ARE DEFINED CONTRIBUTION PLANS A COMMITMENT DEVICE?

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Introduction

Many who want to save more for retirement or get in shape are tripped up by short-run temptations. Yet some who are tempted still achieve their goals by following strategies that limit bad behavior. These commitment devices restrict decision making in the present by erecting barriers to temptation. Defined contribution plans in the United States resemble a commitment device because they are framed as savings for a future goal and they involve a penalty for withdrawal to fund current spending. To the extent that defined contribution plans serve as a commitment device, their illiquidity may help those who most susceptible to temptation build wealth and achieve retirement security.

There is a growing body of literature that illustrates the tendency of households to exhibit myopia in short-run choices while simultaneously applying more prudent discounting to decisions involving long-run outcomes. These so-called hyperbolics who exhibit time-inconsistent preferences can benefit the most from the use of commitment devices that restrict short-run choice. One form of commitment device is an automatic savings plan that withdraws assets from current income. An automatic savings plan avoids the conflict between short-run and long-run preferences that exists when an individual has to choose whether to save or spend from their paycheck. The temptation to raid a savings plan can also be reduced by increasing the penalties assessed when on funds withdrawn from an illiquid account. It is possible that those who are susceptible to short-run temptations and who place a great value on future saving will benefit the most from the use of a more restrictive savings vehicle.

This paper investigates whether defined contribution plans and other tax advantaged accounts can help hyperbolic households who value the future save more effectively. We also employ a unique method to identify hyperbolic individuals through the use of a structural modeling approach in which we estimate both a myopic and a long term time discounting factor score for each respondent based on health behavior questions available in the National Longitudinal Survey of Youth 1979. We then identify hyperbolic respondents by comparing their myopic and long term time discounting and selecting those who exhibit high myopia and strong future orientation in health-related decision making domains. This method of selecting hyperbolics based on behaviors

in non-financial domains avoids possible biases, such as unobserved financial literacy or financial experience that may arise if financial behaviors are used to identify hyperbolics.

In health behaviors, myopia prevents individuals from achieving long-run goals when they, for example, place a great value on long-run health by reading nutrition labels to select a better diet while simultaneously giving in to the craving to smoke. Similarly, myopics will find it difficult to avoid the temptation of spending income in the present despite professing a desire to save more for retirement. A defined contribution savings plan reduces the temptation to spend current income by automatically transferring assets into a savings plan that includes features which serve as important barriers to short-run spending. While restricting short-run choice, these barriers may actually improve the lifetime welfare of workers whose long-run preferences require more prudent savings practices.

We test whether forced saving vehicles such as defined contribution plans and tax advantaged accounts are more valuable in helping hyperbolics build wealth to fund future retirement consumption. We find evidence that hyperbolic households are less likely to use tax advantaged accounts possibly due to the higher perceived entry cost and tendency toward procrastination. They are no different in the amount saved within defined contribution plans, consistent with the automatic enrollment feature in most employer sponsored plans, but they save less in voluntary sheltered savings vehicle like an IRA. Participation in a defined contribution plan has a much greater impact on wealth accumulation over time among hyperbolics than it does among non- hyperbolics. Those who value the future, but who have difficulty resisting short run temptation, benefit more from the use of a defined contribution savings vehicle that acts as a commitment device in a manner that is consistent with hyperbolic preference theory. Our results suggest that automated savings plans can be a useful tool for helping those with time inconsistent preferences achieve long-run financial goals.

Literature Review

Many who appear present oriented in short-run choices simultaneously apply more prudent discounting to decisions involving outcomes in the long run. Individuals persistently engage in behaviors that involve a suboptimal intertemporal tradeoff such as smoking (Bickel et al, 1999; Mitchell, 1999), gambling (Dixon et al., 2003), drug use (Kirby et al., 1999), and alcoholism (Petry, 2001) while simultaneously wishing they could quit in order to improve long-

run welfare. Most U.S. households report that they wish they could save more for retirement, but more than half of them never actually increase their retirement saving amount (Angeletos et al., 2001).

Inconsistency in time preference (also referred to as dynamic inconsistency) leads to a reduction in welfare when long-run utility preferences are sabotaged by an inability to resist short-run temptation (Laibson, 1997). It is not optimal to prefer a consumption path that reflects a low long-run discount rate while making short-run choices that involve a large transfer of utility from the future to the present. Although literature in multiple fields provides evidence of the consequence of this dynamic inconsistency, this paper focuses on financial decisions.

