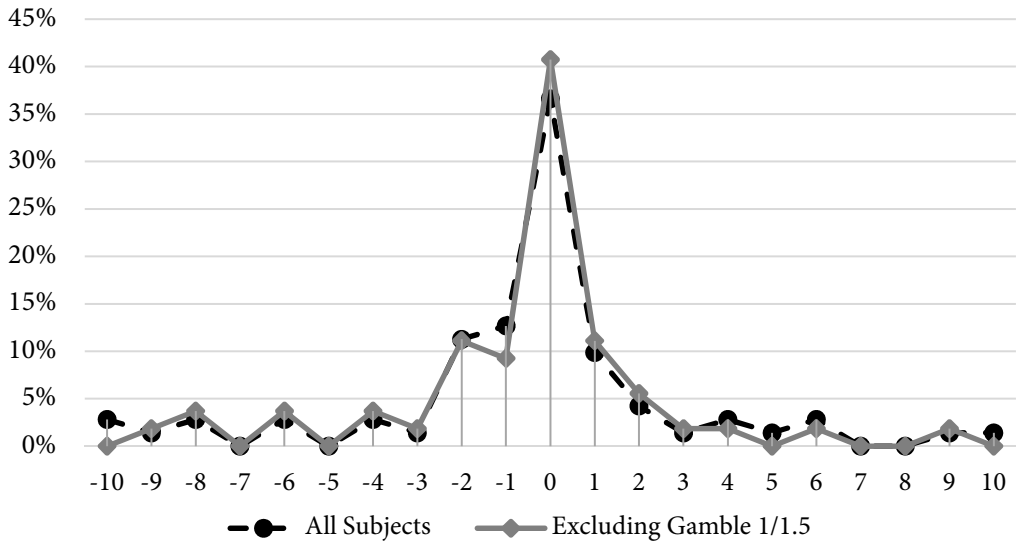
TABLE 2 Within-Subject Choice by Choice Set

| CHOICE SET A | CHOICE SET B: 1.5 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 2 | 4 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 3 | 2 | 3 | 7 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 4 | 1 | 1 | 0 | 1 | 0 | 1 |
| 6 | 0 | 2 | 0 | 1 | 1 | 4 | 1 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 9 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 11 | 2 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 5 |

TABLE 3 Within-Subject Choice Predictions & Behaviour

| | Predictions | % of Subjects satisfying prediction |
|---|---|---|
| *Ordering* | permits subjects to be on the first row, the first column or the main diagonal and nowhere else. | 55 |
| *Single-peakedness* | permits subjects to be on the main diagonal or in the top two cells of the first column, and nowhere else. | 42 |
| *Strict certainty effect* | permits subjects to be on the first row, but not in its left-most column. | 7 |
| *Weak certainty effect* | permits subjects being strictly above the main diagonal. | 25 |

FIGURE 7 Deviations of Choice between Choice Sets




*Note:* Deviations are calculated by taking the difference of choice in Set B from choice in Set A. Gambles 1/1.5 have the same rank.

choice. 39 subjects (55%) did not violate ordering, and 30 subjects (42%) did not violate single-peaked preferences. Figure 7 shows the deviation from the choice in set A to the choice in set B. '0' implies consistent choice, 10/−10 a jump from gamble 1/1.5 to gamble 11 or vice versa[10].

Overall, 42% of all subjects were consistent in their choice, i.e. chose the same gamble or gamble 1/1.5, respectively. In this figure, positive deviations are consistent with a weak certainty effect (as they imply choosing an option with lower variance in choice set A). 18 subjects (25%) exhibit a weak certainty effect. Although I observe inconsistency between choice sets – 58% of subjects are not consistent – a Wilcoxon signed-rank test suggests that these differences are not systematic. This is a non-parametric test for repeated measurements on a single sample. Results show that I cannot reject the null of equal lottery choices between pairs of observations ($p = 0.29$). This implies that I do not find evidence of significant differences in choice between choice set A and choice set B, hence no evidence for a certainty effect, strict or weak.

To investigate violations of ordering, I exclude all subjects that chose either gamble 1 or gamble 1.5. Again, the Wilcoxon signed-rank test shows that I cannot reject the null ($p = 0.94$), hence I find no evidence that subject significantly deviate from consistent choice between sets.

10 A qualification of this analysis is that I am treating a deviation from gamble 2 to 3 identical to a deviation from gamble 10 to 11, although Figure 2 shows that the difference in variance is non-linear between the pairs. However, the main interest here is in deviations of choice between choice sets to analyse order effects, hence it is not necessary to 'weight' choice-pair deviations by their difference in variance.

## 3.4 DISCUSSION OF STUDY 1

The results show that subjects in my experiment do not exhibit a disproportionate preference for certainty. My experimental design aims to investigate the certainty effect by offering subjects choice sets where one certain option is substituted with an option with slightly higher risk. But results show that I do not find a certainty effect between subjects as there is no statistically significant distributional shift by including a certain option in the choice set. I also find no evidence of a certainty effect within subjects as subjects do not statistically significantly deviate in their choice between rounds.

This implies that the concerns discussed before about using certainty in OLSDS are not supported by my findings. Furthermore, though some subjects do violate single-peakedness and even ordering, there is little evidence of a systematic pattern in these violations, or that the concept of a certainty effect helps to organise them. What can explain these results, which are in contrast to the evidence on the certainty effect discussed before?

Firstly, my results are in strong contrast to the results found by IK. In the same choice task, they found that 63% out of 68 subjects select the certain option. In contrast, only 13% out of 71 subjects chose this option in the same choice set in my experiment. As mentioned in the introduction, these differences may be attributable to the different environment in which the experiments were performed: IK approached subjects in the field, while subjects in my study were invited to a controlled laboratory experiment. A further qualification is that IK randomise the order of lotteries between subjects, while in my setting they are ordered ascending by expected value and risk, which may have had an effect on the salience of the certain option. I will explore this and the difference between field and laboratory behaviour in Study 2 of this chapter.

Secondly, subjects may have treated the two choices not independently. One of the objectives of the IQ test was to separate the two choice tasks, so that subjects do not simply repeat their first choice without considering the task. Unfortunately, it is not possible to distinguish whether the non-violation of ordering in my results is due to subjects repeating choice without consideration or due to 'consistent' single-peaked preferences. However, decision times between rounds suggest that non-isolation may indeed form part of the explanation: mean time for choice in round 1 is around 35 seconds, in round 2 this falls to around 23 seconds (Kolmogorov-Smirnov $p < 0.001$).

Thirdly, I used a random lottery incentive mechanism (RLIM), but subjects may still not have treated the two choices in the experiment in isolation, but as

one compound lottery. This argument has been brought forward by (Holt, 1986), but several studies found no evidence in support for it (see, for example, Starmer & Sugden, 1991, Cubitt et al., 1998 and Hey & Lee, 2005). Nevertheless, the only way to be logically certain that responses to a paid experimental task cannot be influenced by the presence of other such tasks, is to have only one paid task. This design has been used and even recommended in certain cases (Cubitt et al., 2001; Cox et al., 2014), but a drawback of it is that it rules out within-subject tests. This made a single-task design an inappropriate choice for my investigation. Nevertheless, my results do not depend entirely on within-subjects tests, and it is unlikely that differences between choice sets A and B in round 1 behaviour could have been influenced adversely by the presence of an as yet unknown subsequent task.

Fourthly, my experiment is a strong test of the certainty effect, and any non-EUT model prediction, because I modify the choice sets only slightly, but keep the remaining structure fixed. Dickhaut et al. (2003) suggest that certainty may trigger different choice processes, even though "the differences among lotteries may not be large enough to induce different choices" (p.3536). It is possible that a stronger manipulation of the 'gamble 1.5' or manipulations of the fixed lotteries would generate a statistically significant certainty effect. Future research might explore this notion further.

Fifthly, this suggests that the certainty effect may not be as pronounced as implied by previous research. The majority of experiments that have documented the certainty effect focussed on evidence of lottery-pair common-ratio-type variants. Only two lotteries are involved in each round – in my experiment, eleven lotteries are involved in each round, which allows subjects to choose more in line with their preferences. One could think of my setting as common-ratio-type lottery-pair choice *plus* an additional nine more lotteries: would we expect to find a preference reversal, if the common ratio paradox is presented with a total of eleven options?

Overall, this also suggests that both the certainty effect and models that aim to explain it, such as $u$–$v$ models, may struggle in a more complex setting. This may be a conceptual issue, because these models were developed to explain systematic choice paradoxes in the very particular environment of lottery-pairs. However, few empirical studies have investigated the performance of these models in environments of different complexity, and more research is needed in this particular domain.

# 4

# STUDY 2: SIMPLICITY SEEKING

The results presented by Iyengar & Kamenica (2010) are, as discussed before, sufficiently striking to warrant a replication attempt. Furthermore, the results of my Study 1 cast some doubt on the replicability of at least one of IK's experiments. However, one important difference between mine and IK's study is that the experiments are performed in different environments: IK recruit subjects 'in the field', i.e. they approach passers-by on campus, whereas in my Study 1 results are generated in a controlled laboratory setting. Study 1 of this chapter is also not concerned with studying behaviour when subjects face small or large choice sets. Hence, in this section, I focus on the robustness of all of IK's experimental results. I replicate both of IK's treatments in the field as well as in a controlled laboratory environment.

## 4.1 EXPERIMENTAL DESIGN

### 4.1.1 Iyengar & Kamenica (2010)

In two experiments subjects are asked to select one option from a menu of gambles. Menus always contain a 'simple' option, but two groups of subjects face either a 'Limited' (i.e. small) or an 'Extensive' (i.e. large) choice set, where the number of alternatives is varied. In both experiments the choice set consists of either 3 options ('Limited') or 11 options ('Extensive'). Subjects face only one of these choice sets and make only one choice. An overview of the experiments and treatments is shown in Table 4.

In the first experiment, henceforth the 'Dyadic experiment', the simple option has no risk and yields a certain outcome of $5, while all other options are 50:50 dyadic gambles with different payoffs. IK argue that the certain option is simpler compared to the dyadic gambles as it requires less time to calculate the expected value: in an unrelated study they find that subjects calculate the expected value of the simple option in around 5 seconds, whereas subjects need between 7.6–16 seconds to calculate the expected value for the other risky gambles[11]. The simple

11 This result is surprising given that evaluation of the simple option requires no computation at all.

TABLE 4 Experiments and Treatments Overview

| TREATMENTS | EXPERIMENTS: Dyadic | EXPERIMENTS: Hexadic |
|---|---|---|
| Limited | simple option is certain<br>other 2 options are dyadic | simple option is dyadic<br>other 10 options are hexadic |
| Extensive | simple option is certain<br>other 10 options are dyadic | simple option is dyadic<br>other 10 options are hexadic |

option may then become more attractive in a larger choice set as it has the lowest evaluation time, and evaluation time is at a greater premium when the larger, Extensive choice set is faced.

The menu of options of the Dyadic experiment is shown in Table 5. The eleven gambles of the Extensive condition are (weakly) increasing in expected value and increasing in variance. The Limited condition includes the simple, risk-free option plus the riskiest gamble with the highest expected value and a gamble near the middle of the expected value/variance distribution (i.e. gambles 1, 4 and 11). The order in which gambles where presented was randomised between subjects.

A preference for the simple option in the Dyadic experiment may also be a preference for certainty. Hence, in the second experiment (henceforth the 'Hexadic experiment'), subjects are asked to select one gamble among a set of gambles with six outcomes (Table 6). Here, the simple option is the riskiest as it pays out either $0 or $10 with 50% chance, while the other gambles have more complex structures as several other payoffs have two decimal places. Again, the authors argue that the first option is simple because, in an unrelated experiment, subjects require around 6.3 seconds to compute the expected value of the simple gamble, while for the other gambles they required 19–61 seconds. Relative to the simple option, gambles are decreasing in expected value and variance. Again, the order of gambles was randomised between subjects. The Limited condition contained the simple option plus two other gambles randomly selected and varied between subjects.

IK conducted both experiments by having their research assistants approach passers-by on the campus of Columbia University (New York, USA). They asked subjects to fill out a questionnaire regarding student satisfaction, unrelated to the experiment. After completing the survey, subjects were presented with the choice task of selecting one gamble from the menu of options for compensation. The lottery was then played out and subjects were paid accordingly. In the Dyadic experiment, the outcome was determined with a coin toss performed by the experimenter, in the Hexadic experiment subjects rolled a die.

TABLE 5 Dyadic Experiment

| | *If the coin shows...* | | | |
|---|---|---|---|---|
| | Limited | | Extensive | |
| Gamble # | Heads | Tails | Heads | Tails |
| 1 | 5.00 | 5.00 | 5.00 | 5.00 |
| 2 | | | 4.50 | 7.75 |
| 3 | | | 4.00 | 8.25 |
| 4 | 8.75 | 3.50 | 8.75 | 3.50 |
| 5 | | | 9.50 | 3.00 |
| 6 | | | 2.50 | 10.00 |
| 7 | | | 10.50 | 2.00 |
| 8 | | | 1.50 | 11.25 |
| 9 | | | 11.75 | 1.00 |
| 10 | | | 12.50 | 0.50 |
| 11 | 13.50 | 0.00 | 13.50 | 0.00 |

*Note:* Table shows payoffs of all lotteries in the Dyadic experiment. The 'extensive' condition includes all lotteries, the 'limited' condition includes gambles #1, #4 and #11. Lotteries are presented in random order.

TABLE 6 Hexadic Experiment

| | *If the die falls on...* | | | | | |
|---|---|---|---|---|---|---|
| Gamble # | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 0.00 | 0.00 | 0.00 | 10.00 | 10.00 | 10.00 |
| 2 | 8.00 | 0.00 | 2.75 | 9.75 | 0.00 | 8.75 |
| 3 | 0.00 | 0.75 | 4.25 | 5.50 | 8.50 | 9.75 |
| 4 | 0.75 | 9.25 | 8.75 | 7.00 | 1.25 | 1.50 |
| 5 | 0.50 | 3.00 | 1.50 | 9.75 | 7.00 | 6.50 |
| 6 | 2.50 | 3.25 | 9.50 | 1.50 | 10.00 | 1.50 |
| 7 | 8.50 | 3.25 | 2.50 | 8.50 | 0.00 | 5.50 |
| 8 | 4.50 | 4.50 | 8.75 | 8.50 | 0.75 | 1.25 |
| 9 | 1.00 | 7.50 | 0.75 | 6.50 | 5.50 | 6.75 |
| 10 | 2.00 | 3.25 | 3.75 | 9.25 | 7.75 | 2.00 |
| 11 | 1.00 | 2.00 | 6.75 | 7.50 | 5.75 | 4.75 |

*Note:* Table shows payoffs of all lotteries in the Hexadic experiment. The 'extensive' condition includes all lotteries, the 'limited' condition includes gamble #1 and two other lotteries chosen at random. Lotteries are presented in random order.

### 4.1.2 Replication

*In the Field*

The field replication aimed to follow IK's procedure closely: I approached passers-by at the University of Nottingham campus (in June 2014) and asked them to fill out a brief questionnaire[12]. The appendix shows the questionnaire (Figure C.7) and the procedure (Figure C.8). Subjects were randomly selected into one of the four treatments, as shown in Table 4. After the questionnaire, subjects continued by choosing one option from the menu of choices. An example of the choice task of the Hexadic experiment is shown in Figure C.9.

There are three differences between IK and my setup: firstly, the 'unrelated' questionnaire is different, but mimics IK's use of a naturalistic, but independent survey to generate a task to be rewarded. However, the questionnaire embeds some basic demographic questions, such as age, gender, nationality and study area, which I will use in my analysis. Secondly, IK resolve the Dyadic experiment with a coin, flipped by the experimenter. I decide to let subjects resolve the lottery themselves by providing them with a die to avoid an unnecessary difference between the gambles with two outcomes and those with six outcomes. Consequently, I change the column headers of the options to say "If the die falls on 1,2 or 3" and "If the die falls on 4,5 or 6", instead of describing a coin flip. Thirdly, I use exactly the same nominal values for the payoffs, but instead pay subjects in £-Sterling, while IK pay their subjects in US-$. At the time when the replication was conducted (June 2014), this represents a roughly 65% higher nominal payoff.

