

Present-Biased Preferences and Money Demand

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Abstract

Participants in the De Nederlandsche Bank Household Survey (DHS) were asked questions allowing to elicit subjective discount factors over different time horizons. The answers of most participants indicate present-bias as they show a higher annualized nominal rate of return for a three-month delay than for a twelve-month delay. One way to deal with one's present-bias problem is to impose limits on future spending by holding wealth in non-liquid assets. We therefore predict that agents with more severe present-bias problems hold a lower share of their wealth as money. Our data provide statistically significant evidence in support of this prediction. (JEL classification: *D11, D12, D90*)

Key words: Behavioral Economics, Intertemporal choice, Non-exponential Discounting, Pre-commitment, Present-bias.

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1 Introduction

Over the last two decades, empirical research on inter-temporal choice has documented various inadequacies of the traditional discounted utility model as a descriptive model of behavior. One major limitation of the traditional discounted utility model is the assumption that discount rates are constant over time. A large part of the empirical evidence, based either on experimental and survey data, suggests that the average discount rate over longer intervals is lower than the average discount rate over shorter intervals. Moreover, and related to this, many individuals prefer an immediate smaller reward over a delayed larger reward, but prefer the delayed larger reward when a constant delay is added to both options. These individuals have time inconsistent preferences and, in particular, present-biased preferences (PBP).

Beginning with R.H. Strotz (1955) and Phelps and Pollack (1968), a number of models propose a theory compatible with these facts.¹ More recently, Benhabib et Al. (2010) elicit preferences for money-time pairs via experimental techniques and, in line with most of the previous literature, find that discount rates are high and decline with both delay and amount. They also find clear evidence for present-bias and that data favor a specification with a small present-bias in the form of a fixed cost. In a field study conducted in the United States, Meier and Sprenger (2010) find that individuals with PBP are more likely to have credit card debt.

A common implication of these models is that sophisticated individuals may voluntarily engage in commitment devices to improve their welfare.² For instance, in a field experiment study in the Philippines, Ashraf et Al. (2006) find that women with PBP - showing preference reversals on hypothetical time discount questions - were more likely to open a commitment saving product. Bauer et Al. (2012) propose a field experiment study involving Indian microfinance clients where discount rates are elicited using choices over actual rewards. They find that women with PBP are more likely than others to borrow through microcredit institutions. Fang and Silverman (2009) empirically implement a dynamic structural model of labor supply and welfare program participation for agents with potentially time-inconsistent preferences, and examine the potential gains from commitment mechanisms such as welfare time limits and work requirements. Akin (2012) shows that, in costly long-run projects providing a bonus motive, agents with higher self-control problems should be given a higher bonus to prevent inefficient procrastination. Moreover, procrastination appears to decrease when partial naives learn self-preferences.

In this paper, we make use of subjective discount factors elicited by CentERdata, a survey agency at Tilburg University specializing in internet surveys, and included in the De Nederlandsche Bank Household Survey (DHS). For instance, in one of the questions we consider, respondents are asked every year in the time period between 1995 and 2002 to indicate the

¹For instance, these models assume hyperbolic or quasi-hyperbolic preferences (Ainslie 1992; Laibson 1997; O'Donoghue and Rabin 1999; Frederick et Al. 2001) theories of temptation (Gul and Pesendorfer 2001, 2004), or dual-self models of self-control (Fudenberg and Levine 2005) to reconcile facts and theory.

²A review of theories and empirical evidence on the use of commitment devices is provided by Bryan et Al. (2010).

amount of money they require to compensate for the receipt of hypothetical rewards later in time (in three months and twelve months). Time preference estimated this way may capture a combination of true time preference and the expected change in the marginal utility of money. Moreover, consider the case that consumers are liquidity constrained. The self-assessed time preference will be a combination of true time preference and a higher expected change in the marginal utility of money than that of unconstrained consumers. A related problem arises if we consider a standard model without present biased preferences where the discount factor depends on the actual market interest rate at the margin of the individual portfolio. In such a case, for some the relevant marginal rate would be the (high) interest rate on debt, while for others it would be the (low) interest rate on savings deposits. Another potential problem is that people may be more skeptical about the delivery of future payments than they are about current payments. As our empirical model relies on a present-bias index (*PBI*), which is obtained by taking the ratio of annualized subjective discount rates of different maturities, the index is likely to be purified from the last two problems. We discuss below how we address the liquidity constraints problem.

Our principal aim is to determine whether these discount factors are useful information and whether the resulting present-bias indexes may help us predict answers on simple questions about objectively observable variables. The experimental literature provides evidence that this relationship exists. Whether this relationship also emerges with survey data, where the subjects are not guided by the experimenter and no monetary incentives are provided, is an open question remained unexplored so far.

In addition, we want to understand whether subjects with present-biased preferences adopt pre-commitment strategies to prevent themselves from consuming more in the future than would be ideal from the perspective of the present. Apart from buying commitment saving products, present biased individuals may in any case seek to avoid liquidity both by underweighting in money and overweighting in illiquid assets. This is what we want to study. The definition of money we use corresponds to M2 excluding cash and is equal to the sum of net balances of checking accounts, savings arrangements, savings certificates, deposit accounts and deposit passbooks controlling for private loans, extended lines of credit, loans from family or friends, study loans, credit card debts, outstanding debts on hire-purchase contracts, debts based on payment by installment and/or equity based loans, outstanding debts with mail-order firms, shops or other sorts of retail business. As a proxy of illiquid assets, we consider both the value of the house and housing equity.

Throughout our null hypothesis is that all agents have time consistent preferences and that answers to hypothetical questions which seem to indicate otherwise are uncorrelated with choice behavior. Alternatively, the null can also be interpreted as evidence that individuals have present-biased preferences but do not engage in pre-commitment devices. We motivate the alternative hypothesis by considering the behavior of a sophisticated agent with PBP. It is also

possible that individuals hold less liquid assets simply because they spend their money more quickly. In the subsequent sections, we discuss and empirically evaluate to what extent this latter interpretation of results can be considered less likely.