Hyperbolic time discounting theory is proposed to capture this present-bias and to explain multiple sub-optimal financial decisions. Time-inconsistent choices may contribute to high levels of expensive credit card debt even among those who are simultaneously saving for long-run goals (Laibson, 1997; Angeletos et al., 2001; Meier and Sprenger, 2010). Ikeda and Kang (2015) also find a positive association between present-bias and household indebtedness in their Japanese sample. Myopic preferences may also explain the use of costly payday loans and bank overdrafts (Carrell and Zinman, 2008). A lack of self-control and procrastination also contributes to insufficient participation in retirement saving plans (Madrian and Shea, 2001; Thaler and Benartzi, 2004). Hasting and Mitchell (2011) show that myopia in short-run choices negatively impacts self-reported retirement savings.

Hyperbolics are not doomed to financial failure. It is possible that many are aware of the loss created by their own time inconsistent preferences and seek commitment devices to help them restrict the short-run temptation in their future selves. Laibson (1997) suggests that households intentionally hold significant levels of illiquid assets within their portfolio while holding fewer assets that provide easy access to immediate consumption such as liquid accounts and unused credit balances. Thaler and Benartzi (2004) propose an employer-based saving plan where participants voluntarily commit to automatically contribute to their retirement saving account and increase contributions as their salaries increase. Agreeing to commit one's future self to be more prudent in the future dramatically increases saving rates among workers. Cho and Rust (2013) finds that most customers that are offered a free installment loan by a credit card company either turn down the offer or recommit to pay it off early. Beshears et al. (2015) find that subjects who

are provided with a liquid saving account and commitment account which requires penalties upon withdrawals favor illiquidity in order to restrict short-run temptation. Similar international evidence is also found by Karlan and Linden (2014).

There is also evidence that those who are less able to resist short-run temptation are more attracted to commitment devices. Ashraf, Karlan and Yin (2006) design a commitment saving device in which the account balance only becomes available after either a certain time period or a saving amount is surpassed. They find strong evidence that hyperbolic households are more likely to use these commitment saving products than non-hyperbolics.

While all the studies mentioned above are conducted in an experimental setting, only a few microeconomic studies are able to find evidence of the demand for commitment devices in actual financial decisions. Sourdin (2008) provides some evidence in their Australian sample that households with low self-control are more likely to invest in illiquid pensions. Cadena and Keys (2013) suggest that some postsecondary students in their sample turn down interest-free student loans as a commit device to avoid excessive spending.

Beshears et al. (2015) suggest that heterogeneity in present-bias and sophistication among U.S. households could explain the lack of empirical evidence in household surveys. The use of commitment devices might also be too sensitive to their costs (Augenblick et al., 2014) and reduced flexibility (Dupas and Robinson, 2013; Burke et al., 2014). Laibson (2015) provides a theoretical model and a simple illustration supporting this argument, and argues that a pure commitment device is hard to find in reality. The commonly used illiquid saving account often comes with tax benefits and large entry costs in the real world. The default option in employer sponsored defined contribution plans adds an additional challenge to the empirical study of commitment devices (see more discussion in Carroll et al., 2009).

This study adds to the literature by investigating whether the defined contribution plan and other tax advantaged accounts serve as commitment devices to these hyperbolic households and help them to save. This study is also the first to identify the hyperbolic households through a construct of health related behaviors.

Theoretical Framework

We implement Laibson's (1997) quasi-hyperbolic time discounting model as our theoretical framework. Similar to the exponential time discounting model, δ represents the long term discount factor in the utility function. $\beta\delta$ presents the discount factor in the near term. β alone represents the present-bias factor. A lower β indicates a greater tendency to make time inconsistent decisions. In other word, the long run preference of the agents is sabotaged by their short-run temptation, which leads to significant reduction in welfare. We refer agents with lower β as hyperbolics in the later text.

$$U_t = E_t \left[u(C_t) + \beta \sum_{\tau=1}^{T-t} \delta^{\tau} u(C_{t+\tau}) \right]$$

The agents can be modeled as a sequence of future selves. Under the assumption of full sophistication, agents have full knowledge of their present bias and predict that each of their future selves will make time-inconsistent choice. They therefore choose to use commitment devices to constrain their future selves from short-term temptation. A commitment device either limits the choices on the future selves or makes it very costly to make myopic decisions. The more present biased they are, the more commitment devices they should choose to use. In doing so, they maximize the expected lifetime utility.