After subjects made their lottery choice, I asked them to answer two brief questions to elicit risk attitude and a measure of impatience:

- How do you see yourself: are you generally a person who is fully prepared to take risks or do you try to avoid taking risks? Please tick a box on the scale, where the value 0 means: 'unwilling to take risks' and the value 10 means: 'fully prepared to take risk'.
- How do you see yourself: are you generally an impatient person, or someone who always shows great patience? Answers are coded on an 11-point scale, with 0 referring to 'very impatient' and 10 'very patient'.

12 The introduction of IK's questionnaire reads: "We are interested in gathering Columbia students' opinions about other renowned universities. Each of the following 5 pages lists a college or university at the top and a brief list of questions probing your opinion about that college or university. The questions are relatively straightforward. Answer to the best of your ability. Thank you for participating!". However, on p. 531 Iyengar & Kamenica (2010) state that subjects were asked to complete "a brief one-page questionnaire". I follow the description in the main text and use a one-page questionnaire which includes questions about IT usage.

These questions are commonly used as proxies for risk attitude and discounting in surveys and are based on Dohmen et al. (2010) and Dohmen et al. (2011). The advantage is that they are easy for subjects to understand, are not time consuming to fill out and easy to implement. Furthermore, Vischer et al. (2013) show that they provide similar estimates as more complex elicitation procedures, such as multiple price list mechanisms. I use these proxies for their simplicity so that the IK lottery choice task is the only incentivised task that subjects face, equivalent to a single-task individual choice protocol (see Cubitt et al., 2001).

Overall, subjects had to complete three stages:

1) fill out the unrelated questionnaire;
2) complete the choice task;
3) answer the attitudinal questions.

Stages were presented on three separate pages on a clipboard. After subjects completed all stages they were provided with a die, rolled it, and were paid according to the outcome of their choice.

*In the Laboratory*

Laboratory experiments were conducted at the Centre for Decision Research and Experimental Economics (CeDEx) at the University of Nottingham in June 2013 and June 2014 (see Figure C.10). Subjects were randomly drawn from CeDEx' subject pool via ORSEE (Greiner, 2004) and randomly assigned into one of the four treatments. As in the field replication, I used the same nominal values, which represented a 60%–65% higher payoff due to the $/£ conversion.

The experiments were conducted with pen and paper. At the beginning, instructions were provided and read out loud. These explained the experimental procedure (Figure C.11). Next, the lottery choice task was distributed. As shown in Figure C.12, the introduction to the choice task was slightly altered to reflect the laboratory setting. I did not impose a time limit, but after 5 minutes I asked subjects to raise their hands if they had finished with the choice task (which all subjects had).

I continued by collecting the choice task and distributed an ability task based on Sousa (2010), for which I allowed 15 minutes. This task consisted of 12 questions, as shown in Figures C.13 to C.15. The first three questions were the three-item cognitive reflection test (Frederick, 2005, CRT), the remaining nine questions assessed quantitative, sequential and verbal reasoning skills. I included these questions for two reasons: firstly, IK's notion of 'simple options' is dependent on the computation time of expected values, which should be directly related to cognitive ability. Secondly, both of IK's experiments involve choice over risky

gambles (apart from the simple option in the Dyadic experiment), and there is a notion that suggests that risk aversion is negatively related to cognitive ability (Frederick, 2005; Burks et al., 2009; Dohmen et al., 2010).

In contrast to the direct way of measuring specific aspects of cognitive ability, the CRT captures the degree to which subjects reflect on answers rather than giving intuitive responses. Frederick (2005) explains performance on the three questions as a test for intuitive ('System 1') or rational ('System 2') thinking. Several studies show that the CRT is a better predictor of decision-making biases than general intelligence measures (see, for example Toplak et al., 2011). Hence, the CRT might capture dimensions of ability relevant to simplicity seeking that may not be captured by the other nine questions of the ability task.

The final task was a brief end-of-experiment questionnaire, where I elicited the same covariates as in the field, including the two proxies for risk and impatience. Subjects received a £2 show-up fee, which was conditional on filling out this questionnaire. After the completion of the final task, I asked subjects to come to the experimenter's desk one by one, where I provided them with a die. They rolled the die and were paid according to their choice and the outcome of the lottery.

## 4.2 RESULTS

### 4.2.1 Sample & Summary Statistics

I collect data from a total of 242 subjects, with an almost equal split between the Limited and Extensive conditions. For the Dyadic experiment, 122 subjects are available, 40 subjects in the field and 82 subjects in the laboratory replication. 120 subjects are in the Hexadic experiment. 40 subjects in the field replication and 80 subjects in the laboratory. This compares to IK: they show results from 137 subjects in the Dyadic experiment and from 120 subjects in the Hexadic experiment.

In the Dyadic experiment, subjects earned on average £6 in the field and £8 in the laboratory, due to the £2 show-up fee. In the Hexadic experiment, subjects earned on average £5.50 in the field and £7.50 in the laboratory. Sample summary statistics can be found in Table 7. For each experiment, I show summary statistics for all subjects, those in the field replication and those in the laboratory replication, split by Limited and Extensive condition. I follow this convention throughout the results section. My null hypothesis is that there should be no differences between subject behaviour in the field and the laboratory. By splitting the analysis into three categories, I am able to investigate this hypothesis and allow for direct comparison with IK's field results.

TABLE 7 Sample Characteristics

| | a) Dyadic Experiment | | | | | | b) Hexadic Experiment | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All | | Field | | Laboratory | | All | | Field | | Laboratory | |
| | Limited | Extensive | Limited | Extensive | Limited | Extensive | Limited | Extensive | Limited | Extensive | Limited | Extensive |
| *Lottery Selection* | | | | | | | | | | | | |
| Simple lottery | 0.30 | 0.15 | 0.50 | 0.30 | 0.20 | 0.07 | 0.31 | 0.24 | 0.30 | 0.15 | 0.32 | 0.28 |
| *Demographics* | | | | | | | | | | | | |
| Age | 20.74 | 21.07 | 20.80 | 21.95 | 20.71 | 20.63 | 22.23 | 21.15 | 25.70 | 21.80 | 20.54 | 20.82 |
| Female (= 1) | 0.56 | 0.62 | 0.65 | 0.60 | 0.51 | 0.63 | 0.57 | 0.47 | 0.55 | 0.60 | 0.59 | 0.41 |
| European national (= 1) | 0.69 | 0.67 | 0.75 | 0.80 | 0.66 | 0.61 | 0.70 | 0.73 | 0.75 | 0.85 | 0.68 | 0.67 |
| Economics student (= 1) | 0.10 | 0.02 | 0.05 | 0.00 | 0.12 | 0.02 | 0.15 | 0.12 | 0.10 | 0.15 | 0.17 | 0.10 |
| Student (= 1) | 0.98 | 0.97 | 0.95 | 0.90 | 1.00 | 1.00 | 0.95 | 0.95 | 0.85 | 0.85 | 1.00 | 1.00 |
| *Behavioural Characteristics* | | | | | | | | | | | | |
| Risk Attitude (0–10) | 6.03 | 5.87 | 6.50 | 6.30 | 5.80 | 5.66 | 6.05 | 5.97 | 6.55 | 6.05 | 5.80 | 5.92 |
| Impatience (0–10) | 5.48 | 4.92 | 6.35 | 5.10 | 5.05 | 4.83 | 4.85 | 5.20 | 4.90 | 5.75 | 4.83 | 4.92 |
| *Ability* | | | | | | | | | | | | |
| CRT Q1 correct | | | | | 0.63 | 0.41 | | | | | 0.41 | 0.64 |
| CRT Q2 correct | | | | | 0.51 | 0.54 | | | | | 0.54 | 0.67 |
| CRT Q3 correct | | | | | 0.63 | 0.61 | | | | | 0.56 | 0.74 |
| Quantitative reasoning score (0–3) | | | | | 2.29 | 2.39 | | | | | 2.44 | 2.46 |
| Sequential reasoning score (0–3) | | | | | 2.83 | 2.83 | | | | | 2.73 | 2.85 |
| Verbal reasoning score (0–3) | | | | | 1.12 | 1.24 | | | | | 1.02 | 1.28 |
| Observations | 61 | 61 | 20 | 20 | 41 | 41 | 61 | 59 | 20 | 20 | 41 | 39 |

*Note:* Risk attitude and impatience are measured on an eleven point scale, see Section 4.1.2. '0' implies risk averseness and low impatience, '10' risk tolerance and high impatience. The scale of the 'impatience' variable is inverse compared to the original wording of the question.

Subjects are, on average, 21.3 years old and 56% of all subjects are female. 96% of subjects are students (all subjects in the laboratory are students, 9 subjects in the field are non-students with a mean age of 26). I group all nationalities into a European/non-European binary variable, and 70% of all subjects are Europeans.

The average risk attitude across subjects is 6 on the 11-point scale, which implies a slight tendency for (subjectively-reported) risk tolerance[13]. There is little difference between self-reported risk attitude across experiments, but subjects in the field state higher risk tolerance (6.35) compared to subjects in the laboratory (5.80). I include the impatience proxy inversely, '0' implies low impatience and '10' high impatience. Subjects state a higher degree of impatience in the field (5.50) compared to the laboratory (4.90). Interestingly, there also appears to be a difference in impatience between the Limited and Extensive conditions: in the Dyadic experiment, subjects are less impatient than in the Extensive condition, which is particularly pronounced in the field. This relation is reversed in the Hexadic experiment, where subjects are more impatient in the Extensive condition. I explore these differences further in the following sections.

The cognitive ability questions were answered extremely well. Out of 3 questions, subjects answer on average 2.4 questions correctly in the quantitative reasoning task and 2.8 questions correctly in the sequential reasoning task. The verbal reasoning task is perhaps the most challenging one, especially for non-native English speakers, and the average of correct answers is 1.17. Subjects answer, on average 1.72 out of the three CRT questions correctly, which is above average compared to the mean of 1.24 found by Frederick (2005). Interestingly, there are differences in CRT performance between treatments and experiments: in the Dyadic experiment, 63% of subjects answer Question 1 correctly in the Limited condition, which compares to 41% in the Extensive condition. This is reversed in the Hexadic experiment.

For my further analysis, I follow the methodology of Frederick (2005) and Sousa (2010) and create two variables that capture high ability. Firstly, subjects have high ability in the general ability questionnaire if they answer strictly more questions correctly than the median of correct answers (the median is 7). Around one fifth of subjects in the laboratory are in this group. Secondly, subjects have high ability in the CRT if they answer all three questions correctly (the median is 2). Around one third of subjects are in this category.

13 The 11-point scale of the Dohmen et al. (2010, 2011) questions do not allow interpretation of 'risk attitude' in the technical sense, e.g. whether subjects are risk-seeking in the sense of preferring a lottery to its expected value. I use the terms 'risk averse' and 'risk seeking/tolerant' to reflect lower and higher responses, respectively, on the 11-point scale, or to represent the coding described on p. 143

### 4.2.2 Main Results

*Dyadic Experiment*

The main results of the Dyadic experiment are shown in Figure 8. The three different schedules show the results for a) all subjects, b) subjects in the field, and c) subjects in the laboratory. For better comparison, the original IK results are also included in schedules a) and b) behind my results. Table B.1 in the Appendix shows the exact percentages and subject numbers.

The results of IK show that 16% chose the simple option in the Limited condition, but 63% chose the simple option in the Extensive condition. In a 2x2 Fisher's exact test, this implies a statistically significant increase at $p < 0.001$ for simplicity when the choice set is expanded. In contrast, the treatment effect is reversed in my replication: considering all subjects, 30% chose the simple option in the Limited condition, which fell to 15% in the larger choice set. This reversal is also seen in the Field results, which can be compared directly to IK: half of all subjects chose the certain £5 in the Limited condition, which fell to 30% in the Extensive condition. In the laboratory, 20% chose the simple option in the Limited condition, and only 7% chose it in the Extensive condition.

Table 8 shows $p$-values of Fisher's exact test for the Dyadic experiment in Schedule a), first row, testing the null hypothesis of no significant difference for the simple option in the Limited and Extensive conditions. Considering one-tailed $p$-values, we can reject the null considering all subjects and subjects in the laboratory at the 10% level. This implies that the reverse-treatment effect is weakly statistically significant.

*Hexadic Experiment*

The results of the Hexadic experiment are shown in Figure 9, again in three different schedules. They reveal a similar pattern as in the previous experiment: IK's results show that 16% of all subjects preferred the simple option in the Limited condition, which increased to 57% in the Extensive condition. Again, the increase in the attractiveness for the simple option is statistically significant in their data at the 0.1% significance level. This treatment effect is not visible in my replication: 31% of all subjects in the Limited condition preferred the simple gamble, which dropped to 24% in the Extensive condition. This reversal is stronger in the field (30% to 15%) and weaker in the laboratory (32% to 28%).

Results of the Fisher's exact test are shown in Schedule b), first row, of Table 8. They indicate that I cannot reject the null of no difference in preference for the simple options across treatments for all subjects, in the field and in the laboratory.

