Do Wealth Fluctuations Generate Time-Varying Risk Aversion? Evidence from Australian Panel Data

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1 Introduction

Risk-aversion is a central topic in economics, serving as the cornerstone of models employed to describe phenomena from individual financial decisions to aggregate macroeconomic trends, and a whole host of pricing and market interactions besides that. However the concept lends itself more to psychological investigation rather than economic, being largely unobservable. The nebulous nature of risk-aversion can only be handled by applying simplifying assumptions.

One assumption is that risk-preferences are relatively stable and do not change over time. Another is that most humans exhibit constant relative risk aversion (CRRA) in their behaviour. That is, risk-aversion is directly correlated with wealth, so that people are willing to risk the same proportion of their current wealth and is independent of the absolute value of wealth. These two assumptions are central to the research question of my thesis. I want to explore whether and how risk aversion varies over time. More specifically, I want to test the assumption of CRRA and whether habit formation plays a role in risk preferences.

1.1 Habit Formation and Time-varying Risk Aversion

Habit formation is a modification to the traditional CRRA utility function where a habit term is added so that an agent derives utility only from consumption that is above this habit level. The habit can represent either a level of consumption that is considered normal and expected or it could be a subsistence level of consumption that is necessary for a normal life. The key aspect is that the agent does not want to fall below this level under any circumstances. This is represented by assigning consumption paths that fall below the habit level a utility of minus infinity. The particular form of habit I will be focusing on is a difference habit as in Campbell (1993). In this paper the habit term in the utility function generates time-varying risk-aversion, that depends on how close consumption is to the habit level. This is in contrast to models that use a CRRA utility function. This implication is the key observation that I test in this paper.

Under the assumption of CRRA agents, where risk aversion is constant relative to wealth, risk preferences are very stable and do not vary much over time. If utility is instead derived from a habit utility function, changes to wealth generate much larger changes in risk-aversion.

This could be a better explanation of some phenomenon such as the behaviour of investors in bad economic times. After experiencing a large negative wealth shock, individuals are much more reluctant to take risks in the market and this seems to persist even when the economy improves (Malmendier and Nagel, 2011).

In this thesis, I investigate the link between changes in wealth and changes in risk-aversion, as measured by the share of household assets held in equity. This is also a test of the theory of habit preferences more generally and provides evidence from micro-data to inform the debate on macroeconomic shocks and investor behaviour.

As well as testing the theory of habit formation, I hope to add to the understanding of the determinants of risk-aversion as well as giving some insight into idiosyncratic saving behaviour of households and the investment environment in Australia.

1.2 Outline

Since many previous studies have been conducted on this topic, I orientate my methodology closely on those works, particularly that of Brunnermeier and Nagel (2008). I take the same approach by using a dataset from a household panel survey, however I use data from Australia which is more recent. The panel data provides the right setting to observe changes over time and across different households. I focus on the variables of total wealth and the share of wealth invested in risky assets and observe how these change from one period to another. As well as that I use a probit regression to investigate the effect of wealth changes on the decisions to enter and exit the market.

If wealth changes have a significant effect on attitudes to risk, this would support the theory of habit preferences. My results fit very closely with previous works and do not provide evidence in support of the habit theory, indicating that the hypothesis of CRRA preferences cannot be rejected. The new data and different context however, provide a new estimate of the effect and the richness of the dataset allows me to test some secondary theories such as the wealth effect and the possible role of loss-aversion, which add to the understanding of saving behaviour in Australian households.

The rest of this thesis is organised as follows: Section 2 provides an overview of the research that informs this question. Section 3 gives a detailed derivation of the theoretical model used as a framework for my empirical work. Section 4 describes the data. Section

5 details the methodology. Section 6 summarises the results of the main tests. Section 7 reports results from some secondary tests. Section 8 discusses the results and compares them with other studies. Section 9 provides some conclusions and an outlook on future areas for research.

2 Literature Review

2.1 Habits and Macro-finance Theory

The field of financial economics has investigated how individuals make decisions on how much to save and how to choose the optimum portfolio. The classical models predict agents who want to maximise the expected utility of their wealth. Focusing on expected utility rather than wealth itself indicates that risk plays an important role. The attitude towards risk in this decision is determined by the curvature utility function. Different kinds of utility functions can lead to different results, since assumptions about the degree and type of risk aversion must be made. One simple classification of utility functions defines decreasing relative risk aversion (DRRA), increasing relative risk aversion (IRRA) or constant relative risk aversion (CRRA).

Portfolio choice literature typically assumes an agent who has CRRA. This means that they are happy to take on risks that are in proportion to their wealth. Furthermore, it is generally assumed that risk-preferences are stable and do not change over time.

Using models with CRRA utility functions, it was found that some of the implications for asset-pricing do not line up with empirical data. These are so-called puzzles of financial economics, such as the equity-premium puzzle (**?**). One solution to these puzzles has been to adjust the utility function to reflect other assumptions about the agent's relation to risk.

In macroeconomic literature habits have been posited as solutions to observations that contradict theory. Boldrin et al. (2001) used habits to explain business cycle facts, Shore and White (2002) the equity home bias, Carroll and Weil (1994) saving and growth phenomena, and Fuhrer (2000) to explain consumption's response to monetary and other shocks.