Defined contribution plan and other tax advantaged accounts that are available to U.S. households fit the definition of commit devices. Besides the tax benefits and employer matches in contribution, these accounts provide significant benefits to these hyperbolic agents. The automatic saving feature withdraws resources from current income without forcing the individual to make a choice. The 10% penalty and restrictions on the early withdrawal make it harder and more costly for households to consume these resources before the long term goal is achieved. These accounts also frame the savings as money set aside a future goal, creating a behavioral barrier (or emotional cost) to the households when consuming these resources prematurely. The instruments successfully avoid the conflict between short-run and long-run preferences that exists when an individual has to choose whether to save or spend from their paycheck.

Based on this quasi-hyperbolic time discounting model, we hypothesize that: *Those who exhibit strong short-run myopia, and who place a great value on future saving, will benefit the most from the use of defined contribution accounts as a forced saving vehicle.*

Measurement of Time Preference

Literature on hyperbolic intertemporal discounting has implemented money choice experiments to measure delayed discounting. Most of these studies (Rachlin et al.1991; Raineri and Rachlin, 1993; Lichetam et al. 1996; Vuchinich and Simpson, 1998) use hypothetical money choice task (HMCT) in which subjects make choices based on hypothetical money rewards. Kirby (1997) and subsequent studies (Johnson and Bickel, 2002; Madden et al. 2003) use real money rewards to measure delayed discounting. While Simpson and Vuchinich (2000) provide some evidence of the reliability of the HMCT method, there are some differences in results produced by HMCT and real money rewards (Kirby, 1997). One possible cause is the existence of a magnitude effect where agents tend to have a higher discount rate toward a smaller reward than a larger reward (Green and Myerson, 2004).

Myopia is also highly associated with impulsivity or sensation seeking. Moeller et al. (2001) define myopia as a combination of three elements: (1) insensitivity to negative consequences of current behavior; (2) rapid, unplanned reaction to stimuli; and (3) failure to consider long-term consequences. Based on these three elements, it is safe to argue that myopic behavior should be highly correlated with impulsive behavior. If so, it is possible to design a myopic construct based on behavioral predictors. Finke and Huston (2013) use this approach to measure myopic and sensation seeking in the near-future term. Their study suggests that, out of the eight behaviors that involve a tradeoff between present and future utility, two constructs arise from a factor analysis that mirror myopia in short-term events and long-term time preference in distant events. Consistent with the previous literature, behaviors like, seatbelt use, smoking, drinking and drug use, are strongly associated with myopia and short-term sensation seeking. Similarly, Brown and Previtero (2015) use delay of decision in health care planning as a measure of present bias.

Similar to the measurement of myopia or impulsivity, the current literature most commonly uses hypothetical money questions to measure the long term discounting, i.e. the long term time preference. Similar to the measurement of a short term discount factor, there are some concerns in using hypothetical money questions. In addition, structural measurement is also used in a few studies. Finke and Huston (2013) find that health behaviors created as a proxy of long term discounting are far more consistent predictors of retirement savings intention than

hypothetical money questions. These behaviors include reading nutrition labels when shopping for food, regular exercise, eating a healthy diet, body mass index, and education attainment.

Data and Methodology

Based on a large nationally representative longitudinal survey with both financial information and health related behaviors, we are able to create an empirical measurement of time preference. This study uses data from the National Longitudinal Survey of Youth conducted by U.S. Bureau of Labor Statistics. This survey follows two cohorts of American youth and asks about their health related behaviors, financial matters, household composition, etc. We use data from the 1979 cohort, which was initially interviewed at age 14 to 22 in 1979.

The NLSY Cohort 79 is particularly useful in measuring retirement savings because the respondents have reached to age 47 to 55 by 2012, which are the peak life cycle savings years. The NLSY also includes health-related behaviors that allow us to proxy the myopic and long term time discounting in a structural modeling approach.

In our study, myopia is measured through short-run behaviors that reflect a reduced ability to resist short-run temptation in various decision making domains. We measure myopia based on the following variables: excessive drinking in the last month, times of cocaine use in lifetime, times of cigarette used in lifetime and whether currently smoking, age of first sex, and time discounting in one month. The detailed descriptions of these variables are presented in Appendix C. Most of these variables capture health behaviors that are associated with impulsivity. The correlation matrix among these behaviors is presented in Appendix D. These variables have relatively large correlation with each other, supporting the idea that they are all motivated by the same latent myopic preferences.