FIGURE 8 Dyadic Experiment Results

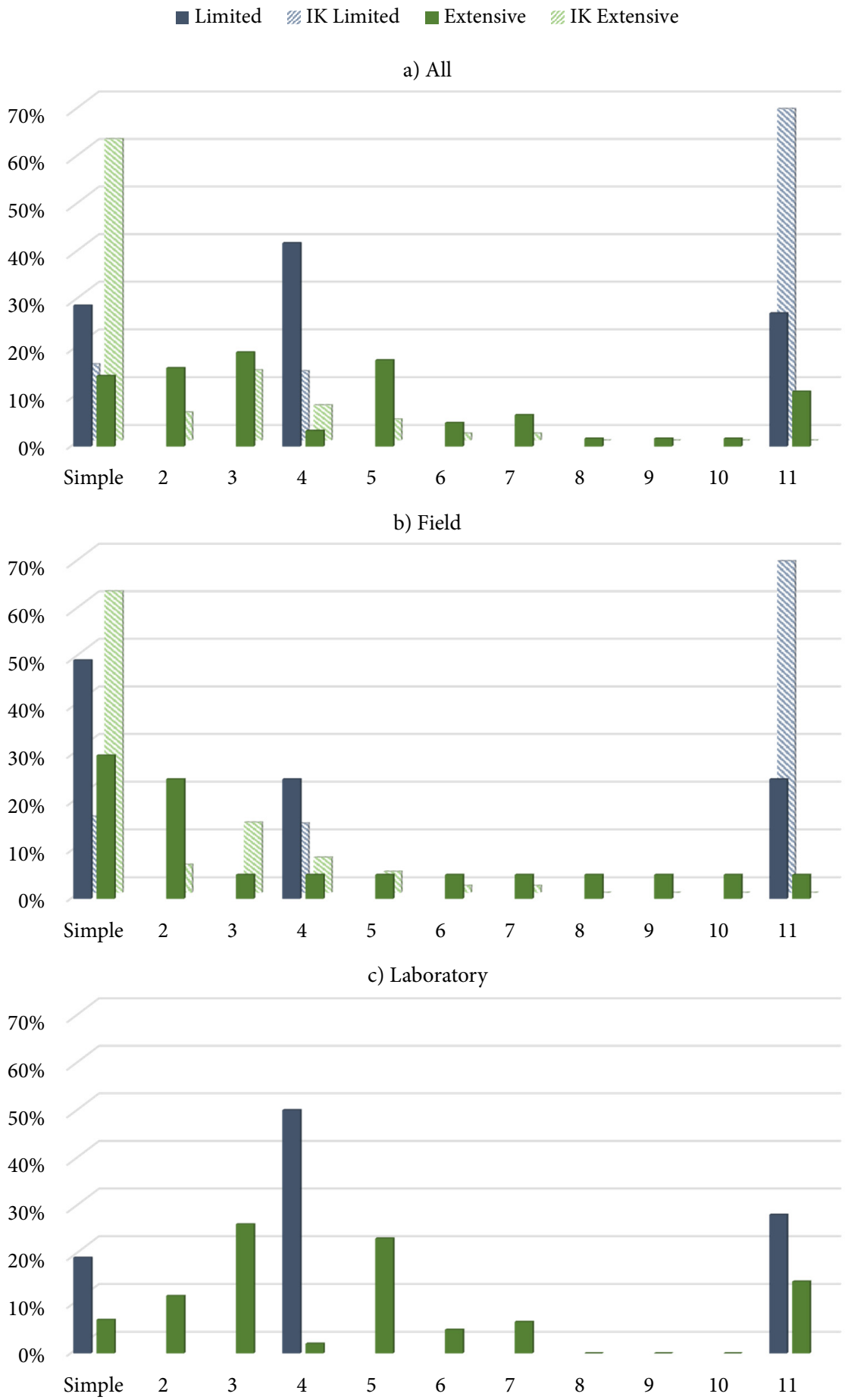


FIGURE 9 Hexadic Experiment Results

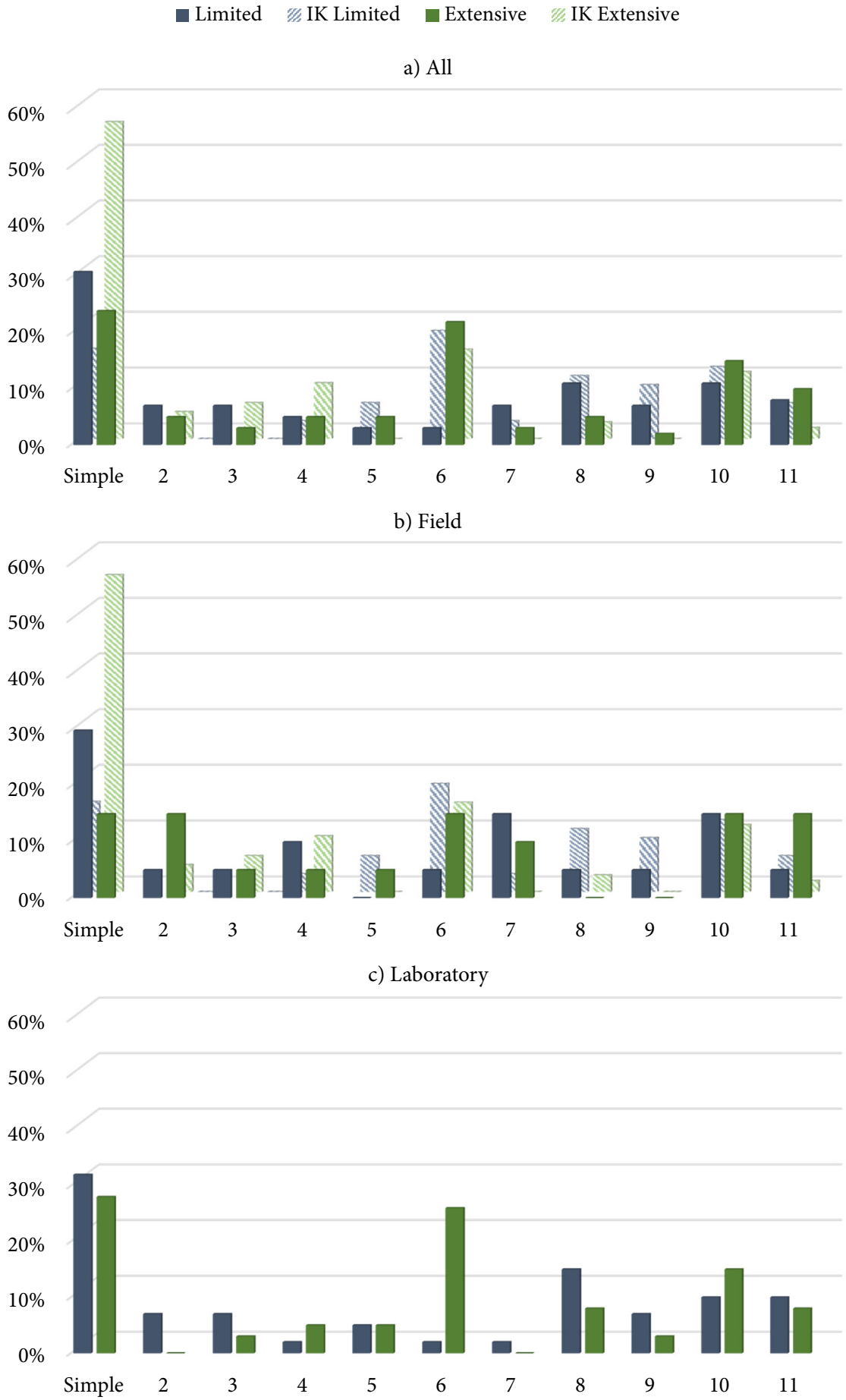


TABLE 8 Treatment Tests: Limited vs Extensive

| | a) Dyadic Experiment | | | b) Hexadic Experiment | | |
|---|---|---|---|---|---|---|
| | All | Field | Lab | All | Field | Lab |
| *Full Sample* | **0.040** | 0.165 | **0.097** | 0.241 | 0.226 | 0.462 |
| *Gender* | | | | | | |
| Male | **0.082** | 0.500 | **0.058** | 0.536 | 0.204 | 0.348 |
| Female | 0.222 | 0.240 | 0.500 | 0.175 | 0.756 | 0.148 |
| *Nationality* | | | | | | |
| Non-UK/EU | 0.229 | 0.698 | 0.180 | 0.198 | 0.244 | 0.460 |
| UK/EU | 0.100 | 0.150 | 0.338 | 0.534 | 0.500 | 0.230 |
| *Risk Attitude* | | | | | | |
| Risk Averse | 0.120 | 0.500 | **0.029** | 0.508 | | 0.513 |
| Risk Neutral | 0.500 | 0.331 | 0.500 | 0.111 | | 0.112 |
| Risk Seeking | 0.220 | 0.171 | 0.753 | 0.550 | 0.225 | 0.254 |

*Note:* Cells show one tailed p-values of Fisher's Exact test. p-values < 0.1 are in bold.

### *Individual Characteristics and Choice*

To further interrogate these results I look at choice of subgroups. Summary statistics show that there are some differences in individual characteristics between experiments and treatments, as well as the laboratory and field environments. In addition to the reversal in my results, there also appear to be differences in baseline choice between my results and IK, but also between the field and the laboratory: in the Dyadic experiment, half of all subjects selected the simple option in the Limited condition in the field, which dropped to just 20% in the Laboratory. By examining subgroup behaviour I am able to investigate whether the reverse-treatment effect and baseline choice have been driven by particular subject characteristics.

I first create a series of result figures where the percentage-columns are split by gender, nationality and risk attitude. Due to the amount of output I move these into Appendix B, p. 174. To test the significance of subgroup choice, I again perform Fisher's exact test to evaluate the significance of choosing the simple option between conditions, but now for each subgroup (Table 8).

I begin by describing gender: in the Dyadic experiment (Figure B.1), both males and females exhibit the reverse-treatment effect, but the Exact test shows that this is only significant for males in the laboratory ($p = 0.058$). The figure reveals that the baseline increase in the attractiveness of the simple option in the field is primarily driven by females. This may suggest that females are more likely to choose a risk-

free option in a field setting, which is 'noisier' than the laboratory environment. This behaviour is also apparent in the Hexadic experiment (Figure B.2). Here, the preference for the simple option (i.e. the one with the most risk) is primarily driven by males. Panel c) shows a slightly higher preference for the simple option in the Extensive condition for males (16% against 23%). But the Exact test reveals that none of these differences are statistically significant.

I continue by looking into subject behaviour by the country of origin. I use two broadly defined groups, European against non-European behaviour. Overall, no subgroup reveals a preference for simplicity across treatments. In the Dyadic experiment (Figure B.3), choice of the simple option appears to be primarily driven by Europeans, which is particularly obvious in the field ($p = 0.100$ in the Exact test). A similar, pattern can be seen in the Hexadic experiment as well (Figure B.4), but the Exact tests show that these differences are not statistically significant at the 10%-level or less.

The next subgroup is risk attitude. For this I redefine the risk attitude proxy to be either risk averse (0–4 on the 11-point scale), risk neutral (5 on the scale) or risk tolerance (6–10 on the scale). In the Dyadic experiment (Figure B.5), subjects are typically risk averse or risk neutral if they chose the simple option (and equivalently risk tolerant when choosing the riskiest gamble 11). The Exact test shows that the reverse-treatment effect is statistically significant for risk averse subjects in the laboratory ($p = 0.029$). In the field, there is a slight preference for simplicity in the larger choice set among risk averse subjects, but this is not statistically significant. In the Hexadic experiment, the relation between risk attitude and choice is more obvious: only risk-tolerant subjects chose the simple option in the field (Figure B.6). In the laboratory, primarily risk tolerant subjects chose the simple option in the Extensive condition. The Exact test reveals that none of these differences are statistically significant.

### *Field vs Laboratory*

Both the general result figures as well as the subgroup figures reveal that subjects chose differently in the laboratory or in the field. In this section, I investigate whether choice is statistically different between the field and the laboratory for all subjects, those in the Limited condition and those in the Extensive condition. I again provide tests for subgroup behaviour to investigate whether choice patterns are driven by individual characteristics.[14]

14 Subjects are not randomly assigned to field and laboratory environments. Thus, if there is a difference between the two environments, I would not be able to distinguish between that difference arising from the effect of different procedures on given subjects, and it arising from differences in how subjects are selected into the different environments.

I first investigate whether choosing the simple option is different between the two environments. I use Fisher's exact test and report one-tailed $p$-values in Table 9. In the Dyadic experiment, 40% of all subjects chose the simple option in the field, but only 13% of subjects chose it in the laboratory, which is statistically significant at the 1% level. The significant preference for the £5 in the field also exists when considering the Limited and Extensive conditions separately. In the Hexadic experiment, the difference is not nearly as large (overall 23% in the field and 30% in the laboratory), but the Exact test reveals no significant difference. This may suggest a preference for simplicity in the field compared to the laboratory, but as the only significant tests are in the Dyadic experiment, where the simple option has no risk, it is impossible to disentangle a 'simplicity effect' from a 'certainty effect'.

There are several significant differences in subgroups in the Dyadic experiment: females were more likely to choose the simple option in the field, as were European nationals. Risk neutral and risk tolerant subjects were more likely to choose the simple option in the field. I will investigate this more closely in regression estimates in the next section.

In the Hexadic experiment the differences in subgroups between the field and the laboratory are far less pronounced, and not statistically significant (the exceptions are 'risk neutral' for all subjects and 'medium impatience' in the Limited condition at $p < 0.1$). Again, this shows that I cannot infer any preference for simplicity in the field from the results in the Dyadic experiment, as the structure between risk and simplicity is inverse between experiments.

The results above test whether choice of only the *simple* option is different in environments. But I also test whether choice over *all* items in the menu are different between environments, i.e. whether subjects chose differently across the entire distribution in the field vs the laboratory. I use the Kolmogorov-Smirnov test, the null hypothesis being that both distributions are equal. Results of this test can be found in Table 10, where I report $p$-values. Results show that subjects chose significantly differently in the Dyadic experiment ($p = 0.003$) between the field and the laboratory, although this result is primarily driven by subject behaviour in the Extensive condition. Also females and European nationals were more likely to choose differently. There is again a pattern to suggest that risk attitude impacts how choice was made between the field and the laboratory, but this will be analysed more closely in the next section. In contrast, subjects did not choose significantly differently in the Hexadic experiment.

TABLE 9 Simple Lottery: Field vs Laboratory

| | a) Dyadic Experiment | | | b) Hexadic Experiment | | |
|---|---|---|---|---|---|---|
| | All | Limited | Extensive | All | Limited | Extensive |
| *Full Sample* | **0.001** | **0.017** | **0.028** | 0.260 | 0.568 | 0.216 |
| *Gender* | | | | | | |
| Male | 0.128 | 0.849 | 0.104 | 0.474 | 0.858 | 0.195 |
| Female | **0.007** | **0.022** | 0.151 | 0.289 | 0.258 | 0.737 |
| *Nationality* | | | | | | |
| Non-UK/EU | 0.872 | 0.697 | 0.248 | 0.167 | 0.475 | 0.181 |
| UK/EU | **0.002** | **0.008** | **0.084** | 0.607 | 0.741 | 0.543 |
| *Risk Attitude* | | | | | | |
| Risk Averse | 0.783 | 0.377 | **0.099** | 0.667 | 0.672 | |
| Risk Neutral | **0.005** | **0.009** | 0.248 | **0.082** | 0.126 | 0.661 |
| Risk Seeking | **0.038** | **0.036** | 0.896 | 0.657 | 0.930 | 0.279 |

*Note:* Cells show one tailed p-values of Fisher's Exact test. p-values < 0.1 are in bold.

TABLE 10 All Options: Field vs Laboratory

| | a) Dyadic Experiment | | | b) Hexadic Experiment | | |
|---|---|---|---|---|---|---|
| | All | Limited | Extensive | All | Limited | Extensive |
| *Full Sample* | **0.003** | 0.107 | **0.039** | 0.997 | 0.989 | 0.955 |
| *Gender* | | | | | | |
| Male | 0.145 | 0.903 | 0.184 | 0.996 | 0.976 | 0.809 |
| Female | **0.037** | 0.194 | 0.282 | 0.951 | 0.980 | 0.788 |
| *Nationality* | | | | | | |
| Non-UK/EU | 0.481 | 1.000 | 0.269 | 0.829 | 0.852 | 0.840 |
| UK/EU | **0.007** | **0.068** | 0.137 | 0.723 | 0.760 | 1.000 |
| *Risk Attitude* | | | | | | |
| Risk Averse | 0.114 | 1.000 | **0.025** | 0.138 | 0.660 | 0.383 |
| Risk Neutral | **0.014** | **0.020** | 0.245 | 0.230 | 0.634 | 0.463 |
| Risk Seeking | 0.366 | 0.464 | 0.690 | 0.952 | 0.995 | 0.873 |

*Note:* Cells show p-values of the Kolmogorov-Smirnov test for equality of distribution functions. p-values < 0.1 are in bold.

### 4.2.3 Regression Estimates

The results above show that the simple option is not significantly more attractive in the Extensive condition than the Limited condition, neither in the laboratory, the field or when all data is pooled together. What can explain these results? In order to investigate the relation between choice patterns and covariates in more detail I estimate a series of econometric models. For each experiment I provide several specifications to assess the robustness of the results. I use linear models and report bootstrapped standard errors.

*Simple Option*

The first two models estimate the relation between choosing the simple option and covariates. For this I estimate a series of linear probability models, where the dependent variable is a binary variable of choosing the simple option.

DYADIC EXPERIMENT Results for the Dyadic experiment are shown in Table 11. The Wald chi-squared test shows that all models are statistically significant at $p < 0.01$, hence results are not driven by sample size. The first column shows results for all subjects including a control for the Limited condition. This control is positive and statistically significant at the 5%-level, implying that subjects in the Limited condition are 17.3 percentage points (pp) more likely to choose the simple option. This is further evidence of the reversal of the treatment effect in my replication compared to IK's original results. Also included are measures of self-assessed risk attitude and impatience in their continuous format ranging from 0 (risk averse/low impatience) to 10 (risk tolerant/high impatience). In Column 1, risk attitude is negatively-signed and significant at the 5% level. This implies that greater risk averseness is associated with a greater likelihood of choosing the (risk-free) simple option.

Column 2 again shows estimates for the entire sample, including a control for the environment and an interaction between the treatment and environment. The estimates confirm the results from the Fisher's exact test above: subjects in the field are significantly more likely (32.1 pp) to choose the simple option, but this is not driven by an interaction with the Limited condition. In this specification, impatience is also negative and significant, implying that those with lower impatience are less likely to choose the simple option.

