Understanding the Correlation between Alzheimer's Disease Polygenic Risk, Wealth, and the Composition of Wealth Holdings

I. Introduction

We explore whether people save differently when they have a greater or smaller polygenic risk of developing Alzheimer's Disease. The issue is motivated in part because the so-called Baby Boomers are rapidly aging into ranges at which people develop Alzheimer's Disease and Related Dementias (hereafter ADRD). We also explore this question because there is an increasing interest among social scientists in using genetic data to explain social and economic behavior. We take advantage of developments in genetics that have opened up new opportunities for social scientists to better understand and explain how people manage life in advance of the onset of ADRD. Recently conducted large-scale genome-wide association studies (GWAS) have discovered a number of genetic variants (single nucleotide polymorphisms, or SNPs) that exhibit credible and robust associations with the onset of Alzheimer's Disease (Lambert et al. 2013). There is a tendency to assume that these data represent an exogenous assignment of factors that explains social and economic outcomes.

Here we explore whether this assumption holds. We study differences in the amount and type of financial assets people hold.[1] To start, we show that a person's Alzheimer's Disease PGS is statistically correlated with whether and how much a person holds assets in Certificates of Deposit, government savings bonds, and treasury bills and in Individual Retirement Accounts and Keogh accounts. For convenience, we label these asset types as "hands-off" and "hands-on" assets respectively. We do so to reflect the idea that "hands-off" assets require simpler management decisions only sporadically while "hands-on" assets require more involved decision-making on a more frequent basis. Using data from the 1992-2014 Health and Retirement Study (HRS), we find that, relative to people with lower PGS, people with higher Alzheimer's Disease polygenic risk hold roughly 8 percent more wealth in "hands-off" assets and around 15 percent less wealth in "hands-on" assets (both statistically significant differ from zero). The puzzle we seek to explain is why. If a person's Alzheimer's Disease polygenic score is truly exogenous, one should not observe such differences.

Our finding of a statistically significant difference in asset holdings by PGS might be explained by the findings of Barth, Papageorge and Thom (2017). They find that, after controlling for education, labor market earnings, and other factors, a one standard deviation increase in the education attainment PGS is associated with a 23 percent increase in wealth among retired households. They also show that the genetic endowment for educational attainment is statistically significantly related to financial and

[1] We find no correlation between a person's Alzheimer's Disease polygenic risk score and his net worth, housing assets and nonfinancial assets. Results are available upon request.

investment decisions such as stock market participation, financial literacy, more correct expectations about macroeconomics events and stock market returns, and a financial planning horizon. We extend Barth et al.'s (2017) findings by testing hypotheses about pathways through which a person's risk for Alzheimer's disease might change wealth accumulation and allocation decisions.

As noted above, we posit that these two asset categories differ in the degree to which a person has to monitor or manage them. We suggest that, if a person knows that he or she faces a higher risk of developing Alzheimer's Disease, it would be optimal to save in the "hands-off" asset category. But, as noted above, it is typical to assume that people do not know their ADRD polygenic risk.

To try to reconcile the observed behavior, we explore three hypothesis. We hypothesize that people with different PGS save/allocate wealth in different ways because…

H1: …they know their polygenic risk of developing ADRD;
H2: …they have lower cognitive capacity (and their PGS for general cognition is correlated with the Alzheimer's Disease PGS);
H3: …the GWAS process that generated the Alzheimer's Disease PGS failed to fully account for the aging process.

To test the first hypothesis we use data on factors that might inform a person about his/her polygenic risk of developing AD. In particular, we use data on whether a person knows that his or his/her spouse's parents have/had memory-related diseases.

To test the second hypothesis we use data on the PGS for general cognition of the respondent and his/her spouse and the interaction of that score with the Alzheimer's disease PGS. This hypothesis is informed by theory and evidence that suggests that cognitive abilities may affect individuals' decision about how to allocate their savings because costs of acquiring and processing information about investing in certain types of assets could be greater for those who have lower cognitive skills (e.g., stocks). Extant literature has documented the relation between cognitive ability and behavioral biases (Frederick, 2005; Dohmen et al., 2010; Benjamin, Brown, & Shaprio, 2013), and financial decisions and outcomes (McArdle, Smith, & Willis, 2009; Grinblatt, Keloharju, & Linnainmaa, 2011; Christelis, Jappelli, & Padual, 2010; Agarwal & Mazumder, 2013). For example, using the Survey of Health, Ageing and Retirement in Europe (SHARE), Christelis, Jappelli, and Padula (2010) found that cognitive abilities measured in mathematical, verbal fluency, and recall skills are positively correlated with stock market participation directly and indirectly through mutual funds and retirement accounts.