We measure the proxy of long term time discounting factor or future orientation using the following variables: use of nutrition labels when shopping for food, regular exercise in the past month, educational attainment, body mass index and time discounting in one year. The detailed descriptions of these variables are presented in Appendix C. Most of these variables capture health behaviors that are associated with future orientation. Similar to the myopia proxy, we include time discounting at one year measured through a hypothetical money account question. The correlation matrix among these behaviors is presented in Appendix D. These variables also have relatively

large correlations with each other, supporting the idea that they reflect the same latent rate of long-run time discounting.

To proxy myopia and long term time discounting, we conduct a principle component analysis on each latent variable. The weight of the standardized element is also listed in Appendix D. The first component measure of myopia captures 35% of total variance, while the first component measure of long term time discounting captures 30% of total variance.

Many behavioral questions used in our study are asked in a sub–module that is not mandatory for all respondents. By survey year 2012, the retention rate was 57.2%, and the sample size dropped to 7,297 out of the initial 12,684 respondents. The main reasons for dropping from the survey is a failure to locate respondents, respondent refusal, respondent deceased, and other reasons. We identify a sample of 4189 respondents who answered all the behavioral questions and participated in all the survey waves until 2012.

Table 4.1 Short-term Time Preference Measurement and Actual Behaviors

	Myopic		
	High (n=1379)	Mid (n=1385)	Low (n=1425)
Smoke less than 100 cigarette in life	9.43%	51.3%	94.4%
Smoke more than 100 cigarette in life but quit	19.5%	30.5%	5.0%
Smoke more than 100 cigarette and currently smoker	71.1%	18.3%	0.6%
Drug use more than 10 times in life	30.8%	3.5%	0%
Age of first sex	14.82	16.3	18.69

Table 4.1 shows the summary statistics of the myopic measures sorted in three groups. The measure clearly separates people who are very myopic and have low self-control or high impulsivity from their counterparts. For individuals with a high value in the myopic measure, 71.1% of them reported that they smoked more than 100 cigarettes in their life and were currently smoking at the time of survey. 30.8% reported to have used cocaine more than 10 times in their life. The age of first sex is about 14.82. For individuals with low value in the myopic measure, 94.4% of them reported that they have smoked less than 100 cigarettes in their life and were not

currently smoking. None reported the use of cocaine in life. And the average age of first sex is 18.69.

Table 4.2 Long-term Time Preference Measurement and Actual Behaviors

	Long Term Discounting		
	High (n=1375)	Mid (n=1394)	Low (n=1420)
Daily body exercise	64.9%	94.6%	99.1%
Highest Education			
Less than High School	26.9%	8.4%	0.2%
High School	69.0%	72.7%	25.1%
Some College	3.1%	12.5%	15.9%
College	1.8%	5.8%	38.5%
Graduate and Professional	0.2%	0.7%	20.4%
Frequently read Nutrition Label	1.69	3.26	4.19
Body Mass Index	29.61	28.57	26.27

Table 4.2 shows the summary statistics of the long term discounting measures sorted in three groups. Similarly, this measure clearly separates future oriented individuals from the present oriented individuals. For those with high long term time discounting, 64.9% reported having daily exercise. 69% of them only have a high school degree and they are relative overweight compared to other groups. For those with low long term time discounting, 99.1% exercise daily, and about 59% have a college, graduate or professional degree. And they are more likely to report reading nutrition labels during food shopping.

With the measures of myopia and long term time discounting, we are able to identify hyperbolic individuals as those who apply a high rate of time discounting in short-term decisions while simultaneously applying a low rate of time discounting in long-term decisions. We identify 313 individuals who are included in both highly myopic group and low long term discounting group. We also use all other individuals in the low long term discounting group as the reference group in our empirical analysis. We purposely focus on individuals with low long term time

discounting only, because they are the group whose long run time preference could be jeopardized the most by the time-inconsistent choices.

Summary Statistics

Table 4.3 shows the summary statistics of demographic and asset holdings by hyperbolic households and other households. The p values of difference between these two groups are also provided. The hyperbolics and the other groups are not significantly different in their age, gender and race/ ethnicity. Although education level is not included in our measure of myopia, hyperbolics tend to have significantly lower education attainment. This suggests that myopia or low self-control could result in disruption of human capital investment. The hyperbolic groups also have low home and stock ownership, possibly due to lower creditworthiness and procrastination. The hyperbolic groups also have significantly lower holdings in almost all type of assets, and greater values of almost all type of borrowing and debt.

