School of Economics

Working Paper 2005-17

Pension Contribution as a Commitment Device: Evidence of Sophistication among Time-inconsistent Households.

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ISSN 1444 8866

PENSION CONTRIBUTIONS AS A COMMITMENT DEVICE: EVIDENCE OF SOPHISTICATION AMONG TIME-INCONSISTENT HOUSEHOLDS

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OCTOBER 2005

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Sophisticated agents with self-control problems value commitment devices that constrain future choices. Using Australian household data I test whether these households value commitment devices in the form of illiquid pension contributions. Applying various probabilistic choice models, the results confirm the conjecture that households with problems of self-control are more likely to invest in illiquid pensions while less likely to hold very liquid forms of assets.

I. INTRODUCTION

Sophisticated agents with self control problems value commitment devices that constrain future choices. While most economists would probably agree with this statement, empirical evidence is thin on the ground. Using theory and evidence drawn from the literature in psychology and behavioral economics to motivate the analysis, this paper presents empirical evidence to support the contention that households with problems of self-control value commitment devices. The underlying premise is that consumers with problems of self-control are not naïve and to some extent recognize the desirability of tying their hands in the future; the degree to which they succeed in doing so depends upon their level of sophistication[1]. For example, individuals may simultaneously exhibit impatient behaviour with respect to, say, accumulating credit-card debt and patient behaviour with respect to contributing to retirement accounts through pension funds.

The focus of this paper is on the relationship between self-control problems and purchase of an illiquid asset that has the feature of a commitment device. First, a measure of impatience is constructed to capture self-control problems, and the simple relationships between this measure and various demographic and household characteristics are presented. Second, the relationship between this measure and various asset classes, including pension contributions, is investigated using appropriate statistical techniques. A fundamental result from the experimental psychology literature is that not only do individuals behave impatiently but they also behave in a time inconsistent manner and can be said to exhibit a 'reversal of preferences'. Much of the behavioral economics literature has focused on the extreme assumptions of 'sophistication' or 'naïveté'. In the present context, the sophistication assumption has testable implications because sophisticated individuals appreciate the existence of commitment devices that they use to commit to a course of action today such that this commitment precludes future incarnations of their selves from behaving in a time inconsistent manner. Conversely, the naïveté assumption does not immediately lead to such testable hypotheses because these individuals are observationally equivalent to those who could merely have a high (constant) rate of time preference. The hypothesis to be tested, therefore, is that a commitment device is more likely to be adopted by sophisticated hyperbolic households and that, the

[1] Sophistication in this context refers to individuals who are aware of their self-control problems. In the literature on hyperbolic preferences, sophisticated agents are those who are aware that they will behave in a time-inconsistent manner in the future.

greater the problems of self control, the more likely are households to contribute to an illiquid asset.

I test the hypothesis using data from the 1998-99 wave of the Australian Bureau of Statistics (ABS) Household Expenditure Survey (HES). The Australian experience is valuable in this context because restrictions on early withdrawal of voluntary pension contributions, which became almost total in 1999, make this a highly illiquid form of saving. Illiquid saving, in the form of voluntary contributions to superannuation is found to be partially correlated with a measure of impatience constructed using proxies for impatient behaviour such as smoking, drinking, gambling, and whether a household has credit card debt, after controlling for household demographic characteristics, life-cycle considerations and other control variables. Individuals knowing themselves to have problems of self-control tie their hands by saving in illiquid assets, but the degree to which they succeed in doing this depends upon their education, wealth and other household characteristics.

This paper proceeds as follows. In Section 2, I review some of the literature on time preference and the notion of sophistication and pre-commitment. Section 3 briefly outlines the institutional background of Superannuation in Australia. Section 4 describes the empirical methodology and in Section 5 the empirical results are presented. Section 6 concludes.

II. THEORETICAL AND EMPIRICAL BACKGROUND

Both the concepts of impatience and sophistication are central to the empirical analysis in this paper. In this section, some of the literature on time preference, from both the psychology and economics perspectives, is reviewed to motivate the techniques used in identifying a proxy of impatience and self-control. In the second sub-section, I present some theoretical and empirical evidence on the concept of sophistication and its role in individual/household planning and behavior.

II.1. Time preference and impatience.

Fundamental to the study of intertemporal choice is the extent to which agents care less about the future. While it is difficult to extract information on individuals' or households' rate of time preference from expenditure survey data, it is nonetheless important to account for differences in time preference and self-control across households. Any analysis involving the examination of individuals' choice behavior over time, necessarily involves a treatment of discount rate heterogeneity. The importance of identifying impatience is relevant for economics from the view that

certain behaviors involve trade-offs between current costs and future benefits. Costs in this context may not merely be monetary but psychological, while expected benefits may include better health status and a reduction in the probability of mortality as in the case of smoking and drinking

In economics, the standard approach to discounting has been modeled with an exponential discount function that assumes a constant discount rate between each adjacent period. The assumption of a constant rate of time preference necessarily implies behavior that is time-consistent. In the last decade, however, beginning with Laibson [1997], economists have been increasingly concerned with more realistic assumptions about individuals' intertemporal behavior. The idea that agents behave in a time-inconsistent manner has been successfully incorporated into intertemporal optimization settings which has led to different predictions to the standard models. A widely used discount function (beginning with Phelps and Pollack [1968] and more recently Laibson [1997]) that captures time inconsistency is quasi-hyperbolic. For example, when time is discrete the intertemporal utility function is:

$$U_t(c_0, c_1, \mathrm{K}, c_T) = u(c_t) + \beta \sum_{i=1}^{T} \delta^i u(c_{t+i}), \tag{1}$$

in which the per period functions are $(1, \beta\delta, \beta\delta^2, \beta\delta^3, ...)$. This nests the standard time-consistent case when β =1.

While earlier economics papers have identified time-inconsistent behavior [Strotz, 1956; Phelps and Pollack, 1968], it is the psychology profession that has done the most for advancing our knowledge of time-inconsistent behavior at the individual level. The identification of time preference rates and impatience (impulsivity) has been investigated extensively in the psychology literature with many studies, mostly clinical experiments, finding that discount functions for delay discounting are hyperbolic, rather than exponential.[2] In general, preferences over a delayed reward have been found to be characterized by a hyperbolic discount function, where the present value of a reward "increase(s) by an increasingly larger proportion per unit time as the reward approaches" [Kirby, 1997]. This type of discount function best characterizes time-inconsistent and present-biased behavior.

Most studies in the experimental psychology literature have been primarily concerned with hypothetical monetary payoffs and higher discount rates have been found to be correlated with behavior such as smoking, drinking and gambling [Vuchinich and Simpson, 1998; Bickel et al, 1999; Mitchell, 1999; Petry, 2001; Petry

[2] See Ainslie [1992, 2001], Thaler [1981] and Kirby [1997] for reviews.

and Casarella, 1999].[3] Several studies also indicate that individuals with dual addictive disorders have extremely high discounting rates and that a hyperbolic discount function best characterises their temporal discounting[4]. I rely on these results as evidence that gambling is associated with impatience and that gambling, together with smoking and drinking, provides a reasonable indicator of self-control problems. Since many of these behaviors are also associated with risk tolerance, the implication is that impatience and risk tolerance are in fact related. This view is consistent with the literature on personality theory which equates impulsivity with preferences for such things as immediate gratification, *risky activities*, drug usage, and novel sensations, among others [Mitchell, 1999].

On the other hand, the economics literature on the measurement of time preference has primarily started from the *time-consistency* assumption and, as such, attempts have been made to quantify the *constant* rate of time preference [for example, Fuchs, 1982; Lawrance, 1991; Barsky et al, 1997]. The results from these studies suggested that education and income were negatively related to time preference while smoking and credit card debt on which interest was paid were positively related to time preference.[5]

II.2. Sophistication and Precommitment

Of most relevance to this study is the finding that humans, while exhibiting preferences that are characterised by present-bias, are also observed to be engaging in long-term planning behavior that would imply a non-myopic perspective [Monterosso and Ainslie, 1999]. This feature is consistent with aspects of self-control and, in the present framework, sophistication. The implication is that, while agents have hyperbolic discount functions, they are also capable of recognising their weaknesses for immediate gratification and make efforts to offset or thwart them by making use of precommitment devices, such as long-term saving products, even though they may, in certain cases, have lower rates of return than other investment instruments.

In Strotz's [1956] famous paper, consumer behavior under the assumption of sophistication is investigated and contrasted to that of naïveté. In particular, he proposes that individuals are born with time-inconsistent preferences and that,

[3] While it appears clear that problem gamblers discount more heavily than non-problem gamblers, it is not so clear whether *some* gambling is indicative of high discounting.

[4] There is some evidence that there is not a single impulsiveness trait that links an inability to delay gratification with a tendency to gamble and take risks. This result is confirmed in studies that investigate separately the discounting of delayed rewards and probabilistic rewards [Myerson et al, 2003; Holt et al, 2003]. However, Green et al [1999] suggest that although the processes that underlie the types of discounting are not identical, they are "fundamentally similar".