Columns 3–5 estimate the same model just for subjects in the field and the laboratory, which allows me to further qualify the magnitude of the impact of covariates. Results reveal the same patterns as for the results of the entire sample,

TABLE 11 Dyadic Experiment 'Simple Lottery' Regression Estimates

| | (1) Full Sample β / SE | (2) Full Sample + Treatment β / SE | (3) Field β / SE | (4) Laboratory β / SE | (5) Laboratory + Ability β / SE |
|---|---|---|---|---|---|
| *Demographics* | | | | | |
| Age | 0.030 | 0.025 | 0.046 | 0.017 | 0.021 |
| | (0.019) | (0.018) | (0.039) | (0.021) | (0.020) |
| Female (= 1) | 0.095 | 0.076 | 0.185 | 0.050 | 0.052 |
| | (0.093) | (0.082) | (0.165) | (0.101) | (0.100) |
| European national (= 1) | 0.081 | 0.056 | 0.074 | 0.039 | 0.045 |
| | (0.080) | (0.081) | (0.197) | (0.088) | (0.093) |
| Economics student (= 1) | 0.035 | 0.099 | 0.081 | 0.154 | 0.173 |
| | (0.147) | (0.149) | (0.271) | (0.190) | (0.186) |
| Student (= 1) | 0.508** | 0.715*** | 0.952** | | |
| | (0.228) | (0.235) | (0.449) | | |
| *Behavioural Characteristics* | | | | | |
| Risk Attitude (0–10) | −0.051** | −0.065*** | −0.127*** | −0.048** | −0.047** |
| | (0.022) | (0.020) | (0.046) | (0.024) | (0.023) |
| Impatience (0–10) | −0.021 | −0.035** | −0.030 | −0.032* | −0.038** |
| | (0.017) | (0.015) | (0.037) | (0.017) | (0.018) |
| *Treatment Controls* | | | | | |
| Limited Condition (3 Gambles) | 0.173** | 0.137* | 0.258* | 0.126* | 0.148* |
| | (0.073) | (0.072) | (0.156) | (0.071) | (0.077) |
| Field | | 0.321*** | | | |
| | | (0.110) | | | |
| Limited Condition x Field | | 0.106 | | | |
| | | (0.162) | | | |
| *Ability* | | | | | |
| All CRT questions correct (= 1) | | | | | −0.134* |
| | | | | | (0.073) |
| High Ability (= 1) | | | | | 0.038 |
| | | | | | (0.089) |
| Observations | 122 | 122 | 40 | 82 | 82 |
| Adjusted $R^2$ | 0.098 | 0.257 | 0.197 | 0.133 | 0.142 |
| Wald chi2 | 23.941 | 49.578 | 52.365 | 13.894 | 16.507 |
| Prob > chi2 | 0.004 | 0.000 | 0.000 | 0.005 | 0.006 |
| Baseline predicted probability | 0.235 | 0.236 | 0.518 | 0.137 | 0.117 |

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses.

but the magnitude of the coefficients for risk attitude and the Limited condition are substantially higher in the field compared to the laboratory. This may suggest that risk averseness and being in the Limited condition have a stronger impact on choice in the field.

Column 6 shows results for subjects in the laboratory including the two measures of ability: those who answer all CRT questions correctly are 13.4 pp less likely to choose the simple option ($p < 0.1$). This suggests that subjects with higher ability may be less likely to 'rely' on the simple option because they are more comfortable at evaluating risky gambles. This is consistent with the notion that individuals with higher cognitive ability are less risk averse (Dohmen et al., 2010).

HEXADIC EXPERIMENT Table 12 shows results for the Hexadic experiment, where the simple option is the riskiest. Again, all models are statistically significant. The control for the Limited condition is positive and significant at the 5%-level for all subjects (Column 1), suggesting that subjects in this condition are 13.4 pp more likely to choose the simple option. But this effect disappears as soon as controlling for the field/laboratory environment. Hence, there is only limited evidence to suggest that subjects are consistently more likely to choose the simple option in the Limited condition. Column 2 shows that subjects are less likely to choose the simple option in the field, but this effect is only weakly significant.

In this experiment, where no risk free option exists, controls for gender and nationality are negative and statistically significant, implying that females and European nationals are less likely to choose the simple (i.e. riskiest) option. This pattern holds for all specifications except for European nationals in the field, where the control is not statistically significant.

Risk attitude is positive and significant at the 1%-level with a comparable coefficient of around 0.08 throughout all specifications. This suggests that risk tolerant subjects are around 8 pp more likely to choose the simple option. This and the results from the Dyadic experiment before suggest that risk attitude plays an important role, and I will explore this in more detail below.

Results also show that more impatient subjects are more likely to choose the simple option. This result appears to be driven by subjects in the laboratory as the coefficient is not statistically significant in the field (Column 3). This is surprising: we may think that impatient subjects are less willing to evaluate an entire menu of complex lotteries and are hence more likely to select the simple option (in this case 'simple' and 'salient' would be equivalent). But if that were the case this should also be apparent in a 'noisier' field environment, and not only in the laboratory were time is specifically allocated to evaluate lotteries. A qualification of this results may be the small sample size in the field.

TABLE 12 Hexadic Experiment 'Simple Lottery' Estimates

| | (1) Full Sample β / SE | (2) Full Sample + Treatment β / SE | (3) Field β / SE | (4) Laboratory β / SE | (5) Laboratory + Ability β / SE |
|---|---|---|---|---|---|
| *Demographics* | | | | | |
| Age | −0.008 | −0.007 | 0.004 | −0.076*** | −0.079*** |
| | (0.012) | (0.012) | (0.014) | (0.030) | (0.030) |
| Female (= 1) | −0.241*** | −0.228*** | −0.333** | −0.189** | −0.191* |
| | (0.080) | (0.080) | (0.145) | (0.096) | (0.109) |
| European national (= 1) | −0.169** | −0.157* | 0.025 | −0.320*** | −0.313*** |
| | (0.084) | (0.084) | (0.172) | (0.091) | (0.098) |
| Economics student (= 1) | −0.110 | −0.099 | −0.180 | −0.110 | −0.098 |
| | (0.117) | (0.115) | (0.221) | (0.138) | (0.153) |
| Student (= 1) | −0.073 | −0.124 | 0.024 | | |
| | (0.226) | (0.226) | (0.267) | | |
| *Behavioural Characteristics* | | | | | |
| Risk Attitude (0–10) | 0.082*** | 0.084*** | 0.076*** | 0.089*** | 0.086*** |
| | (0.016) | (0.017) | (0.028) | (0.022) | (0.024) |
| Impatience (0–10) | 0.058*** | 0.060*** | 0.044 | 0.074*** | 0.074*** |
| | (0.016) | (0.015) | (0.030) | (0.020) | (0.021) |
| *Treatment Controls* | | | | | |
| Limited Condition (3 Gambles) | 0.134** | 0.087 | 0.172 | 0.065 | 0.048 |
| | (0.068) | (0.087) | (0.138) | (0.089) | (0.099) |
| Field | | −0.153* | | | |
| | | (0.091) | | | |
| Limited Condition x Field | | 0.135 | | | |
| | | (0.152) | | | |
| *Ability* | | | | | |
| All CRT questions correct (= 1) | | | | | −0.026 |
| | | | | | (0.099) |
| High Ability (= 1) | | | | | −0.073 |
| | | | | | (0.117) |
| Observations | 120 | 120 | 40 | 80 | 80 |
| Adjusted $R^2$ | 0.327 | 0.328 | 0.314 | 0.374 | 0.361 |
| Wald chi2 | 94.723 | 95.502 | 24.821 | 87.706 | 81.125 |
| Prob > chi2 | 0.000 | 0.000 | 0.003 | 0.000 | 0.000 |
| Baseline predicted probability | 0.297 | 0.297 | 0.220 | 0.282 | 0.254 |

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses.

*Attitude to Risk*

The results above demonstrate that self-reported risk attitude significantly predicts choosing the simple option in both experiments: in the Dyadic experiment, risk averseness is associated with choosing the simple, risk-free option and in the Hexadic experiment risk tolerance is associated with choosing the simple, risky option. But these models only allow assessing the role of risk attitude on the binary outcome of choosing the simple option. To investigate the relationship between risk attitude and choice further, I estimate a series of linear models where I sort all gambles by increasing variance. Hence, the dependent variable is subject's choice where the gamble with the lowest variance has a rank of '1' and the gamble with the highest variance has rank of '11'.

For this estimation I pool all observations for both experiments together and use treatment controls to distinguish group effects. The results of these models are shown in Table 13, and all models are statistically significant. As expected, the treatment controls show that subjects in the Hexadic experiment are significantly more likely to choose a riskier option (due to the prominence of the 0-10 gamble), throughout all specifications. The control for the Limited condition is not significant in any model, hence there is no evidence to suggest that subjects choose differently with respect to risk between treatments.

Columns 1 and 2 show estimates for the entire sample. Among covariates, females are significantly less likely to choose a riskier option, which confirms the pattern of results from the results before. Subjects in the field are significantly less likely to choose a riskier gamble. The proxy for impatience is positive and significant, implying that those with higher impatience are more likely to choose a riskier gamble. Column 2 includes interactions between experiments, treatments and environments. None of these interactions are significant.

Importantly, risk attitude is positive and significant at the 1%-level while including controls for treatments, interactions and the above stated covariates. The coefficient of risk attitude implies that a 1-unit increase towards risk tolerance is associated with a 70 pp increase in choosing a 1-rank riskier gamble.

The remaining two columns split the sample into subjects in the field (Column 3) and the laboratory (Column 4). In both specifications, risk attitude remains highly significant, but there is no significant pattern regarding impatience. The magnitude of the coefficient on risk attitude implies that risk has a stronger impact in the laboratory (0.821) compared to the field (0.528). This may be due to subjects choosing less risky options in the field, but also because subjects may be more able to 'consult' their preferences in the laboratory. The specification for the laboratory sample also includes the proxies for ability. Both coefficients are positive as expected, but not statistically significant.

TABLE 13 'Risk' Regression Estimates

| | (1) Full Sample $\beta$ / SE | (2) Full Sample + Interactions $\beta$ / SE | (3) Field Sample $\beta$ / SE | (4) Laboratory Sample $\beta$ / SE |
|---|---|---|---|---|
| *Demographics* | | | | |
| Age | 0.018 | 0.004 | 0.055 | −0.040 |
| | (0.068) | (0.075) | (0.121) | (0.119) |
| Female (= 1) | −0.972** | −0.971** | −1.626 | −0.419 |
| | (0.444) | (0.456) | (1.026) | (0.613) |
| European national (= 1) | −0.274 | −0.298 | 0.143 | −0.602 |
| | (0.464) | (0.476) | (1.191) | (0.533) |
| Economics student (= 1) | −0.283 | −0.333 | 0.031 | −0.466 |
| | (0.715) | (0.730) | (1.754) | (0.842) |
| Student (= 1) | −1.596* | −1.559 | −1.243 | |
| | (0.908) | (0.962) | (1.150) | |
| *Behavioural Characteristics* | | | | |
| Risk Attitude (0–10) | 0.698*** | 0.700*** | 0.528*** | 0.821*** |
| | (0.121) | (0.123) | (0.197) | (0.163) |
| Impatience (0–10) | 0.214** | 0.217** | 0.313 | 0.176 |
| | (0.096) | (0.099) | (0.209) | (0.118) |
| *Treatment Controls* | | | | |
| Hexadic Experiment | 1.921*** | 1.766*** | 2.463** | 1.776*** |
| | (0.418) | (0.681) | (1.029) | (0.683) |
| Limited Condition (3 Gambles) | 0.149 | 0.388 | 0.015 | 0.476 |
| | (0.421) | (0.709) | (1.088) | (0.674) |
| Field | −1.203** | −1.557** | | |
| | (0.517) | (0.763) | | |
| *Interactions* | | | | |
| Hexadic Experiment x Limited Condition | | −0.404 | 0.158 | −0.368 |
| | | (1.000) | (1.878) | (1.018) |
| Hexadic Experiment x Field | | 0.856 | | |
| | | (1.132) | | |
| Limited Condition x Field | | −0.366 | | |
| | | (1.263) | | |
| Hexadic Experiment x Limited Condition x Field | | 0.555 | | |
| | | (1.872) | | |
| *Ability* | | | | |
| All CRT questions correct (= 1) | | | | 0.725 |
| | | | | (0.572) |
| High Ability (= 1) | | | | 0.510 |
| | | | | (0.782) |
| Observations | 242 | 242 | 80 | 162 |
| Adjusted $R^2$ | 0.241 | 0.233 | 0.193 | 0.243 |
| Wald chi2 | 72.465 | 81.241 | 45.217 | 54.753 |
| Prob > chi2 | 0.000 | 0.000 | 0.000 | 0.000 |
| Baseline predicted probability | 4.806 | 4.806 | 3.997 | 5.419 |

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses.

## 4.3 DISCUSSION OF STUDY 2

The results of my replication are in stark contrast to the original results found by Iyengar & Kamenica (2010). They find that subjects exhibit a dramatic increase in the preference for simple options when the choice set is extended from three to eleven options. In my replication, this effect does not exist. I find that the treatment effect is actually reversed, sometimes significantly so. This does not suggest evidence for 'non-simplicity-seeking', but instead suggests that once the choice set is extended, subjects are able to make choices that match their preferences better.

What can explain the substantial differences in results? The difference cannot be explained by different behaviours in a field or laboratory setting, as the reverse-treatment effect is consistent in both environments. One possible explanation may be the subject pool differences of the sample where the experiments were conducted. These may explain IK's findings, but if differences between University of Nottingham vs Columbia University student subjects are a significant factor, then simplicity seeking cannot be a fundamental feature of human decision making.

Another possible explanation may be the conversion of lottery payoffs from US-$ to £-Sterling. This results in substantially higher nominal payoffs in my replication, but does not take purchasing power into consideration. But if this would explain the results, then it would suggest that IK's subjects are less concerned about the monetary value of their choice and just exhibit the preference for the simple options because they are the most salient ones. Continuing this argument, subjects in my replication are more concerned about their choices because of the (relatively) higher potential earnings. This may be true, but then the case for 'simplicity seeking' could only be generalised over nearly irrelevant outcomes, but not for choices such as retirement planning.

Instead of simplicity seeking, my results suggest that subjects simply choose according to their risk attitude. My measure of risk attitude is highly significant with sizeable coefficients throughout all econometric specifications. This explanation is supported by the fact that risk is involved in all of the treatments. In particular, the Extensive condition of the Dyadic experiment is very similar to an OLSD used to elicit risk attitude (see, Harrison & Rutström, 2008). If simplicity-seeking is indeed the main explanation for IK's results, then elicitation procedures that involve a certain option would be hugely biased (because certainty is 'simpler'), an argument unsupported by the large number of studies that apply them (for example, Barr & Genicot, 2008). In fact, IK's result in the Dyadic experiment is driven by a complete switch in subjects' behaviour from choosing the riskiest option to the certain option: 70% of subjects choose the riskiest gamble in the

Limited condition, and not a single subject in the Extensive condition. This may suggest that IK's sample is not consistent with regards to risk attitude between treatments.

Looking into field vs laboratory behaviour, my results suggest some interesting differences: it appears that subjects are more likely to prefer certainty in the field. This may be explained by the greater attractiveness of a certain, but unexpected amount of money. In the laboratory, subjects can evaluate all options more closely and also received a show-up fee, which may have induced more risk seeking behaviour.

# 5

# CONCLUSIONS

This chapter presented evidence of two studies motivated by a recent finding of Iyengar & Kamenica (2010, IK) that subjects exhibit disproportionate preferences for certain and/or simple options. Study 1 investigated the certainty effect in a design that went beyond the pairwise lottery choices that are typically used to demonstrate a certainty effect. I used the choice set of IK where their results showed that the majority of subjects preferred the certain option among several risky lotteries. I modified this choice set and substituted the certain option with an option that was very similar, but involved a small amount of risk.

My results showed that subjects did not exhibit a disproportionate preference for certainty. Instead, the majority of subjects chose consistently between choice sets. One implication of this result is that methods for risk elicitation such as OLSD are not 'contaminated' by the inclusion of a certain option. The discussion of this result highlighted several potential explanations for the absence of a treatment effect, one of which is the apparent non-replicability of the results of IK.

The second study was concerned with the robustness of IK's results. I replicated all experiments of Iyengar & Kamenica (2010) under essentially the same conditions in the field as well as in the laboratory. The results showed that IK's results were not replicable in any environment and that the original treatment effect was actually reversed. I dissected this result by looking into individual characteristics of subjects and found that self-assessed risk attitude predicts choice.