Empirical Models

We start the empirical analysis by investigating the effect of present bias on household financial outcomes by estimating an ordinary least square regression model as shown below:

Table 4.3 Summary Statistics by Types of Households

	Whole Sample (n=1420)	Hyperbolic Households (n=313)	Other Households (n=1107)	p-value of difference in Column II and III
Age 43-46	48.94%	47.60%	49.32%	0.592
Age 47-51	51.06%	52.40%	50.68%	0.592
Education				
<High School	0.21%	0.96%	0.00%	0.083
High School	25.07%	38.98%	21.14%	<0.001
Some College	15.85%	16.93%	15.54%	0.551
College	38.45%	29.07%	41.10%	<0.001
Graduate	20.42%	14.06%	22.22%	<0.001
Hispanic	11.83%	14.06%	11.20%	0.192
Black	22.25%	21.73%	22.40%	0.800
Other Race	65.92%	64.21%	66.40%	0.473
Male	42.32%	43.13%	42.10%	0.744
Homeowner	82.18%	71.57%	85.19%	<0.001
Married	65.49%	54.95%	68.47%	<0.001
Tax Adv Owner	56.48%	46.65%	59.26%	<0.001
Stock/MF Owner	52.11%	44.73%	54.20%	0.003
Real Income	116,283	93,998	122,598	<0.001
Net worth	503,205	384,718	536,794	0.002
Total Assets	741,868	525,515	803,041	<0.001
Financial Assets	370,882	232,404	410,036	<0.001
Liquid Assets	47,485	35,343	50,918	0.040
Illiquid FA	323,397	197,061	359,119	<0.001
Residence	335,017	250,242	359,084	<0.001
Illiquid Assets	507,024	360,215	548,534	<0.001
Retirement Acts	174,131	110,773	192,045	<0.001
Tax Adv Acts	98,711	59,800	109,712	<0.001
Mortgage	136,308	118,655	141,308	0.109
Total Other Debt	16,996	25,023	14,727	0.014
Credit Card Debt	11,266	14,032	10,485	0.059
Student Loan	30,897	41,922	26,706	0.086

$$\text{Log (Financial Outcome)} = \beta_0 + \beta_1 * \text{Hyperbolic} + \beta_2 * \text{Age} + \beta_3 * \text{NumChildren} + \beta_4 * \text{Male} + \beta_{5\text{-}7} * \text{Education Dummies} + \beta_8 * \text{Hispanic} + \beta_9 * \text{Black} + \beta_{10} * \text{Married} + \beta_{11} * \text{LogRealIncome} + \beta_{12} * \text{LogInheritance} + \varepsilon$$

Where Log (Financial Outcome) is a continuous variable of the logarithm of various financial outcomes, such as average real income, net worth, etc; Hyperbolic is a dummy variable identifying the hyperbolic households in our sample. Based on theory and the summary statistics above, we expect that hyperbolic households will have lower financial wealth and greater debt.

We also control for other key demographic variables that are likely to be related to financial outcomes (Ashraf et al., 2006; Sourdin, 2008; Fang and Silverman, 2009; Beshears et al., 2011; Kang and Ikeda, 2013; Fang and Wang, 2013). Age is a continuous variable representing respondents' age; NumChildren is a continuous variables representing number of children in the household; Male is a dummy variable representing the gender of the respondents; Education dummy variables represent the highest education degree obtained by the respondent; Hispanic and Black are dummy variables representing the race/ethnicity of the respondent; LogIncome is a continuous variable measuring the logarithm of household average income between 1996 and 2012, adjusted to 2012 dollar; and LogInheritance is a continuous variable of the logarithm of inheritance received by the households until 2012.

We then study the effect of defined contribution plans and other tax advantage accounts on saving of hyperbolic households. Similar to Brown and Previtero (2015), we start by investigating plan participation and account balance. We estimate the following logistic regression model to study how hyperbolic households participate in these plans:

$$\text{Logit (Prob (Participation))} = \beta_0 + \beta_1 * \text{Hyperbolic} + \beta_2 * \text{Age} + \beta_3 * \text{NumChildren} + \beta_4 * \text{Male} + \beta_{5\text{-}7} * \text{Education Dummies} + \beta_8 * \text{Hispanic} + \beta_9 * \text{Black} + \beta_{10} * \text{Married} + \beta_{11\text{-}12} * \text{Net worth Dummies} + \beta_{13} * \text{LogRealIncome} + \beta_{14} * \text{LogInheritance}$$