Motivated by their findings, we estimate models of savings after controlling for an individual's PGS for general cognition and the interaction of that score with the Alzheimer's Disease PGS. GWAS

identified thirteen SNPs to be associated with general cognition (Davies et al., 2015), and some of these SNPs may be also related with the Alzheimer's Disease PGS.

Our last hypothesis explores an implicit assumption – that the Alzheimer's Disease PGS is exogenous across people and time. Our approach is slightly different from that of Korniotis and Kumar (2011), who hypothesized that aging impacts investment behavior through the accumulation of greater investment knowledge from experience but also through cognitive deterioration. We conjecture that, as people advance to old age, they can better estimate their risk of developing ADRD (some may underestimate or even choose to ignore their chance of developing such disease when they are younger). If a person is more forgetful, it is rational for him/her to allocate his/her savings into financial instruments that do not require active management or full attention. To test this hypothesis, we estimate the baseline model after interacting an individual's Alzheimer's Disease PGS and his/her age.

Briefly, our extended model results show that the first two sets of controls do not account for the observed correlation. The interaction with age does. Once one controls for the age*Alzheimer's Disease PGS correlation, people with different Alzheimer's Disease PGS do not save more or less and are not more likely to allocate savings to "hands-off" or "hands-on" asset types. That is, once one accounts for the age*Alzheimer's Disease PGS correlation, the Alzheimer's Disease PGS can be considered to be an exogenous assignment. The results of the study suggest that people would alter their savings behavior if they knew for certain that they were at higher risk of eventually developing memory problems.

More broadly, there are good reasons to study whether and how social and economic behavior varies systematically with polygenic risk of various diseases or behaviors. The absolute and relative number of people age 65 and older continue to grow and the number of old adults with ADRD will increase. In 2017, 5.5 million U.S. residents suffer from ADRD (10 percent of Americans age 65 or older are ADRD victims) (Alzheimer's Association, 2017). Because ADRD tends to be underdiagnosed and underreported, the number of Americans with ADRD may be underestimated. Alzheimer's Association (2017) also projects that, by 2025, the incidence of ADRD will increase to 7.1 million (approximately 35 percent increase from the 5.3 million of Americans age 65 or older in 2017).

As ADRD progress, victims find it increasingly difficult to perform normal life activities. The literature collects survey data (which we use) on "activities of daily living" (ADLs) and "instrumental activities of daily living" (IADLs). In more advanced stages of ADRD, victims may slow the decline in their quality of life when family members or paid workers provide them with long-term care (LTC). When people pay, long-term care is not cheap. For example, in 2017 the median rates for a semi-private room in a nursing home and for assisted living facilities were $7,148 per month and $3,750 per month (Genworth, 2017). Long-term care from family members may pay less out-of-pocket but they still pay both money and non-monetary costs. Researchers estimate that, in 2016, informal caregivers of ADRD

victims spent 18.2 billion hours of unpaid care, amounting to an estimated economic value of $230.1 billion (Wolff, Spillman, Freedman, & Kasper, 2016). Further, as women increasingly participate in the labor market and as couples bear fewer children and are more likely to divorce, adult children face competing demands on their time. It may be stressful for people to resolve those competing demands.

Our study is also important because the U.S. government spends considerable sums of taxpayer dollars to treat and care for ADRD victims. Even though Medicare does not pay for nursing home and other LTC services, in 2016, Medicare covered healthcare costs for ADRD victims that were three times greater than similarly aged beneficiaries without ADRD ($23,497 vs $7,223 respectively) (Alzheimer's Association, 2016). Medicaid does pay the cost of LTC for low-income individuals. In 2016, average annual Medicaid payments for ADRD victims were 23 times larger than the average payment for those without ADRD ($8,182 versus $349 respectively) (Alzheimer's Association, 2016).

Despite this government spending, ADRD victims (or their families) still pay substantial out-of-pocket costs. End-of-life health care costs and the costs of LTC for ADRD victims significantly exceed costs of people with other conditions. Kelley et al. (2015) estimate that total end-of-life and LTC costs in the last 5 years of life were $341,651 per person for ADRD victims and $217,820 per person for non-ADRD victims. Facing these considerable costs, it is important to identify factors associated with people's decisions about savings because of the expected growth in public expenditures to treat and care for people with ADRD. Our evidence will help inform efforts by state and federal governments to create incentives for people to save at greater rates to cover the costs of such care.