What are the lessons learned from the results of these studies? Firstly, we can benefit greatly from investigating the robustness of experimental results, as the non-replication of IK's shows. The importance of robustness studies has gained more momentum in the experimental economics community (see, for example, the new *Journal of the Economic Science Association*), and my results contribute to this discussion.

Secondly, the results of my replication data highlighted that subjects chose differently outside the laboratory. For example, they preferred less risky options significantly more in the field. If we aim to generalise results from laboratory studies to real-life behaviour, these differences should be explored in more detail.

Thirdly, a large amount of the evidence on the certainty effect is generated by pairwise-lottery choice scenarios and binary gambles. But my results suggest

that the stability of the certainty effect depends on the complexity of the choice sets offered to subjects. In the debate of 'choice architecture' and 'libertarian paternalism', it seems important to investigate the role of complexity in greater detail to address apparent puzzles in decision making.

# BIBLIOGRAPHY


ABDELLAOUI, M., BLEICHRODT, H. & PARASCHIV, C. (2007). 'Loss Aversion Under Prospect Theory: A Parameter-Free Measurement'. *Management Science*, 53(10), pp. 1659–1674.

ANDREONI, J. & SPRENGER, C. (2010). 'Certain and uncertain utility: The Allais paradox and five decision theory phenomena'. *Levine's Working Paper Archive*.

— (2012). 'Uncertainty Equivalents: Testing the Limits of the Independence Axiom'. *NBER Working Paper Series*, 17342.

ARKES, H.R. (1991). 'Costs and benefits of judgment errors: Implications for debiasing.' *Psychological Bulletin*, 110(3), pp. 486–498.

BALLINGER, T.P. & WILCOX, N.T. (1997). 'Decisions, Error and Heterogeneity'. *The Economic Journal*, 107(443), pp. 1090–1105.

BARR, A. & GENICOT, G. (2008). 'Risk Sharing, Commitment, and Information: An Experimental Analysis'. *Journal of the European Economic Association*, 6(6), pp. 1151–1185.

BERTRAND, M., KARLAN, D., MULLAINATHAN, S., SHAFIR, E. & ZINMAN, J. (2010). 'What's Advertising Content Worth? Evidence from a Consumer Credit Marketing Field Experiment *'. *The Quarterly Journal of Economics*, 125(1), pp. 263–305.

BINSWANGER, H.P. (1980). 'Attitudes toward Risk: Experimental Measurement in Rural India'. *American Journal of Agricultural Economics*, 62(3), p. 395.

BOTTI, S. & IYENGAR, S.S. (2006). 'The Dark Side of Choice: When Choice Impairs Social Welfare'. *Journal of Public Policy & Marketing*, 25(1), pp. 24–38.

BURKS, S.V., CARPENTER, J.P., GOETTE, L. & RUSTICHINI, A. (2009). 'Cognitive skills affect economic preferences, strategic behavior, and job attachment.' *Proceedings of the National Academy of Sciences of the United States of America*, 106(19), pp. 7745–7750.

BUTLER, D.J. & LOOMES, G.C. (2007). 'Imprecision as an Account of the Preference Reversal Phenomenon'. *American Economic Review*, 97(1), pp. 277–297.

CHERNEV, A., BÖCKENHOLT, U. & GOODMAN, J. (2014). 'Choice overload: A conceptual review and meta-analysis'. *Journal of Consumer Psychology*, (forthcoming).

CONLISK, J. (1989). 'Three Variants on the Allais Example'. *The American Economic Review*, 79(3), pp. 392–407.

COX, J.C., SADIRAJ, V. & SCHMIDT, U. (2014). 'Paradoxes and mechanisms for choice under risk'. *Experimental Economics*, (forthcoming).

CUBITT, R.P., STARMER, C. & SUGDEN, R. (1998). 'On the validity of the random lottery incentive system'. *Experimental Economics*, 1(2), pp. 115–131.

— (2001). 'Discovered preferences and the experimental evidence of violations of expected utility theory'. *Journal of Economic Methodology*, 8(3), pp. 385–414.

— (2004). 'Dynamic decisions under uncertainty: some recent evidence from economics and psychology'. In: *The Psychology of Economic Decisions: Vol 2: Reasons and Choice*. Ed. by I. BROCAS & J.D. CARRILLO. Vol. 2. Oxford: Oxford University Press, pp. 81–107.

DAVE, C., ECKEL, C.C., JOHNSON, C.A. & ROJAS, C. (2010). 'Eliciting risk preferences: When is simple better?' *Journal of Risk and Uncertainty*, 41(3), pp. 219–243.

DEAN, M. (2008). 'Status quo bias in large and small choice sets'. *Brown University Working Paper*.

DHAR, R. (1997). 'Consumer Preference for a No-Choice Option'. *Journal of Consumer Research*, 24(2), pp. 215–231.

DICKHAUT, J., MCCABE, K., NAGODE, J.C., RUSTICHINI, A., SMITH, K. & PARDO, J.V. (2003). 'The impact of the certainty context on the process of choice.' *Proceedings of the National Academy of Sciences of the United States of America*, 100(6), pp. 3536–41.

DIECIDUE, E., SCHMIDT, U. & WAKKER, P.P. (2004). 'The Utility of Gambling Reconsidered'. *Journal of Risk and Uncertainty*, 29(3), pp. 241–259.

DOHMEN, T., FALK, A., HUFFMAN, D. & SUNDE, U. (2010). 'Are Risk Aversion and Impatience Related to Cognitive Ability?' *American Economic Review*, 100(3), pp. 1238–1260.

DOHMEN, T., FALK, A., HUFFMAN, D., SUNDE, U., SCHUPP, J. & WAGNER, G.G. (2011). 'Individual Risk Attitudes: Measurement, Determinants, and Behavioral Consequences'. *Journal of the European Economic Association*, 9(3), pp. 522–550.

ECKEL, C.C. & GROSSMAN, P.J. (2002). 'Sex differences and statistical stereotyping in attitudes toward financial risk'. *Evolution and Human Behavior*, 23(4), pp. 281–295.

— (2008). 'Forecasting risk attitudes: An experimental study using actual and forecast gamble choices'. *Journal of Economic Behavior & Organization*, 68(1), pp. 1–17.

FISCHBACHER, U. (2007). 'z-Tree: Zurich toolbox for ready-made economic experiments'. *Experimental Economics*, 10(2), pp. 171–178.

FREDERICK, S. (2005). 'Cognitive Reflection and Decision Making'. *Journal of Economic Perspectives*, 19(4), pp. 25–42.

GILBOA, I. (1988). 'A combination of expected utility and maxmin decision criteria'. *Journal of Mathematical Psychology*, 32(4), pp. 405–420.

GNEEZY, U., LIST, J.A. & WU, G. (2006). 'The Uncertainty Effect: When a Risky Prospect Is Valued Less Than Its Worst Possible Outcome'. *The Quarterly Journal of Economics*, 121(4), pp. 1283–1309.

GREENLEAF, E.A. & LEHMANN, D.R. (1995). 'Reasons for Substantial Delay in Consumer Decision Making'. *Journal of Consumer Research*, 22(2), p. 186.

GREIFENEDER, R., SCHEIBEHENNE, B. & KLEBER, N. (2010). 'Less may be more when choosing is difficult: choice complexity and too much choice.' *Acta Psychologica*, 133(1), pp. 45–50.

GREINER, B. (2004). 'The Online Recruitment System ORSEE 2.0 - A Guide for the Organization of Experiments in Economics'. *University of Cologne Working Paper Series in Economics*, 10.

HARLESS, D.W. (1992). 'Predictions about indifference curves inside the unit triangle'. *Journal of Economic Behavior & Organization*, 18(3), pp. 391–414.

HARLESS, D.W. & CAMERER, C.F. (1994). 'The Predictive Utility of Generalized Expected Utility Theories'. *Econometrica*, 62(6), pp. 1251–1289.

HARRISON, G.W. & RUTSTRÖM, E.E. (2008). 'Risk Aversion in the Laboratory'. In: *Risk Aversion in Experiments (Research in Experimental Economics, Volume 12)*. Ed. by J.C. COX & G.W. HARRISON. Emerald Group Publishing Limited, pp. 41–196.

HEY, J.D. & LEE, J. (2005). 'Do Subjects Separate (or Are They Sophisticated)?' *Experimental Economics*, 8(3), pp. 233–265.

HOLT, C.A. (1986). 'Preference reversals and the independence axiom'. *The American Economic Review*, 76(3), pp. 508–515.

HUCK, S. & WEIZSÄCKER, G. (1999). 'Risk, complexity, and deviations from expected-value maximization: Results of a lottery choice experiment'. *Journal of Economic Psychology*, 20(6), pp. 699–715.

IYENGAR, S.S. & LEPPER, M.R. (2000). 'When choice is demotivating: Can one desire too much of a good thing?' *Journal of Personality and Social Psychology*, 79(6), pp. 995–1006.

IYENGAR, S.S. & KAMENICA, E. (2010). 'Choice proliferation, simplicity seeking, and asset allocation'. *Journal of Public Economics*, 94(7-8), pp. 530–539.

IYENGAR, S.S., JIANG, W. & HUBERMAN, G. (2004). 'How much choice is too much? Contributions to 401(k) retirement plans'. In: *Pension Design and Structure: New Lessons from Behavioral Finance*. Ed. by O. MITCHELL & S. UTKUS. Vol. 401. Oxford: Oxford University Press, pp. 83–95.

KAHNEMAN, D. & TVERSKY, A. (1979). 'Prospect Theory: An Analysis of Decision under Risk'. *Econometrica*, 54(2), pp. 263–291.

LI, M. & CHAPMAN, G.B. (2009). ''100% of anything looks good': the appeal of one hundred percent.' *Psychonomic Bulletin & Review*, 16(1), pp. 156–62.

LOOMES, G. & SUGDEN, R. (1998). 'Testing Different Stochastic Specificationsof Risky Choice'. *Economica*, 65(260), pp. 581–598.

MCCORD, M. & NEUFVILLE, R. DE (1986). '"Lottery Equivalents": Reduction of the Certainty Effect Problem in Utility Assessment'. *Management Science*, 32(1), pp. 56–60.

MEHTA, J. & SUGDEN, R. (2013). 'Making Sense of Complex Choice Situations'. In: *Behavioural Economics in Competition and Consumer Policy*. Norwich: ESRC Centre for Competition Policy, University of East Anglia.

NEILSON, W.S. (1992). 'Some mixed results on boundary effects'. *Economics Letters*, 39(3), pp. 275–278.

OFGEM (2014). 'A simpler, clearer, and fairer energy market for consumers'. *ofgem Factsheets*, (accessed 02/10/2014).

REN, Y. (2014). 'Status Quo Bias and Choice Overload: An Experimental Approach'. *Indiana University Working Paper*.

SCHEIBEHENNE, B., GREIFENEDER, R. & TODD, P.M. (2010). 'Can There Ever Be Too Many Options? A Meta-Analytic Review of Choice Overload'. *Journal of Consumer Research*, 37(3), pp. 409–425.

SCHMIDT, U. (1998). 'A Measurement of the Certainty Effect'. *Journal of Mathematical Psychology*, 42(1), pp. 32–47.

SIMONSOHN, U. (2009). 'Direct risk aversion: evidence from risky prospects valued below their worst outcome.' *Psychological Science*, 20(6), pp. 686–92.

SONSINO, D., BENZION, U. & MADOR, G. (2002). 'The Complexity Effects on Choice with Uncertainty - Experimental Evidence'. *The Economic Journal*, 112(482), pp. 936–965.

SOPHER, B. & GIGLIOTTI, G. (1993). 'A test of generalized expected utility theory'. *Theory and Decision*, 35(1), pp. 75–106.

SOUSA, S. (2010). 'Are smarter people really less risk averse?' *CeDEx Discussion Paper Series*, 17.

STARMER, C. & SUGDEN, R. (1991). 'Does the random-lottery incentive system elicit true preferences? An experimental investigation'. *American Economic Review*, 81(4), pp. 971–978.

STARMER, C. (2000). 'Developments in Non-Expected Utility Theory: The Hunt for a Descriptive Theory of Choice under Risk'. *Journal of Economic Literature*, 38(2), pp. 332–382.

THALER, R.H. & SUNSTEIN, C.R. (2003). 'Libertarian Paternalism'. *American Economic Review*, 93(2), pp. 175–179.

TOPLAK, M.E., WEST, R.F. & STANOVICH, K.E. (2011). 'The Cognitive Reflection Test as a predictor of performance on heuristics-and-biases tasks.' *Memory & Cognition*, 39(7), pp. 1275–89.

TVERSKY, A. & SHAFIR, E. (1992). 'Choice under conflict: The dynamics of deferred decision'. *Psychological Science*, 3(6), pp. 358–361.

TVERSKY, A. & KAHNEMAN, D. (1992). 'Advances in prospect theory: Cumulative representation of uncertainty'. *Journal of Risk and Uncertainty*, 5(4), pp. 297–323.

VISCHER, T., DOHMEN, T., FALK, A., HUFFMAN, D., SCHUPP, J., SUNDE, U. & WAGNER, G.G. (2013). 'Validating an ultra-short survey measure of patience'. *Economics Letters*, 120(2), pp. 142–145.

WAKKER, P. & DENEFFE, D. (1996). 'Eliciting Utilities von Neumann-Morgen When or Probabilities Are Unknown Distorted'. *Management Science*, 42(8), pp. 1131–1150.

# CHAPTER V

# CONCLUSION TO THE THESIS

# CONCLUSION TO THE THESIS

This thesis provided new insights into financial decision making using analysis of representative samples of UK households as well as incentivised experiments. In this final chapter, I conclude my findings and highlight the contributions made to the respective literatures. I also suggest further research avenues motivated by my results.

Chapters II and III used representative survey data of UK households to investigate the role of financial literacy and individual behavioural characteristics in financial choice. The second chapter investigated the co-holding puzzle, i.e. the simultaneous holding of liquid savings and consumer credit debt. I found that co-holding is prevalent among 12% of UK households, many of whom hold many thousands of pounds of liquid savings and consumer credit simultaneously, costing the household hundreds of pounds each year.

The explanation which I explored focussed on co-holding as a form self-control, suggested in a theoretical model by Bertaut et al. (2009). In their model, co-holding arises as a rational response to the realisation of impulsive spending tendencies. The results of my econometric models showed that self-control, but not financial literacy, predicts co-holding. Co-holders are, on average, better at answering the questions used to measure financial literacy. However, they are also much more likely to report being impulsive in their spending decisions.

The third chapter analysed the determinants of mortgage choice, specifically in relation to repayment types and interest rate types. Recent years have shown that new mortgage products can work for good or bad, depending on how the instrument is provided by financial institutions and used by consumers. Non-amortising alternative mortgage products (AMPs) in particular have created much controversy due to their complex nature. My analysis focussed on the role of financial literacy and behavioural traits. I developed a set of questions specifically aimed to test understanding of key concepts of mortgages. I also included survey instruments to proxy impulsive present bias, discount rates, and attitude to risk.

I found that holders of AMPs are substantially worse at answering my financial literacy questions relative to holders of repayment mortgages (SMPs). On average, AMP holders answer only 1.5 out of four questions correctly; SMP holders answer 2.5 questions correctly. But there is little difference in literacy between holding fixed or adjustable rate mortgages (FRM/ARM). Multivariate regression results

show financial literacy positively predicts both holding of AMPs as well as ARMs. Behavioural traits are also important predictors for AMP holding, but not for ARM holding. Holders of AMPs are significantly more likely to report an impulsive present bias for consumption. This suggests that AMPs may attract consumers who are less likely to sufficiently understand their features and put more weight on present consumption.

What are the implications of the results from these two chapters? Firstly, both chapters highlight that behavioural characteristics are important determinants of financial choice. Recent years have seen substantial advancements in 'stepping outside the laboratory' to investigate the role of behavioural characteristics and consumer decision making for samples representative of the population. These include, (i) cross-validation of simple proxy questions with complex laboratory measures (e.g. Dohmen et al., 2010 and Vischer et al., 2013), (ii) relating laboratory measures to real-life outcomes such as health and employment (e.g. Burks et al., 2012), and (iii) incorporation of incentivised choice experiments into household surveys (e.g. Ameriks et al., 2007). This kind of research typically involves high costs, both monetary and in labour, but they enhance our understanding of decision making by providing researches with the opportunity to elicit behavioural traits by observing real choices, and then relating these choices to household financial decisions.