In asset-pricing literature habits have been used to explain the equity premium puzzle (see Constantinides, 1990; Abel, 1990; Campbell and Cochrane, 1999), the pro-cyclical variation of stock prices (Campbell and Shiller, 1988) and the counter-cyclical variation of stock market volatility (Harvey, 1989).

2.2 Habits in Micro-data

Since first being introduced in a theoretical context, many empirical tests have followed. There are two main ways to test habit theories using micro-data. Firstly, the problem can be looked at in terms of consumption, to determine if trends in consumption display auto-correlation that would be consistent with habit formation.

Studies by Dunn and Singleton (1986) and Heaton (1993) using aggregate consumption data found very little evidence of habit formation. Eichenbaum et al. (1988) found evidence of habit persistence in leisure choices but not in consumption. Muellbauer (1988) on the other hand found positive results, suggesting the observation interval plays a significant role. Heaton (1993) found similarly, that at very short horizons consumption is durable, but at quarterly frequencies habit persistence is evident. Ferson and Constantinides (1991) found evidence of habit formation at monthly, quarterly and yearly observation intervals. Braun et al. (1993) observed habit formation in Japan and Chen and Ludvigson (2009) also found evidence of a non-linear form of internal habit. Ravina (2019) used novel credit card data with observations at quarterly intervals and a model with household-specific interest rates and found evidence of habit formation in consumption.

The second approach looks at the other side of the coin: saving - specifically how households allocate their funds between risky and safe assets. This is the approach that I am following. As well as the study by Brunnermeier and Nagel there have been a range of similar investigations in different countries, using different data.

Studies using data from the survey of Italian households by Chiappori and Paiella (2011) and Cappelletti (2012) examined exactly this question and found no evidence or only very weak evidence in favour of habit formation. The latter used a Heckman two-step regression to control for households' choice of holding risky assets and found statistically significant but not economically significant effects. Tsigos and Daly (2016) investigated the effects of wealth on risk-aversion with the HILDA dataset. Using a first differences regression they found that there is a significant positive relationship between changes in wealth and changes in risk aversion. They propose decreasing relative risk aversion (DRRA) as the best explanation, but this could also be consistent with habit preferences. There are however significant differences in the theoretical model that was used (based on the static mean-variance portfolio developed by Bucciol and Miniaci (2011)) and how property wealth was considered, which make it difficult to compare directly with other studies.

The last significant study is that of Freestone and Breunig (2020). They used HILDA data and information on aggregate interest rates to investigate the determinants risk-aversion in Australian households. They identified the exact parameter for risk-aversion using an Euler-equation derived from a CRRA utility function. In the process they test the validity of assuming CRRA, finding no evidence to support a utility function with DRRA or habit preferences.

These different studies show inconsistent results although the tendency indicates that evidence of habit formation is either weak or quite hard to find in the data that is available.

2.3 Brunnermeier and Nagel (2008)

The paper by Brunnermeier and Nagel (2008) serves as a basis for my analysis. They used household panel data from the PSID in the USA to investigate the influence of wealth change on risk-aversion and the implications for individuals portfolio choices. They tested the prediction that increases in wealth lead to decreases in risk-aversion.

The model I use is the same as that which Brunnermeier and Nagel derive from Samuelson (1969). This specification regresses changes in risky asset share on change in liquid wealth. They found no evidence to support the existence of habits and pointed to CRRA as the best description of the behaviour observed in their data. They controlled for a large range of factors as well as fixed effects. They also investigated a possible alternative theory to describe the investment behaviour of households - inertia. They hypothesised that households are slow to rebalance their portfolios and that this is the main driver of investment decisions. This explains why households do not respond to short-term changes in wealth or expected returns. I take the framework from this paper for my investigation, specifically the model specification, variable descriptions and control control variables, as well as using the results as a reference to compare my findings to.

2.4 HILDA Dataset

As well as the above-mentioned research on this particular topic, there have been many studies about investment and saving behaviour of Australian households more generally. Topics covered include portfolio choice, wealth effects, role of property ownership, role of pension savings programs, role of tax incentives for property investment, role of gender, role of financial literacy.

Cardak and Wilkins (2009) investigated portfolio choice finding strong effects from a range of factors including labour income risk, health, home ownership, immigrant status and English proficiency. Using subjective measures of both risk-aversion and wealth improvement, Kettlewell (2019) investigated the role of common personal life events in explaining short-run dynamics in risk preferences. He found that wealth improvements lead to less risk-aversion and that wealth deterioration, parenthood and the death of spouse or child lead to more risk-aversion. These effects are large close to the event but revert to the mean over time.

Factors which are specific to the Australian context include pension savings programs (Kingston and Thorp, 2019), property investment (see Ryan-Collins and Murray, 2021; Cho et al., 2021), gender and financial literacy (see Preston and Wright, 2019, 2023). These have been very useful for explaining some unique feature of the Australian investment environment as well as informing many of the control variables used in my analysis.

2.5 Risk Aversion and Portfolio Choice

Finally, there is a wide range of research covering risk aversion more generally, often focusing on the determinants of risk aversion and the variability or otherwise of risk preferences.

Guiso et al. (2018) use bank data and lab experiments to examine the main drivers of varying risk-aversion, identifying four channels: changes in wealth, changes in background risk, shocks to the expected distribution of returns and shocks in emotions. Dohmen et al. (2015) highlight heterogeneity between countries in risk-aversion using panel data from Germany and Ukraine. A survey by Chuang and Schechter (2015) points out the differences between experimental and empirical measures of risk-aversion, finding varying levels of stability across different measures. They also highlight the importance of cultural context.

Portfolio choice has also been extensively studied with wealth effects playing a major role as well as of gender, geography, life-stage, emotions and expectations, cohort effects and loss-aversion (see Shum and Faig, 2006; Tsiaplias et al., 2023; Golosov et al., 2023; Calvet et al., 2009, among others).

3 Theory

3.1 Model with Habits

In this paper I analyse the implications of habit formation for risk-aversion in saving decisions. The intuition is that households use a portion of their wealth to insure against negative shocks that might reduce future consumption below the habit level. This portion of the wealth is invested in safe assets. It follows then that when wealth increases, there is less risk to future consumption and households are more willing to invest in risky assets. This hypothesis can be tested using household data on wealth and investments.

3.2 Derivation

To illustrate how risk aversion can be time-varying when agents' preferences have difference habits, I use the same model of portfolio choice from Brunnermeier and Nagel (2008). It is a variation on the model first put forward by Samuelson (1969), namely a discrete time model in which a representative household with an infinite time horizon chooses the optimal choice of assets to hold. The agent receives wealth at the start of period t and decides how much of it to consume and how much of it to save, with the option of saving in a risky asset or a risk-free asset. Wealth is denoted as W_t, consumption is C_t, the risky asset has return R_t and the risk-free asset has a constant return R_f. The agent chooses C_t as well as the proportion α of $W_t - C_t$ to invest in the risky asset.In a model with habits the agent maximises:

$$\max E_t \sum_{\tau=0}^{\infty} \delta^{\tau} \frac{(C_{t-\tau} - X)^{1-\gamma}}{1-\gamma} \tag{1}$$

Subject to the intertemporal budget constraint:

$$W_{t+1} = (1 + R_{p,t+1})(W_t - C_t) \tag{2}$$

With δ as the subjective time-preference discount factor, γ the curvature of the utility function, $R_{p,t+1} = \alpha(R_t - R_f) + R_f$ is the return on investors' liquid wealth portfolio, and X is the habit. Consumption paths with $C_t \leq X$ at some future t with non-zero probability are assigned negative infinity utility. Risky asset returns are assumed to have a log-normal distribution and for simplicity, expected returns and volatility are constant.

In this model X is constant so that it would represent either a slow-moving internal habit or an external habit which is not dependent on the consumption of any single agent. This is consistent with the literature on difference habits.

The problem is solved by redefining consumption and mapping the objective function and budget constraint onto a standard CRRA problem. Define surplus wealth $W_t^* \equiv W_t - (X/R_f) - X$ and surplus consumption $C_t^* \equiv C_t - X$. The maximisation problem can then be rewritten as:

$$\max E_t \sum_{\tau=0}^{\infty} \delta^{\tau} \frac{C_{t+\tau}^{*1-\gamma}}{1-\gamma} \tag{3}$$

Now assume the agent invests a fraction α_t^* of $W_t - C_t - (X/R_f)$ into the risky asset at time t, and the rest into the riskless asset. The return on this surplus portfolio is $R_{p,t+1}^* \equiv \alpha_t^*(R_t - R_f) + R_f$. That leaves X/R_f to be invested into the riskless asset. The budget constraint becomes:

$$W_{t+1} = (1 + R_{p,t+1}^*)(W_t - C_t - \frac{X}{R_f}) + (1 + R_f)\frac{X}{R_f} \tag{4}$$

Using the definitions it can be reformulated as:

$$W_{t+1}^* = (1 + R_{p,t+1}^*)(W_t^* - C_t^*) \tag{5}$$

Therefore this problem maps onto the problem of a CRRA investor with wealth W_t^*, consumption C_t^* and risky asset portfolio share α_t^*. If expected returns and volatility are constant then risky asset share is constant, i.e. $\alpha_t^* = \alpha^*$, as shown by Samuelson (1969). This habit utility investor then has a risky asset share as a fraction of post-consumption wealth at time t of

$$\alpha_t = \alpha^*(1 - \frac{X}{(W_t - C_t)R_f}). \tag{6}$$

This share is increasing in W_t, holding X constant. The agent insures against future wealth decreases by investing the present value of the future habit X/R_f in riskless assets, and they invest surplus wealth like a CRRA investor. So if W_t is close to X/R_f, the agent's relative risk aversion is high, but if W_t is a lot greater than X/R_f, the agent invests much like a CRRA investor.

Although this model considers only the agents liquid wealth, the effects of background wealth from property or business ownership are minimised as long as the returns on background wealth are not strongly correlated with stock returns. Assuming that α^* is 1, the model can be approximated as:

$$\alpha_t = \alpha^*(1 - \frac{X}{(w_t - C_t)R_f}) \tag{7}$$

Which forms the basis for the tests in this paper related to habit effects. In this model, the presence of habits induces variation in risky asset shares, particularly that wealth increases lead to an increase in the share of liquid wealth invested in risky assets.

Linearising and performing a first-order Taylor approximation gives:

$$\alpha_t = 1 - \frac{X}{(W_t - C_t)R_f} \tag{8}$$

$$= 1 - \exp(x - w_t) \tag{9}$$

$$\approx \kappa - \rho(x - w_t) \tag{10}$$

Taking first differences gives the following equation:

$$\Delta\alpha_t = \rho\Delta w_t \tag{11}$$

As long as X is approximately constant, this result is accurate. This assumption is reasonable if we consider external habits that are not affected by idiosyncratic wealth shocks, or internal habits that are slow moving and therefore adjust very slowly to wealth changes. This will be the equation I use in the following empirical tests.

4 Data

4.1 Data Description

The data I use for this analysis is from the Household, Income and Labour Dynamics in Australia Survey (HILDA), a household-based panel survey conducted in Australia starting in the year 2001.[1] A representative sample of households were chosen to survey and data was collected in yearly intervals by a combination of interviews and questionnaires. The survey includes core questions which are asked each wave and more specialised modules which are included at regular intervals. The module on wealth, which includes many of the variables required in this analysis, is conducted every four years starting with the second wave in 2002. The most recent wave with wealth data is 2022. That makes a total of six periods with the required variables. The data is maintained by the Melbourne Institute and funded by the Australian Government. I will discuss the definitions of the variables that I use for my analysis. To make the variables comparable over time, I deflate all financial variables by the Australian consumer price index (CPI) into June 2022 Australian dollars.

With surveys, there is often the issue of missing data. Although the survey was conducted very thoroughly there are still some observations that are missing for a variety of reasons. The biggest issue is response rates, with only 66% of households responding in the first wave. Some households that were chosen and included in the first wave failed to respond to future waves, with the attrition rate ranging from roughly 5% to 15% (Summerfield et al., 2021). Since the analysis here requires two consecutive waves of data to calculate the difference variables, and one more previous period for some control variables, this limited the amount of observations that could be used.

The rate of missing data points in households that completed surveys and questionnaires is relatively low. Overall about 22% to 29% of households are missing income data with 29% to 39% of households missing wealth data (Summerfield et al., 2021). Where missing variables were the result of questions not being applicable, such as inheritance received or equity owned, I assumed that they were equal to zero. This should not affect the validity of the results. The survey provides imputations for many missing variables, but for the

[1] This paper uses unit record data from the Household, Income and Labour Dynamics in Australia Survey (HILDA) conducted by the Australian Government Department of Social Services (DSS). The findings and views reported in this paper, however, are those of the author and should not be attributed to the Australian Government, DSS, or any of DSS' contractors or partners. DOI:10.26193/R4IN30

purposes of this analysis I have decided to rely on imputations only for control variables to avoid biassing estimations of the variables of interest.

4.2 Variable Definitions

The variables of interest for the analysis are liquid wealth, financial wealth, liquid risky asset share and financial risky asset share. The HILDA survey has an extensive range of derived variables that are relevant, however the measures used in Brunnermeier vary slightly. I define risky assets as equity investments, considering cash-like assets, retirement funds, trust funds and life insurance as risk-free assets. Liquid wealth is then calculated as total financial assets minus personal debts which include credit card debt, student loan debt and other personal debts. Financial wealth is derived by adding net business and property equity to liquid wealth.

The HILDA data provides no information on the composition of each of these asset classes so I assume that all equity investments are risky in comparison to other liquid assets. I define the liquid risky asset share as equity investments divided by liquid assets and the financial risky asset share as equity investments divided by financial wealth.

4.3 Sample Selection

To conduct the analysis I restrict the sample. The first requirement is that wealth and income data is available for at least three consecutive waves. This is necessary for the main variables of interest and for some control variables a lag of one period is required. Some changes in household composition are difficult to control for, so I included only observations where there was no change in marital status between the two periods. When there is a large change in household wealth changes due to a change in the member of the household there may be other factors that influence the risky behaviour. Thirdly, the saving patterns of retirees follow different patterns so only households with primary members that are not retired are included in the sample. To exclude extreme values for risky asset shares, due to high indebtedness or fluctuations that are close to zero, I include only households with liquid and financial wealth levels that are greater than $10,000. After applying these conditions, there are a total of $6,502$ household-year observations which I use for the regression analysis.

4.4 Summary Statistics

The summary statistics are in Table 1. The top panel shows the pooled cross-section/time-series statistics for all households that fulfilled the data and minimum lag requirements to be included in the sample. The bottom panel shows the statistics for households that hold stocks in consecutive periods.

As the table shows, the share of households participating in the stock market is 35%. This is significantly lower than in Brunnermeier and Nagel (2008)'s sample, which has a stock market participation rate of 45%. Although lower than the sample in the PSID data, this is still probably an overestimate when compared to the population as a whole, due to the sample selection criteria. The stock market entry variable in the top panel is a dummy that is set to one for households that did not participate at $t-4$ and did participate at t, and zero if the household does not hold stocks in $t-4$ and t. Similarly the stock market exit variable is equal to one for households that own stock in $t-4$ but not t and zero for those who participated in $t-4$ and t. The amount of turnover in the group of participants is relatively low. In both cases about 8% of participants leave/enter the market between each period. The first test I conduct explores whether the probability of entry and exit is related to changes in liquid wealth.

Looking at the wealth and income variables and comparing all households with stock market participants, it is clear that stock market participants have higher wealth and income on average and across all quartiles. This shows that the ownership of stocks is more concentrated among higher income groups. The HILDA Survey is representative of the population as a whole and comparisons with aggregate data have shown that it covers the upper-end of the wealth distribution well (Finlay, 2012).

5 Econometric Issues

The equation to estimate is:

$$\Delta_4 \alpha_t = \beta q_{t-4} + \gamma \Delta_4 h_t + \rho \Delta_4 w_t + \varepsilon_t \tag{12}$$

This is equation 11 derived above, with the addition of control variables and an error term.

There are two categories of controls. The first group includes demographic characteristics and lifestyle variables which are known at time $t-4$. This also includes an intercept and fixed effects for year and region. The second group accounts for significant changes in household situation and composition that may have occurred between periods t and $t-4$. These are contained in the vector $\Delta_4 h_t$. Finally the error term ε_t captures other effects that are not captured in the model and are uncorrelated with q_{t-4}, $\Delta_4 h_t$ and $\Delta_4 w_t$.

5.1 Life-Cycle Effects and Preference Shifters

In order to isolate the effects of wealth changes on changes in risk-aversion, I need to include controls for other factors that influence investment behaviour and attitudes to risk. These controls can be divided into two broad groups that can be called life-cycle effects and preference shifters. Following life-cycle theories of consumption as well as empirical investigations, I consider that significant life changes would influence saving behaviour. To control for these effects I include variables that are known in period $t-4$: demographic characteristics that include age and age squared, dummy variables for completed high school and university, as well as their interactions with age and age squared, gender dummy variables and their interactions with age and age squared, marital status and a measure of health status. Also in this category are household characteristics made up of number of children, number of people, and an indicator for whether the household's head's job is covered by a union contract. I also include the log of equity in vehicles, log of household income at $t-8$, two-year growth in log family income at $t-4$ and $t-6$, and a variable for inheritances received in the 4 years up to and including year $t-4$.

The preference shifter variables are to control for significant changes in the makeup of the household which would influence how resources are allocated. These are mainly changes from period $t-4$ to period t, including change in household size, change in number of children, dummies for house and business ownership in period t and $t-4$. Since households may save for a long time to buy a house this controls for changes associated with that. I also include an indicator variable for non-zero labour income in period t and $t-4$ to control for changes in labour market participation which could be correlated with changes to sources of other income.

5.2 Idiosyncratic vs Aggregate Wealth Changes

The partial equilibrium portfolio choice model focuses on the decision of a single household, holding aggregate quantities and prices constant. However, if a change in wealth happens that affects all households so that they all want to adjust their exposure to risky assets, the effect on asset allocation is reduced since it is now the price of risky assets that adjust and not the quantity. To control for this and focus on household-specific variation, I include time fixed effects in q_{it-k}. In addition, to filter out local effects, I interact the year dummies with dummies for the eight states in Australia, which results in a set of year-state dummies.

5.3 Measurement Error

Measurement error is a standard issue with micro-data from surveys. If wealth and the risky asset share have a standard measurement error, the resulting OLS estimator would be inconsistent because the residuals are correlated. This is further complicated if the two components of the risk asset share, risky and riskless assets, have a measurement error. Overall it is difficult to determine in what direction this bias would go due to the fact that both the numerator and denominator are made up of components of wealth.

To get around this possible issue, I include a TSLS regression using instruments to measure the effect of changes in wealth. The instrumental variables are dummies for income growth from $t-4$ to t that is above the 90th quantile and below the 10th quantile, and a dummy for whether and inheritance was received in the period from $t-4$ to t. Unfortunately this approach also results in a less precise estimate compared to the OLS estimator. Therefore I have included results from both the OLS and TSLS regressions in my reports.

6 Results

6.1 Wealth changes and Stock Market Participation

The first question to look at is the effect of wealth changes on decisions to enter and exit the stock market. The results of the probit regressions are in table 2. In the first regression I estimate the likelihood that a household that is not invested in the stock market in period

$t-4$ has decided to enter the market by period t. In the second regression I estimate the likelihood that a household that holds stocks in period $t-4$ reduces their stock holding to zero by period t. The table shows the marginal effects, the effects on the probability of entry or exit, evaluated at the sample means of the explanatory variables. Also included in the regressions are controls for preference shifters, lifecycle effects, and time-region fixed effects.

The coefficient for the changes in liquid wealth has the expected sign - increases in wealth are positively correlated with entering the market by period t, whereas wealth increases are negatively correlated with exiting the market by the next period. The coefficients are precisely measured so that they are statistically significantly different from zero. This indicates that there is certainly some effect, however, the absolute size of the effect in both cases is small and economically insignificant. The coefficient of 0.0265 implies that an increase in liquid wealth by 10% correlates to a roughly 0.2% increase in the probability of entering the stock market. Similarly the coefficient of -0.0195 for changes in wealth on stock market exit implies that an increase in wealth of 10% would lead to a roughly 0.2% decrease in the likelihood of exiting the market. This is again highly statistically significant.

Since stock market entry and exit thesis is also consistent with CRRA preferences, the results are more of an indication as to the extent of measurement errors and other noise in the data. The precisely measured effects point towards an insignificant disruption due to noise. These results are consistent with time-varying risk aversion due to changes in wealth as well as CRRA preferences, however there may be other effects at play which have not been measured, such as participation costs, etc.

6.2 Wealth Changes and Asset Allocation

The next test to look at is the relationship between the share of wealth held in risky assets and changes in liquid wealth. For this test I only look at those households that are invested in the stock market in period t and $t-4$, to condition on market participation. This leaves a sample of 2,265 observations. I want to estimate equation 12, using OLS and TSLS.

6.2.1 First Stage

The first-stage estimates for the TSLS are in Table 3. I use three instruments for changes in wealth. These are two indicator variables for whether changes in log income between $t-4$

and t were above the 90th percentile or below the 10th percentile and an indicator for if there was any inheritance received in the 4 years up to and including period t.

The results in the table show that the instruments have a strong effect on the instrumented variable. The coefficients have the expected signs with a growth in income above the 90th percentile correlating with a positive change in liquid wealth and growth that is below the 10th percentile with a negative change in liquid wealth. The indicator for inheritance received also has a strong positive link to rises in liquid wealth. The partial R^2 is relatively low at 0.024, which indicates that there is quite a lot of variation which is not explained by the instruments. However, the relevance of the instruments is evident. The individual coefficients for income change quantiles are significant at the 1% level, and the inheritance flag is significant at the 5% level. The joint F-stat is 42.36 which is well above the rule of thumb of 10 suggested by Staiger and Stock (1997), therefore these are sufficiently strong instruments.

6.2.2 Changes in Liquid Risky Asset Share

The results of the main regressions are summarised in Table 4. I regressed the change in the liquid risky asset share on the change in log liquid wealth including controls for life-cycle effects, preference shifters and fixed-effects. The model with habits predicts that the coefficient should be positive, however the coefficient that I found is very close to zero and not significant. This provides no evidence for the existence of habits. The OLS estimation is -0.008 with a standard error of 0.007, which is of the same order of magnitude. This means that the hypothesis that the real coefficient is zero cannot be rejected. The adjusted R^2 is very low which suggests that there is a lot that is not explained by the variables that I have included in the regression. Even among the control variables there are very few coefficients which are statistically significantly different from zero. These include the fixed effects relating to the state of Tasmania, which suggests that the households there experience a significantly different environment for investing. The other significant variables are those for house ownership in period $t-4$ and period t which indicates that buying a house is the most important event for shifting risky asset shares. Whether this signifies shifts in risk-aversion is hard to determine without knowing more about the individual risk profiles of property assets.

The TSLS results control for possible measurement errors. Considering the instruments are relatively strong, the results indicate that measurement error is not a big factor. The coefficient found is a little larger but the standard error is still of the same magnitude, putting the confidence interval squarely around the zero. Both estimates are therefore quite similar. The Sargan test shows that the model is not over-identified with a p-value of 0.31. These two results indicate that there is no good evidence for the model with habits over the model with CRRA.

6.2.3 Changes in Financial Risky Asset Share

The second regression is to test if the effect of background risk leads to different conclusions. The results are reported in Table 5. I regress the change in the financial risky asset share on the change in log financial wealth including the same controls as before. This is relevant if households with CRRA preferences keep the proportion of risky assets, including home equity and business equity constant. The implication for a model with habits is that changes in financial wealth should cause changes in the financial risky asset share.

The results again show that there is no significant link. The coefficient from the OLS regression is larger now, at 0.121 but the standard error of 0.108 means that it is not statistically significant. The TSLS regression delivers a coefficient which is approximately zero and only a slightly smaller standard error of 0.073. Similar to the previous regressions, the variables for the state of Tasmania and the house ownership effects are the only controls which are significant. This indicates a relatively large and significant effect of purchasing a house on the share of wealth invested in risky assets, but provides no evidence for the effect of habits.

7 Robustness Checks

7.1 Adjust Sample

The two checks that I conduct are based on adjusting the sample used for the analysis. I investigate the hypotheses that different groups of households may react differently to changes in wealth. I test whether there is a difference in effect between wealthy households and less wealthy households. To do this I split the sample used in the main analysis into two groups - those that have liquid wealth above the median and those that have liquid wealth below the median, and then repeat the same regressions as above. I also check if there is an effect based on differences in financial wealth using an analogous method. The results are in Tables 6 and 7. None of the coefficients are significant, giving no evidence for any effect. Although the variation in signs and magnitudes of the coefficients suggest that there may be some heterogeneity in households, the estimations are far too imprecise to draw any conclusions. The control variables for house ownership, and in some cases university education, remain significant.

The second check is based on the theory of loss-aversion being more important than risk-aversion. I investigate whether there is any difference in effect based on whether households experienced negative changes in wealth or positive changes in wealth between the observation periods. Significant differences here would indicate that risk-aversion is not the main driver, but rather loss-aversion. Again I split the sample into two groups based on whether they experienced a gain in wealth over the period, or a loss in wealth. Then I carry out the same analysis on changes in liquid and financial wealth, using OLS and TSLS methods. The results are summarised in Tables 8 and 9. Similar to the previous check, the coefficients are mostly insignificant. The only coefficient that is significant to the 10% level is the OLS estimation for the change in log liquid wealth in the group that experienced a loss in liquid wealth. However the sign is negative which would not indicate the opposite effect than if loss-aversion was a significant factor. Also the TSLS first-stages show a low F-stat, most likely due to the small sample size. These weak instruments result in biassed estimates (Staiger and Stock, 1997). Here there is no evidence for variation in the effect based on loss-aversion.

8 Discussion

I will now summarise the main points of similarity and difference between this study and the investigation by Brunnermeier and Nagel on which it is based. The headline results are the same, finding no evidence for habit preferences. Despite the difference in data, I tried to replicate the methodology as closely as possible, which shows that the different setting does not cause any significant difference in the results.

The main differences between the two studies is in the data used. The original study was conducted with data from the 80's and 90's however I use data from the 00's and 10's.

As the development and uptake of technology in finance has improved over the years, one might expect more people to be investing in equities due to lower costs and fewer barriers to entry. I found no evidence for this. The other key difference is in that the original study was conducted in the USA, whereas I use data from Australia. Apart from any cultural differences in attitudes to risk, the saving and investing environment can vary significantly between countries. Comparing the summary statistics it is obvious that owning stocks is less common in Australia than in the USA. This effect seems to heavily out-weigh any changes over time that might make it easier to invest.

The differences in saving behaviour across countries seems clear. But there also seems to be significant variation within countries based on geographic factors. In my regressions many of the state variables showed consistently significant results. This points to factors such as remoteness, urban/rural divides and local economic shocks as important determinants of risk-aversion and saving behaviour. In future analyses it could be useful to break down households based on these factors to determine what kind of effect it could reveal.

The two other significant differences between the two studies are the gaps between time periods. In the original study data is available every 2 and 5 years (designated by the variable k). This allows habits of varying speeds to be tested. In my investigation, there is a uniform gap between the period of 4 years. This means that any quicker moving habits may have been missed. However, the original study found no evidence even for the $k = 2$ sample, which suggests that how fast or slow-moving the habits are does not play a large role in the ease of detecting them.

Although I did not find any evidence for habits, I did replicate the findings of Brunnermeier as well as supporting the conclusions from Chiappori and Paiella (2011), and Freestone and Breunig (2020) . My results also point to some topics in the area of wealth growth and asset allocation which may be interesting for future research. My investigation is consistent with reports from the Reserve Bank of Australia, which indicate that in Australia there are two main factors that are important for wealth growth - mandatory retirement saving programs (superannuation) and property investments (Finlay, 2012). Equity investments are neither significant ways to save for retirement nor to build wealth, as might be the case in other countries. Therefore how these sources of background risk are handle is crucial to consider in future research.

9 Conclusion

In this thesis I have tested the assumption of CRRA empirically using data from the HILDA survey. Risk-aversion is a key topic in economics as it is central to many theoretical and applied models of decision-making under uncertainty. My findings can be summarised as follows:

1. Changes in liquid wealth do affect households' decisions to enter or exit the stock market. This is consistent with CRRA preferences.

2. There is no significant effect between changes in household wealth and risky asset shares. This provides no evidence to support the theory of habit formation.

3. Home ownership has a significant effect on risky asset shares in all of my regressions. This indicates that property plays a key role in portfolio choice.

4. University education also has a significant effect on risky asset shares, pointing to the importance of education and financial literacy in decision making.

5. There are significant differences between Australia and USA with regards to attitudes to saving and regulatory framework.

6. My robustness checks find no significant wealth effects or loss-aversion effects on households' portfolio choice.

These results cast further doubt on the plausibility of habits in explaining macroeconomic fluctuations and financial puzzles. Other behavioural economic explanations may be more successful in explaining these phenomena and fitting the micro-data. Guiso et al. (2018) present a possible route for further research, highlighting the role of emotions and saliency. In any case, more research is needed to pin down the exact nature of risk-preferences and their implications for household saving and asset allocation.

Appendix

Table 1: Summary Statistics

Variable	Mean	Tenth percentile	Median	Ninetieth percentile	N
All Households, 2010 - 2022					
Liquid wealth	523,144	62,494	286,950	1,160,270	6,502
Financial wealth	1,294,011	136,882	844,917	2,727,798	6,502
Income	127,980	50,477	115,153	214,458	6,502
Stock market participation	0.35	0	0	1	6,502
Stock market entry	0.08	0	0	1	6,502
Stock market exit	0.08	0	0	1	6,502
Stock market participants, 2010 - 2022					
Liquid wealth	799,915	120,806	491,050	1,690,840	2,265
Financial wealth	1,919,366	448,379	1,324,520	3,771,609	2,265
Income	147,390	57,284	131,789	244,478	2,265
Δ_4 log liquid wealth	0.30	-0.53	0.30	1.14	2,265
Δ_4 log financial wealth	0.29	-0.24	0.25	0.86	2,265
Δ_4 log income	0.02	-0.47	0.06	0.49	2,265
Percent liquid assets risky	0.14	0.00	0.05	0.40	2,265
Percent financial wealth risky	0.62	0.31	0.49	0.90	2,265
Δ_4 percent liquid assets risky	-0.01	-0.17	-0.01	0.12	2,265
Δ_4 percent financial wealth risky	-0.01	-0.24	-0.01	0.21	2,265

Table 2: Changes in Liquid Wealth and Stock Market Entry and Exit - Probit Regressions

	Entry	**Exit**
	mean	mean
Δ_4 log liquid wealth	0.0265	-0.0195
	(0.004)	(0.004)
Δ_2 log income$_{t-4}$	0.0189	0.0094
	(0.008)	(0.006)
Δ_2 log income$_{t-6}$	0.0169	0.0145
	(0.008)	(0.009)
Log income$_{t-8}$	0.0199	0.0250
	(0.008)	(0.008)
Preference shifters	Y	Y
Life-cycle controls	Y	Y
Year-region FE	Y	Y
Pseudo R^2	0.053	0.035
N	6,484	6,484

Notes: Estimates are marginal effects evaluated at sample averages of the explanatory variables. Standard errors are reported in parentheses.

Table 3: First-Stage Regressions

	Δ_4 log liquid wealth$_t$	Δ_4 log financial wealth$_t$
Instruments:		
$I_{(\Delta_4 log\ income_t < tenth\ percentile)}$	-0.285	-0.186
	(0.061)	(0.040)
$I_{(\Delta_4 log\ income_t > ninetieth\ percentile)}$	0.262	0.171
	(0.074)	(0.050)
Inheritance$_t$	0.123	0.109
	(0.058)	(0.035)
Controls:		
Δ_2 log income$_{t-4}$	0.014	0.027
	(0.038)	(0.031)
Δ_2 log income$_{t-6}$	0.056	0.079
	(0.035)	(0.032)
Log income$_{t-8}$	-0.023	-0.013
	(0.021)	(0.017)
Preference shifters	Y	Y
Life-cycle controls	Y	Y
Year-region FE	Y	Y
Partial R^2 of instruments	0.024	0.023
F-test of instruments	42.36	44.13
[p-value]	[0.00]	[0.00]
N	2,265	2,265

Note: Heteroskedasticity- and autocorrelation-robust standard errors are reported in parentheses.

Table 4: Changes in the Proportion of Liquid Assets invested in Risky Assets

	OLS	TSLS
Δ_4 log liquid wealth$_t$	-0.008	0.032
	(0.007)	(0.037)
Preference shifters	Y	Y
Life-cycle controls	Y	Y
Year-region FE	Y	Y
Adj. R^2	0.006	-
Over-identification test	-	[0.31]
N	2,265	2,265

Note: Heteroskedasticity- and autocorrelation-robust standard errors are reported in parentheses and p-values in brackets.

Table 5: Changes in the Proportion of Financial Wealth invested in Risky Assets

	OLS	TSLS
Δ_4 log financial wealth$_t$	0.121	-0.007
	(0.108)	(0.073)
Preference shifters	Y	Y
Life-cycle controls	Y	Y
Year-region FE	Y	Y
Adj. R^2	0.03	-
Over-identification test	-	[0.95]
N	2,265	2,265

Note: Heteroskedasticity- and autocorrelation-robust standard errors are reported in parentheses and p-values in brackets.

Table 6: Changes in the Proportion of Liquid Assets invested in Risky Assets - Grouped by Liquid Wealth

	Upper Half		Lower Half	
	OLS	TSLS	OLS	TSLS
Δ_4 log liquid wealth$_t$	-0.003	0.110	-0.015	-0.050
	(0.012)	(0.057)	(0.009)	(0.052)
Preference shifters	Y	Y	Y	Y
Life-cycle controls	Y	Y	Y	Y
Year-region FE	Y	Y	Y	Y
Adj. R^2	0.02	-	-0.00	-
First-stage F-test of instruments	-	29.40	-	18.43
Over-identification test	-	[0.27]	-	[0.95]
N	1,132	1,132	1,132	1,132

Note: Heteroskedasticity- and autocorrelation-robust standard errors are reported in parentheses and p-values in brackets.

Table 7: Changes in the Proportion of Financial Assets invested in Risky Assets - Grouped by Financial Wealth

	Upper Half		Lower Half	
	OLS	TSLS	OLS	TSLS
Δ_4 log financial wealth$_t$	-0.044	0.031	0.256	0.013
	(0.025)	(0.080)	(0.191)	(0.111)
Preference shifters	Y	Y	Y	Y
Life-cycle controls	Y	Y	Y	Y
Year-region FE	Y	Y	Y	Y
Adj. R^2	0.06	-	0.06	-
First-stage F-test of instruments	-	19.01	-	26.06
Over-identification test	-	[0.95]	-	[0.91]
N	1,132	1,132	1,132	1,132

Note: Heteroskedasticity- and autocorrelation-robust standard errors are reported in parentheses and p-values in brackets.

Table 8: Changes in the Proportion of Liquid Assets invested in Risky Assets - Grouped by Loss or Gain

	Gain		Loss	
	OLS	TSLS	OLS	TSLS
Δ_4 log liquid wealth$_t$	-0.002	0.110	-0.034	-0.093
	(0.010)	(0.057)	(0.018)	(0.147)
Preference shifters	Y	Y	Y	Y
Life-cycle controls	Y	Y	Y	Y
Year-region FE	Y	Y	Y	Y
Adj. R^2	-0.00	-	0.00	-
First-stage F-test of instruments	-	29.14	-	7.57
Over-identification test	-	[0.13]	-	[0.44]
N	1,632	1,632	633	633

Note: Heteroskedasticity- and autocorrelation-robust standard errors are reported in parentheses and p-values in brackets.

Table 9: Changes in the Proportion of Financial Assets invested in Risky Assets - Grouped by Gain or Loss

	Gain		Loss	
	OLS	TSLS	OLS	TSLS
Δ_4 log financial wealth$_t$	0.173	-0.170	0.291	0.213
	(0.114)	(0.105)	(0.342)	(0.225)
Preference shifters	Y	Y	Y	Y
Life-cycle controls	Y	Y	Y	Y
Year-region FE	Y	Y	Y	Y
Adj. R^2	0.06	-	0.02	-
First-stage F-test of instruments	-	21.69	-	6.23
Over-identification test	-	[0.81]	-	[0.87]
N	1,749	1,749	516	516

Note: Heteroskedasticity- and autocorrelation-robust standard errors are reported in parentheses and p-values in brackets.

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