where Participation is a dummy variable representing respondents' participation in either defined contribution plans or other tax advantaged accounts. Other tax advantaged accounts include tax advantaged retirement accounts initiated by individuals, education saving accounts, and variable annuity products. Literature suggests that procrastination could explain the lower participation in the retirement plans (Madrian and Shea, 2001; Thaler and Benartzi, 2004). Making saving and investment decisions in retirement plans or other tax advantaged account can present significant entry costs, especially to the hyperbolic households. We therefore expect that hyperbolic households in general will be less likely to participate in defined contribution plans and other tax advantage accounts. However, the Pension Protection Act (PPA) of 2006 provides employers with statutory authority to automatically enroll employees into defined contribution plans. It is possible that there exists no difference in defined contribution plan participation by hyperbolic households. We add the additional control variable of net worth, which is a categorical variable representing household wealth in 2012. To avoid the endogeneity with dependent variable, we subtract defined contribution plan balance or the tax advantaged account balance from the net worth calculation.

We study the account balance by hyperbolic households by estimating an ordinary least square regression model as shown below:

$$\text{Log (Account Balance)} = \beta_0 + \beta_1 * \text{Hyperbolic} + \beta_2 * \text{Age} + \beta_3 * \text{NumChildren} + \beta_4 * \text{Male} + \beta_{5\text{-}7} * \text{Education Dummies} + \beta_8 * \text{Hispanic} + \beta_9 * \text{Black} + \beta_{10} * \text{Married} + \beta_{11\text{-}12} * \text{Net worth Dummies} + \beta_{13} * \text{LogRealIncome} + \beta_{14} * \text{LogInheritance} + \varepsilon$$

where Log (Account Balance) is a continuous variable of the logarithm of account balance in either defined contribution plans or other tax advantaged accounts, conditional on plan participation. We expect to see no difference in the account balance by hyperbolic households. We argue that once they break the entry barrier and participate in the plan, they commit themselves to

a level of saving that is determined by their long term time preference. With the PPA of 2006, tax advantaged accounts may also come with an automatic contribution feature.

With a better understanding of the participation and contribution behavior by hyperbolic households, we then study the effect of plan participation on wealth of hyperbolic households by estimating another ordinary least square regression model as shown below:

$$\begin{aligned}\text{Log (Net Worth)} = {} & \beta_0 + \beta_1 * \text{Hyperbolic} + \beta_2 * \text{Participation} \\ & + \beta_3 * \text{Hyperbolic*} \text{ Participation} + \beta_4 * \text{Age} + \beta_5 * \text{NumChildren} + \beta_6 * \text{Male} \\ & + \beta_{7\text{-}9} * \text{Education Dummies} + \beta_{10} * \text{Hispanic} + \beta_{11} * \text{Black} + \beta_{12} * \text{Married} \\ & + \beta_{13\text{-}14} * \text{Networth Dummie} + \beta_{15} * \text{LogRealIncome} + \beta_{16} * \text{LogInheritance} + \varepsilon\end{aligned}$$

Where Log (Net Worth) is a continuous variable of the logarithm of household total net worth; Participation is a dummy variable representing respondents' participation to either defined contribution plans or other tax advantaged accounts; Hyperbolic* Participation is the interaction term of plan participation and hyperbolic households. With the commitment device feature of defined contribution plans and other tax advantaged accounts, we hypothesize that the plan participation will be relatively more beneficial to these hyperbolic households because both the forced saving and illiquidity are able to constrain their short-term temptations and help them achieve long-term financial goals.

Table 4.4 Financial Outcomes by Hyperbolic Households: Estimated through OLS Regression