If *PBI* were meaningless, we should not find any statistically significant relationship with the subjects' money demand. However, we find evidence that subjects with more severe PBP hold less of their wealth as money. Importantly, agents with higher *PBI*, elicited at one time, hold less money at other times. Given the potential effect of liquidity constraints on elicited *PBI*, this somewhat weakens a very important concern about the direction of causation. Our results are robust to various specifications of the model and sample. A possible interpretation is that individuals with PBP are to some extent sophisticated and implement pre-commitment strategies (Shefrin and Thaler, 1981; Laibson, 1997; Ashraf et Al., 2006; Bauer et Al., 2012; Bryan et Al., 2010).

There is ample experimental evidence supporting the hypotheses that most people have time inconsistent (and present-biased) preferences and that some peoples' preferences are more time inconsistent than others'. Choices made in experiments illustrate that people value pre-commitment devices.³ Furthermore, directly elicited discount factors over different time horizons help explain differences in behavior in experimental settings. These valuable observations leave two important questions open. Can useful information about rates of time preference be elicited in a survey? Do ordinary economic decisions regularly made by economic agents depend on time inconsistency in the way theorists predict?

It is very possible that answers on questions about rates of time preference are particularly problematic. The quantities to be elicited appeared first in the work of economic theorists (Strotz, 1955) and it is not clear that they can be described in plain English (or in our case Dutch). In fact, the questions used in the CentERdata survey are ambiguous. To give a meaningful answer to such questions, respondents have to make an effort to understand the questions followed by an effort to introspect. While it is conventional for economic theorists to assume that introspection is effortless, it isn't for everyone (the reader is invited to introspect to find if introspection is effortless for him or her).

Our null hypothesis is that survey elicited psychological parameters are not related to actual economic behavior. Our preferred alternative hypothesis is that agents are sophisticated in the sense of Strotz (1955). It is also possible that agents are unsophisticated. It is not easy to understand or model the behavior of an unsophisticated agent. Therefore, while our statistical tests are designed to test the null against the alternative that agents are sophisticated, we can't rule out the possibility that they are unsophisticated.

The remainder of the paper is organized as follows. Section 2 describes the main features of the data set and defines the present-bias index. Section 3 presents the econometric model. Section 4 reports the empirical results and robustness checks. The final section concludes.

³See, for instance, Ashraf et Al. (2006), Bauer et Al. (2012) and, for an updated review, Bryan et Al. (2010).

2 Data

Our analysis is based on De Nederlandsche Bank Household Survey (DHS), managed by CentERdata, a research institute at the University of Tilburg (The Netherlands), that was launched in 1993. DHS is a household survey in which all members of the household are requested to fill out a questionnaire every year. However, children are not asked most of the survey questions when they are below age 16.⁴

The DHS is an unbalanced panel. When the survey started, it consisted of two panels, one representative of the Dutch population (RE), including 1,760 households, and the other representative of high-income earners with an annual gross income higher than Dfl. 105,000 (HI), including approximately 900 families. The last wave of the panel consists of 1,800 households in the RE panel and only 29 in the HI panel. The severe reduction in the HI panel is due to the fact that since 1997 new families have not been recruited for the HI panel, so it quickly shrank as the higher income families exited the panel.

The dataset is uniquely suited for our purposes, because it contains both a financial section with information on assets and liabilities, such as checking and savings account balances, home ownership and mortgages, and a psychological section with subjective information.

The period we consider in our analysis runs from 1997 to 2002, as some variables of interest were collected only in these years. All variables are derived from the self-reported information in the questionnaire. Self-reported information on income, assets and liabilities have been aggregated by CentERdata.

Data on wealth are reported by the agents in the questionnaires on assets and liabilities and accommodation and on mortgages and then aggregated by CentERdata into a dedicated data set. If the respondent declared ownership of a particular asset but didn't report its value, he was asked to choose among several intervals. If he chose a range, the middle value of the range is imputed, otherwise no value is reported. Household total wealth is obtained summing durable goods together with savings, checking account balances, bonds, stocks, debts and real estate of all the family's members.

The estimate of total net family income we use is supplied by respondents. It is derived from a question where respondents are asked to indicate the interval which corresponds to the income realized over the last twelve months.⁵

The dataset includes questions - asked every year in the period under consideration - that can be used to derive subjective discount rates.⁶ Specifically, there are sixteen questions involving different time horizons (three months or a year), size of amounts (1,000 and 100,000 Dfl.) and different framing (receipt/payment and delay/speed-up). Respondents are asked to state

⁴A detailed description of the DHS dataset, that was formerly known as Center Savings Survey (CSS) and before that as VSB panel, can be found in Nyhus (1996) and Giamboni et Al. (2013).

⁵Alternative estimates of income were taken into consideration and results did not change.

⁶Questions on the discount factor have been used in a number of articles. For instance, see Nyhus, 1999 and Donkers and van Soest, 1999.

the present (or future) amount, which in their opinion is equivalent in value to a future (or present) amount presented by the researcher. When the respondents answer, they implicitly use a discount rate, which is assumed to be their subjective discount rate. As delayed consequences are often associated with risk, it is stressed that the delays are without any risk of losing the reward. These questions are administered to the respondents in Dutch language. The English translation of such questions, as provided by CentERdata, is reported in an appendix, which is available on request. In our investigation we make use of the principal component analysis to extract from the sixteen questions the dominant patterns of the two subjective discount rates with a three-month maturity and twelve-month.

Using information from these questions as an estimate of the subjective discount rate may be problematic for a number of reasons. To illustrate such problems, we consider the first two questions on the discount factor. They concern the compensation subjects require for receiving an hypothetical money reward with delay of either three months or twelve months. The exact text is as follows:

Imagine you win a prize of Dfl. 1,000 in the National Lottery. The prize is to paid out today. Imagine, however, that the lottery asks if you are prepared to wait THREE MONTHS (A YEAR) before you get the prize. There is no risk involved in this wait. How much extra money would you ask to receive at least to compensate for the waiting term of THREE MONTHS (A YEAR)? If you agree on the waiting term without the need to receive extra money for that, please type 0 (zero).