But the biggest obstacle in research in household finance remains the availability and reliability of data. Similar to most of the studies that relate behavioural traits to consumer finance, I rely on self-reported data. By cross-comparison I show that the data used in this research is similar to other surveys. But if there is a systemic bias, for instance a tendency towards under-reporting debt or not truthfully revealing behaviour in hypothetical scenario-based questions to elicit traits, cross-comparison does not overcome the underlying issue. This offers two suggestions for future research: first, validation studies such as Zinman (2009), particularly for UK and European data where this kind of research is clearly lacking, in order to investigate systemic biases in household surveys. Second, using data where choice behaviour is observed rather than self-assessed. Important contributions have been made in this area by using individual level transaction data (Gross & Souleles, 2002a,b) or tax records. For example, Chetty et al. (2014) use tax records for the entire working population of Denmark to investigate the impact of government savings policies on saving behaviour. They find that the impact of direct government subsidies on savings is almost negligible, but auto-enrolment into savings plans has a large impact on aggregate savings.

This is further evidence of the importance of behavioural biases, in this case the (over-)reliance of individuals on defaults (Thaler & Benartzi, 2004). But the

downside of lender-provided data or tax records is that it is typically not possible to observe behavioural characteristics and biases. But the 'behavioural implications' of my results suggest a challenge of rationalising household financial management, and a further direction for future research: understanding of financial decision making involves not only observing apparent violations of rational behaviour, but also understanding the types of mechanisms and facilities households might utilise to accommodate tenets of their behaviour which prevent them from behaving in a purely rational manner. The combination of experimental methods with observed data would provide researchers with further understanding of the determinants of individual decision making, as well as understanding of the choice patterns and the choice heuristics households use.

The second implication is the role of financial literacy. The results in Chapters II and III highlight that there are potentially important interaction effects between behavioural characteristics, behavioural biases and financial literacy. There is only limited evidence in the literature that investigate these interactions. For example, analysing enrolment into 401(k) savings plans in the US, Agnew et al. (2003) show that financially literate individuals are more likely to opt into savings plans with significantly higher contributions, while individuals with lower literacy use the default savings levels.

Further research into these interactions would enhance our understanding of the workings of financial literacy further. The literature has now established that financial literacy is important for informed financial choices, as discussed in the recent review by Lusardi & Mitchell (2014). But it seems that now, given that we understand the causal link between financial literacy and financial outcomes, the focus should perhaps shift on how we can improve financial choices for individuals with limited understanding of financial concepts. In the UK, policy-makers focus their attention on providing financial advice and financial education. For example, the 'Money Advice Service' was created in 2010, an independent body with a government mandate to "enhance the understanding and knowledge of members of the public of financial matters" (Financial Services Act, 2010). More recently, the UK government has become directly involved by including financial education into the national curriculum for English secondary school pupils.

But very little is known on the efficacy of financial advice and financial education on the quality of decisions. Even less is known about the efficacy on low-income or unemployed households, as much of the available evidence concerns pension schemes and investment decisions. Fernandes et al. (2014) conduct a meta-analysis of 168 papers covering 201 studies on the relationship of financial literacy and financial education to financial behaviours. Their conclusion is that all interventions to improve financial literacy explain only 0.1% of the variance of

financial outcomes, with weaker effects in low-income groups. Even with large and costly interventions, a positive impact of education on behaviour disappears after 20 months.

If financial education has a limited impact on financial outcomes, then perhaps financial advice is a better way. Here, the evidence appears a little more positive. Elliehausen et al. (2007) report that receiving credit counselling (or debt advice) is associated with a positive change in borrower credit profiles, particularly for borrowers who had the least ability to handle credit before receiving advice. But relying on financial advisors may give rise to agency problems, as shown by Inderst & Ottaviani (2012), as advisors may want to maximise commissions by recommending particular types of products. Hackethal et al. (2012) provide evidence suggestive of this notion, and find that advisors may recommend unsuitable products and encourage excessive trading. Furthermore, the analysis of the efficacy of financial advice struggles with self-selection issues. Hackethal et al. (2012) find that advisors are typically matched with older and wealthier investors. If individuals with lower incomes or lower ability are less willing or able to seek financial advice, then advice cannot act as a substitute for poor financial literacy, and is not suitable as a general tool to improve financial choices.

Clearly, understanding the mechanisms to improve financial choice is a large and important field for further research. As discussed above, both the analysis and provision of financial education and financial advice are complex. For example, in a recent paper I investigate who is more likely to seek debt advice using survey data, and find evidence to support the notion that debt advice can act as a substitute for financial literacy (Disney et al., 2014). But more research is needed to investigate the efficacy of advice and education that does not rely on survey data or self-assessment of outcomes, for example in the form of randomised controlled trials.

Chapter IV investigated financial decision making from a more fundamental level, specifically whether biases in the sense of preferences for certainty and simplicity affect individual choice. Recent empirical evidence by Iyengar & Kamenica (2010) shows that people exhibit a strong preference for simple options in large choice sets relative to small choice sets, and also that preferences for certainty and simplicity are potentially interlinked.

The chapter provided evidence of two studies motivated by this result: Study 1 investigated the claim that the strong preference for the simple option in the large choice set in one of Iyengar & Kamenica's experiments derives from it being a certainty, and hence constitutes a type of certainty effect. I used a choice set of eleven option where the results of Iyengar & Kamenica (2010) showed that 60% of subjects preferred the certain option. I tested the prevalence of the certainty effect by offering subjects this choice set, or, alternatively, a choice set where

the certain option has been substituted with a gamble that has slightly higher variance. The objective of this experimental design was to investigate IK's result of a strong preference for the certain option, by observing subjects' behaviour when the certain option is substituted with a near certain option. My design provided a test for the certainty effect, by moving away from certainty to a slightly more risky option, but in an environment where several other options are present.

The results of this study suggested that subjects did not exhibit a disproportionate preference for certainty, as subjects did not prefer the certain or 'near-certain' option differently. This suggests that the certainty effect may not be as pronounced as implied by previous evidence. But in the majority of experiments who have documented the certainty effect only two lotteries are involved in each round, as in the common ratio- and common consequence effects (Allais, 1953; Kahneman & Tversky, 1979). In my experiment, eleven lotteries were involved, which allowed subjects to choose more in line with their preferences. Hence, my experiment was a strong test of the certainty effect, because I modified the choice sets only slightly, but kept the remaining structure fixed. A stronger manipulation of certainty or other experimental variables may have generated a statistically significant treatment effect.

A suggestion for future research is to investigate the determinants that trigger a certainty effect more closely, both in laboratory and field settings. Only few studies relate the certainty effect to real life financial decisions (e.g. Wakker et al., 1997 for insurances). But a preference for certainty may be an important behavioural bias for consumer choice in other domains as well, for example portfolio diversification or retirement savings.

The second study focussed on replicating the original results of Iyengar & Kamenica (2010). They find that, when faced with a set of 11 options, subjects have a significantly higher preference for a simple option relative to when the choice set has only 3 options. Motivated by the failure to replicate the results of one of their choice sets in Study 1, I replicated all of their experiments and found that subjects did not reveal a significant preference for simplicity in the large choice sets. Instead, my results suggest that subjects chose according to their risk attitude.

These results highlight the importance of replication studies to assess the robustness of experimental results. Experiments, including those shown in this thesis, typically rely on student samples. But if we want to infer behaviour in the laboratory to the population, in particular when this involves behavioural biases and outcomes related to financial choice, future research should investigate that apparent puzzles exist outside the laboratory and beyond student samples as well.

In conclusion, this thesis contributed to the literature by providing further insights into the importance of financial literacy and behavioural characteristics

on financial choice, as well as exploring new methods to investigate apparent puzzles in consumer choice and behavioural biases. My results highlighted the importance of robustness in experimental studies and the importance in underlying behavioural characteristics on individual choice behaviour in financial decision making.

# BIBLIOGRAPHY


AGNEW, J., BALDUZZI, P. & SUNDÉN, A. (2003). 'Portfolio Choice and Trading in a Large 401(k) Plan'. *American Economic Review*, 93(1), pp. 193–215.

ALLAIS, M. (1953). 'Le Comportement de l'Homme Rationnel devant le Risque: Critique des Postulats et Axiomes de l'Ecole Americaine'. *Econometrica*, 21(4), p. 503.

AMERIKS, J., CAPLIN, A., LEAHY, J. & TYLER, T. (2007). 'Measuring Self-Control Problems'. *American Economic Review*, 97(3), pp. 966–972.

BERTAUT, C.C., HALIASSOS, M. & REITER, M. (2009). 'Credit Card Debt Puzzles and Debt Revolvers for Self Control'. *Review of Finance*, 13(4), pp. 657–692.

BURKS, S., CARPENTER, J., GÖTTE, L. & RUSTICHINI, A. (2012). 'Which measures of time preference best predict outcomes: Evidence from a large-scale field experiment'. *Journal of Economic Behavior & Organization*, 84(1), pp. 308–320.

CHETTY, R., FRIEDMAN, J.N., LETH-PETERSEN, S., NIELSEN, T.H. & OLSEN, T. (2014). 'Active vs. Passive Decisions and Crowd-Out in Retirement Savings Accounts: Evidence from Denmark'. *The Quarterly Journal of Economics*, 129(3), pp. 1141–1219.

DISNEY, R., GATHERGOOD, J. & WEBER, J. (2014). 'Credit Counseling: A Substitute for Consumer Financial Literacy?' *IFS Working Paper*, W14(32).

DOHMEN, T., FALK, A., HUFFMAN, D. & SUNDE, U. (2010). 'Are Risk Aversion and Impatience Related to Cognitive Ability?' *American Economic Review*, 100(3), pp. 1238–1260.

ELLIEHAUSEN, G., CHRISTOPHER LUNDQUIST, E. & STATEN, M.E. (2007). 'The Impact of Credit Counseling on Subsequent Borrower Behavior'. *Journal of Consumer Affairs*, 41(1), pp. 1–28.

FERNANDES, D., LYNCH, J.G. & NETEMEYER, R.G. (2014). 'Financial Literacy, Financial Education, and Downstream Financial Behaviors'. *Management Science*, 60(8), pp. 1861–1883.

FINANCIAL SERVICES ACT (2010). *Chapter 28*. London: The Stationery Office.

GROSS, D.B. & SOULELES, N.S. (2002a). 'An Empirical Analysis of Personal Bankruptcy and Delinquency'. *The Review of Financial Studies*, 15(1), pp. 319–347.

— (2002b). 'Do Liquidity Constraints and Interest Rates Matter for Consumer Behavior? Evidence from Credit Card Data'. *The Quarterly Journal of Economics*, 117(1), pp. 149–185.

HACKETHAL, A., HALIASSOS, M. & JAPPELLI, T. (2012). 'Financial advisors: A case of babysitters?' *Journal of Banking & Finance*, 36(2), pp. 509–524.

INDERST, R. & OTTAVIANI, M. (2012). 'Financial Advice'. *Journal of Economic Literature*, 50(2), pp. 494–512.

IYENGAR, S.S. & KAMENICA, E. (2010). 'Choice proliferation, simplicity seeking, and asset allocation'. *Journal of Public Economics*, 94(7-8), pp. 530–539.

KAHNEMAN, D. & TVERSKY, A. (1979). 'Prospect Theory: An Analysis of Decision under Risk'. *Econometrica*, 54(2), pp. 263–291.

LUSARDI, A. & MITCHELL, O.S. (2014). 'The Economic Importance of Financial Literacy: Theory and Evidence'. *Journal of Economic Literature*, 52(1), pp. 5–44.

THALER, R.H. & BENARTZI, S. (2004). 'Save More Tomorrow™: Using Behavioral Economics to Increase Employee Saving'. *Journal of Political Economy*, 112(1), 164–S187.

VISCHER, T., DOHMEN, T., FALK, A., HUFFMAN, D., SCHUPP, J., SUNDE, U. & WAGNER, G.G. (2013). 'Validating an ultra-short survey measure of patience'. *Economics Letters*, 120(2), pp. 142–145.

WAKKER, P., THALER, R.H. & TVERSKY, A. (1997). 'Probabilistic Insurance'. *Journal of Risk and Uncertainty*, 15(1), pp. 7–28.

ZINMAN, J. (2009). 'Where is the missing Credit Card Debt? Clues and Implications'. *Review of Income and Wealth*, 55(2), pp. 249–265.

# APPENDICES TO CHAPTER IV

# A

# PROOF OF PROPOSITION

PROOF: Postulate 2 implies Postulate 1. so it is only necessary to show that if Postulate 1 holds then $C(\cdot)$ satisfies Condition 1; and that if Postulate 2 holds then $C(\cdot)$ satisfies Condition 2.

Suppose Postulate 1 holds and let $\succ$ be the ordering that rationalises $C(\cdot)$:

suppose that $C(A) \neq l_1$ , $C(B) \neq l_{1.5}$,
then $C(A)$ is top-ranked by $\succ$ in $\{l_2, ..., l_{11}\}$.

The same is true of $C(B)$. As $\succ$ is a strict ordering, only one element of $\{l_2, ..., l_{11}\}$ is top-ranked by $\succ$ in that set. So, it is immediate that $C(A) = C(B)$. Hence, Postulate 1 implies Condition 1.

Now suppose Postulate 2 holds and let $\succ$ be the ordering that rationalises $C(\cdot)$.

To establish part (a) of Condition 2:

suppose that $C(A) = l_1$
then $l_1$ is top ranked by $\succ$ in $A$ as $\succ$ rationalises $C(\cdot)$.

Since $\succ$ is single-peaked, either $l_1$ is top ranked by $\succ$ in $L$ (Case 1) or $l_{1.5}$ is top ranked by $\succ$ in $L$ (Case 2). In Case 2, it is immediate (from the fact that $\succ$ rationalises $C(\cdot)$) that $C(B) = l_{1.5}$. In Case 1, the same result holds in virtue of $\succ$ being single-peaked and the fact that $v(l_1) < v(l_{1.5}) < v(l_2) < ... < v(l_{11})$.

To establish part (b) of Condition 2:

suppose that $C(B) = l_{1.5}$
then $l_{1.5}$ is top ranked by $\succ$ in $B$ by Postulate 2.

Thus, since $\succ$ is single-peaked, either Case 1 or Case 2 holds. Now, in Case 1, it is immediate that $C(A) = l_1$; whereas, in Case 2, either $l_1$ or $l_2$ is top-ranked by $\succ$ in $A$, because $\succ$ is single-peaked and $v(l_1) < v(l_{1.5}) < v(l_2) < ... < v(l_{11})$. Thus, in either Case, $C(A) \in \{l_1, l_2\}$. Hence, Postulate 2 implies Condition 2. □

# B

# ADDITIONAL RESULTS

*Please turn over.*

TABLE B.1 Dyadic Experiment Results

| | All | | Field | | Laboratory | | Iyengar & Kamenica | |
|---|---|---|---|---|---|---|---|---|
| Gamble # | Limited | Extensive | Limited | Extensive | Limited | Extensive | Limited | Extensive |
| 1 (simple) | 30% | 15% | 50% | 30% | 20% | 7% | 16% | 63% |
| 2 | | 16% | | 25% | | 12% | | 6% |
| 3 | | 20% | | 5% | | 27% | | 15% |
| 4 | 43% | 3% | 25% | 5% | 51% | 2% | 14% | 7% |
| 5 | | 18% | | 5% | | 24% | | 4% |
| 6 | | 5% | | 5% | | 5% | | 1% |
| 7 | | 7% | | 5% | | 7% | | 1% |
| 8 | | 2% | | 5% | | 0% | | 0% |
| 9 | | 2% | | 5% | | 0% | | 0% |
| 10 | | 2% | | 5% | | 0% | | 0% |
| 11 | 28% | 11% | 25% | 5% | 29% | 15% | 70% | 0% |
| Subjects | 61 | 61 | 20 | 20 | 41 | 41 | 69 | 68 |

*Note:* See Table 5 for a description of the gambles.