[5] The relationship between time preference and credit card debt in Fuchs [1982] was positive but not statistically significant.

through avenues such as parental training and social pressure, these 'thrifty' individuals can either replace their innate, time-inconsistent preferences with time-consistent ones (in which case there is no need for precommitment) or, being aware of their time-inconsistency, value the strategy of precommitment. The second group – the 'spendthrifts' – consists of those that through, for example, lack of education or training, behave purely in a time-inconsistent manner. This group will not make use of commitment devices.

More recent literature on life-cycle consumption models attempts to incorporate realistic time preference structures gleaned from the psychology literature outlined above and explicitly allows for time-inconsistent preferences. Laibson et al [2000], using the Panel Survey of Income Dynamics and the Survey of Consumer Finances, identify some stylized facts about individuals in the United States, including that consumers hold high levels of illiquid wealth while *simultaneously* holding high levels of credit card debt; such consumers behave patiently while accumulating illiquid wealth but impatiently with respect to credit card debt. In a simulated life-cycle model, they find that time-inconsistent preferences can better explain the observed financial data than can the usual exponential discounting models. This behavior, they find, is consistent with a sophisticated hyperbolic consumer who is 'tying her hands' from splurging today and therefore can potentially reduce, to some extent, her desire for present gratification. Similarly, Laibson et al. [1998] investigate the role of partially illiquid, defined contribution pension plans as a commitment device for sophisticated hyperbolics.

To the extent that saving in *Superannuation and Annuities* represents future consumption in retirement years and thus foregone consumption today, standard life-cycle models predict that saving and impatience should be negatively correlated. The crucial difference when time-inconsistency is assumed is that contributions to *Superannuation and Annuities*, while representing additions to saving, also serve the purpose of an external commitment mechanism and have the function of pre-committing to a plan of action. One of the key predictions of the hyperbolic model is that *sophisticated* hyperbolic households should value the external commitment and therefore 'impatience' should be found to be positively related to the probability of investing in *Superannuation and Annuities*.

I am concerned with the characteristics of households that invest in *Superannuation and Annuities*. While there are many factors that influence the decision to invest in an illiquid asset, the hypothesis tested here is that it is far-sighted, sophisticated hyperbolic agents that will choose to do so. Since illiquid asset

investment captures patient behavior and if agents are sophisticated, I expect to observe a positive relationship between this type of patient behavior and the proxies for impatience, after controlling for variables that account for sophistication and other socio-demographic household characteristics.

Thaler and Shefrin [1981] approach the same problem in a different way. They do not rely on time discounting to characterize the observed paradox of simultaneous patient and impatient behavior by individuals. Rather, they model the consumer as a dual-self organization, similar to a principal-agent problem. This framework allows for conflict to exist within the person where the two 'selves' have conflicting objective functions. This analysis is extended by Fudenberg and Levine [2004] who model a similar individual but in a game-theoretic framework. The predictions of the two models are similar and lead to the same predictions as the hyperbolic model albeit through a different mechanism. The dual-self model of Thaler and Shefrin, however, provides better intuition for the idea of sophistication and pre-commitment.

In the Thaler and Shefrin model the individual is represented as consisting of a myopic short-run self – the doer – and a patient long-run self – the planner. The conflict arises because the planner has the long term in mind while the doer is completely absorbed with the current period's utility. The planner doesn't consume but, rather, derives utility from the consumption of the doers. However, the planner cannot implement this plan without imposing some controls on the doer. Without some constraints on the doer's actions, the doer would overconsume and consume life-time income in the first period. The way in which the planner imposes control is by way of a *psychic technology* capable of affecting the doer's behavior. The extent to which rules can successfully be employed to alter the doer's behavior depends on the level of *sophistication* of the individual. In the extreme case, all doer discretion can be eliminated by imposing rules that emulate perfect pre-commitment or perfect commitment devices – perfect in the sense that the rules can approximate the choices that the planner would make.

What determines sophistication and how do we measure it? Intuitively, sophistication is expected to be determined by such things as education, family background in the form of parental training, wealth and income. Indeed, Thaler and Shefrin suggest that the rules which individuals adopt to mitigate the desires of the short-run self are learned from parents and other models. They further suggest that "there will be differences in the use of rules depending on social class, education and age" [1981, p.398].

Conversely, we could assume that individuals have an endowed level of 'impatience' but rather than expending effort reducing it, as in Becker and Mulligan [1997], individuals expend effort reducing their *time-inconsistency*. This approach is consistent with Strotz's argument discussed above. We could interpret this as making an effort to increase β in equation (1), since $\beta = 1$ is the time consistent case nested in the quasi-hyperbolic function. This can be thought of as leading to the sophistication assumption. Given this assumption of "endogenous sophistication", individuals then have the choice of relying on internal commitment mechanisms as in Benhabib and Bisin [2004] or of making use of (perhaps simpler) external commitment devices, such as illiquid assets, to help to ensure that their short-run self stays on track.

Related to the notion of commitment is the empirical work on retirement planning. Lusardi [2003] explores the wealth accumulation of persons close to retirement and their active planning for retirement and finds that those who plan for retirement also have a higher level of pre-retirement wealth, after controlling for preferences, demographic factors and permanent income. In the terminology of Thaler and Shefrin, this is an example of the long-term planner imposing some rules on the myopic doer so that the planner's long-term goals are implemented. Lusardi further finds that those who plan are more likely to have higher education than those who don't. Ameriks et al [2003], using a tailor-made survey to capture the propensity to plan, report the same relationship between planning and wealth accumulation. These examples are consistent with the concept of sophistication used here; sophisticated agents are more likely to plan for retirement. In a related study, Ameriks et al [2004] find that problems of self-control are negatively related to wealth accumulation – both liquid and illiquid – but find that self-control problems will have a greater (negative) effect on the accumulation of liquid financial assets than on retirement accumulation where the assets are typically accumulated in pension funds and are more illiquid.[6]

III. INSTITUTIONAL BACKGROUND

Retirement income provision for Australian households comprises three pillars. First is the public pension with universal coverage, but asset and means tested. Second is the Superannuation Guarantee, a mandatory retirement saving plan

[6] Ameriks et al [2004] suggest that "*the impact of self-control problems should vary according to the liquidity characteristics of the underlying assets…In particular, it should be hard for those with self-control problems to accumulate financial assets outside their retirement account.*"

which compels all employers to contribute, on behalf of their employees, a percentage of the employee's wages on top of wages (7 per cent in 1998/9) into a private account. It is a fully funded, private system where employer contributions are fully preserved until minimum retirement age. Third is voluntary saving, which can include housing, financial assets and voluntary contributions into individual Superannuation accounts.

The taxation arrangements for Superannuation are complex but concessional. Voluntary contributions to individual accounts are not tax deductible unless employer-sponsored contributions are not available, for example, for the self-employed. While personal contributions are not tax-deductible, earnings in the hands of funds are taxed at concessional rates and tax is not levied on undeducted contributions upon exit at retirement While there is some provision for encouraging voluntary contributions, there are also disincentives or, rather, perhaps not enough incentives to alter individuals' participation decisions.[8] In the analysis that follows, I investigate and identify the co-determinants of voluntary contributions to Superannuation.

An important feature for this paper is the illiquidity of superannuation contributions in Australia, whether under the Superannuation Guarantee or voluntary. After 1992 the importance of saving for retirement was heavily publicized by the government. Legal restrictions on early withdrawal were tightened, such that by 1999 both compulsory employer and voluntary employee contributions into Superannuation accounts were preserved within the system and could not be accessed until the minimum retirement age.[9]

IV. Empirical Methodology

What are the models' predictions of the relationship between impatience and illiquid wealth? First, if the world is populated exclusively by exponential consumers, then we would expect that higher impatience decreases the probability of holding superannuation and annuities since the more short-sighted the less value is placed on future consumption. Second, if the world is populated by naïve hyperbolic consumers, these individuals do not value commitment and therefore the more

[7] Minimum retirement age depends on year of birth; the maximum is currently age 60 for the younger cohorts. From 1 July 1999, both compulsory employer and voluntary employee contributions into Superannuation accounts are preserved within the system and cannot be accessed until the minimum retirement age. However, special hardship conditions will enable early release of funds under very exceptional circumstances

[8] .For example, from August 1996 a contributions surcharge of 15 per cent, was introduced for high-income individuals.