In the questions above, for example, while it is clear that CentERdata aimed to elicit rates of pure time preference (note ‘at least to compensate for the waiting’), the question can be interpreted as referring to something quite different, the current nominal discount factor, because of the reference to the present situation.⁷ It is possible that at least some respondents based their response on their current marginal utility of consumption and the expected marginal utility of the delayed consumption. If they were liquidity constrained at the time of the survey, they might expect considerably higher consumption after the delay. In that case the reported discount rate will be contaminated by an unusually high expected ratio of current to future marginal utility.

A closely related problem is that, in standard models without present biased preferences, agents’ discount factors should depend on the market interest rate which they face, and that debtors face a higher interest rate than savers.⁸ This would not be a problem for us if debtors face equally high annual and (annualized) three-month interest rates, since - as we explain below - our measure of present bias depends on the ratio of three-month and twelve-month discount factors. In contrast, our measure of present bias will be distorted if agents are currently in debt

⁷It is not clear if respondents would have given the same answer if asked about a reward to be paid out at some indefinite time t in the future and asked how much more they would require to collect it at t plus three months and at t plus twelve months.

⁸We are very thankful to an anonymous referee for proposing this clearer and simpler example of the possible problems.

but expect to repay the debt within the year. In these presumably relatively rare cases, the relevant three-month and annual market interest rates can be quite different.

Since our interest is in the effect of time preference over different horizons on liquidity preference, these are very serious problems. We wish to know if a high rate of time preference over three months compared to the rate of time preference over twelve months causes respondents to avoid liquidity. If respondents interpret the questions as referring to the current three-month and twelve-month discount factors - which depend not only on time preference but also on the marginal utility of consumption at the present and in three months or in twelve months - then liquidity constrained agents (and short-term debtors) will appear to have PBP simply because they currently have low consumption and a high marginal utility of consumption.

To deal with the potential endogeneity of the responses to the question reported above, we consider the relationship between money holdings at time t and the average of responses by the same household at times different from t . A shock to money holdings at time t , such as an unexpected large expense, might affect the responses at time t but should not affect the average responses at times other than t .

It remains possible that agents systematically find themselves liquidity constrained (or in debt) for example at the end of each month. It is possible that such agents are so very unsophisticated that they haven't noticed this and that they make financial decisions (say at the beginning of the month) assuming that they won't be liquidity constrained (or in debt) in the upcoming month.⁹ Alternatively, it is possible that agents notice the pattern but refrain from choosing high money balances anyway, because they do not wish to be free to spend for the whole month. We consider such behavior to be sophisticated in the sense of Strotz.

Table 1 shows some descriptive information of responses to the questions reported above. The number of head of households participating in the DHS survey ranges between 1,549 and 2,239, depending on the year (column 1). The number of subjects who provided all the information necessary for implementing the estimation analysis independently from the fact they provided the information on the discount factor or not are between 510 and 1762, depending on the year. The majority of these respondents also gave valid answers on the discount factor (column 3 and 4). The share of subjects who answered 'zero' to the questions on the discount factor ranges between 7 and 15 % (column 5 and 6). The responses to the other fourteen questions on discount factor show similar rates of responses (overall, zero and positive values).

[Table 1 About Here]

The share of 'zeros' declines across waves, while the number of non-responses increase. Some respondents may have used 'zero' and 'do not know' as substitutes. If this is true, using observations with discount rates of zero may cause our estimates to be biased. Moreover, it

⁹In the subsequent sections, we consider alternative strategies to address the problem of endogeneity.

is reasonable to expect that, among respondents who did not ask any extra-compensation, some may have a negative discount rate because they want to restrain themselves from spending all the money at once, i.e., are prepared to pay a premium to enforce self-control (Shefrin and Thaler, 1988; Kahneman and Thaler, 1991). In previous analyses of similar data (e.g. Daniel, 1994), the respondents who reported discount rates equal to zero, were deleted from the sample. Instead, we will perform our estimates both including and excluding these observations.

Discount rates at three months and at twelve months can be derived from the answers to the questions above applying the following simple rules:¹⁰

$$DR3_i = \left(1 + \frac{\text{extra amount of money}}{1,000} \right)^4 - 1$$

$$DR12_i = \frac{\text{extra amount of money}}{1,000}$$

where subscript i refers to the number of the question. Discount rates obtained in this fashion can only be interpreted under the following usual assumptions (see also Read, 2004): (a) Both the present and delayed outcomes occur with certainty. (b) All outcomes are consumed immediately. (c) The outcomes are context independent. As a simple example, consider a liquidity constrained person who expects her income to increase with time. For this person, the future outcome evaluated in the context of her future wealth may indeed carry a lower utility than the present outcome evaluated in the context of her present wealth. (d) The utility of the outcome (x) is multiplicative in x . This means that the function linking $u(x)$ to x is approximately linear over the relevant range. In our case this means that the prize is small enough that it has a negligible effect on the marginal utility of wealth. (e) Utility from outcomes is time independent. Expressed more formally, this assumption states that $u(x_1)$ is independent of when x_1 occurs.

Table 2 shows means and standard errors of the sixteen annualized discount rates calculated over all sampled individuals and time. The $DR3_i$ show average values ranging between 0.02 and 0.31. $DR12_i$ show average values ranging between 0.02 and 0.19. Such values seem in line with the other estimates in literature.¹¹ Note also that all $DR3_i$ s have higher mean values than the respective $DR12_i$ s. This finding is evidence against the exponential discount function. The possible presence of an upward bias in subjective discount rates, as suggested some previous studies, is unlikely to be the responsible of the non-exponential discount function as such bias

¹⁰These formulas can be used to calculate the annualized discount rates at three and twelve months from answers to the sixteen questions on the discount factor. Specifically, the formulas reported below are suitable for questions 1, 5, 9, 13 and 2, 6, 10 and 14, respectively. The remaining three-month and twelve-month discount rates can be obtained by applying the same two formulas reported below, but substituting '1,000' with '100,000', to the answers to questions 3, 7, 11, 15, and 4, 8, 12, 16, respectively.

¹¹The fact that only 1 % of individuals made the mistake of requesting a greater amount for the shorter delay of waiting suggests that the responses were roughly accurate. These observations are dropped from the data.

would affect both discount rates and probably more intensively the further delay in the future ($DR12_i$). However, this evidence is not sufficient to clearly identify which alternative discount function is used by individuals. The hyperbolic function, the quasi-hyperbolic with variable or fixed cost or even other explanations are consistent with our evidence. Table 2 also shows that the $DR3_i$ s have more variability than the $DR12_i$ s, suggesting that individuals are more heterogeneous when the delay is short and that such differences decline as the delay increases.