DV: Log(Financial Outcomes)	Real Income	Net Worth	Total Assets	Tax Adv. Account	Credit Card Debt	Mortg. Balance	Other Debt
Hyperbolic	-0.11** (-2.43)	-0.35*** (-2.75)	-0.32** (-2.44)	-0.59* (-1.85)	0.5* (1.69)	1.02*** (3.07)	0.55* (1.82)
Age	0.02** (2.32)	0.04* (1.94)	0.05** (2)	0.04 (0.6)	0 (-0.02)	-0.12** (-2.12)	0 (-0.03)
# of Children	0.07*** (3.88)	-0.04 (-0.8)	-0.01 (-0.26)	-0.23* (-1.71)	0.2 (1.57)	0.29** (2.18)	0.2 (1.57)
Male	0.11*** (2.94)	-0.14 (-1.31)	-0.13 (-1.2)	-0.52* (-1.94)	-0.58** (-2.38)	0.4 (1.53)	-0.61** (-2.41)
Some College	0.12** (2.13)	0.18 (1.09)	0.31* (1.8)	0.19 (0.45)	0.96** (2.51)	1.05** (2.43)	1.03*** (2.63)
College	0.42*** (8.79)	0.51*** (3.71)	0.5*** (3.44)	1*** (2.8)	0.78** (2.38)	0.81** (2.25)	0.85** (2.52)
Graduate School	0.64*** (11.68)	0.49*** (2.98)	0.41** (2.39)	0.18 (0.42)	0.69* (1.8)	0.61 (1.47)	0.8** (2.02)
Hispanic	-0.06 (-0.97)	-0.19 (-1.15)	0.01 (0.05)	-0.66 (-1.59)	0.55 (1.43)	0.22 (0.51)	0.58 (1.47)
Black	-0.33*** (-7.07)	-0.83*** (-6.13)	-0.73*** (-5.18)	-1.13*** (-3.29)	0.82*** (2.6)	0.24 (0.66)	0.9*** (2.79)
Married	0.58*** (14.35)	0.67*** (5.49)	0.89*** (6.89)	2.41*** (7.69)	0.13 (0.47)	-0.22 (-0.69)	0.13 (0.44)
Log(Real Income)		1.16*** (14.99)	1.39*** (17.42)	1.98*** (10.17)	-0.2 (-1.1)	0.22 (0.96)	-0.26 (-1.41)
Log(Inheritance Received)	0.01** (2.14)	0.05*** (4.28)	0.05*** (4.19)	0.12*** (4.03)	-0.03 (-1.33)	-0.06** (-2.26)	-0.04 (-1.4)
Log(Residence Value)						1.25*** (7.68)	
Adj. R^2	0.34	0.38	0.41	0.25	0.01	0.09	0.02
Obs	1413	1268	1403	1412	1413	1161	1413

***,**,* indicate significance at the 0.01, 0.05 and 0.10 levels respectively; t-value is provided in the bracket.

Empirical Results

Table 4.4 shows the regression result of our first regression model. Consistent with hyperbolic consumption theory, present bias is negatively associated with household financial outcomes. Hyperbolic households tend to have lower average income and significantly lower educational attainment. In theory, income and education attainment are positively associate with financial outcomes and could mediate the effect of present bias on the financial outcomes. However, even after controlling for these two factors we still observe a significant difference in financial outcomes by hyperbolic households. This suggests that present bias affects financial outcomes through not only income and education, but also other aspects such as impulsive spending, procrastination in saving and investment decisions. Minority groups tend to have lower financial wealth and greater debt, and inheritance received is associated with positive financial outcomes. Controlling for residence value, hyperbolic households tend to have a larger mortgage balance than other households in the sample.

Table 4.5 Retirement Plan Participation by Hyperbolic Households: Estimated through Logistic Regression

DV: Retirement Participation Dummy	Defined Contribution	Other Tax Adv Accounts
Hyperbolic	0.95	0.79*
Age	1.02	0.97
# of Children	0.82***	0.95
Male	0.69***	0.91
Some College	0.77	1.24
College	1.26	1.36*
Graduate School	0.76	1.02
Hispanic	0.4***	1.2
Black	0.46***	0.99
Married	3.23***	2.36***
Net-worth: Mid	1.94***	1.41**
Net-worth: High	3.62***	1.6***
Log(Real Income)	2.18***	1.67***
Log(Inheritance Received)	1.05***	1.02*
Obs	1413	1413

Table 4.5 shows the logistic regression results from our second model. Hyperbolic households are less likely to initiate a tax advantaged account than other households in our sample. We do not observe a significant difference in defined contribution participation. This result is

consistent with the fact that default enrollment is a common feature of employer sponsored defined contribution plans. Minority groups

Table 4.6 Retirement Plan Account Balanced Conditional on Participation: Estimated through Ordinary Least Square Regression

DV: Log(Account Balance) Conditional on Participation	Defined Contribution	Other Tax Adv. Accounts
Hyperbolic	-0.22*	-0.15
	(-1.65)	(-1.24)
Age	0.06***	0.03
	(2.66)	(1.48)
# of Children	0.002	-0.02
	(0.04)	(-0.35)
Male	-0.25**	0.11
	(-2.37)	(1.14)
Some College	0.29	0.22
	(1.52)	(1.36)
College	0.22	0.32**
	(1.51)	(2.48)
Graduate School	0.2	0.3**
	(1.18)	(2)
Hispanic	-0.19	-0.25*
	(-1)	(-1.66)
Black	-0.39**	-0.37***
	(-2.35)	(-2.91)
Married	0.32**	-0.01
	(2.1)	(-0.11)
Net-worth: Mid	0.43***	0.59***
	(3.34)	(4.91)
Net-worth: High	0.57***	0.66***
	(3.93)	(4.79)
Log(Real Income)	0.86***	0.83***
	(7.81)	(7.69)
Log(Inheritance Received)	0.01	0.01
	(1.18)	(0.7)
Adj. R^2	0.25	0.27
Obs	648	800

***,**,* indicate significance at the 0.01, 0.05 and 0.10 levels respectively; t-value is provided in the bracket.

are less likely to participate in a defined contribution plan. Marriage, income, net worth and inheritance received increase the likelihood of participating in both defined contribution plans and other tax advantaged accounts. Education seems to be associated with the use of tax advantaged accounts possibly due to the lower perceived entry cost and reduced tendency toward procrastination (Brown and Previtero, 2015).

Table 4.6 shows the OLS regression results of our third model. Conditional on participation, there is no difference in tax advantaged account balance but a significantly lower defined contribution plan balance. Age is positively associated with defined contribution account balance, possibly because of longer duration of participation. Similar to plan participation, minority groups tend to have a lower balance and marriage, income, net worth and inheritance received are positively related to the account balance. Educational attainment again is positively associated with tax advantaged account balance, as sophistication could reduce the entry cost.

Table 4.7 shows the OLS regression results of our last model. We hypothesize that participation in defined contribution plans and other tax advantaged accounts provides greater benefits to hyperbolic households. Similar to the findings in Table III, hyperbolic households tend to have significantly lower net worth than households who do not have time-inconsistent preferences. Plan participation in general increases household net worth possibly because of employer match and tax deferral. Consistent with our hypothesis, we find that account participation provides greater benefits to hyperbolic households. Once participating in defined contribution plans or tax advantaged accounts, hyperbolic households are able to use these illiquid accounts to save more and constrain themselves from impulsive spending. We find empirical evidence that these defined contribution accounts are far more effective at increasing wealth among hyperbolic households than among non-hyperbolics.

Table 4.7 Effect of Plan Participation by Hyperbolic Households on Net worth: Estimated through Ordinary Least Square Regression

DV: Log(Net worth)	Defined Contribution	Other Tax Adv Accounts
Hyperbolic	-0.66***	-0.63***
	(-3.95)	(-3.51)
Plan Participation	0.58***	0.70***
	(4.64)	(5.87)
Hyperbolic*Participation	0.74***	0.65***
	(3.00)	(2.65)
Age	0.04*	0.05**
	(1.90)	(2.38)
# of Children	-0.02	-0.03
	(-0.34)	(-0.67)
Male	-0.09	-0.12
	(-0.86)	(-1.21)
Some College	0.2	0.12
	(1.21)	(0.76)
College	0.45***	0.42***
	(3.27)	(3.08)
Graduate School	0.47***	0.43***
	(2.90)	(2.70)
Hispanic	-0.06	-0.21
	(-0.35)	(-1.32)
Black	-0.72***	-0.84***
	(-5.37)	(-6.35)
Married	0.5***	0.49***
	(4.01)	(4.01)
Log(Real Income)	1.06***	1.08***
	(13.74)	(14.21)
Log(Inheritance Received)	0.04***	0.04***
	(3.60)	(4.06)
Adj. R^2	0.40	0.41
Obs	1268	1268

***,**,* indicate significance at the 0.01, 0.05 and 0.10 levels respectively; t-value is provided in the bracket.

Conclusion

In this study, we construct a behavioral measure of myopia and long term time discounting and identify a group of hyperbolic households. We compare their financial behavior and test whether forced saving vehicles such as defined contribution plans and tax advantaged accounts could serve as a commitment device and help these households to achieve their long term goals. We find evidence that hyperbolic households are less likely to use tax advantaged accounts possibly due to the perceived entry cost and procrastination but their defined contribution plan participation rates are similar to non-hyperbolics. Once participating, hyperbolics accumulate significantly more wealth from owning an illiquid defined contribution account than non-hyperbolics. This suggests that defined contribution accounts fit the definition of commitment device and provide significant benefits to households with a tendency to make time-inconsistent choices.

Making the illiquidity features more salient may achieve additional benefits. For example, making the early withdrawal penalty more salient may promote a higher saving rate rather than deterring savers. Financial planners also need to understand that the creation of liquid savings funds meant to pay for potential emergencies may be less effective at building wealth among hyperbolics than accounts that are effectively framed as illiquid or for which there are either real or perceived penalties for early withdrawal.