[9] Special hardship conditions will enable early release of funds only under very exceptional circumstances

impatient, the less likely they will be to hold illiquid assets. Third, if agents are modelled according to the dual-self model of Thaler and Shefrin, and if the short-run self is impatient and the long-run self patient, then we expect to see a conflict between the two selves, and higher impatience will be positively related to the probability of holding *Superannuation and annuities*. Finally, if individuals are sophisticated hyperbolics, they value commitment and impatient behavior will be positively related to the probability of holding illiquid assets

The data used are from the 1998-99 wave of the ABS Household Expenditure Survey (HES), which is a cross-sectional survey of approximately 7000 Australian households and contains data on demographics, education, occupation, sources of income and detailed expenditure items. The reporting unit is the household rather than the individual and therefore, as is usual in survey data on income and expenditure, the analyses are in terms of the household reference person. I remove households where there are multiple families and restrict the sample to households where the reference person is between 25 years of age and less than 75 years of age. Further, I retain only households where financial decisions are determined as a single income unit. For example, this may include both spouses working but for decision purposes it is as though there is only one source of income. In this way we capture only single family or single household income and expenditure. Since contributions to superannuation can only be made if employed, households whose reference person is unemployed or not working are removed. The resulting sample consists of 3491 households, of which 1684 make voluntary contributions to *Superannuation and Annuities* and 1807 do not.

IV.1. Measuring Impatience

A measure for impatience is central to the empirical tests. A proxy variable is constructed that accounts for household differences in time preference (impatience). The HES contains detailed data on household expenditure items, and a number of expenditure items are identified in the data that have been found to be correlated with impatience and which qualify for inclusion based on the studies cited above. These include expenditure on smoking, drinking, gambling, and credit card interest payments as an indicator for the presence of credit card debt.[10] I construct indicators

[10] As described above, experimental psychology tests reveal that smoking, drinking and gambling are associated with a higher rate of time preference compared to non-participation and, in particular, that it is a hyperbolic discount function that best characterises delay discounting in these experiments. The proxies could be criticized on the grounds that these behaviors could be capturing individual risk preferences rather than impatience. However, it has been found that these risky behaviors can also explain impulsivity and are in fact related [Mitchell, 1999; Monterosso and Ainslie, 1999; and Barsky et al, 1997].

for these behaviors since I am primarily interested in whether these behaviors are observed rather than how much is spent on them.[11] Assuming that underlying these behaviors is impatience, or problems of self-control, I use principal component analysis to identify a common factor that relates these behaviors to a latent trait variable – impatience – and therefore create an aggregate impatience index to include in the empirical analysis.

All the impatience proxies used are dichotomous and so the usual correlation matrix is not strictly valid. To correct this I use a correlation matrix based on tetrachoric correlations between the variables, x_i, that explicitly accounts for the discrete nature of the impatience proxies and then perform principal component analysis (PCA). PCA linearly transforms a set of p variables into another set of $k \leq p$ uncorrelated variables that explains the total variation in the original set. It is similar to factor analysis, but in factor analysis the aim is to explain the common variance, rather than the total variance, between the observed variables. In PCA the focus is to express the principal component as a linear function of the x_i [Dunteman, 1989][12]

Tables I and II summarize the principal component analysis, and Tables III and IV summarize the resulting impatience index. If the observed behaviors are all capturing impatience, they will be positively correlated. Table V presents pairwise and partial correlations between the four measures. All correlations are positive and most are statistically significant. Since true impatience is a latent variable and thus unobservable, I use this constructed index as a proxy for impatience and believe that it will be positively correlated with the true, unobservable impatience trait.[13]

IV.2. Illiquid and Liquid Assets

[11] Expenditure is at the household not at the individual level so it is impossible to disentangle whether, for example, all the members smoke or just one of them. My impatience index therefore is for a given household. Data on consumption levels of these items is also not available.

[12] As a robustness check, I construct an additional five impatience indices based on a) factor analysis using the score, b) factor analysis using the factor loadings to weight the variables, c) principal component analysis using the score, d) principal component analysis using the factor loadings as weights and finally e) the sum of the indicators on the four impatience variables using equal weighting. There is no appreciable difference in the results when the five methods are used

[13] To qualify as a proxy two conditions need to be met: First, is that the proxy be redundant if included with q, that is, $E(y \mid x, q, z) = E(y \mid x, q)$, where q is an unobservable variable and z is a proxy for q. y is the dependant variable and x is a vector of observable covariates. The second condition is that we require the correlation between q and each element of x be zero once we partial out z [Wooldridge, 2002].

The dependent variable is a dichotomous variable equal to unity if a household makes voluntary contributions to *Superannuation and Annuities,* and zero otherwise.[14] It is not the sole measure of illiquid saving since there are other illiquid assets identified in the HES which could be effective saving vehicles. It is important to stress that this analysis examines the probability of investing in an illiquid asset as a way of constraining future choices of households. Annuities, while not as illiquid as superannuation, are characterised by long-term returns and early withdrawal often involves negative returns since administration costs are typically high in the early years of the plan, including this should therefore pose no problem.

The HES contains flows from assets such as stocks, bank deposits, and other property as well as whether a household is a homeowner and the value of the home. I include dummy variables for whether a household holds any assets in these forms as well as interaction terms between the dummies and the income flows from these assets. These can serve as proxies for 'taste for saving' since in general, households that have investment income are most likely to have saved the assets to generate that income, or simply, as discussed below, as proxies for household wealth. Given the different liquidity characteristics of these assets, it is also of interest to see how the probability of holding these assets is related to the impatience proxy.[15]

IV.3. Sophistication

I include a number of variables that can be thought of as proxies for sophistication such as education qualification attained, wealth, in the form of dwelling value, and indicators for whether a household has income from investments. These variables for wealth can be included since the income flows in the current period relate to investment decisions in a previous period. Therefore these wealth proxies are treated as predetermined variables. In addition, occupation categories are included since these could be capturing social class or the effect of peers both of which can contribute to an individual's general sophistication. These variables are intrinsically entwined with future earning potential, or permanent income, and therefore any significant positive relationship between superannuation and these variables could also be revealing that the rich save more [Dynan et al, 2004].

[14] This variable potentially includes individuals working in the public sector where compulsory "quasi-voluntary" employee contributions form part of the salary package. However, households report voluntary contributions in expenditure diaries as disbursements and it is therefore most likely that these contributions are made after quasi-voluntary contributions are deducted from the pay.

[15] The HES is not an ideal data set for analysing household saving. Unlike the similar and frequently used Consumer Expenditure Survey in the United States, the HES suffers from issues in the timing of income and consumption. Taste for saving can be captured in the error term or across discount rate heterogeneity through the impatience index.

I classify the household reference person into four broad education groups; the control group is *High school dropouts*, those that have completed high school as their highest qualification, those with intermediate qualifications such as basic vocational and associate diploma, and those with a bachelor's degree or higher. As well as being a proxy for sophistication, education attainment can also be capturing future earning potential and thus, permanent income.

The HES does not contain any detailed data on the wealth holdings of households, except for dwelling value, but does contain data on flows from assets such as rental income from property, dividend income from stocks and interest income from bank deposits. In all my specifications I ignore liabilities and focus instead on flows from these assets. Additionally, since for many households the family home is their primary asset and the main source of retirement saving, gross dwelling value is included as an additional proxy variable for wealth holding. Given that the primary residence is the next most illiquid asset, it is of interest whether the probability of investing in *Superannuation and Annuities* decreases with higher values of the primary residence since some substitutability between Superannuation and home value would be expected.

IV.4. Demographics

Demographic variables affect the need for saving and are potentially important sources of variation in saving at the micro level. Including variables on family composition, such as gender, family size and marital status as control variables are important for analysing life cycle saving decisions.[16] Also, controlled for are nine broad employment categories. The control group is *Labourers and associated workers*. In addition to controlling for household before-tax income, I include dummy variables to indicate the primary source of household income, these are: *Wages and Salaries*, *Self-employed*, *Investments* and *Government benefits* which is the control group.

When analysing investment in *Superannuation and Annuities* cohort effects and life-cycle effects may be relevant. In particular, different cohorts may have had exposure to different retirement schemes, or the need for current retirement saving may not be as crucial since they have already accumulated sufficient or age may alter the perception of what is a necessary level of funds for retirement. This last point may be of relevance to younger cohorts since they may have been exposed to different advertising related to the need for adequate retirement provision, while the older

[16] Marital status also includes couples living in a de-facto relationship.

cohorts may not feel that any further commitment of funds for retirement purposes will alter their standard of living in old age[17]. Or simply, different cohorts have differing attitudes to saving. This effect may in part have an impact through lifetime earnings since, in a growing economy, younger cohorts generally have higher current and lifetime income than earlier cohorts and hence save less than older cohorts. Age can also capture aspects of sophistication and the ability to impose rules on the short-run, impatient self as in Thaler and Shefrin. The HES data set contains indicators for the age category to which the household reference person belongs in five year bands. I construct an age variable as the midpoint of the age categories to create a continuous variable – this allows the inclusion of age and a quadratic in age.

V. DATA AND RESULTS

This section provides a description of the data and the results of the empirical estimation. First, I examine the simple relationships between impatience and other variables. Second, and this is the fundamental result, I investigate the relationship between impatience and the probability of contributing to a very illiquid asset, *Superannuation and Annuities.* Finally, I examine how impatience affects the probability of holding other forms of assets which are characterized by varying degrees of liquidity.