[Table 2 About Here]

Principal Components Analysis and the Time Inconsistency Index

To obtain a single pair of discount rates in place of the eight pairs resulting from the sixteen questions, we make use of the principal component analysis (*PCA*). We perform a *PCA* on all eight discount rates at three months to obtain a single estimate ($DR3$), and we employ the same procedure to obtain a single estimate of the discount rate at twelve months ($DR12$).¹² We can use $DR3$ and $DR12$ to infer a quantitative measure of time inconsistency of preferences by the formula:

$$PBI^* = \frac{1 + DR3}{1 + DR12} - 1$$

If PBI^* is close to zero, individuals have approximately constant discount rates and hence time consistent preferences. The reverse is true the more PBI^* is far from zero. Overall, 2,069 respondents exhibit present-bias ($PBI^* > 0$), while 1489 show future-bias ($PBI^* < 0$). Our analysis only focuses on the financial behavior of those with subjective discount rates declining as the time delay increases (present-biased individuals). Moreover, as there is no reason to believe that future biased individuals (those with $PBI^* < 0$) engage in similar commitment devices, in the next sections we replace PBI^* with the following simple transformation:

$$PBI = \begin{cases} \frac{1+DR3}{1+DR12} - 1 & \text{if } PBI^* \geq 0 \\ 0 & \text{if } PBI^* < 0 \end{cases}$$

Table 3 reports summary statistics referring to the set of variables used in the estimation analysis.¹³ We show means and standard errors distinguishing between individuals with present-biased preferences and individuals with either time consistent or future biased preferences. T-test

¹²We use the *pca* routine of *STATA11* with option 'components' set to 1. After examined the diagnostics, we have persuaded that the only first component is sufficient to identify the dominant pattern that relates all answers on the discount factor.

¹³A more detailed explanation of the variables, including the exact questions from which they are derived, is provided in an appendix, which is available on request.

suggests that the difference between the means of the two groups is statistically significant in the case of wealth, money demand, age, expected inflation and credit restriction occurrence. In contrast, we do not find significant differences in the mean values of the two groups for the remaining variables, including the education level.

[Table 3 About Here]

3 Econometric specification

The empirical model we consider is as follows

$$A_{it} = \alpha_0 + \alpha_1 PBI_{it} + \alpha_2 IM_{it} + \alpha_3 Z_{it} + \eta_{it} \quad (1)$$

where A indicates the logarithm of the amount of a specific household liquid asset; PBI is the present-bias index; IM is an index for the degree of impatience; Z is a set of variables including the logarithm of the family's income and the logarithm of the family's total wealth, the logarithm of the amounts of each kind of liability (private loans, extended lines of credit, loans from family or friends, study loans, credit card debts, outstanding debts on hire-purchase contracts, debts based on payment by installment and/or equity based loans, outstanding debts with mail-order firms, shops or other sorts of retail business), the subjective expected inflation rate, the respondent's age, the number of income recipients in the household, the number of people in the household, whether any household member is looking for a job, whether any credit refusal or restriction occurred, university education, dummies for financial sophistication, employment sector (whether public or private), time and regional dummies (to account for common shocks); η is the error term.

The null hypothesis ($\alpha_1 = 0$) is compatible with two alternative or concurrent interpretations. On the one hand, it may correspond to the hypothesis that survey respondents actually have time consistent preferences and that the responses to the sixteen questions are uncorrelated with real behavior - that the apparent present-bias reported is due to misunderstanding of the questions or a failure of introspection or lack of motivation to answer seriously. On the other hand, the null hypothesis may also mean that individuals with PBP do not engage in the examined commitment devices and therefore they are unsophisticated. The alternative hypothesis has the joint implication that i) respondents understand questions and report their own true discount rates and ii) individuals with PBP have sophisticated behavior, exploiting commitment strategies in order to improve their welfare.

While the above reported interpretation is plausible, it may also be possible that individuals with PBP are naïve and, for instance, hold a lower share of their wealth in liquid assets as a

result of spending the most liquid assets first. If this second explanation applies, we may expect these individuals to consider themselves as liquidity constrained. As pointed out in the section above, one way to deal with this endogeneity problem is to consider the average responses on the discount factor at times other than t . To consider the fact that people might find themselves systematically liquidity constrained in all the interviews, we include a dummy variable in all specifications of the model to control for respondents' self-reported credit restriction or refusal and evaluate how it affects correlation between money demand and PBI .¹⁴ Finally, in the robustness checks section, we provide further evidence in support of the commitment motivation. Specifically, we examine whether people with more PBP are those that, apart from holding less liquidity, also buy a greater amount of illiquid assets to refrain from excessive immediate consumption.¹⁵

Previous evidence suggests that the average level of patience (either current or future) may differ between present-biased individuals and time consistent individuals. An estimate of the degree of impatience (IM) is included to distinguish between the effect of present-bias (change in discount rate) and the effect of higher impatience. There is not a consensus about what variable is better to choose as an estimate of the degree of impatience. Ashraf et Al. (2006) control for both current and future patience. Meier and Sprenger (2010) control for the average of current and future discount rate. Bauer et Al. (2012) run a dual set of comparisons: in one specification they control for current discount rate and measure the difference in present-biased behavior relative to individuals with same current patience but time consistent; in the second specification they control for future discount rate. We will allow IM to correspond to the principal components of the subjective annualized discount rates at three months and twelve months ($DR3$ and $DR12$).