TABLE B.2 Hexadic Experiment Results

| | All | | Field | | Laboratory | | Iyengar & Kamenica | |
|---|---|---|---|---|---|---|---|---|
| Gamble # | Limited | Extensive | Limited | Extensive | Limited | Extensive | Limited | Extensive |
| 1 (simple) | 31% | 24% | 30% | 15% | 32% | 28% | 16% | 57% |
| 2 | 7% | 5% | 5% | 15% | 7% | 0% | 5% | 0% |
| 3 | 7% | 3% | 5% | 5% | 7% | 3% | 6% | 0% |
| 4 | 5% | 5% | 10% | 5% | 2% | 5% | 3% | 10% |
| 5 | 3% | 5% | 0% | 5% | 5% | 5% | 6% | 0% |
| 6 | 3% | 22% | 5% | 15% | 2% | 26% | 19% | 16% |
| 7 | 7% | 3% | 15% | 10% | 2% | 0% | 3% | 0% |
| 8 | 11% | 5% | 5% | 0% | 15% | 8% | 11% | 3% |
| 9 | 7% | 2% | 5% | 0% | 7% | 3% | 10% | 0% |
| 10 | 11% | 15% | 15% | 15% | 10% | 15% | 13% | 12% |
| 11 | 8% | 10% | 5% | 15% | 10% | 8% | 6% | 2% |
| Subjects | 61 | 59 | 20 | 20 | 41 | 39 | 62 | 58 |

*Note:* See Table 6 for a description of the gambles.