Tables VI and VII and Figures I to V, present some simple relationships between *Impatience*, *Superannuation and Annuities*, household income, a constructed measure of liquidity and various demographics from the HES. In particular, the data reveal that:

1. Impatience increases with income at low levels of income and then declines with higher levels of income. Figures I and II show, respectively, the relationship between impatience and deciles of household per capita income *including* investment income and between impatience and deciles of household per capita income *excluding* investment income. A clear positive relationship up to around median per capita income turns negative and then stabilises in the upper deciles. One conjecture for this positive relationship is that as household income increases, agents are more able to afford to indulge in the 'vices' that they would like to engage in but that low income had hitherto prevented them from. At almost all income levels households making

[17] The introduction of the Superannuation Guarantee was accompanied by a widespread advertising campaign informing individuals of the introduction of the new scheme; it was difficult not to be aware of the new legislation. In addition, the last several years have seen a burgeoning of media articles dealing with the need for adequate retirement provision.

contributions to superannuation are more impatient than those that do not. Moreover, the finding that impatience appears to be positively related to household income at low income levels is in contrast to Lawrance's [1991] finding that impatience and income are negatively related.

2. The relationship between impatience and age (Figure III) is roughly constant up to age group 35-39, after which it rises through middle age and then begins to decline into old age. There is no noticeable difference between those with superannuation and those without.[18] Spearman rank correlation tests conducted for impatience with age and income reject the null hypothesis of independence for these two variables. There are some conflicting arguments about the correlation of impatience with age. On the one hand, as individuals age there is an accumulated experience that teaches individuals that patience may be a virtue. On the other hand, as the end of life approaches, the distance between the current period and the end of life decreases and so there is the possibility that impatience increases since there is no longer any need to exercise patience – the planning horizon is much shorter.
3. One of the most interesting features of the data is shown in Figure IV. The relationship between education qualification and impatience reveals that impatience is strongly decreasing in education attainment. This correlation is the strongest yet and lends some support to the Becker and Mulligan hypothesis that agents expend effort, partly through education, to reduce their impatience. Fuchs [1982] and Lawrance [1991] also find this negative relationship. It is consistent with the proposal of sophistication and thus provides support for the use of education as a proxy for sophistication. Figure IV also captures the difference in impatience between those with superannuation and those without. What is conspicuous is the obviously higher level of impatience for those making contributions to superannuation. T-tests of differences of average impatience levels between those with superannuation and those without for each education group are significant at the 5% level for all groups except group 2 (basic vocational) and groups 7 (post grad diploma) and 8 (higher degree).
4. In Figure V, I compare the simple relationship between a measure of liquidity and impatience. The liquidity measure is a constructed variable with five ordinal categories of illiquidity where the illiquid assets include superannuation contributions, home ownership and other property. The liquid

[18] The results for the age categories 9 and 10 with super are not valid since they include only 2 and 1 observations respectively.

assets include bank deposits and stocks. Category 1 indicates that a given household holds all three types of illiquid assets found in the HES and holds no liquid assets, thus it is the most illiquid category. Category 5 is the most liquid where a household holds only liquid assets – bank deposits and stocks from which dividends are received. Categories 2 – 4 indicate households that hold combinations of assets with increasing degrees of liquidity. The graph clearly reveals that liquidity is inversely related to impatience.

V.1. Impatience and contributions to illiquid wealth

The central analysis in this paper is in the examination of the relationship between the probability of holding illiquid wealth and impatience. A discrete choice model of participation in voluntary superannuation is specified. It is assumed that each household's participation decision can be described by a vector of socio-economic characteristics X_i and impatience Imp_i:

$$super_i^* = X_i\beta + Imp_i\gamma + \varepsilon_i \tag{2}$$

In general, $super_i^*$ is unobservable. What is observed is a dummy variable, defined as $super_i = 1$ if $super_i^* > 0$, and $super_i = 0$ otherwise. The decision to participate in voluntary superannuation involves a random component, specifically, the probability that a household participates is

$$\begin{aligned} \text{prob}(super_i = 1) &= \text{prob}(super_i^* > 0) \\ &= \text{prob}(\varepsilon_i > -X_i\beta - Imp_i\gamma) \\ &= 1 - F(-X_i\beta - Imp_i\gamma), \end{aligned} \tag{3}$$

where F is the cumulative distribution function for ε_i which are assumed to follow a normal distribution. The parameters are then estimated by fitting a probit model to the 1998 HES data.[19]

The results in Table VIII show that, after controlling for many variables that could affect a household's likelihood of contributing, impatience positively and significantly affects the probability of contributing to *Superannuation and Annuities*. This provides evidence consistent with sophistication in a household's decision to invest in a long-term and very illiquid asset.

[19] A logit model was also estimated for comparison. The results were not dissimilar to the probit estimates and are not reported.

Many of the demographic variables are related to the probability of contributing to *Superannuation and Annuities* in the expected way. The coefficients on age and income are significantly positive, while being female decreases the probability of contributions. Marriage and family size while having the expected sign are not statistically significant.

Relative to the base line category of *High school dropouts*, the three education classes are all positive but the *Higher degree* category has a significantly higher probability of affecting superannuation contributions. In the occupation categories, compared to the control category of *Labourers and related Workers*, all are positive but only the "white collar" occupations are statistically significant.

The asset dummies positively affect the probability of contributing to superannuation and annuities, although the property dummy is positive but not statistically significant. The coefficients on the flows from these assets are all negative but only the coefficient on bank interest is significant. Being a home owner is positive while the value of the home is negative. As noted above, the presence of these other assets could be capturing taste for saving, while the negative coefficients on the flows could be capturing the effect of substitutability between assets types. That is, the higher the flows from these assets, the less likely a household is to contribute to superannuation since they have other assets upon which to rely. An analogous interpretation can be applied to the *Home owner* dummy and *Dwelling value*. The findings are consistent with some of the empirical regularities on household saving behaviour identified in Browning and Lusardi [1996].

Underlying the estimation is the assumption that holding other assets is predetermined since investment flows capture investment decisions taken in earlier periods. Perhaps this assumption is too strong since there are unobserved household characteristics that affect both the decision to hold superannuation and the decisions to hold other types of assets. The next section specifically accounts for the potential correlation in the unobservables by estimating the joint decision potentially inherent in asset choice using a multivariate probit model of portfolio choice.

V.2. Impatience and portfolio choice

To the extent that households appreciate the existence of commitment in the form of illiquid assets, it is instructive to examine how holding other types of assets, each with varying levels of liquidity, are affected by my impatience measure. This analysis also serves as a check on the predictions of the theory for sophisticated households, in the sense that impatience is expected to increase the probability of

holding illiquid assets and decrease the probability of holding liquid assets. Accordingly, I next examine how impatience affects the probability of holding four other types of assets.

While contributions to an illiquid asset represent a commitment device, there are clearly other assets that a household may choose to hold. In particular, households make decisions not only about superannuation, but also about other financial assets and home ownership. Whereas in the preceding analysis the dependent variable was a dichotomous variable capturing whether a household made *contributions* to the illiquid asset, *Superannuation and Annuities*, in this sub-section the additional dependent variables are indicators that identify whether a given household *already holds* an asset rather than making additions to it. The indicators for the different asset types are classified according to illiquidity: the most illiquid asset is *Superannuation* and *Annuities*, followed by being a home owner, holding property that generates rental income, holding stocks from which dividends are received and finally the most liquid are bank deposits.

Explicitly allowed for are the joint decisions of holding different types of assets by estimating a multivariate probit model of portfolio choice.[20] In a multivariate probit framework, a 0-1 variable is observed for whether a given household holds each asset class and any correlations across the error terms due to unobservable household-specific factors can be accounted for. If the error terms are uncorrelated across assets, individual standard single-equation probits can be estimated. Conversely, if the error terms are correlated, it is preferable to model the asset-holding decisions jointly as in the multivariate probit framework. As is usual in the empirical literature on household portfolio choice, participation decisions are modelled as reduced form equations and the portfolio choice problem can therefore be modelled as a standard commodity choice problem [Hochguertel, Alessie and van Soest, 1997].

Defining an underlying latent propensity variable Y_h^* for the participation in each of the five asset classes (*h = super (S), home (H), stocks (St), bank (B), property (P)*), these underlying propensities are related to the household's observed characteristics X_h, with unknown coefficient vector $\beta_{\mathbf{h}}$ and other unobserved characteristics, ε_h. Assuming a linear relationship, the population regression function is

[20] Multivariate probit estimation has been used in many fields from modeling joint decisions about portfolio choice [Bertaut and Starr-McCluer, 2001] to modeling participation in drugs [Zhao and Harris, 2004] among others.

(4) $$Y_{ih}^{*} = X_{ih}^{'}\beta_h + Imp_{ih}\gamma_h + \varepsilon_{ih},$$

where *h* indexes the asset types and *i* indexes the household. Individually equation (4) is a binary probit equation for participation in each asset:

(5) $$Y_{ih} = \begin{cases} 0 & if\ Y_{ih}^{*} \le 0 \\ 1 & if\ Y_{ih}^{*} > 0 \end{cases}$$

I assume that ε_{ih} jointly follow a multivariate normal distribution with mean zero and covariance matrix Σ, that is, $(\varepsilon_S, \varepsilon_H, \varepsilon_{St}, \varepsilon_B, \varepsilon_P) \sim MVN(0, \Sigma)$ where

$$\Sigma = \begin{bmatrix} 1 & \rho_{HS} & \rho_{StS} & \rho_{BS} & \rho_{PS} \\ \rho_{SH} & 1 & \rho_{StH} & \rho_{BH} & \rho_{PH} \\ \rho_{SSt} & \rho_{HSt} & 1 & \rho_{BSt} & \rho_{PSt} \\ \rho_{SB} & \rho_{HB} & \rho_{StB} & 1 & \rho_{PB} \\ \rho_{SP} & \rho_{HP} & \rho_{StP} & \rho_{BP} & 1 \end{bmatrix}.$$

Given the potential substitutability or complementarity between these asset classes it is likely that the error terms of these equations will be correlated. The multivariate probit model is estimated via simulated maximum likelihood on the 3491 observations using the GHK algorithm [Greene, 2003]. The number of draws is set to 60 which is approximately the square root of the number of observations. Results for the multivariate probit analysis are presented in Table IX.

The multivariate results show that the impatience measure is positively and significantly related to holding *Superannuation and Annuities*, with the magnitude not greatly changed from the result in the previous single equation probit of Table VIII. *Impatience* appears to have no significant effect on the probability of holding the other forms of illiquid assets, homes and investment properties. An explanation is that the decision to hold housing assets can be motivated by many different factors since housing serves the dual function of an investment and a generator of housing services [Arrondel and Lefebvre, 2001]. This result highlights the difficulty of identifying an illiquid asset with the primary property of tying the saver's hands for a lengthy period of time, a feature captured by the Australian *Superannuation and Annuities* category.

The effect of impatience on the probability of holding stocks and bank deposits – the two most liquid asset categories – is negative and significant for both, so that more impatient households are less likely to hold these liquid assets. While this is the expected result, it is not possible to identify the type of household. First, as previously discussed, sophisticated hyperbolic households are less likely to hold liquid assets, but naïve hyperbolics are also less likely to hold assets. A similar argument can be applied to exponential discounters. . Evidence presented in Lusardi

[2003], confirming her prior assumption that a higher rate of time preference is associated with a reduced probability in holding stocks, is consistent with the results found here. Ameriks et al [2004] also confirm this result, finding that problems of self-control are associated with lower liquid wealth holdings. Consequently, while it is not conclusive which type of household we are identifying with this result, it is nonetheless consistent with the sophisticated hyperbolic hypothesis. As mentioned above, the impatience index could be criticised on the grounds that it is capturing attitudes towards risk with the implication that a higher measure of the index is associated with more risk loving behavior. However, if this is the case, then the expected sign on the impatience coefficient for the probability of holding stocks should be *positive* rather than *negative* since it is generally accepted that stocks are the riskier type of asset.

Consistent with expectations, age has a positive and significant effect on the probability of holding all asset types, except on the probability of holding stocks. This finding is supported by other studies [Bertaut and Starr-McCluer, 2001; Haliassos and Bertaut, 1995]. Also as expected, the coefficients on household income are all positive and statistically significant. Being a female head of the household negatively affects the probability of holding all asset types, but only those for holding superannuation and stocks are statistically significant. Marriage is also associated with an increase in the probability of holding all assets, except it is not significant for holding superannuation. Household heads holding a Bachelors degree or higher (*Higher Degree*) have a higher probability of holding all five asset classes, other things being equal, compared to households with lower qualifications. This may reflect higher earning potential or higher wealth holdings for this group. It may also reflect the fact that higher educated households have an information gathering advantage, and is thus consistent with sophistication.

As shown at the bottom of Table IX, estimates of the error correlations, ρ_h, from the multivariate probit are positive and significant for most pairs of equations, suggesting that most assets are at least complements to each other. The negative correlation between being a home owner and holding investment property is negative and unexpected since most property investors in the sample are also home owners, but it is not statistically significant. The null hypothesis that the disturbance terms are uncorrelated across equations is rejected. Since I include a proxy for time preference, any unobserved variation could be reflecting such other factors as risk preference, expectations about future income or returns and family background. Overall, the results from the multivariate probit analysis in Table IX confirm the results in the

single equation probit. The signs and significance of the coefficients on most variables are similar.

V.3. Impatience and liquidity

Finally, as an additional check on the relationship between impatience and illiquidity, I estimate a multinomial logit model using the liquidity categories outlined above.[21] The dependent variable categories are 0-1 variables representing the 5 categories of liquidity plus a category for households that hold no assets. Frequencies and distribution of the categories are presented in Tables X and XI. The independent variables are the same as in the multivariate probit framework and the estimated coefficients are presented in Table XII.

For all categories, households with higher measured impatience are more likely to hold only illiquid assets as is revealed by the significant negative coefficient on the impatience index for all categories. Only the most salient features of the remaining results will be discussed. Table XII shows that age has mixed results on the likelihood of holding various types of asset groups. In particular, age significantly increases the probability of holding only illiquid assets relative to holding no assets (category 0) and holding mostly liquid assets (category 4), while it reduces the likelihood of holding only illiquid assets relative to holding mostly illiquid assets (category 2). Households with higher income are more likely to hold only illiquid assets relative to holding no assets, which is to be expected. Holding mostly illiquid assets (category 2) or an equal mix of liquid and illiquid (category 3) is more likely for higher income households than merely holding illiquid assets. This is also consistent with other studies suggesting that higher income households have a more diversified portfolio. They are also less likely to hold only liquid assets (category 5) relative to only illiquid assets. The effects of education on asset holdings are also mixed: households whose head has a bachelor's degree or higher are more likely to hold only illiquid assets rather than no assets but less likely to hold only illiquid assets when compared to holding a mix of mostly illiquid assets. This is likely to be capturing the higher income levels for more educated households. Only household heads with high school or intermediate qualifications are significantly likely to hold mostly illiquid assets (category 2) relative to all illiquid. After controlling for education and household income as well as various demographics, the results presented in Table XII provide additional support for the hypothesis that Australian

[21] The dependent variable has ordinal characteristics and thus an ordered probit model may seem more appropriate. However, tests reveal that the parallel regressions assumption can be rejected therefore a multinomial logit is preferred.

households in this sample are sophisticated rather than naïve with impatience generally increasing the probability of holding illiquid assets.

VI. Conclusion

This paper investigated how problems of self-control, as proxied by an index for impatience, can help explain the probability of Australian households investing in illiquid assets. Evidence was found to support the contention that problems of self-control positively affect the probability of investing in illiquid assets such as Superannuation. Conversely, households with self-control problems were less likely to hold assets in a very liquid form such as bank deposits. Explanations for these results are to be found in the psychology and behavioral economics literature that deals with the notion of self-control and sophistication. In particular, households that have observed problems of self-control recognize this and succeed somewhat in tying their hands. Three econometric models were specified and results for all robustly found that impatience, as measured by a constructed index, and after controlling for other household characteristics, significantly and positively affected the probability of investing in illiquid assets.

This paper contributes to and complements the literature on household saving, household portfolio choice and retirement saving by identifying an additional household characteristic that affects investment decisions. These findings can assist in more fully understanding household behavior for the purpose of policy making; particularly policy that seeks to encourage and increase private provision for retirement. Recognizing that households are indeed sophisticated, while also exhibiting problems of self-control can help in devising innovative long-term investment instruments as in Thaler and Benartzi [2004] and others that specifically take these problems into account. If households with problems of self-control are more likely to invest in assets that are characterized by illiquidity, then we should be encouraging the development of new saving instruments that specifically cater to the *commitment* needs of households. Furthering our understanding of household saving can assist in developing incentives for increasing household private wealth accumulation for retirement. In addition, this analysis provides evidence that households who make use of this type of device are sophisticated hyperbolic discounters.

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VIII. APPENDIX

TABLE I: POLYCHORIC CORRELATION MATRIX

	Smoke	*Gamble*	*Drink*	*Credit card debt*
Smoke	1			
Gamble	0.105	1		
Drink	0.213	0.231	1	
Credit card debt	0.110	0.129	0.073	1

TABLE II: PRINCIPAL COMPONENT ANALYSIS

Factors	*Eigenvalues*	*Proportion explained*	*Cum. explained*
1	1.442	0.360	0.360
2	0.942	0.236	0.596
3	0.895	0.224	0.820
4	0.721	0.180	1.000

TABLE III

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Impatience index	3491	0	1	-1.794	1.869

TABLE IV: IMPATIENCE INDEX

	Impatience index	*Behaviour*	*Freq.*	*Percent*	*Cum.*
1	-1.794	*None*	352	10.08	10.08
2	-1.112	*Credit card debt only*	207	5.93	16.01
3	-0.860	*Gambling only*	82	2.35	18.36
4	-0.830	*Smoke only*	157	4.50	22.86
5	-0.710	*Drink only*	443	12.69	35.55
6	-0.178	*Gambling and credit card debt*	63	1.80	37.35
7	-0.148	*Smoke and credit card debt*	145	4.15	41.51
8	-0.028	*Drink and credit card debt*	319	9.14	50.64
9	0.104	*Smoke and gambling*	52	1.49	52.13
10	0.223	*Gambling and drinking*	196	5.61	57.75
11	0.254	*Smoke and drink*	410	11.74	69.49
12	0.786	*Smoke, gamble and credit card debt*	58	1.66	71.15
13	0.905	*Gamble, Drink and credit card debt*	180	5.16	76.31
14	0.936	*Smoke, drink and credit card debt*	373	10.68	87.00
15	1.187	*Smoke, gamble and drink*	206	5.90	92.90
16	1.869	*Smoke, drink, gamble and credit card debt*	248	7.10	100.00
	Total		3,491	100	

Note: The standardized impatience index consists of 16 unique values. Since there are four behaviours associated with self-control problems, there are 15 different combinations of behaviours possible in addition to households who do not participate in any of the behaviours.

TABLE V: CORRELATIONS BETWEEN IMPATIENCE VARIABLES.

	Smoke	*Drink*	*Gamble*	*Credit card debt*
Smoke	1	0.112***	0.043***	0.059***
Drink	0.122***	1	0.133***	0.027
Gamble	0.064***	0.142***	1	0.074***
Credit card debt	0.067***	0.045***	0.082***	1

**** indicates significance at the 1% level. Upper triangle are partial correlations, lower triangle are pair wise correlations.*

TABLE VI: CHARACTERISTICS OF THE SAMPLE

	No Super		*Super*		*Total*
Characteristic	*(n)*	*Average Impatience*	*(n)*	*Average Impatience*	*(n)*
Age					
25 – 29	264	-0.012	154	0.010	418
30 – 34	305	-0.042	260	0.044	565
35 – 39	340	-0.017	318	0.068	658
40 – 44	262	0.012	311	0.122	573
45 – 49	212	-0.113	245	0.176	457
50 – 54	178	-0.043	219	-0.030	397
55 – 59	108	-0.075	119	0.071	227
60 – 64	77	-0.265	52	-0.118	129
65 – 69	33	-0.372	5	0.049	38
70 – 74	28	-0.740	1	0.254	29
Education					
High school dropout	559	-0.005	379	0.164	938
High school only	189	0.049	190	0.058	379
Intermediate education	731	-0.034	629	0.164	1,360
Higher degree	328	-0.286	486	-0.131	814
Occupation					
Managers and administrators	147	-0.102	197	0.095	344
Professionals	366	-0.228	462	-0.106	828
Associate professionals	249	-0.018	267	0.110	516
Tradespersons and related workers	278	0.085	211	0.103	489
Advanced clerical and service workers	57	-0.086	46	0.328	103
Intermediate clerical, sales and service	233	-0.002	206	0.164	439
Intermediate production and transport workers	195	0.049	149	0.183	344
Elementary clerical, sales and service workers	107	-0.156	68	0.218	175
Labourers and related workers	175	-0.113	78	0.004	253
Gender					
Male	1151	-0.025	1252	0.066	2403
Female	656	-0.108	432	0.033	1088
Marital status					
Married	1319	-0.004	1340	0.105	2659
Single	488	-0.192	344	-0.127	832
Number of kids under 15					
0	959	-0.066	882	0.054	1841
1	331	-0.059	309	0.064	640
2	346	-0.019	333	0.040	679
3+	171	-0.053	160	0.103	231
All	**1,807**	**-0.062**	**1,684**	**0.066**	**3,491**
	51.76 %		**48.24 %**		
Household Income *Mean*	47513		64466		
Median	40664		58682		
Mean Value of Dwelling	143283		157630		

Source: Author's tabulation from 1998-99 HES. Frequency and proportions of households contributing to superannuation. N=3491, ages 25 – 74 inclusive. Unemployed and those not in the labour force are excluded. Impatience index constructed using principal components analysis on smoking, drinking, gambling, and credit card debt.

TABLE VII: ASSET OWNERSHIP

	Total	***No super***		***Super***	
	(n)	*(n)*	*Avg. impatience*	*(n)*	*Avg. impatience*
Stocks	791	325	-0.122	466	-0.029
Home owner	2544	1252	-0.037	1292	-0.065
Property owner	455	190	-0.024	265	0.030
Bank deposits	1001	448	-0.192	553	-0.003

FIGURE I

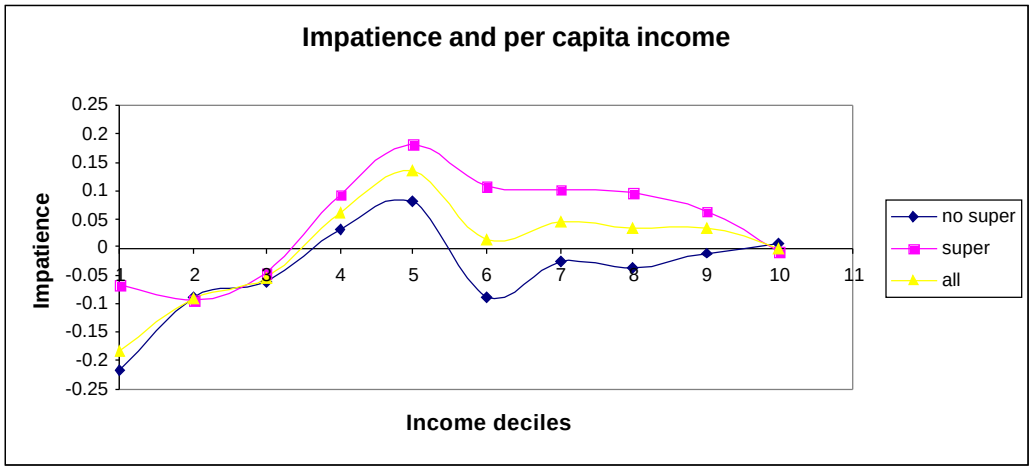


FIGURE II

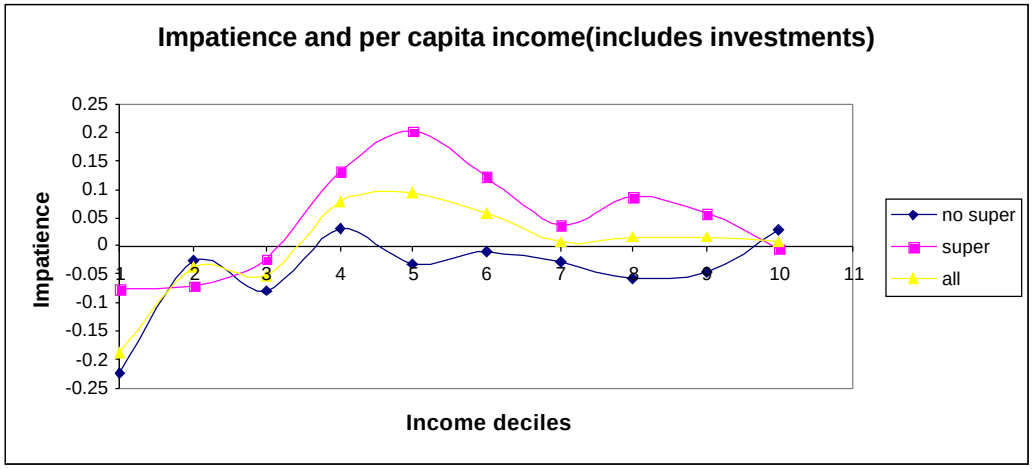
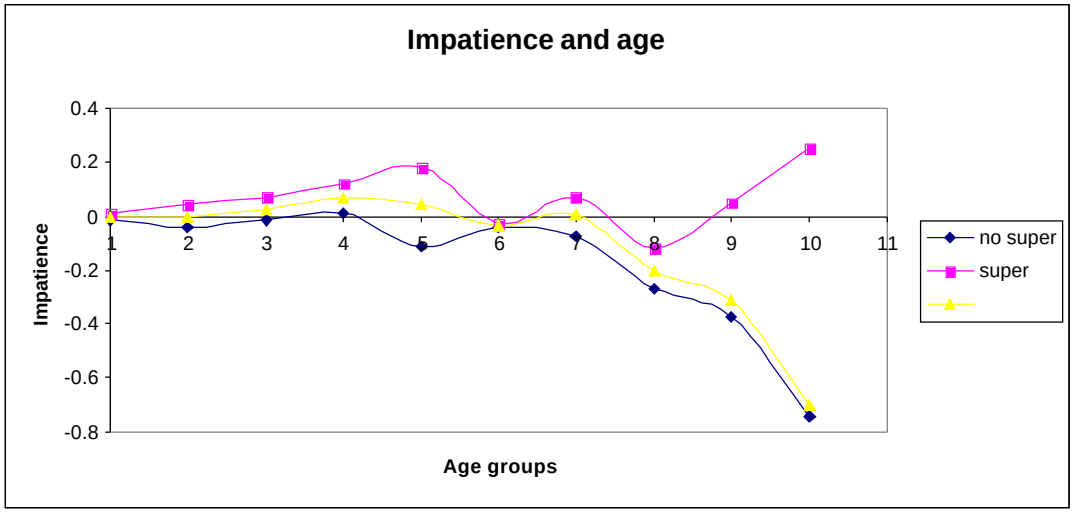


FIGURE III

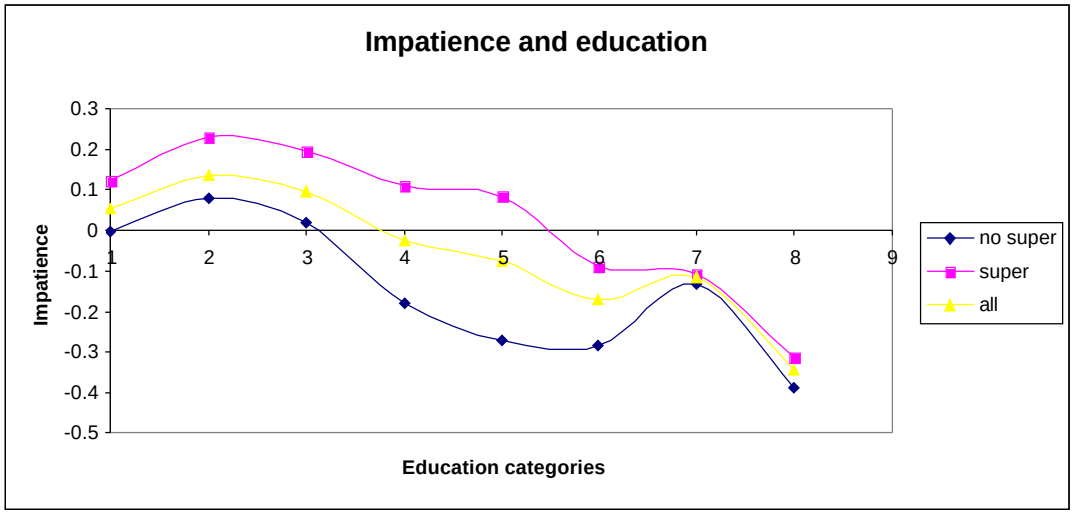


Note: Age categories 9 and 10 for households with super are not strictly valid since they include only 5 and 1 observations, respectively.

Key to figure III

1: 25-29 years	6: 50-54 years
2: 30-34 years	7: 55-59 years
3: 35-39 years	8: 60-64 years
4: 40-44 years	9: 65-69 years
5: 45-49 years	10: 70-74 years

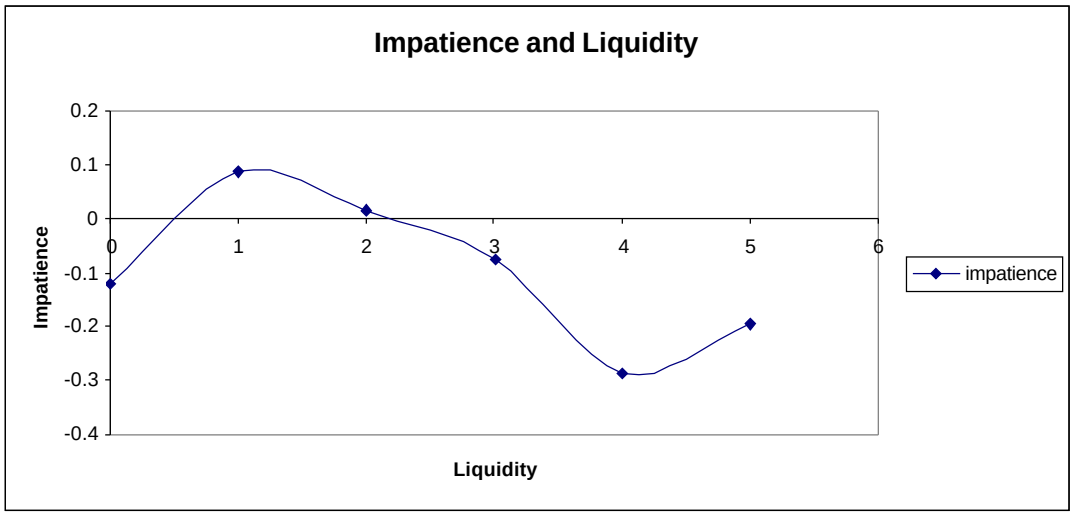
FIGURE IV



Key to figure IV.

1-school only	5-undergrad dip
2- bas voc	6-bachelor
3-skill voc	7-postgrad diploma
4-ass dip	8-higher degree

FIGURE V



Note: Category 1 is only illiquid assets held and category 5 is only liquid assets held. Intermediate categories are in decreasing liquidity. Illiquid assets include superannuation, residence and property. Liquid assets include bank deposits and stocks.

TABLE VIII: IMPATIENCE AND ILLIQUID ASSETS. PROBIT ESTIMATION.

Dependent variable: Superannuation and Annuities	*Coefficient (z-score in parentheses)*	*Marginal effects*
Impatience	0.0556**	0.0222
	(2.13)	
Age	0.1017***	0.0405
	(5.93)	
Age squared	-0.0011***	-0.0004
	(-5.40)	
HH income (no investment)/1 000	0.0062***	0.0025
	(6.78)	
High school only†	0.1725**	0.0687
	(2.05)	
Intermediate education†	0.0320	0.0128
	(0.53)	
Higher Degree†	0.2208***	0.0879
	(2.77)	
Gender† (Male=0)	-0.2461***	-0.0974
	(-4.54)	
Family size	-0.0202	-0.0080
	(-0.95)	
Marriage †	0.0298	0.0119
	(0.43)	
Managers & Administrators†	0.3213***	0.1273
	(2.68)	
Professionals†	0.2798***	0.1112
	(2.59)	
Associate Professionals†	0.2807***	0.1115
	(2.64)	
Tradespersons & related workers†	0.1339	0.0534
	(1.23)	
Advanced Clerical & Service workers†	0.3510**	0.1386
	(2.21)	
Intermediate Clerical, Sales & Service workers†	0.3301***	0.1309
	(3.05)	
Intermediate production & transport workers†	0.1461	0.0582
	(1.31)	
Elementary clerical, sales & service workers†	0.2912**	0.1155
	(2.20)	
Home owner†	0.2662***	0.1051
	(4.02)	
*Home owner*dwelling value/10 000*	-0.0115***	-0.0046
	(-5.14)	
Dividend income dummy†	0.2141***	0.0852
	(3.75)	
*Dividend dummy*dividend income*	-0.0002	-0.0001
	(-0.76)	
Property income dummy†	0.0767	0.0306
	(1.10)	
Bank income dummy†	0.2101***	0.0836
	(3.79)	
*Bank interest dummy*bank interest income*	-0.0037***	-0.0015
	(-2.92)	
*Property dummy*property income*	-0.0003	-0.0001
	(-0.96)	
Principal income – wages†	0.9208***	0.3333
	(6.28)	
Principal income – self employed†	0.4078**	0.1607
	(2.53)	
Principal income – investments†	0.3464	0.1368
	(1.56)	
Constant	-3.8579***	
	(-10.09)	

N=3491
Wald chi2(29) = 433.73
Log pseudo likelihood = -2159.24
Pseudo R2 = 0.1069
Per cent correctly predicted = 65.77%
****, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.*
† indicates dummy variable and marginal effects are for discrete change of dummy variable from 0 to 1. Robust standard errors.

TABLE IX: MULTIVARIATE PROBIT ESTIMATION.

Multivariate Probit	*Superannuation*	*Stocks*	*Property*	*Bank Deposits*	*Home*
Impatience	0.0596**	-0.0658**	-0.0073	-0.0971***	0.0102
	(2.31)	(-2.31)	(-0.23)	(-3.57)	(0.36)
Age	0.1063***	0.0186	0.1155***	0.0412**	0.1005***
	(6.31)	(1.04)	(4.91)	(2.32)	(5.52)
Age squared	-0.0011***	-0.0000	-0.0011***	-0.0002	-0.0007***
	(-5.76)	(-0.17)	(-4.17)	(-1.03)	(-3.58)
HH income (no investment)/1000	0.0057***	0.0042***	0.0038***	0.0034***	0.0033***
	(6.19)	(5.09)	(4.32)	(4.29)	(3.13)
Marriage†	0.0576	0.1183	0.3545***	0.2485***	0.5346***
	(0.84)	(1.55)	(3.80)	(3.48)	(7.16)
Gender†(Male=0)	-0.2447***	-0.1177**	-0.0818	-0.0250	-0.0252
	(-4.55)	(-1.96)	(-1.18)	(-0.44)	(-0.43)
Family size	-0.0292	-0.0034	-0.0137	-0.1006***	0.0721***
	(-1.39)	(-0.14)	(-0.52)	(-4.51)	(2.94)
Managers & Administrators†	0.3216***	0.5538***	0.5941***	0.2619**	0.1476
	(2.72)	(3.98)	(3.48)	(2.18)	(1.18)
Professionals†	0.2940***	0.4507***	0.4933***	0.0815	0.1674
	(2.75)	(3.40)	(3.01)	(0.73)	(1.49)
Associate Professionals†	0.2744***	0.5697***	0.4880***	0.1135	0.2538**
	(2.62)	(4.35)	(3.01)	(1.03)	(2.30)
Tradespersons & related workers†	0.1598	0.3757***	0.2693	-0.0097	0.2581**
	(1.49)	(2.82)	(1.57)	(-0.09)	(2.29)
Advanced Clerical & Service workers†	0.3587**	0.6378***	0.7228***	0.0871	0.4504***
	(2.28)	(3.53)	(3.50)	(0.51)	(2.63)
Intermediate Clerical, Sales & Service workers†	0.3418***	0.4184***	0.3981**	0.1128	0.3027***
	(3.20)	(3.09)	(2.38)	(1.00)	(2.74)
Intermediate production & transport workers†	0.1398	-0.0094	0.3346*	-0.1392	-0.0198
	(1.26)	(-0.06)	(1.95)	(-1.15)	(-0.17)
Elementary clerical, sales & service workers†	0.2869**	0.3272**	0.3168	0.1652	-0.1184
	(2.20)	(1.98)	(1.59)	(1.19)	(-0.90)
High school only†	0.1660**	0.1911**	0.2201**	-0.0139	0.0467
	(2.00)	(2.06)	(2.02)	(-0.16)	(0.53)
Intermediate education†	0.0277	0.1737**	0.1179	0.0803	0.1457**
	(0.46)	(2.50)	(1.48)	(1.25)	(2.21)
Higher Degree†	0.2109***	0.3813***	0.2353**	0.2090**	0.1959**
	(2.69)	(4.38)	(2.43)	(2.54)	(2.24)
Principal income – wages†	0.9345***	0.1901	0.1145	0.2766**	0.1582
	(6.46)	(1.33)	(0.65)	(2.24)	(1.32)
Principal income – self employed†	0.4044**	0.0111	0.1304	0.1956	0.4506***
	(2.55)	(0.07)	(0.68)	(1.39)	(3.23)
Principal income – investments†	0.2659	0.7044***	0.7404***	0.7510***	0.2772
	(1.26)	(3.62)	(3.22)	(4.08)	(1.38)
Constant	-3.8099***	-2.5417***	-5.0815***	-2.4434***	-3.3645***
	(-10.19)	(-6.29)	(-9.43)	(-6.21)	(-8.55)
Estimates of error Correlations					
ρ *with superannuation*	-------	0.1190***	0.0538	0.0928***	0.0530*
	-------	(3.84)	(1.48)	(3.10)	(1.71)
ρ *with stocks*	-------	-------	0.1736***	0.2831***	0.1665***
	-------	-------	(4.74)	(9.39)	(4.80)
ρ *with property*	-------	-------	-------	0.1525***	-0.0002
	-------	-------	-------	(4.34)	(-0.01)
ρ *with bank deposits*	-------	-------	-------	-------	0.1119***
	-------	-------	-------	-------	(3.40)
N = 3491					
Log Pseudo likelihood = -8820.94					
Wald chi2 (105) = 1346.07					
***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.*					

Multivariate Probit estimation using the GHK simulated ML method with robust standard errors. Based on 60 draws. Coefficients with z-score in parentheses.

TABLE X: LIQUID AND ILLIQUID ASSET HOLDINGS.

Number of Liquid assets held	*Number of Illiquid assets held* 0	1	2	3	*Total*
0	404	946	651	68	2,069
	19.53	45.72	31.46	3.29	100
	78.75	63.32	51.54	30.77	59.27
1	91	417	444	100	1,052
	8.65	39.64	42.21	9.51	100
	17.74	27.91	35.15	45.25	30.13
2	18	131	168	53	370
	4.86	35.41	45.41	14.32	100
	3.51	8.77	13.3	23.98	10.6
Total	513	1,494	1,263	221	3,491
	14.69	42.8	36.18	6.33	100
	100	100	100	100	100

Distribution and frequencies of the number of liquid and illiquid asset holdings by households.

Key to Table X
Frequency
Row percentage
Column percentage

TABLE XI

Liquidity	*Frequency*	
0	404	No assets held
1	1,665	Only illiquid assets held
2	597	Mostly illiquid assets
3	585	Equal holding of illiquid and liquid
4	131	Mostly liquid assets held
5	109	Only liquid assets held

Number of households by liquidity category. Category zero represents no assets held

TABLE XII: LIQUIDITY AND IMPATIENCE.

Multinomial Logit estimation.	*Liquidity Categories – category 1 omitted (only illiquid assets held)*				
	0 No assets	*2*	*3*	*4*	*5 liquid assets only*
Impatience	-0.1372*	-0.1168**	-0.1709***	-0.3439***	-0.2437*
	(-1.89)	(-2.05)	(-2.97)	(-3.40)	(-1.94)
Age	-0.2100***	0.1751***	0.0023	-0.1089*	-0.0811
	(-4.72)	(4.11)	(0.06)	(-1.86)	(-1.07)
Age squared	0.0019***	-0.0015***	0.0003	0.0016**	0.0006
	(3.62)	(-3.06)	(0.66)	(2.52)	(0.66)
HH income (no investment)/1000	-0.0177***	0.0107***	0.0039**	0.0034	-0.0093*
	(-4.70)	(6.29)	(2.00)	(1.02)	(-1.83)
High school only†	-0.3416	0.4704**	-0.0538	0.0736	-0.0089
	(-1.63)	(2.45)	(-0.29)	(0.19)	(-0.02)
Intermediate education†	-0.2578*	0.4876***	0.0114	0.1977	0.2449
	(-1.68)	(3.44)	(0.08)	(0.73)	(0.86)
Higher Degree†	-0.4642**	0.7219***	0.1690	0.7538**	0.3286
	(-1.98)	(4.17)	(0.98)	(2.33)	(0.80)
Gender†(Male=0)	0.4354***	0.0466	-0.0142	0.0574	-0.0975
	(3.08)	(0.37)	(-0.12)	(0.24)	(-0.38)
Family size	-0.1591**	-0.1142**	-0.1268***	-0.1217	-0.3013***
	(-2.42)	(-2.54)	(-2.70)	(-1.32)	(-2.63)
Marriage †	-0.4212**	0.6241***	0.1872	0.1597	-0.2042
	(-2.31)	(3.80)	(1.23)	(0.60)	(-0.68)
Managers & Administrators†	-0.8515**	0.6740**	0.5309**	0.5792	0.3061
	(-2.43)	(2.22)	(2.08)	(1.16)	(0.62)
Professionals†	-0.3943	0.4199	0.2088	0.2068	0.0949
	(-1.51)	(1.46)	(0.88)	(0.43)	(0.20)
Associate Professionals†	-0.6771**	0.4988*	0.3812*	0.4611	-0.4621
	(-2.64)	(1.74)	(1.65)	(0.97)	(-0.96)
Tradespersons & related workers†	-0.3110	0.4007	0.0117	-0.1222	0.0834
	(-1.28)	(1.37)	(0.05)	(-0.23)	(0.19)
Advanced Clerical & Service workers†	-0.8905**	0.8437**	-0.0229	0.7022	-27.9524***
	(-2.33)	(2.22)	(-0.06)	(1.08)	(-68.81)
Intermediate Clerical, Sales & Service workers†	-0.7857***	0.5324*	0.0433	0.5131	-0.4301
	(-3.24)	(1.81)	(0.18)	(1.05)	(-0.90)
Intermediate production & transport workers†	-0.0616	0.1359	-0.5178*	-0.5717	-0.0965
	(-0.26)	(0.43)	(-1.92)	(-0.93)	(-0.20)
Elementary clerical, sales & service workers†	-0.1013	0.4928	0.0031	0.7342	0.3151
	(-0.37)	(1.33)	(0.01)	(1.31)	(0.62)
Principal income – wages†	-0.3487	0.8891**	0.2700	-0.0813	-0.3874
	(-1.50)	(2.17)	(0.99)	(-0.18)	(-0.90)
Principal income – self employed†	-0.7881***	0.3293	0.1869	0.0678	-1.3464**
	(-2.70)	(0.75)	(0.62)	(0.14)	(-2.28)
Principal income – investments†	-0.0548	1.5408***	1.3057***	1.5601***	0.5608
	(-0.11)	(2.88)	(3.22)	(2.77)	(0.81)
Constant	6.0594***	-8.2536***	-2.1095**	-1.5665	1.2233
	(6.62)	(-8.50)	(-2.54)	(-1.12)	(0.72)

N=3491.
Log pseudo likelihood = -4555.11
Pseudo R = 0.0910
Wald chi2(105) = 33008.82
****, **, and * indicate significance at the 1%, 5% and 10% levels, respectively. † Indicates dummy variables*