One of the potential reasons why $DR3$ is higher than $DR12$ is that people are unable to annualize interest rates and underestimate the power of exponential growth (Stango and Zinman, 2009). If that were the case, PBI may capture, at least in some cases, less financially sophisticated people instead of present-biased individuals and this may affect financial behavior. As underlined by Stango and Zinman, less financially sophisticated individuals are expected to save less and prefer shorter maturities. It is not clear how this may affect demand for liquidity. It is likely that financial naïveté is positively related to lack of self-control (or present-bias) and produces similar effects, that is, lower share of liquid assets may be the result of spending the most liquid assets first. Gathergood (2012) finds that both lack of self-control and financial illiteracy are positively associated with non-payment of consumer credit and self-reported excessive financial burdens of debt with a stronger role for lack of self-control than for financial illiteracy in explaining consumer over-indebtedness. To explore the importance of this possible source of endogeneity, we include in the equation a dummy variable on university

¹⁴The respondents are asked to indicate whether, in the past two years, they made a request for credit been turned down or were not given as much credit as they applied for.

¹⁵We are very thankful to an anonymous referee for proposing this illuminating strategy.

education, as we expect financial sophistication is positively correlated with education. As educational attainment may not be an unquestionable proxy for financial literacy (van Rooij et Al., 2012), we consider other questions of the DHS dataset. In addition to the educational dummy, we consider self-assessments on i) how knowledgeable a subject considers himself with respect to financial matters (*know*), ii) what sources of advice used to make important financial decisions for the household (*advice*), iii) whether the respondent or somebody else is responsible for the financial administration of the household (*involved*).¹⁶ However, self-assessments of financial knowledge are subjected to the limit - known as the Dunning-Krueger effect - that overconfidence increases with incompetence.

Survey data may contain a certain number of incorrect answers because respondents misunderstand questions. Some of our data may be affected by such mistakes and, in particular, the cases where respondents have reported the value ‘zero’. To address this potential source of bias, we replicate our estimates after dropping those subjects who respond ‘zero’ to all sixteen questions.

4 Results

In this section we report the results of the empirical model presented in section 3. We pool observations from all sampled years (1995-2002) to increase the efficiency of the estimates. To deal with the presence of possible outliers either in the space of regressors and in the space of residuals, estimates are performed by using the robust estimator available in Stata 11 (*emphrreg*) with default parameters.¹⁷ To account for possible correlation of errors at the individual household level through time, we compare results obtained with the robust estimator *rreg* with those obtained using the OLS with heteroskedastic robust standard errors.

In this section, we only focus on heads of households for a number of reasons. Firstly, the fact that for some variables responses from the same household are highly correlated or correspond may affect the consistency of the estimates. Heads are more likely to give well-informed and accurate responses than other family components. Finally, heads are more likely to be re-interviewed and therefore available information across the waves. However, in the next subsection, we will also take into account the responses by partners. In all cases, the estimates of total wealth, liquid and illiquid assets, debt and liability refer to the entire family and are calculated by summing up the information collected from all interviewed family components.

The dependent variable is given by the household’s demand for money. It represents the desire of households and businesses to hold assets in a form that can be easily exchanged for goods and services. The definition of money we use corresponds to M2 excluding cash and is

¹⁶The complete text of these questions is reported in an appendix, which is available on request.

¹⁷The *emphrreg* procedure first performs an initial screening based on Cook’s distance > 1 to eliminate gross outliers prior to calculating starting values and then performs Huber iterations followed by biweight iterations with tuning constant of 7 (Li, 1985). A more detailed description of *emphrreg* and some Monte Carlo evaluations are provided in Hamilton (1991).

equal to the sum of net balances of checking accounts, savings arrangements, savings certificates, deposit accounts and deposit passbooks (expressed in logarithms).

Table 4 shows the results obtained from the estimation of equation (1). Column (1) reports results from a specification including a parsimonious set of regressors: indexes for present-bias and income level, estimates of family wealth, debts and liabilities, and time and region dummies. Column (2) shows results from a specification that includes indexes for present-bias and income level, the logarithm of total wealth, any debt and liability, the respondent's age, age squared, university education, the expected inflation rate, dummy on whether occurred any credit refusal or restriction, the number of family components, dummy on whether any job seeker, the number of recipients, dummies on employment sector (whether public or non-public institution), time and region. Columns (3) and (4) also include, as an estimate of the degree of impatience, the subjective discount rate at three months and twelve months, respectively.

To address the possible endogeneity problem discussed in section 2, due to either liquidity constraints or naïveté of the subject, we substitute PBI with the average of the PBI s of the same household at times different from t ($PBIN$). Columns (5), (6), (7) and (8) show results of estimations using $PBIN$ in place of PBI .

[Table 4 About Here]

Columns (1-8) show that the coefficients on PBI and $PBIN$ all have the expected sign and all are significant at conventional levels. All specifications have reasonable explanatory power as R^2 s range between 28 and 33 %. Coefficients on PBI and $PBIN$ are similar using OLS with heteroskedastic robust standard errors and allowing for correlation of errors that might occur at the individual household level through time. Results show that a standard deviation of increase in the PBI determines a reduction in money demand by between -3.5 and -9.1 percent, while the effect implied by the coefficients of $PBIN$ is between -3.8 and -4.5 percent.¹⁸ The evidence on $PBIN$ suggests that the endogeneity of PBI is not a sufficient explanation of the negative correlation between present-bias and money demand.

The dummy on whether the subject who applied for credit received a refusal or a smaller amount than requested is statistically significantly negatively correlated with money demand, and the omission of this variable does not affect the estimate of the coefficient on PBI ($PBIN$).¹⁹ This evidence supports the view that the correlation between money demand and PBI is not driven by the effect of liquidity constraints on self-reported discount factors. The coefficient on the discount rate at three months is negative and weakly significant (at 10 percent of confidence level) with the specification with $PBIN$ (col. 7). Similarly, the coefficient on the discount rate

¹⁸The magnitude is calculated as the standard deviation of PBI multiplied by the estimated coefficient on PBI over the standard deviation of the dependent variable.

¹⁹We also considered a specification including an interaction term of this dummy with PBI . The coefficient on this interaction term did not appear statistically significant.

at twelve months is negative and statistically significant only with the specification with *PBIN* (col. 8). Comparing results of columns (1-2) and (5-6) with results of columns (3-4) and (7-8), we note that the coefficients of *PBI* and *PBIN* are substantially unaffected by the inclusion of proxies for the degree of impatience. Therefore, the hypothesis that significant coefficients on *PBI* are driven by the positive correlation between present-bias and impatience does not seem to find support.

As expected, income and wealth variables are always positively and significantly related to money demand. University education is positively and significantly related to money demand. With regard to the three dummies on financial sophistication presented in the previous section (*know*, *advice* and *involved*), we find that only *advice* is statistically significant, with a positive sign. This result suggests that, to make important financial decisions, individuals that use information from the newspapers, financial magazines, guides, books and financial computer programs demand more money than those that rely on brochures, advertisements and professional financial advisers. Moreover, the exclusion of the dummy on university education and the three dummies on financial sophistication have little effect on the coefficient on *PBI*. We also consider an alternative specification of the model which includes the interaction between *PBI* and, in turn, each of the dummies on financial sophistication. The coefficient on the interaction term is never statistically significant, suggesting that the correlation between present-bias and demand for money is unlikely driven by the degree of financial sophistication. Age is non-linearly negatively correlated with the dependent variable. Interest rates (proxied by the expected inflation rate) do not seem to play an important role. The number of income recipients in the household has a positive and significant coefficient, while the number of people in the household and the dummy on whether anyone in the household is looking for a job have negative and significant coefficients.

The evidence that subjects with more severe *PBP* hold a smaller share of their wealth in liquid form leads to a number of considerations. First, answers to hypothetical questions elicited in a survey are not meaningless but they seem to contain information on subjects' discount rates. Subjects participating in surveys seem to choose to expend the effort required to understand the questions and introspect. Second, the hypothesis that some individuals have present-biased preferences finds support. Third, some individuals with *PBP*, who are at least partially sophisticated, seem to adopt pre-commitment strategies to restrain themselves from exchanging liquid assets for immediate consumption.²⁰ Fourth, apart from experiments where pre-commitment is clearly a solution to present-bias, economic agents also act as sophisticated in the sense of Strotz in ordinary economic transactions such as investing in real estate.

²⁰An additional check to distinguish this explanation of results from the alternative explanation that subjects are naive and hold less liquid assets because spend their liquid assets first relates to the propensity to hold illiquid assets and is reported in the Robustness checks section.

Robustness Checks

As discussed above, an alternative explanation of the correlation between *PBI* and money demand is that people with a strong present-bias hold less money simply because they spend all the liquid assets they have first. In the section above, to address this issue, we included a dummy variable indicating whether someone had a credit request turned down. As a further check, we look at the relationship between *PBI* (*PBIN*) and illiquid asset holdings. If the commitment motivation holds true, a sophisticated present-biased individual should not just have a small amount of liquid assets; she should also hold a relatively large amount of illiquid assets. Thus, we consider a subjective estimate of the current value of the house and housing equity, that is, the value of the house minus the mortgage balance and run the same regressions whose results are reported in Table 4. In place of money demand, the dependent variable is represented in turn by the value of the house and housing equity. The results seem to suggest that individuals with *PBP* hold relatively more expensive houses and that this relationship is not exclusively explainable by the request of a larger mortgage (Table 5). This evidence can be interpreted as supporting the view that individuals with *PBP* are sophisticated and decide to hold not only less liquid but also more illiquid assets.

[Table 5 About Here]

As argued in the sections above, we suspect some observations may contain errors that affect estimates. Specifically, we suspect that reporting the value ‘zero’ to all sixteen questions may be due to lack of effort or the use of ‘zero’ and ‘do not know’ as substitutes. To check for this, we replicate estimations after dropping these observations. We find that results are very similar to those reported in Table 4. Coefficients on *PBI* (*PBIN*) are all negative and statistically significant at conventional levels with values of about -0.2. OLS estimates give supportive results with coefficients statistically significant at 1 % or 5 % with 5 out of 8 regressions (at 10 % with the remaining 3 regressions).²¹

In the analysis above, we only considered heads of households. We wonder how the inclusion of spouses or unmarried partners (hereafter, we refer to both of them with the generic term ‘partners’) affect estimates. The total number of observations with complete information available increase to about 5,328 (3,558 heads, 1,591 spouses and 179 unmarried partners). Heads and partners show very similar *PBI* values, as implied by the correlation coefficient of 0.88. We estimate the same specifications using all observations and add to the set of the independent variables dummies for head and unmarried partner (with spouse being the excluded restriction). We find confirming results as the coefficient on *PBI* is negative and statistically significant with seven of the eight specifications considered and show similar values. We find

²¹Results of these estimates and the following cases are not reported but are available upon request from the authors.

similar results also when we replace the PBI of the head with the arithmetic mean between the PBI of the head and the PBI of the partner.

So far, we set the present bias index equal to zero for those respondents who have reported future biased preferences ($PBI < 0$; $PBIN < 0$). To check for the sensitivity of the results, we re-estimate the main specifications of the model without any transformation of the negative values of PBI ($PBIN$). Results are still very similar.

Previous studies found that women with PBP are more likely to make use of commitment strategies (Ashraf et Al., 2006; Bauer et Al., 2012). These two studies seem to suggest that women are more ‘sophisticated’ than men. In our study, if we only consider heads of households, who are in most cases men, we find that gender is not important. As one may suspect that this result is a consequence of the low variance of the gender dummy, we include data from the partners and obtain a balanced sample composed for about 58 % by men and for about 42 % by women. However, we find that the gender (male) dummy remains statistically nonsignificant either when used only as a control and when interacted with PBI ($PBIN$).

Further robustness analysis is reported in an appendix, which is available on request.

5 Conclusion

We have analyzed the asset holdings of who report subjective discount factors over delays of three months and twelve months. Most self-reported discount rates decline over delays, so preferences are present-biased. We find that subjects with more severely present-biased preferences hold less liquid assets. These findings may be interpreted as evidence of pre-commitment strategies. Individuals may try to overcome their future self-control problems by choosing to hold less wealth in a liquid form.

Moreover, we have found evidence that survey data are useful information and respondents seem to choose to expend the effort required to understand the questions and introspect. Apart from experiments where pre-commitment is clearly a solution to present-bias, our findings suggest that economic agents also act as sophisticated in the sense of Strotz in ordinary economic transactions such as investing in real estate.

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Table 1: Rate of response and ‘zero’

Year	(1) Respondents	(2) All-items R.	(3) All-items R. and DR	(4) Rate of Response(DR) (%)	(5) Zero	(6) Zero (%)
1997	2239	1762	1646	0.93	248	0.15
1998	1753	929	863	0.93	105	0.12
1999	1549	983	911	0.93	120	0.13
2000	1756	510	394	0.77	30	0.08
2001	2132	891	617	0.69	38	0.06
2002	1939	1092	966	0.88	64	0.07

Note: Column (1) reports the total number of heads of households participating in the survey. Columns (2) reports the number of subjects who provide all information necessary for our estimation analysis, apart from information on the discount factor. Columns (3) reports all observations where information is completed, including all questions on the discount factor. Column (4) reports the rate of response for the questions on the discount factor (ratio column 3 and column 2). Finally, columns (5) and (6) report the number of zeros and the rate of zeros with respect to the total number of available observations (ratio column 5 and column 3).

Table 2: Discount rates: means and standard errors

Discount rates	Three Months		Discount rates	One Year	
	Mean	St.Dev.		Mean	St.Dev.
DR3_1	.312	.642	DR12_2	.193	.242
DR3_3	.194	.556	DR12_4	.119	.17
DR3_5	.0517	.243	DR12_6	.0283	.0609
DR3_7	.0251	.0765	DR12_8	.0191	.035
DR3_9	.0389	.269	DR12_10	.025	.0631
DR3_11	.0313	.226	DR12_12	.0207	.0517
DR3_13	.195	.359	DR12_14	.0839	.101
DR3_15	.108	.276	DR12_16	.0541	.0728

Note: The table reports the subjective discount rate at three-months (annualized) and the subjective discount rate at twelve-months, calculated for each question on discount factor in the questionnaire.

Table 3: Summary statistics by present/future bias

Variables	Future Bias-No bias			Present Bias			Signif. Diff.
	Mean	SE	N	Mean	SE	N	
Money	17,867	40,493	1489	13,649	22,080	2069	YES
Income (cat.)	4	1.2	1489	4.1	1.2	2069	NO
Wealth	137,542	186,454	1489	122,906	188,679	2069	YES
Male	0.84	0.37	1489	0.8	0.4	2069	NO
Age	54	14	1489	50	14	2069	YES
University	0.16	0.37	1489	0.16	0.37	2069	NO
$E_t^{su} \pi_{t+1}$	3.2	3.8	1489	3.5	4.7	2069	YES
No credit	0.07	0.25	1489	0.098	0.3	2069	YES
# family comp.	2.4	1.3	1489	2.4	1.3	2069	NO
Jobseeker	0.03	0.17	1489	0.027	0.16	2069	NO
# recipients	1	0.73	1489	1.1	0.75	2069	NO
Public sector	0.27	0.44	1489	0.28	0.45	2069	NO
Non-public Instit	0.37	0.48	1489	0.37	0.48	2069	NO
privateloans	209	1975	1489	640	12280	2069	NO
extendedlines	780	3367	1489	785	3182	2069	NO
outstandingdebt	18	259	1489	7	72	2069	NO
outstandingdebt2	243	3142	1489	166	1783	2069	NO
familyloans	346	3614	1489	675	5714	2069	YES
studyloans	41	421	1489	145	1067	2069	YES
creditcarddebts	20	305	1489	18	153	2069	NO
otherloans	608	6485	1489	388	4345	2069	NO

Note: The table considers only observations where information on all variables of interest is available. The last column 'Sign. Diff.' reports whether the difference between the means of the two sub-groups (future-biased and present-biased) is statistically significant on the basis of the t test statistic.

Table 4: Estimation Results. All heads of households

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>PBI</i>	b/t -0.247*** -3.64	b/t -0.227*** -3.42	b/t -0.455* -1.91	b/t -0.172** -2.10	b/t	b/t	b/t	b/t
<i>PBIN</i>					-0.293*** -2.87	-0.288*** -2.87	-0.262** -2.57	-0.245** -2.39
<i>DR</i> ³			0.113 1.00				-0.066* -1.74	
<i>DR</i> ¹²				-0.193 -1.13				-0.375** -2.19
<i>ln(Wealth)</i>	0.369*** 27.88	0.358*** 26.24	0.357*** 26.20	0.358*** 26.26	0.359*** 22.22	0.349*** 21.00	0.348*** 20.92	0.348*** 20.98
Income (cat. 2)	-0.096 -0.68	-0.132 -0.95	-0.136 -0.98	-0.127 -0.91	-0.133 -0.77	-0.190 -1.12	-0.188 -1.10	-0.185 -1.09
Income (cat. 3)	0.244* 1.91	0.311** 2.47	0.308** 2.45	0.315** 2.50	0.182 1.16	0.238 1.54	0.238 1.54	0.245 1.58
Income (cat. 4)	0.393*** 3.17	0.430*** 3.49	0.427*** 3.46	0.436*** 3.53	0.226 1.49	0.268* 1.77	0.269* 1.78	0.275* 1.82
Income (cat. 5)	0.545*** 4.20	0.554*** 4.26	0.550*** 4.23	0.562*** 4.31	0.389** 2.43	0.421*** 2.62	0.422*** 2.62	0.433*** 2.69
Income (cat. 6)	0.524*** 3.42	0.492*** 3.21	0.488*** 3.18	0.498*** 3.24	0.338* 1.83	0.326* 1.76	0.333* 1.79	0.341* 1.83
Income (cat. 7)	0.449** 2.46	0.441** 2.46	0.439** 2.45	0.442** 2.47	0.364 1.54	0.362 1.56	0.372 1.60	0.368 1.58
Age		-0.022** -2.08	-0.022** -2.06	-0.022** -2.12		-0.022* -1.66	-0.022* -1.67	-0.023* -1.73
<i>Age</i> ²		0.000*** 2.92	0.000*** 2.91	0.000*** 2.94		0.000** 2.23	0.000** 2.23	0.000** 2.26
<i>E</i> _t ^{su} π_{t+1}		0.003 0.68	0.003 0.67	0.003 0.69		0.001 0.24	0.002 0.27	0.002 0.25
University		0.237*** 4.01	0.234*** 3.96	0.239*** 4.05		0.227*** 3.19	0.227*** 3.19	0.229*** 3.22
advice	0.176*** 3.54	0.113** 2.29	0.110** 2.24	0.115** 2.34	0.173*** 3.06	0.114** 2.02	0.116** 2.06	0.121** 2.15
know	-0.060 -1.19	-0.016 -0.33	-0.017 -0.35	-0.016 -0.32	-0.074 -1.26	-0.036 -0.61	-0.034 -0.59	-0.038 -0.65
involved	0.128** 2.38	0.063 1.15	0.062 1.14	0.064 1.17	0.132** 2.06	0.081 1.24	0.082 1.26	0.084 1.29
No credit		-0.264*** -3.31	-0.264*** -3.31	-0.264*** -3.30		-0.280*** -2.74	-0.280*** -2.74	-0.279*** -2.73
# family comp.		-0.110*** -5.80	-0.110*** -5.82	-0.110*** -5.80		-0.121*** -5.20	-0.122*** -5.23	-0.121*** -5.21
Jobseeker		-0.263** -2.09	-0.265** -2.11	-0.257** -2.05		-0.147 -0.95	-0.146 -0.94	-0.139 -0.90
# recipient		0.161*** 4.95	0.160*** 4.95	0.161*** 4.95		0.145*** 3.79	0.146*** 3.79	0.145*** 3.77
Public sector		0.095** 1.97	0.096** 1.99	0.093* 1.94		0.028 0.50	0.028 0.50	0.026 0.47
Non-public Instit		0.054 1.22	0.055 1.24	0.054 1.22		0.047 0.91	0.049 0.95	0.048 0.94
Private loans	-0.044*** -3.39	-0.033*** -2.58	-0.033*** -2.58	-0.033** -2.57	-0.050*** -3.00	-0.040** -2.44	-0.040** -2.43	-0.039** -2.40
Extended lines	-0.087*** -11.07	-0.076*** -9.78	-0.076*** -9.76	-0.076*** -9.79	-0.086*** -8.88	-0.076*** -7.86	-0.076*** -7.85	-0.076*** -7.87
Outstanding debts	-0.053* -1.84	-0.056** -2.01	-0.056** -2.01	-0.057** -2.03	-0.067* -1.73	-0.073* -1.90	-0.072* -1.89	-0.073* -1.91
Outstanding debts II	-0.011 -0.56	-0.008 -0.42	-0.008 -0.41	-0.008 -0.42	-0.016 -0.68	-0.009 -0.39	-0.009 -0.38	-0.009 -0.37
Family/friends Loans	-0.015 -1.15	-0.002 -0.19	-0.002 -0.19	-0.003 -0.19	-0.022 -1.41	-0.008 -0.50	-0.008 -0.51	-0.009 -0.57
Study loans	0.034** 1.98	0.030* 1.73	0.029* 1.71	0.030* 1.76	0.032 1.42	0.032 1.40	0.031 1.39	0.031 1.39
Credit card debts	-0.033 -1.38	-0.032 -1.37	-0.033 -1.40	-0.031 -1.33	0.006 0.19	0.010 0.34	0.011 0.38	0.013 0.44
Other Loans	-0.007 -0.41	-0.002 -0.13	-0.002 -0.13	-0.002 -0.14	-0.010 -0.52	-0.010 -0.11	-0.002 -0.11	-0.002 -0.11
R-squared	0.305	0.333	0.333	0.333	0.279	0.306	0.307	0.308
N	3558	3558	3558	3558	2461	2461	2461	2461
Magnitude	-5	-4.6	-9.1	-3.5	-4.5	-4.5	-4.1	-3.8

Notes: The Table reports estimates using the entire sample. The dependent variable is given by the sum of checking accounts, savings accounts, savings certificates, savings arrangements and deposit books. Columns (1), (2), (3) and (4) report results of estimates with *PBI*. Columns (5), (6), (7) and (8) report results of estimates with *PBIN* in place of *PBI*. All sets of independent variables also include time and regional dummies, and a constant, but they are not displayed. 'Magnitude' is calculated as the standard deviation of *PBI* multiplied by the estimated coefficient on *PBI* over the standard deviation of the dependent variable. ***, **, * indicate coefficients are significant at 1, 5 and 10 %, respectively. T-statistics are reported in parentheses.

Table 5: Estimation Results. Illiquid assets

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	b/t	b/t	b/t	b/t	b/t	b/t	b/t	b/t
Overall value of the house								
<i>PBI</i>	0.043**	0.044**	0.056	0.040*				
	2.53	2.57	0.98	1.93				
<i>PBIN</i>					0.049*	0.048*	0.038	0.037
					1.69	1.67	1.31	1.25
<i>DR</i> ³			-0.006				0.014	
			-0.22				1.46	
<i>DR</i> ¹²				0.011				0.065
R-squared	0.928	0.929	0.929	0.929	0.918	0.921	0.921	0.921
N	2220	2220	2220	2220	1512	1512	1512	1512
Housing equity								
<i>PBI</i>	0.041*	0.044*	0.024	0.018				
	1.73	1.89	0.30	0.64				
<i>PBIN</i>					0.098**	0.146***	0.142***	0.147***
					2.43	3.71	3.54	3.66
<i>DR</i> ³			0.009				0.006	
			0.26				0.42	
<i>DR</i> ¹²				0.090				-0.004
				1.50				-0.06
R-squared	0.591	0.615	0.615	0.615	0.594	0.623	0.622	0.622
N	2254	2254	2254	2254	1532	1532	1532	1532

Notes: The Table reports estimates using the entire sample. The dependent variable is given in turn by 1) a subjective estimate of the current value of the house and 2) housing equity. Columns (1), (2), (3) and (4) report results of estimates with *PBI*. Columns (5), (6), (7) and (8) report results of estimates with *PBIN* in place of *PBI*. All sets of independent variables also include an index for income level, the logarithm of total wealth, any debt and liability, the respondent's age, age squared, university education, dummies for financial sophistication, the expected inflation rate, dummy on whether occurred any credit refusal or restriction, the number of family components, dummy on whether any job seeker, the number of recipients, dummies on employment sector (whether public or non-public institution), time and region, and a constant, but they are not displayed. ***, **, * indicate coefficients are significant at 1, 5 and 10 %, respectively. T-statistics are reported in parentheses.