FIGURE B.1 Dyadic Experiment: Gender

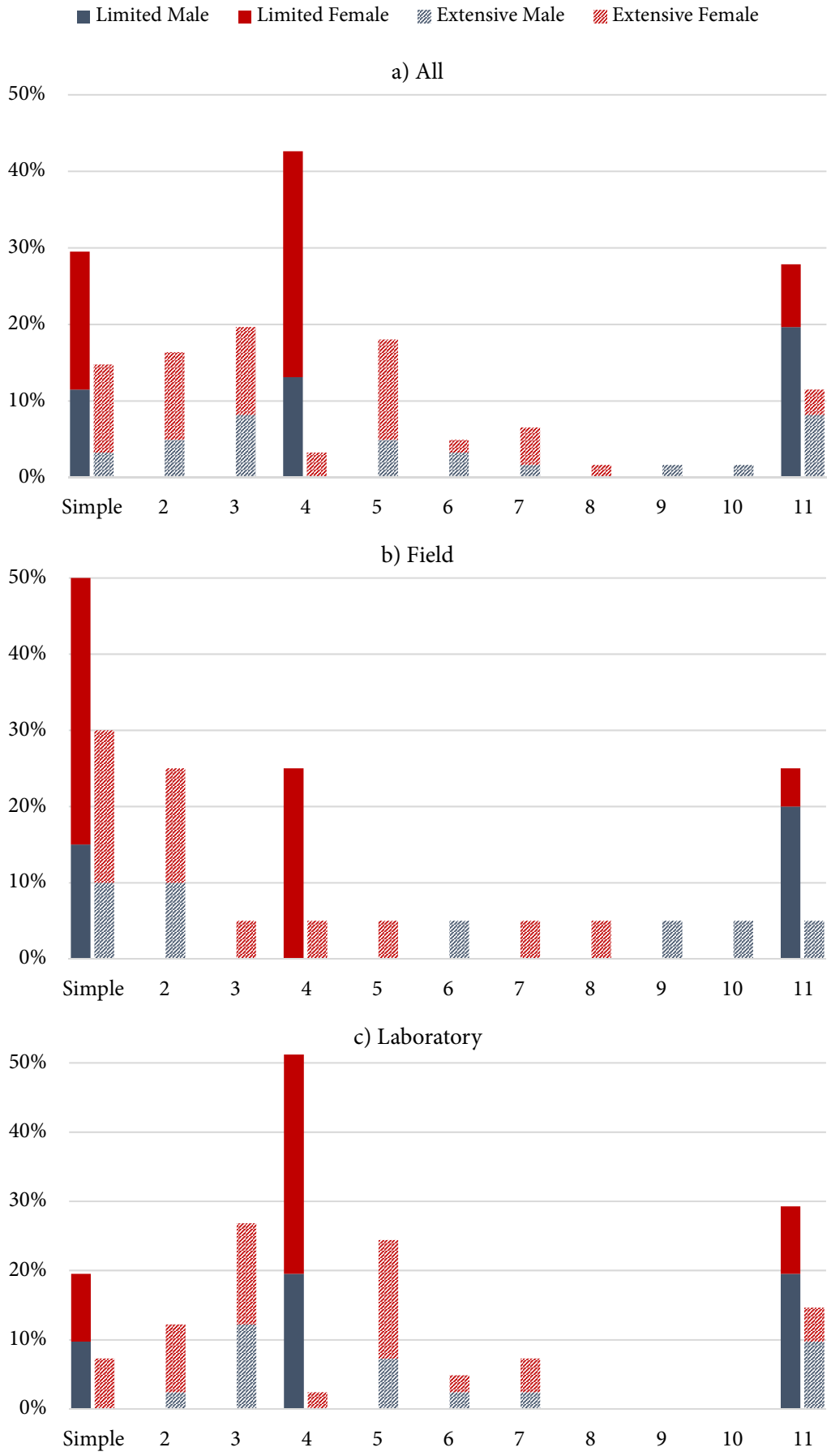


FIGURE B.2 Hexadic Experiment: Gender

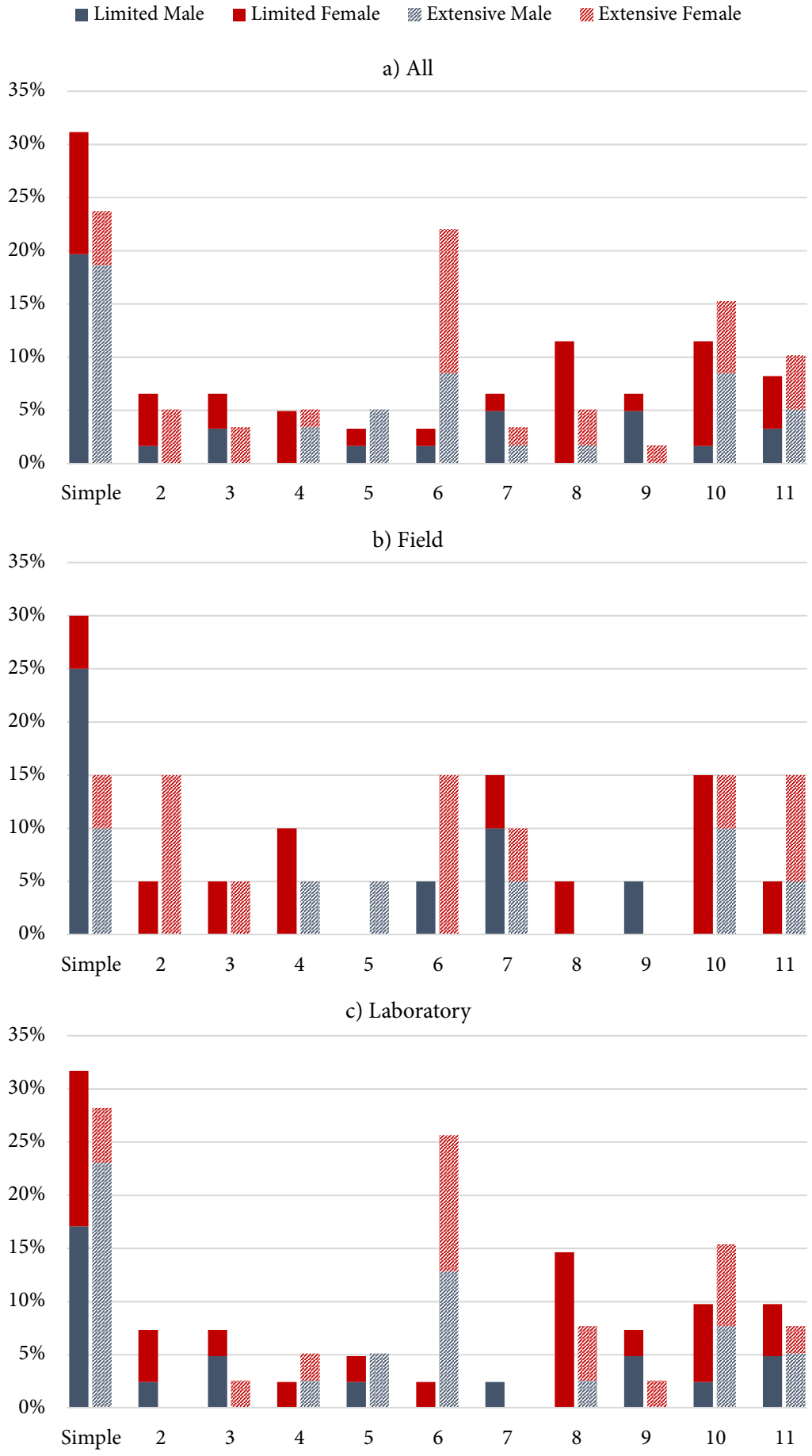


FIGURE B.3 Dyadic Experiment: Nationality

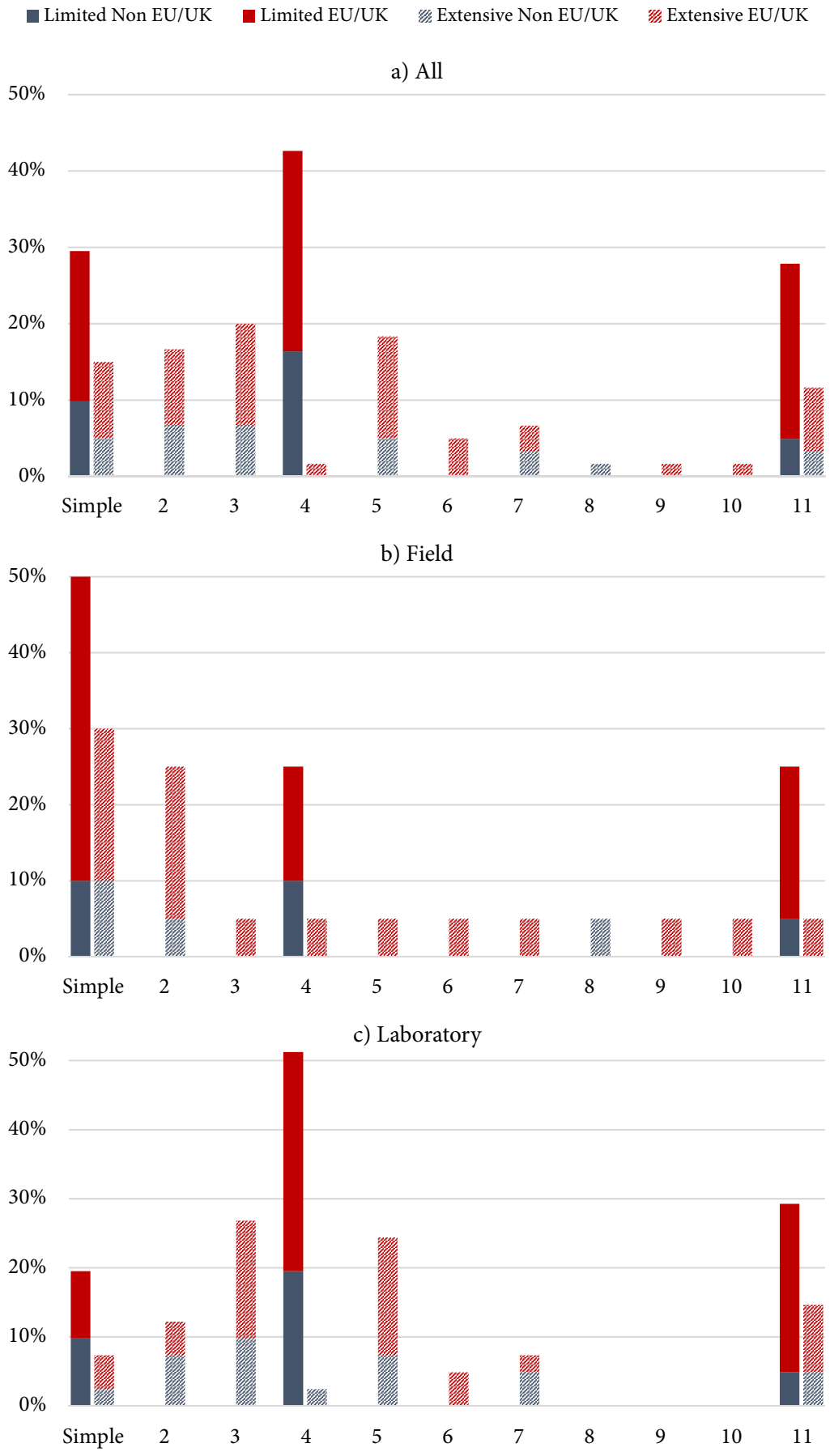


FIGURE B.4 Hexadic Experiment: Nationality

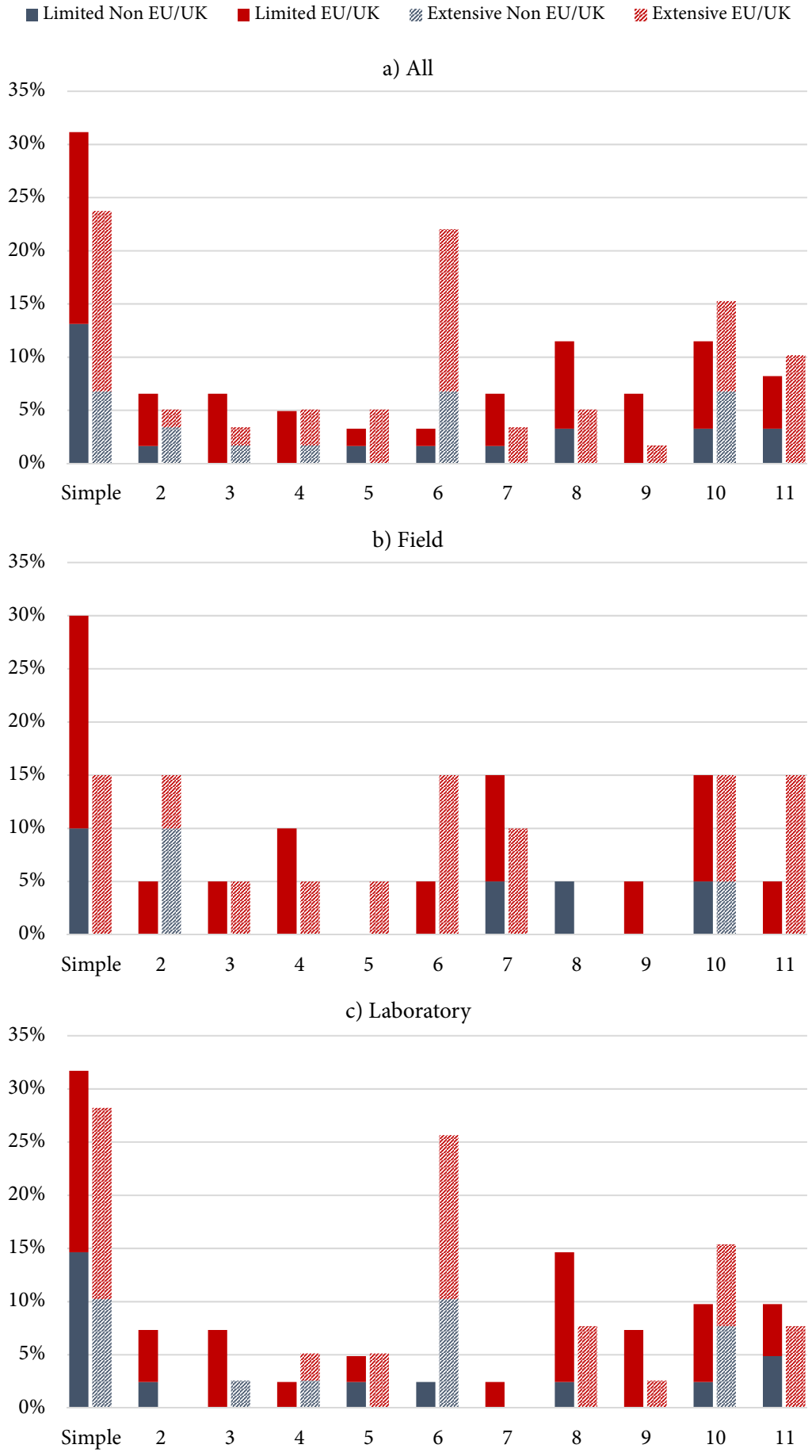


FIGURE B.5 Dyadic Experiment: Risk Attitude

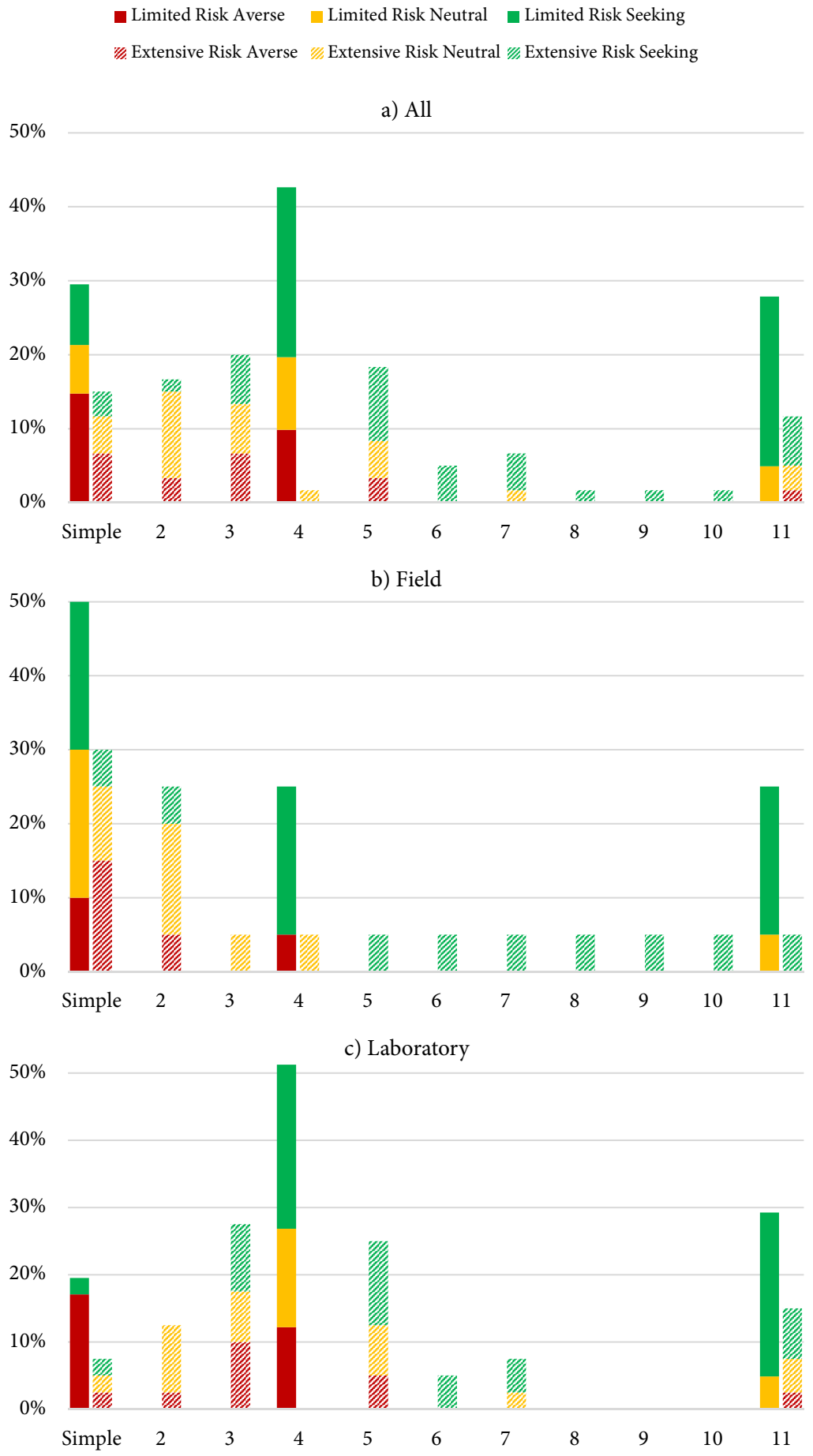
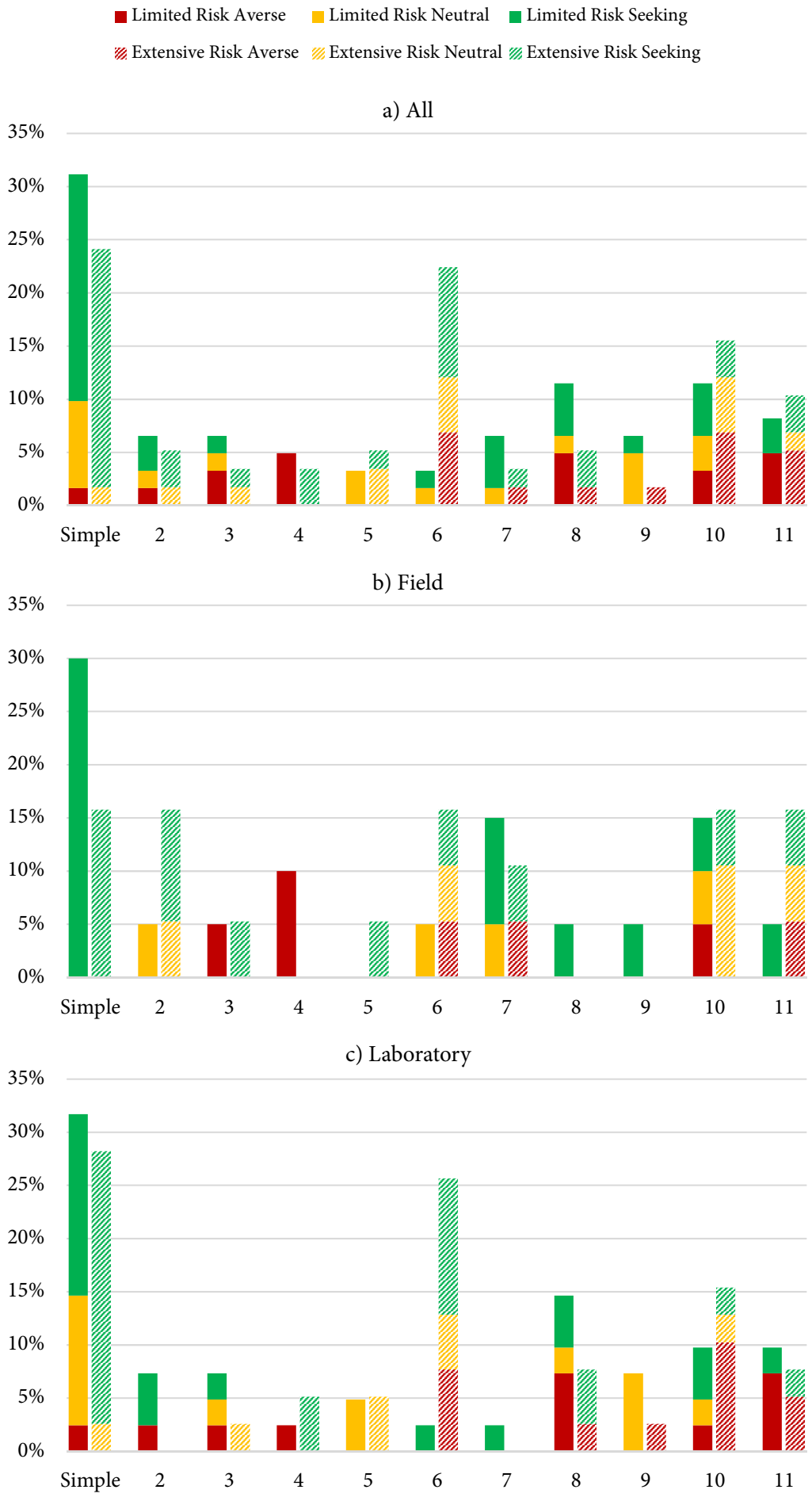


FIGURE B.6 Hexadic Experiment: Risk Attitude



# C

# EXPERIMENTAL SETUP

FIGURE C.7 Field 'Unrelated' Questionnaire

We are interested in gathering student's opinions about computer usage. Your answers will be treated completely confidentially. The questions are relatively straightforward. Answer to the best of your ability. Thank you for participating!

- How old are you? _____
- Please state your gender: _____
- Nationality: ☐ UK ☐ European ☐ Asian ☐ Other: _____
- If you are a student, what is your subject? _____
- What kind of electronic devices do you use:
  ☐ Desktop computer ☐ Laptop or netbook ☐ Smartphone ☐ Tablet
- Do you find it easy to learn something by reading it from a computer screen?
  ☐ Yes ☐ No
- For your studies or any kind of research, do you prefer using print or digital formats?
  ☐ Prefer Print ☐ Prefer Digital ☐ No Preference
- How much do you agree with the statement that electronic devices are as important as part of the learning process as traditional books and classroom activities.

| Strongly disagree | Mildly disagree | Neither agree nor disagree | Mildly agree | Strongly Agree |
|---|---|---|---|---|
| | | | | |

- How much do you agree with the statement that electronic devices could replace more traditional classroom learning devices in schools and universities?

| Strongly disagree | Mildly disagree | Neither agree nor disagree | Mildly agree | Strongly Agree |
|---|---|---|---|---|
| | | | | |

FIGURE C.8 Field Experiment in Action

FIGURE C.9 Hexadic Experiment Example (Field)

Thank you for filling out the questionnaire. For compensation, please select one of the gambles below. You will then cast a die and, depending on how the die falls, receive the amount of money indicated in the table below.

Please check off the desired gamble.

| Please place a check next to the desired option | If the die falls on 1, you receive | If the die falls on 2, you receive | If the die falls on 3, you receive | If the die falls on 4, you receive | If the die falls on 5, you receive | If the die falls on 6, you receive |
|---|---|---|---|---|---|---|
| | £ 0.00 | £ 0.75 | £ 4.25 | £ 5.50 | £ 8.50 | £ 9.75 |
| | £ 0.00 | £ 0.00 | £ 0.00 | £ 10.00 | £ 10.00 | £ 10.00 |
| | £ 2.00 | £ 3.25 | £ 3.75 | £ 9.25 | £ 7.75 | £ 2.00 |

FIGURE C.10 The Laboratory

FIGURE C.11 Laboratory Instructions

You are about to participate in an experiment in economics of decision making.

The experiment consists of two tasks:

1. In the first task you are asked to select one gamble from a set gambles. You will be paid according to the outcome of the gamble you selected. At the end of the experiment you will be individually called forward and the experimenter will provide you with a die. You will cast the die, and depending on how the die falls, receive the amount of money indicated in the table at the end of the experiment in cash. Please select only one gamble.
2. In the second task you are asked to answer 12 questions for which you have 15 minutes in total. Please answer these questions to the best of your ability.

At the end of the experiment you are asked to fill out a questionnaire. On top of your earnings from the gamble you selected you will receive a fee of £2 for filling out the questionnaire. The session will last approximately 45 minutes.

All decisions you make and all information you give are anonymous.

If you have any questions please raise your hand. If you have any questions during the experiment please raise your hand. You must not talk or contact other participants during the experiment. Please do not use your mobile phones or any other electronic equipment.

FIGURE C.12 Dyadic Experiment Example (Laboratory)

Please select **one** of the gambles below and write your initials next to it. At the end of this session, the experimenter will provide you with a die. You will cast the die and, depending on how the die falls, receive the amount of money indicated in the table below.

Please check off the desired gamble.

| Please place a check next to the desired option | If the die falls on 1, 2 or 3 you receive | If the die falls on 4, 5 or 6 you receive |
|---|---|---|
| | £ 8.75 | £ 3.50 |
| | £ 5.00 | £ 5.00 |
| | £ 13.50 | £ 0.00 |

FIGURE C.13 Cognitive Reflection Test

**Section 1**

**Question 1**: A bat and a ball cost £2.20 in total. The bat costs £2.00 more than the ball. How much does the ball cost? _____

**Question 2**: If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? _____

**Question 3**: In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? _____

FIGURE C.14 Quantitative Reasoning

**Section 2**

Solve each of the following problems. Please select your answer by ticking or crossing off.

**Question 4**: A fish tank is half full of water. When 10 gallons are added, the tank is 6/8 full. What is the capacity of the tank in gallons?

___ (A) 30 gallons

___ (B) 40 gallons

___ (C) 50 gallons

___ (D) 60 gallons

___ (E) 80 gallons

**Question 5**: If a dealer had sold a stereo for £600, he would have made a 20% profit. Instead, the dealer sold it for a 40% loss. At what price was the stereo sold?

___ (A) £300

___ (B) £315

___ (C) £372

___ (D) £400

___ (E) £440

**Question 6**: x and y are integers such that x + y < 11, and x > 6. What is the smallest possible value of x - y?

___ (A) 1

___ (B) 2

___ (C) -2

___ (D) 4

___ (E) -4

FIGURE C.15 Verbal Reasoning

**Section 4**

**Question 10**: Choose the answer key which contains a pair of words with a relationship most similar to the relationship between the pair of words in capital letters.

ARCHIVE : RECORDS

___ (A) arsenal : arms

___ (B) locker : uniform

___ (C) box : shoes

___ (D) pantry : bread

___ (E) arsenide : death

**Question 11**: Choose the answer key corresponding to the word with a meaning most nearly opposite to the meaning of the word in capital letters.

CENSURE

___ (A) proceed

___ (B) freedom

___ (C) praise

___ (D) enclosure

___ (E) interest

**Question 12**: Choose the choice that contains the words that best complete the sentence.

To reach Simonville, the traveller needs to drive with extreme caution along the ——- curves of the mountain road that climbs ——- to the summit.

___ (A) jagged - steadily

___ (B) serpentine - steeply

___ (C) gentle - precipitously

___ (D) shady - steadily

___ (E) hair-raising – languidly

FIGURE C.16 Sequential Reasoning

**Section 3**

**Question 7**: Determine the number that should come next in the following series:

3 8 14 21 29 38 ?

___ (A) 46

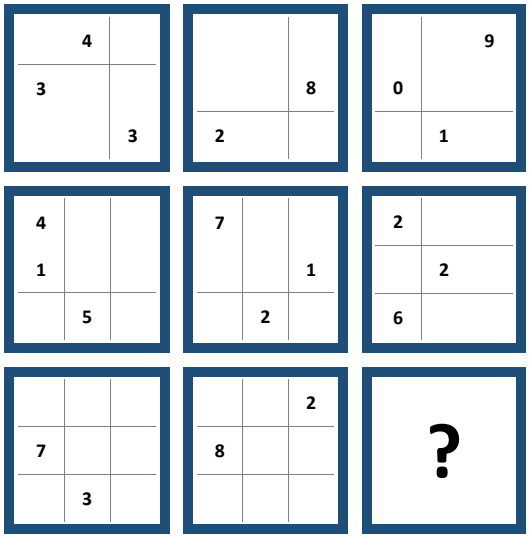
___ (B) 42

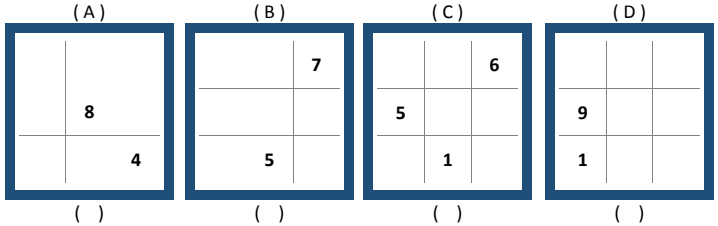
___ (C) 51

___ (D) 54

___ (E) 48

**Question 8**: Determine the missing square:




**Question 9**: Determine the missing square: