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Abstract: We explore the relationship between risk preference and household finances, namely the level of unsecured debt and saving at the household level, within the context of a two period theoretical framework, which predicts that debt and saving are functions of risk aversion. We test the predictions of our theoretical framework for a sample of households drawn from the U.S. *Panel Study of Income Dynamics* (*PSID*). Using a sequence of questions from the 1996 *PSID*, we construct a measure of risk preference allowing us to explore the implications of interpersonal differences in risk preference for whether households hold unsecured debt and/or savings as well as exploring the relationship between risk preference and the accumulation of unsecured debt and savings at the household level. Our empirical findings suggest that risk preference is an important determinant of the level of unsecured debt acquired at the household level with risk aversion serving to reduce the level of unsecured debt accumulated by households, whilst risk preference does not appear to influence the level of financial assets at the household level.

Key Words: Debt; Risk Aversion; Risk Preference; Saving.

JEL Classification: D12; D14

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I. Introduction

Both sides of the Atlantic have witnessed a massive increase in consumer debt over the last decade. For the U.S., figures from the Federal Reserve reveal that debt levels (consumer credit and mortgage debt) were nearly $13,823 billion in 2008 (Federal Reserve, 2009). Such considerable increases in the level of debt at the household level have led to concern amongst policy-makers over the extent of financial vulnerability at the household level. Policymakers have recently commented on the importance of analysing both household financial assets and liabilities in order to ascertain the extent of potential financial pressure at the household level. For example, Alan Greenspan, the former Chairman of the US Federal Reserve Board, commented that unless one simultaneously considers financial assets along with liabilities it is difficult to assess the true burden of debt.[1] Similarly, the Monetary Policy Committee in Great Britain has acknowledged the importance of establishing whether the same households have been accumulating financial assets as well as debt:

> 'the aggregate expansion of both sides of the household sector balance sheet concealed a risk at a disaggregated level; to the extent that some households were accumulating liabilities whilst others were increasing their assets, there was a risk that indebted households might have to adjust their balance sheets and consequently reduce their consumption in the event of an adverse shock.' Minutes of the Monetary Policy Committee, Bank of England, Minutes of the Monetary Policy Committee (2002).

Clearly, in addition to ascertaining the distribution of financial assets and liabilities at the household level, it is important to analyse the determinants of debt and financial assets at the household level (see, Brown and Taylor, 2008). Furthermore, joint holding of assets and debt at the household level reveals interesting insights into the behaviour of households with respect to asset and debt accumulation. For example, debt is often associated with a higher interest rate than that received from savings. It may be the case, however, that households are taking advantage of the numerous interest free credit

[1] '*Understanding Household Debt Obligations' speech a*t the Credit Union National Association, Governmental Affairs Conference, Washington, D.C. February 23, 2004.

arrangements on offer in order to enhance current liquidity or some households may be disinclined to use savings in order to repay debts.

Despite the importance for policy-making, amongst academic economists research into the determinants of debt at the household level is surprisingly scarce. There are, however, a small number of empirical studies on debt, which explore its determinants at the household or individual level. For example, Godwin (1997) explores the dynamics of households' use of consumer credit and attitudes towards credit using U.S. panel data. The findings suggest that there was considerable mobility in debt status during the 1980s, with the majority of households in a different debt quintile in 1989 relative to 1983. In a more recent U.S. study, Crook (2001) explores the factors that explain U.S. household debt over the period 1990 to 1995 and finds that income, home ownership and family size all impact positively on the level of household debt; whilst Brown *et al.* (2005) analyse British panel data and find that financial expectations are important determinants of unsecured debt at the individual and the household level.

There has been relatively more interest in the determinants of saving at the individual and household level. For example, Lusardi (1998) explores the importance of precautionary saving exploiting U.S. data on individuals' subjective probabilities of job loss from the Health and Retirement Survey. Lusardi (1998) reports evidence consistent with precautionary savings motives in that individuals facing higher income risk save more, although the findings suggest that the contribution of precautionary saving to wealth accumulation is not particularly large. In a similar vein, Guariglia (2001) uses the British Household Panel Survey to ascertain whether households save in order to self-insure against uncertainty. Her findings suggest that a significant relationship exists between earnings uncertainty and savings. Moreover, the results imply that households save more if they expect their financial situation to deteriorate. Given the focus on saving and income risk in the existing literature, it is apparent that attitudes towards risk potentially represent an important, yet relatively unexplored, part of the decision-making process.

In this paper, we firstly contribute to the existing literature on household finances by focusing on one particular influence on debt and saving at the household level, namely attitudes towards risk, which has attracted limited attention in the existing literature.[2] One reason why attitudes towards risk have attracted limited attention in the empirical literature may be due the shortage of measures of risk preference at the household and individual level. With respect to debt accumulation, households generally acquire debt to increase current consumption with repayments being made in the future. Typically, this may be due to life cycle reasons and liquidity shortages. Given that debt repayments are generally financed from household income, it is apparent that if income is subject to risk (due to, for example, redundancy, unemployment or changes in real wages), then the risk preferences of the individual will potentially play a key role in the decision to acquire debt, given the distribution of future income and interest rates. Intuitively, one might predict that the more risk averse an individual is, the lower will be the debt he/she incurs if there is a non zero probability that the individual cannot repay the debt in the future. Precautionary saving motives, on the other hand, may lead to a positive association between risk aversion and saving, whereby risk averse individuals save in order to safeguard themselves against adverse future financial shocks. With respect to our second contribution, we aim to jointly explore debt and saving at the household level rather than focusing on just one aspect of household finances, which has commonly been the case in the existing literature. Hence, we aim to add to the growing

[2] One exception lies in the economic psychology literature: Donkers and Van Soest (1999) find that risk averse Dutch homeowners tend to live in houses with lower mortgages.

empirical literature on households' financial portfolios (see, for example, Guiso *et al.* (2002) for a comprehensive review of this area).

In sum, in the presence of uncertain future income streams, the nature of an individual's risk preferences arguably plays an important role in the decision to use unsecured debt to finance current consumption or to save. In order to redress this imbalance in the existing economics literature, we aim to explore the relationship between risk preference and household finances from a theoretical and an empirical perspective.

II. Theoretical Background

We can capture the influences on borrowing and saving described above within a simple life cycle example, which serves to inform our subsequent empirical analysis. We aim to derive closed form solutions for optimal borrowing and saving, so we use a mean-variance specification for the utility function.[3] This can be regarded as an approximation to an underlying more general utility function. In this case, with a finite life, the value function is also mean-variance in disposable resources. Hence, if we restrict attention to a two period problem, our asset behaviour will conveniently reflect that same problem for a multi-period horizon.

There are two assets: $S \geq 0$ is the stock of the savings asset, which has a gross return of R_S; and $D \geq 0$ is the stock of debt, which has a gross cost of R_D. The individual has labour income of y_t in periods $t = 1,2$ and starts life with given stocks, S_1 and D_1. So in period 1, disposable resources, w_1, are given by:

$$w_1 = y_1 + R_{S1}S_1 - R_{D1}D_1 \tag{1}$$

[3] With a general utility function, the coefficient of risk aversion will be a function of current and future consumption so that risk preferences will depend on current and future consumption and its determinants.

These resources are used in period 1 for either consumption or net financial asset holding, so that the budget constraint for period 1 is given by:

$$w_1 = c_1 + S_2 - D_2 \tag{2}$$

Since period 2 is the final period, all available resources are then consumed:

$$c_2 = w_2 = y_2 + R_{S2} S_2 - R_{D2} D_2 \tag{3}$$

In period 1, the labour income and the interest rates of period 2 are unknown and have a joint probability distribution. Utility in each period is denoted by:[4]

$$u(c_t) = Ec_t - \frac{b}{2}\text{var}(c_t); \quad t = 1,2 \tag{4}$$

which is discounted at rate, b . Hence, the trade-off between the mean and variance of consumption is given by:

$$-\frac{\partial E[u(c_t)]/\partial E[c_t]}{\partial E[u(c_t)]/\partial\,\text{var}(c_t)} = \frac{2}{b} \tag{5}$$

where $(b/2)$ is the coefficient of risk aversion. The individual's choice problem is as follows:

$$\begin{aligned} &\max_{c_1, S_2, D_2} c_1 + b\left[Ec_2 - \frac{b}{2}\text{var}(c_2)\right] \\ st.\quad & c_2 = y_2 + R_{S2} S_2 - R_{D2} D_2 \\ & w_1 = c_1 + S_2 - D_2 \\ & S_2, D_2 \geq 0 \end{aligned} \tag{6}$$

Since the individual will always consume all initial wealth over his/her lifetime, we can use the first period budget constraint to eliminate c_1, yielding:

[4] First period utility is linear in first period consumption because during the initial period income is certain and consequently has zero variance. If first period utility were quadratic in consumption, then income would enter the expressions for optimal debt and savings. However, the inter-temporal rate of substitution, equation (5), would no longer equal the risk preference parameter itself, rather the risk preference parameter plus expected consumption. For this reason, we have adopted a mean-variance specification.

$$\max_{S_2, D_2} w_1 - S_2 + D_2 + b\left[Ec_2 - \frac{b}{2}\mathrm{var}(c_2)\right]$$
$$st. \quad c_2 = y_2 + R_{S2}S_2 - R_{D2}D_2 \tag{7}$$
$$S_2, D_2 \geq 0$$

Let m_S, m_D and m_y denote the means of second period interest rates and labour income respectively; and let:

$$\begin{bmatrix} s_{SS} & s_{SD} & s_{Sy} \\ s_{SD} & s_{DD} & s_{Dy} \\ s_{Sy} & s_{Dy} & s_{yy} \end{bmatrix} \tag{8}$$

denote the variance-covariance matrix of these variables. Using the definition of c_2 given by equation (3), problem (7) becomes:

$$\max_{S2, D2} w_1 - S_2 + D_2 +$$
$$b\left[m_y + m_S S_2 - m_D D_2 - \frac{b}{2}(s_{yy} + s_{SS}S_2^{\ 2} + s_{DD}D_2^{\ 2} + 2s_{Sy}S_2 - 2s_{Dy}D_2 - 2s_{SD}S_2D_2)\right] \tag{9}$$
$$st. \quad S_2, D_2 \geq 0$$

with interior solution:[5]

$$D_2 = A_{D2} + B_{D2}(2/b) \tag{10}$$

$$S_2 = A_{S2} + B_{S2}(2/b) \tag{11}$$

where:

$$A_{D2} = \frac{\left(s_{SS}s_{Dy} - s_{SD}s_{Sy}\right)}{\left(s_{SS}s_{DD} - s_{SD}^{\ 2}\right)} \tag{12}$$

[5] Without risk aversion or market imperfections (such as credit tied to goods purchase), the only motivation for joint borrowing and savings is to raise income whenever, on average, the savings rate is above the borrowing rate. With risk aversion and uncertain labour income and interest rates, individuals may both borrow and save to diversify their financial portfolio. For example, a young household with rising mean income expectations engages in debt to finance consumption. In this case, if there is positive correlation between interest rates on debt, interest rates on savings and future income, then the more risk averse the household, the more it will attempt to hedge its risks on future debt and income by saving. In other words, while risk on future income is an outside risk, the household can still control its choice of both debt and savings as financial instruments. Hence, borrowing and saving can be observed at the same time, as depicted in the interior solution.

$$B_{D2} = \frac{\left(s_{SS}(1 - bm_D) - s_{SD}(1 - bm_S)\right)}{b\left(s_{SS} s_{DD} - s_{SD}^2\right)} \tag{13}$$

$$A_{S2} = \frac{\left(s_{SD} s_{Dy} - s_{Sy} s_{DD}\right)}{\left(s_{SS} s_{DD} - s_{SD}^2\right)} \tag{14}$$

$$B_{S2} = \frac{\left(- s_{DD}(1 - bm_S) + s_{SD}(1 - bm_D)\right)}{b\left(s_{SS} s_{DD} - s_{SD}^2\right)} \tag{15}$$

Equations (12) to (15) have a common denominator, $s_{SS} s_{DD} - s_{SD}^2$, which equals one minus the correlation coefficient between interest rates, savings and debt, multiplied by the product of the corresponding variances. In equations (13) and (15) in particular, the numerator represents the hedging component. For example, if $\sigma_{SD} = 0$, then equations (13) and (15) reduce to the expected returns on debt and savings, $\left(1 - \beta\mu_D\right)$ and $\left(1 - bm_S\right)$, divided by the deflation for risk and time preference; whereas if $\sigma_{SD} \neq 0$ then hedging between saving and debt occurs. On the other hand, the possible corner solutions of problem (9) are as follows: $\{S_2 = 0, D_2 > 0\}$, $\{S_2 > 0, D_2 = 0\}$ and $\{S_2 = 0, D_2 = 0\}$. We briefly comment on the corner solutions below, beginning with $\{S_2 = 0, D_2 > 0\}$, which occurs when the lifetime marginal expected payoff of savings is negative evaluated at zero savings. In this case, the optimal level of debt is given by:

$$D_2 = \frac{2(1 - bm_D)}{bbs_{DD}} + \frac{s_{Dy}}{s_{DD}} \tag{16}$$

so long as the following inequality is satisfied:

$$b\,(s_{Dy} s_{SD} - s_{DD} s_{Sy}) < \left(\frac{2}{b}\right)\left[s_{DD}(1 - bm_S) - s_{SD}(1 - bm_D)\right] \tag{17}$$

There are two points particularly worthy of note here. Firstly, with mean-variance utility, the variance of future labour income, s_{yy}, acts as a deadweight loss: utility is lower the higher the variance of income, but the impact of the variance cannot be reduced through debt or saving. Hence, for all types of solution (whether interior or corner), s_{yy} does not appear in the debt or savings equations. Secondly, equation (17) is the condition for a corner solution with no saving. It indicates that the first order condition for saving is strictly negative when debt is set at its optimal value given by equation (16). The left-hand side of equation (17) represents the discounted relative covariance of debt rates with savings rates and income; whereas the right-hand side represents the difference in the expected returns on debt and savings, weighted by the corresponding covariances. If this condition restricting the covariances is satisfied, then the marginal return on savings is negative when savings equal zero, and the effect of risk preference on debt depends only on the mean; that is, on the sign of $(1-\beta\mu_D)$, which, in turn, depends on the relative magnitude of expected borrowing rates, m_D, with respect to the time preference parameter, b . For example, if $m_D < 1/b$, then the expected return on debt is negative, $(1-\beta\mu_D)$ is positive, and debt is increasing in $(2/b)$, i.e. decreasing in risk aversion. Also, note the effect of the covariance between debt and income on the optimal size of debt: in equation (16), if $s_{Dy} > 0$, then the consumer will take on more debt, since when the interest rate on debt is high, income will also be high, so the consumer can afford to repay more debt.

In the corner solution with zero debt, the optimal level of savings is given by:

$$S_2 = \frac{2(1-bm_S)}{bbs_{SS}} - \frac{s_{Sy}}{s_{SS}} \tag{18}$$

so long as the following inequality is satisfied:

$$b(s_{Sy}s_{SD} - s_{SS}s_{Dy}) > \left(\frac{2}{b}\right)\left[s_{SS}(1-bm_D) - s_{SD}(1-bm_S)\right] \tag{19}$$

Here the interpretation is analogous to that of the zero savings corner solution: again the effect of risk preference on saving depends on its mean return, once the condition on the covariances determined by equation (19) is satisfied. In this case, the marginal return on debt is negative at zero debt, and a positive covariance between savings interest rates and income will result in lower savings at the optimum.

To summarise, equations (10), (13) and (16) show that the optimally chosen stock of debt is a linear function of the coefficient of risk aversion. In the interior solution case, the sign of equation (13) determines whether debt is increasing in $(2/b)$, i.e. decreasing in risk aversion; in the corner solution cases this role is played by the sign of the expected return on debt. Identical considerations can be made for the optimal savings equations (11), (15) and (18). Inequalities (17) and (19) serve to determine whether a corner solution with zero savings or with zero debt, respectively, is optimal. The analysis of the set of potential solutions – interior and corner – presented above indicates that risk preference, i.e. the parameter b, plays an important role in determining debt and saving at the household level. In the remaining empirical sections of the paper, we focus on the relationship between unsecured debt, saving and risk preference at the household level: firstly, to explore whether our theoretical prediction that debt and saving are influenced by risk preference is supported from an empirical perspective; and, secondly, to determine the nature of these relationships.

III. Data

Measurement of Risk Preference

The obvious problem with exploring the relationship between household finances and risk preference from an empirical perspective lies in locating a suitable measure of risk preference. For this purpose, we exploit data from the U.S. *Panel Study of Income Dynamics* (*PSID*), which is a representative panel of individuals ongoing since 1968 conducted at the Institute for Social Research, University of Michigan.

The *PSID* 1996 Survey includes a Risk Aversion Section which contains detailed information on individuals' attitudes towards risk. The Risk Aversion Section contains five questions related to hypothetical gambles with respect to lifetime income. To be specific, all employed heads of household were asked the following question (M1): *Suppose you had a job that guaranteed you income for life equal to your current total income. And that job was (your/your family's) only source of income. Then you are given the opportunity to take a new, and equally good, job with a 50-50 chance that it will double your income and spending power. But there is a 50-50 chance that it will cut your income and spending power by a third. Would you take the new job?*[6] The individuals who answered 'yes' to this question, were then asked (M2): *Now, suppose the chances were 50-50 that the new job would double your (family) income, and 50-50 that it would cut it in half. Would you still take the job?* Those individuals who answered 'yes' to this question were then asked (M5): *Now, suppose that the chances were 50-50 that the new job would double your (family) income, and 50-50 that it would cut it by 75%. Would you still take the new job?* Individuals who answered 'no' to Question M1 were asked (M3): *Now, suppose the chances were 50-50 that the new job would double your (family) income, and 50-50 that it would cut it by 20 percent. Then would you take the job?* Those individuals who replied 'no' were asked (M4): *Now, suppose that the chances were 50-50 that the new job would double your (family) income, and 50-50 that it would cut it by 10 percent. Then would you take the new job?*

We use the responses to this series of questions to create a six point ordinal risk aversion index for the head of household h, RA_h as follows:

[6] As Luoh and Stafford (2005) point out, it is important to acknowledge that the question states that the new job will be 'equally as good' such that there is no difference in the non monetary characteristics of the jobs. Without such a qualification, individuals may be less willing to accept the gamble if there are non monetary attachments to their current job (Barsky *et al.*, 1997).

$$RA_h = \begin{cases} 0 \;\; if \;\; M1 = Yes \;\&\; M2 = Yes \;\&\; M5 = Yes & 7.32\% \\ 1 \;\; if \;\; M1 = Yes \;\&\; M2 = Yes \;\&\; M5 = No & 12.93\% \\ 2 \;\; if \;\; M1 = Yes \;\&\; M2 = No & 16.00\% \\ 3 \;\; if \;\; M1 = No \;\&\; M3 = Yes & 15.53\% \\ 4 \;\; if \;\; M1 = No \;\&\; M3 = No \;\&\; M4 = Yes & 19.17\% \\ 5 \;\; if \;\; M1 = No \;\&\; M3 = No \;\&\; M4 = No & 29.44\% \end{cases} \tag{20}$$

where the percentages of individuals in each category are shown in parenthesis. The sample, comprising 2,560 observations, relates to heads of household aged over 18 in 1996. Thus, the index is increasing in risk aversion such that if an individual rejects all the hypothetical gambles offered, the risk aversion index takes the highest value of 5, whilst if the individual accepts all gambles offered the risk aversion index takes the value of zero. It is interesting to note the low (high) percentage of respondents with the lowest (highest) value of the risk aversion index. Intermediate cases lie in between these two extreme values such that individuals are ranked according to their reluctance to accept the hypothetical gambles. The series of questions, thus, enables us to place individuals into one of six categories of risk aversion. Furthermore, as stated by Barsky *et al*. (1997), ‘the categories can be ranked by risk aversion without having to assume a particular form for the utility function,’ p. 540.

The series of questions described above accords with the general approach taken in the economics literature, which is based on classifying individuals in terms of their attitudes towards risk according to their marginal utility of income, with the relatively more risk averse individuals characterised by marginal utility of income diminishing at a relatively fast rate. As stated by Dave and Saffer (2008), who explore the relationship between alcohol demand and risk preference, this measure of attitudes towards risk has been subject to extensive testing in order to ‘minimize misunderstandings and additional complications in interpretation and to ensure consistency with the economist’s concept of risk preference,’ p. 812. In particular, Barsky *et al*. (1997) find that this risk attitudes measure predicts risky behaviour such as smoking, drinking alcohol, not having insurance, choosing risky employment and holding risky financial assets.

It should be acknowledged however that there are potential problems in measuring risk attitudes from categorical survey responses. Recently, Kimball et al. (2009) highlight a number of issues related to the *PSID* risk attitudes measure. In particular, they argue that the gambling responses are characterized by considerable measurement error due to unobserved heterogeneity in preferences. Furthermore, additional details in the description of the gambles can influence the measurement of risk preference. Moreover, there is the possibility that the job-related gamble may be interpreted differently by individuals at different stages of their career. Kimball et al. (2009) address measurement error issues by assuming that individuals have constant relative risk aversion utility, so given the gambles presented, individuals will accept the risky job when their expected utility is greater than the expected utility of their current/safe job. This assumption, together with the series of hypothetical gamble questions presented, enable the authors to assign a range of risk aversion coefficients to each gamble response category. The authors argue that the imputations offer advantages over the categorical sequence of gamble responses in that the responses can be formulated into a single cardinal measure of risk tolerance.[7] In the following empirical analysis, in order to explore the robustness of our findings, we explore the effect of both the ordinal measure of risk aversion denoted by equation (20) and the imputed cardinal measure of risk tolerance constructed by Kimball et al. (2009) denoted by RT_h.

[7] Details of the estimation and imputation procedure are discussed in Kimball et al. (2009). However, as Barsky et al. (1997) note, the downside with such an approach is that a particular form of utility function needs to be imposed in order to convert the ordinal index into a cardinal measure of risk attitudes.

The Measurement of Unsecured Debt and Assets

Detailed information pertaining to unsecured debt is available in the *PSID* for 1984, 1989, 1994, 1999, 2001 and 2003, although the Risk Aversion Section is only available in the 1996 *PSID*. In each of these years, the head of household is asked the following question: *Aside from the debts that we have already talked about, like any mortgage on your main home or vehicle loans, do you (or anyone in your family) currently have any other debts such as for credit card charges, student loans, medical or legal bills, or on loans from relatives? If you added up all of these debts (for all of your family), about how much would they amount to right now?* Thus, the responses to this question yield information pertaining to the level of unsecured debt at the household level at time *t*, which is denoted by d_{ht}. Our sample is restricted to all heads of household aged 18 or over. We analyse an unbalanced panel of data drawn from the 1984, 1989, 1994, 1999, 2001 and 2003 waves with risk attitudes, which are only measured at 1996, being time invariant in the panel. The panel data set comprises 14,329 observations where 87% of individuals are in the sample for the entire period.[8]

With respect to financial assets, for the *PSID*, the head of family is asked to specify the amount of shares of stock in publicly held corporations, mutual funds, investment trusts, money in current (i.e. checking) or savings accounts, money market funds, certificates of deposit, and government savings bonds or treasury bills. The sum of these values is then used to obtain a measure at the household level at time *t* of financial assets, which is denoted by s_{ht}.[9]

[8] The minimum (maximum) number of times an individual is in the *PSID* is 3 (6) times. The hypothesis that the mean of the risk aversion index does not differ by the number of times the individual is in the sample cannot be rejected at the 1 per cent level. In addition, our results are robust to analysing a balanced panel. The standard errors associated with risk aversion have been adjusted for aggregation bias following Moulton (1990).

[9] It should be noted that whilst our theoretical illustration focuses upon savings, our empirical analysis is more general and encompasses relatively liquid financial assets.

IV. Attitudes towards Risk and Debt and Asset Holding

Methodology

We initially explore the relationship between attitudes towards risk and the nature of the financial portfolio at the household level. To be specific, we categorise households depending on whether: $\{S_2 > 0, D_2 > 0\}$, $\{S_2 = 0, D_2 > 0\}$, $\{S_2 > 0, D_2 = 0\}$ or $\{S_2 = 0, D_2 = 0\}$. We define C_{ht} as follows:

$$C_{ht} = j = \begin{cases} 0 & if \quad s_{ht} > 0;\ d_{ht} > 0 \\ 1 & if \quad s_{ht} = 0;\ d_{ht} > 0 \\ 2 & if \quad s_{ht} > 0;\ d_{ht} = 0 \\ 3 & if \quad s_{ht} = 0;\ d_{ht} = 0 \end{cases} \tag{21}$$

where the associated percentages are 46.56%, 8.78%, 30.45% and 14.21%, respectively. The choice of financial portfolio that the household makes can be motivated by a random utility (U) model where there are J choices:

$$U_{htj} = g\,'\boldsymbol{X}_{htj} + q\,'\bar{\boldsymbol{X}}_{hj} + y\ RA_{htj} + e_{htj} \tag{22}$$

and the error term follows a logistic distributional form. The household makes choice j if $\text{prob}\left(U_{htj} > U_{htk}\right)$, $\forall\ \ j \neq k$. In the context of the household financial portfolio, C_{ht} is a random variable denoting the portfolio choice made. The multinomial logit choice model is then given by:

$$\text{prob}\left(C_{ht} = j\right) = \exp^{\left(g_j\,'\boldsymbol{X}_{ht} + q_j\,'\bar{\boldsymbol{X}}_h + y_j RA_{ht}\right)} \Big/ \sum_{k=0}^{3} \exp^{\left(g_k\,'\boldsymbol{X}_{ht} + q_k\,'\bar{\boldsymbol{X}}_h + y_k RA_{ht}\right)} \tag{23}$$

We focus on the influence of attitudes towards risk on the probability of being in each of the four solutions (one interior and three corner solutions) analysed within our theoretical framework. In our set of additional explanatory variables, $\boldsymbol{X}_{ht}$, we include controls for a number of influences, which may affect the level of unsecured debt or assets at the household level. Such controls include the following head of household characteristics: a quadratic in age; gender; ethnicity; marital status; whether the head of household is currently employed; whether the head of household's spouse is employed; whether the head of household owns a business; years of schooling; and whether the head of household has reported good health in the past 12 months. Household controls include: household size; household income (earned and other non labour income); and housing tenure. Table 1 presents summary statistics for the variables used in the empirical analysis.[10]

Due to the panel nature of the data, in order to control for household time invariant effects, i.e. household heterogeneity, we include a vector of additional covariates, $\bar{\boldsymbol{X}}_h$, the household level means over time of those of the $\boldsymbol{X}_{ht}$ that are time variant, within the multinomial logit model. An associated vector of parameters is denoted by q. Following Mundlak (1978) and Martin and Smith (2003), this enables the estimator of g and y to be considered as an approximation to a standard panel fixed effects estimator with dummy variables for households rather than these means.

Results

The results of estimating equation (23) are summarised in Table 2, where for brevity only the estimate of the influence of risk preference is shown, i.e. $\hat{y}$. The first column reports the marginal effects associated with the ordinal measure of risk preference, i.e. risk aversion, whilst in the second column marginal effects are reported for the cardinal measure of risk tolerance. A one standard deviation increase in the ordinal risk aversion index (cardinal risk tolerance) is associated with a 2.4 (7.4) percentage point lower probability of having both positive levels of debt and financial assets, i.e. the interior solution represented by equations (10) and (11). Conversely, a one standard deviation increase in the ordinal risk aversion index (cardinal risk tolerance) is associated with a

[10] All monetary variables have been deflated with 2004 as the base year.

0.71 (1.5) percentage point higher probability of having no debt and no financial assets. Interestingly, in accordance with precautionary saving motives, risk aversion (risk tolerance) is positively (inversely) associated with being in the corner solution characterised by $\{S_2 > 0, D_2 = 0\}$, whilst risk preference as measured by the ordinal or cardinal approach is not found to influence the probability of being in the $\{S_2 = 0, D_2 > 0\}$ corner solution.

V. Attitudes towards Risk and Debt and Asset Accumulation

Methodology

In this section, we explore the influence of attitudes towards risk on the level of debt and financial asset accumulation at the household level. In order to explore the determinants of the level assets and debt at the household level, we treat s_{ht} and d_{ht} as censored variables in our econometric analysis since they cannot have negative values. Following Bertaut and Starr-McCluer (2002), we employ a censored regression approach to ascertain the determinants of $\ln(s_{ht})$ and $\ln(d_{ht})$, which allows for the truncation of the dependent variables. Since the distribution of debt is highly skewed, we specify logarithmic dependent variables following Gropp *et al.* (1997). For households reporting zero debt or assets, $\ln(d_{ht})$ and $\ln(s_{ht})$ are recoded to zero, as there are no reported debt or assets between zero and unity in the *PSID*. Over time, the data reveals that around 45% of households do not have any unsecured debt. In Figure 1A, the distribution of log debt for those heads of household with positive amounts of debt, i.e. $\ln(d_{ht}) > 0$, is shown, with the median level of debt being $4,000. Similarly, Figure 1B shows the distribution of log financial assets for those heads of household with positive amounts of assets, i.e. $\ln(s_{ht}) > 0$, with the median level of assets being $5,000. We denote by $\ln(s_{ht}^*)$ and $\ln(d_{ht}^*)$ the corresponding untruncated latent variables, which theoretically can have negative values. We initially model $\ln\left(s_{ht}\right)$ and $\ln\left(d_{ht}\right)$ independently via a pooled univariate tobit specification for each dependent variable as follows:

$$\ln\left(d_{ht}^{*}\right)=\boldsymbol{\beta}_1'\boldsymbol{X}_{ht}+q_1'\overline{\boldsymbol{X}}_h+p_1\ln\left(s_{ht}\right)+y_1 RA_{ht}+e_{1ht} \tag{24}$$

$$\ln\left(d_{ht}\right)=\ln\left(d_{ht}^{*}\right) \qquad if \quad d_{ht}^{*}>0 \tag{25}$$

$$\ln\left(d_{ht}\right)=0 \qquad otherwise \tag{26}$$

$$\ln\left(s_{ht}^{*}\right)=\boldsymbol{\beta}_2'\boldsymbol{X}_{ht}+q_2'\overline{\boldsymbol{X}}_h+p_2\ln\left(d_{ht}\right)+y_2 RA_{ht}+e_{2ht} \tag{27}$$

$$\ln\left(s_{ht}\right)=\ln\left(s_{ht}^{*}\right) \qquad if \quad s_{ht}^{*}>0 \tag{28}$$

$$\ln\left(s_{ht}\right)=0 \qquad otherwise \tag{29}$$

where the level of debt (financial assets) of household *h* over time *t* is given by d_{ht} (s_{ht}) such that h=1,…,n_h and $\boldsymbol{X}_{ht}$ denotes a vector of head of household and household characteristics, as defined above. In modelling both debt and financial assets, the univariate tobit models incorporate Mundlak fixed effects, $\overline{\boldsymbol{X}}_h$, allowing the parameter estimates to approximate fixed effects. Finally, e_{jht} denotes the stochastic disturbance term, $e_{jht}\sim N\left(0,s_{ht}^{2}\right)$, where j=1,2. Thus, the estimated coefficient y_1 (y_2) serves to inform us about the relationship between the level of unsecured debt (financial assets) and attitudes towards risk at the household level.

The models allow financial assets to influence the level of unsecured debt via p_1 in equation (24) and unsecured debt to influence the level of financial assets via p_2 in equation (27). However, as highlighted in the theoretical analysis presented in Section II, debt and financial assets represent two components of the household’s financial portfolio. Hence, arguably we should model financial liabilities and assets simultaneously, see Brown and Taylor (2008). Consequently, we also model unsecured debt and financial assets simultaneously as a recursive bivariate tobit model as follows:

$$\begin{aligned}\ln\left(d_{ht}^{*}\right) &= \boldsymbol{\beta}_1'\boldsymbol{X}_{ht} + q_1'\bar{\boldsymbol{X}}_h + p_1\ln\left(s_{ht}\right) + y_1 RA_{ht} + l\, bk_{ht} + n_{1ht} \\ \ln\left(s_{ht}^{*}\right) &= \boldsymbol{\beta}_2'\boldsymbol{X}_{ht} + q_2'\bar{\boldsymbol{X}}_h + p_2\ln\left(d_{ht}\right) + y_2 RA_{ht} + n_{2ht}\end{aligned} \quad (30)$$

where $n_{1ht}, n_{2ht} \sim N\left(0, 0, s_{1ht}^{2}, s_{2ht}^{2}, r\right)$ and the covariance between the error terms is given by $s_{1ht,2ht} = r s_{1ht} s_{2ht}$. In the bivariate tobit model, the disturbance terms, n_{1ht} and n_{2ht}, are jointly normally distributed with variances s_{1ht} and s_{2ht}. If the correlation term, r, is zero, then assets and debt are independent. If $r \neq 0$, then this implies a degree of inter-dependence between d_{ht} and s_{ht}. The bivariate approach is particularly interesting in that it encompasses all of the four solutions analysed in the theoretical section, i.e. the three corner solutions and the interior solution. As in the univariate tobit model, bi-directional causality is allowed between unsecured debt and financial assets where identification is achieved via the recursive nature of the model in equation (30) and the inclusion of a binary indicator in the debt equation, bk, which indicates whether the head of household has ever been bankrupt.

Results

The results from the univariate tobit analysis with Mundlak fixed effects, i.e. equations (24) to (29), investigating the determinants of unsecured debt and financial assets are shown in Table 3 Panel A. It is apparent that the ordinal measure of risk preference, RA, is negatively related to debt and positively related to financial assets, which is consistent with the theoretical prediction that debt and financial assets are functions of risk preference. To evaluate the percentage impact of a one standard deviation increase in risk aversion upon the level of debt, we derive the marginal effect of the risk aversion index from the estimated coefficients. This is calculated by multiplying the estimated coefficient through by the scaling factor given by: $\Phi\left(\left\{\boldsymbol{\beta}_j'\boldsymbol{X}_{ht}+q_j'\bar{\boldsymbol{X}}_h+p_j\ln\left(s_{ht}\right)+l\,bk_{ht}+y_j RA_{ht}\right\}/s_j\right)y_j$, where Φ denotes the cumulative distribution of the standard normal and s is the standard error of the regression. An approximation to the scaling factor, $\Phi\left(\left\{\boldsymbol{\beta}_j'\boldsymbol{X}_{ht}+q_j'\bar{\boldsymbol{X}}_h+p_j\ln\left(s_{ht}\right)+l\,bk_{ht}+y_j RA_{ht}\right\}/s_j\right)$, is the proportion of uncensored observations. The standard deviation of RA_{ht} is 1.64 and the proportion of uncensored observations is 0.5534. Hence, a one standard deviation increase in the risk aversion index reduces unsecured debt by approximately 19.1 percentage points. Thus, the effect of risk aversion upon the level of debt appears to be relatively large. Whilst a one standard deviation increase in the ordinal risk aversion index reduces financial assets by around 3 percentage points, a relatively moderate effect in comparison.

Turning briefly to the other explanatory variables, both unsecured debt and financial assets are increasing in the age of the head of household, albeit at a decreasing rate, and total household labour income. Conversely, having a head of household who is non-white is inversely associated with the level of both unsecured debt and assets. Unsecured debt is positively associated with the head of household having an employed spouse and the years of schooling of the head of household. Having a male head of household and a head of household in good health are both inversely associated with the level of debt. These results generally tie in with the findings in the existing literature, see, for example, Brown and Taylor (2008), Crook (2001) and Gropp *et al.* (1997). Interestingly, there is no role for head of household's gender or years of schooling in influencing the level of financial assets. The analysis also allows for financial assets (unsecured debt) to influence the level of unsecured debt (financial assets), where clearly the univariate tobit results suggest a positive association between the two. The results are robust to employing the alternative cardinal measure of risk preference, shown in Panel B, where the positive association remains between unsecured debt and financial assets and risk tolerance has a positive and statistically significant influence.

Arguably, since unsecured debt and financial assets are two components of the household's financial portfolio, the decision to acquire either may be interdependent. The results of estimating the recursive bivariate tobit with Mundlak fixed effects are shown in Table 4 Panel A for the ordinal risk preference measure and Panel B for the cardinal risk preference measure. Clearly, throughout each panel, the r parameter is statistically significant suggesting that inter-dependence exists between assets and debt, a finding in accordance with Brown and Taylor (2008). The first column in Table 4 presents the results of modelling unsecured debt whilst the second column focuses upon financial assets. It is evident from Panel A (B) that the relationship between risk aversion (risk tolerance) and unsecured debt is robust to the simultaneous modelling approach where the two are found to be inversely related. In contrast, risk preference now has a statistically insignificant impact upon financial assets, which highlights the importance of adopting an appropriate modelling strategy, which allows for the inter-dependent nature of the decision-making processes.

V. Conclusions

In this paper, we have contributed to the growing literature on debt and asset accumulation at the household level focusing in particular on the role of risk preference in the decision to acquire debt and accumulate financial assets. Given the uncertainty surrounding the decision to acquire debt as well as the influence of precautionary saving motives, it is surprising that inter-personal differences in risk preferences have not attracted much attention in the empirical literature on household debt and saving. Our theoretical analysis suggests that the optimal levels of debt and saving are functions of risk preference. Our empirical analysis has explored our theoretical priors by investigating the relationship between risk preference and debt and asset accumulation using U.S. household level data drawn from the *PSID*. Our empirical findings suggest that risk aversion is inversely associated with the amount of unsecured debt accumulated at the household level, but inconclusive in the context of asset accumulation, which may reflect the heterogeneous nature of such assets.

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TABLE 1: SUMMARY STATISTICS

	PSID	
	MEAN	STD DEV
Log Debt $\ln\left(d_{ht}\right)$	4.5347	*4.22*
Log Assets $\ln\left(a_{ht}\right)$	6.4876	*3.97*
Ordinal Risk Aversion Index RA_{ht} (0-5)	3.1423	*1.64*
Cardinal Risk Tolerance RT_{ht}	0.1500	*0.57*
Variables in X_{ht}		
Age	40	*11.38*
Age squared	1709	*925.65*
Male (0-1)	0.7550	*0.43*
Non white (0-1)	0.3032	*0.46*
Married (0-1)	0.6354	*0.48*
Employed (0-1)	0.8330	*0.37*
Spouse employed (0-1)	0.4915	*0.50*
Owns a business (0-1)	0.1399	*0.35*
Years of schooling (8-17)	13.2253	*2.37*
Good health (0-1)	0.8985	*0.30*
Household size (1+)	2.4426	*1.45*
Log household labour income	9.7704	*2.66*
Log household other income (i.e. non labour)	2.0611	*3.19*
Rented home (0-1)	0.2852	*0.45*
Home ownership (with a mortgage) (0-1)	0.5461	*0.50*
Home ownership (without a mortgage) (0-1)	0.1521	*0.36*
Previously bankrupt (0-1)	0.0893	*0.29*
OBSERVATIONS	14,392	

TABLE 2: Multinomial Logit Analysis with Mundlak Fixed Effects

	ORDINAL RISK AVERSION (*RA*)		CARDINAL RISK TOLERANCE (*RT*)	
	M.E.	TSTAT	M.E.	TSTAT
$s > 0; d > 0$	-0.0147	*(5.28)*	0.1290	*(4.59)*
$s = 0; d > 0$	0.0001	*(0.45)*	-0.0084	*(0.56)*
$s > 0; d = 0$	0.0097	*(3.72)*	-0.0947	*(3.57)*
$s = 0; d = 0$	0.0043	*(2.90)*	-0.0259	*(2.69)*
Chi2 (93)	3,784.38, *p=[0.000]*		3,775.55, *p=[0.000]*	
OBSERVATIONS	14,329			

Notes: (i) M.E. denotes the marginal effects; (ii) TSTAT denotes t statistics; (iii) control variables are – a quadratic in age; gender; ethnicity; marital status; employee; self employed; years of schooling; whether in good health; household size; log labour income; log unearned income; housing tenure.

TABLE 3: Univariate Tobit Models with Mundlak Fixed Effects

	LOG DEBT $\ln(d_{ht})$		**LOG ASSETS** $\ln(s_{ht})$	
PANEL A: RISK AVERSION (RA) – ORDINAL	COEF	TSTAT	COEF	TSTAT
Head of household characteristics				
Age	0.1788	*(2.42)*	0.1650	*(3.88)*
Age squared	-0.0025	*(4.22)*	-0.0004	*(1.02)*
Male	-1.1288	*(5.63)*	0.0693	*(0.56)*
Non white	-0.7981	*(4.98)*	-2.1289	*(2.09)*
Married	0.2768	*(1.04)*	0.7554	*(4.75)*
Employed	-0.0515	*(0.22)*	0.2896	*(2.08)*
Spouse employed	0.4352	*(2.07)*	-0.0928	*(0.79)*
Owns a business	-0.1461	*(0.56)*	0.4838	*(3.43)*
Years of schooling	0.2847	*(4.13)*	-0.0386	*(0.95)*
Good health	-0.2987	*(1.10)*	0.1706	*(0.97)*
Household characteristics				
Household size	-0.0806	*(1.21)*	-0.0265	*(0.65)*
Log household labour income	0.1079	*(2.99)*	0.1290	*(5.62)*
Log household other income	0.0172	*(0.66)*	-0.0109	*(0.67)*
Rented home	0.2728	*(0.82)*	-0.1595	*(0.81)*
Home ownership (with a mortgage)	0.4412	*(1.45)*	0.2561	*(1.47)*
Home ownership (without a mortgage)	-0.2648	*(0.82)*	0.3216	*(1.74)*
Log debt $\ln(d_{ht})$	–		0.0695	*(7.87)*
Log financial assets $\ln(s_{ht})$	0.1122	*(5.63)*	–	
Risk preference measure				
Risk Aversion (RA) – Ordinal	-0.2105	*(5.49)*	-0.0239	*(1.05)*
F(37, 14292)	28.56 *p=[0.000]*		144.43 *p=[0.000]*	
Left censored	6,399		3,294	
Observations	14,329			
PANEL B: RISK TOLERANCE (RT) – CARDINAL	COEF	TSTAT	COEF	TSTAT
Log debt $\ln(d_{ht})$	–		0.0699	*(7.91)*
Log financial assets $\ln(s_{ht})$	0.1132	*(5.68)*	–	
Risk preference measure				
Risk Tolerance (RT) – Cardinal	1.7586	*(4.59)*	0.0464	*(0.21)*
F(37, 14329)	28.26 *p=[0.000]*		144.50 *p=[0.000]*	
Left Censored	6,399		3,294	
Observations	14,329			

Notes: (i) year controls are included throughout; (ii) control variables in panel B are as in panel A.

TABLE 4: Recursive Tobit Models with Mundlak Fixed Effects

	LOG DEBT $\ln(d_{ht})$		**LOG ASSETS** $\ln(s_{ht})$	
PANEL A: RISK AVERSION (RA) – ORDINAL	COEF	TSTAT	COEF	TSTAT
Head of household characteristics				
Age	0.0290	*(2.58)*	0.1298	*(6.89)*
Age squared	-0.0004	*(2.43)*	-0.0004	*(2.64)*
Male	-0.0039	*(0.08)*	0.0740	*(1.35)*
Non white	-0.0773	*(2.00)*	-0.3242	*(7.46)*
Married	0.3141	*(4.81)*	0.6264	*(8.74)*
Employed	0.0120	*(0.21)*	0.0659	*(1.05)*
Spouse employed	0.1072	*(2.09)*	-0.0565	*(1.03)*
Owns a business	0.0795	*(1.25)*	0.3322	*(5.07)*
Years of schooling	0.0053	*(0.32)*	-0.0844	*(4.66)*
Good health	-0.0677	*(1.03)*	0.1094	*(1.42)*
Household characteristics				
Household size	0.0028	*(0.17)*	0.0076	*(0.40)*
Log household labour income	0.0095	*(2.07)*	0.0351	*(3.76)*
Log household other income	-0.0036	*(0.55)*	-0.0157	*(2.12)*
Rented home	0.0425	*(0.52)*	-0.2925	*(3.23)*
Home ownership (with a mortgage)	-0.0301	*(0.40)*	-0.0965	*(1.20)*
Home ownership (without a mortgage)	-0.0165	*(0.21)*	0.0920	*(1.09)*
Log debt $\ln(d_{ht})$	–		-0.0651	*(5.54)*
Log financial assets $\ln(s_{ht})$	-0.0253	*(4.33)*	–	
Previously bankrupt	0.4003	*(2.91)*	–	
Risk preference measure				
Risk Aversion (RA) – Ordinal	-0.0299	*(3.15)*	0.0035	*(0.34)*
Left censored	6,399		3,294	
Observations	14,329			
Wald Chi2 (39)	1,633.58 *p=[0.000]*			
r	0.1114 *p=[0.000]*			
PANEL B: RISK TOLERANCE (RT) – CARDINAL	COEF	TSTAT	COEF	TSTAT
Log debt $\ln(d_{ht})$	–		-0.0651	*(5.53)*
Log financial assets $\ln(s_{ht})$	-0.0253	*(4.31)*	–	
Previously bankrupt	0.4058	*(2.94)*	–	
Risk preference measure				
Risk Tolerance (RT) – Cardinal	0.2479	*(2.61)*	-0.0809	*(0.78)*
Left Censored	6,399		3,294	
Observations	14,329			
Wald Chi2 (39)	1,629.81 *p=[0.000]*			
r	0.1117 *p=[0.000]*			

Notes: (i) year controls are included throughout; (ii) control variables in panel B are as in panel A.

Figure 1A: Distribution of Log Debt – $\ln\left(d_{ht}\right) > 0$

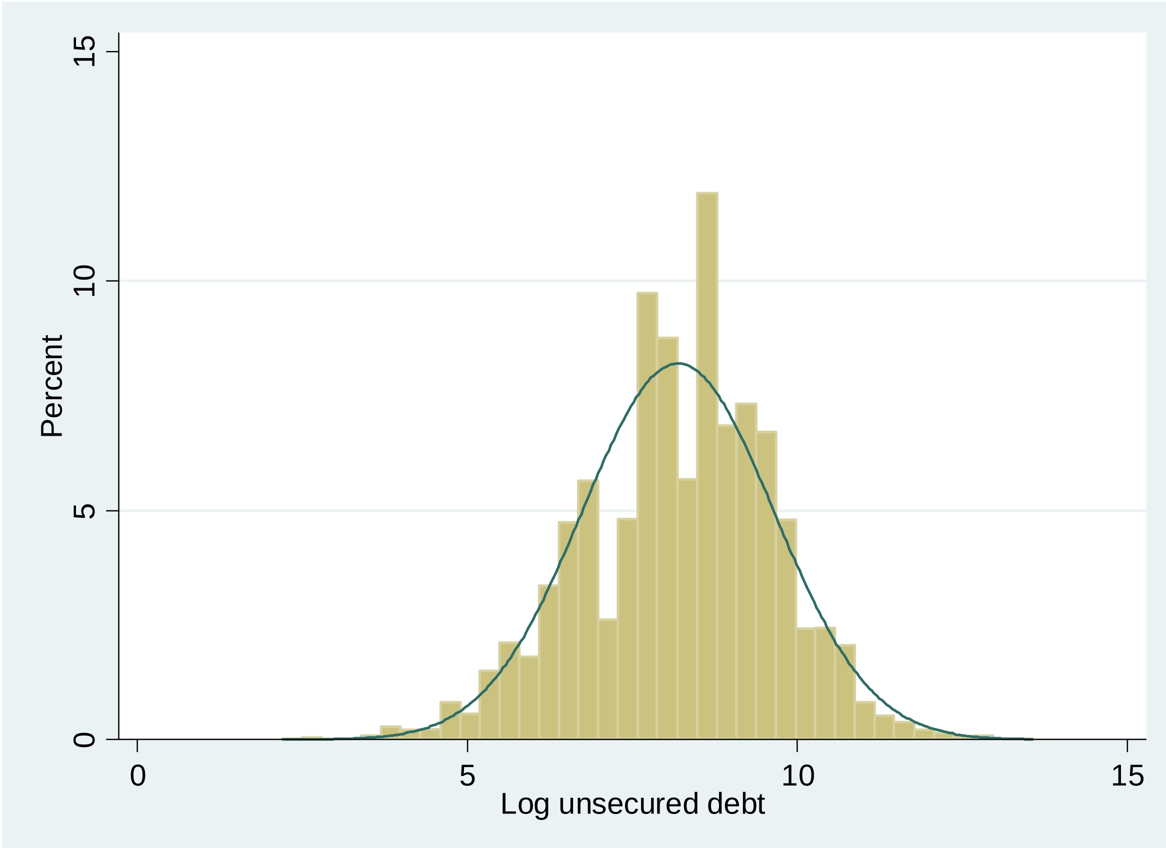

Figure 1B: Distribution of Log Financial Assets – $\ln\left(s_{ht}\right) > 0$