Our study contributes to existing literature that examines how genetics affect financial decisions. Previous twin studies found that genetic traits explain a significant portion of variations in financial risk-taking (e.g., tendency to choose the default funds, ownership of ethical or socially responsible funds, return-chasing behavior) (Cesarini et al., 2010), in stock market participation and asset allocation (Barnea, Cronqvist, & Siegel, 2010), and in behavioral biases in investment (e.g., under-diversification, excessive trading, and the disposition effect) (Cronqvist & Siegel, 2014). These studies are rather limited because researchers do not observe individuals' actual genetic markers. For this reason, it is difficult to identify underlying mechanisms of any association between genetics and financial decisions. With the development of polygenic scores, researchers can potentially identify particular genetic markers associated with various financial decision and then explore possible pathways through which such correlations might arise.

The availability of genetic tests for ADRD has created a dilemma for clinicians providing advice to patients. Since there is no effective treatment for ADRD, improved detection of ADRD risk provides

no clinically actionable information. On the other hand, a positive ADRD screen might induce patients to alter their behavior in welfare-enhancing ways. Even though there is currently no cure for ADRD, knowing one's risk may induce people to start saving earlier to finance the costs of the care they will want later in life. Our evidence suggests that people would alter their savings behavior if they had a clearer idea of their ADRD risk.

The remainder of the paper is organized as follows. In section II, we provide detailed information about the data and the construction of main variables. We describe our method in Section III. Briefly, specify a baseline savings models that includes the PGS of the respondent and his/her spouse. We then specify extended models that add potentially omitted variables through which the PGS correlation might arise, plus the interaction between those variables and the PGS. These extended models test three plausible hypotheses to about the omitted variables that could explain the observed relationship between the Alzheimer's Disease PGS and savings. We present results in Section IV. In section V we conduct several robustness tests to explore other explanations. Section VI concludes.

II. Data and Variables

We use data from the 1992-2014 waves of the Health and Retirement Study (HRS). The HRS is a biennial longitudinal panel survey that collects a rich set of information about American adults age 50 and older and their spouses. The information includes individuals' demographics, physical and mental health status, disability, financial status such as income, net worth, and housing, insurance, work history and current employment status, retirement status and planning, and family structure (Servais, 2004).

In 2006, 2008, and 2010 the HRS collected saliva samples from respondents and their spouses in a randomly selected households (Ware, Schmitz, & Faul, 2017). The HRS constructed polygenic risk scores (PGSs) for a large set of phenotypes. To do this, they used a genome-wide association study (GWAS) in which they correlated genetic variants in individuals with a given trait (Faul & Smith, 2017). The PGSs consist of the weighted sum of the genotype (the number of reference alleles for individuals at each SNP). The PGS for Alzheimer's Disease combines the apolipoprotein E (APOE) locus and 19 single nucleotide polymorphisms (SNPs) associated with Alzheimer's Disease (Ware et al., 2017).

Following the literature, we restrict our sample to HRS respondents who are from European ancestry because researchers derived the SNP weights from a sample that was almost exclusively of European ancestry. PGSs of individuals who are from other ancestry groups may not have the same predictive capability of the outcome of interest (Martin et al., 2017; Ware et al., 2017). We further restrict our sample to couples with non-missing values on genetic, age, education, health status, medical conditions, difficulties with performing activities of daily livings (ADLs) and instrumental activities of

daily livings (IADLs), employment status, and number of years of work of respondents and spouses, number of living children, household income, and financial assets. Our analytic sample is 8,140 individuals (54,106 observations).

Table 1 presents summary statistics on the sample's basic characteristics. Because we include both respondents and spouses in our analyses, summary statistics on the characteristics of respondent and spouses are almost identical. The majority of our sample earned at least a high school degree (88%), had at least good health (83%), and was either retired or not working (67%). The mean age of our average sample member was 66. The mean number of years of work was 35. Figure 1 provides the kernel density curve for the Alzheimer's Disease PGS variable, the genetic index score associated with AD. The distribution of the Alzheimer's Disease PGS variables is approximately normal. As is typical, we normalize the Alzheimer's Disease PGS variable, so that the coefficient on the PGS in multivariate regressions represents the percentage change in the asset of interest in response to a one standard deviation change in the Alzheimer's Disease PGS.

The HRS provides detailed information on household financial assets. Unfortunately, details about some of the financial assets are missing in some waves such as any asset invested in defined contribution (DC) pension accounts from previous employers (e.g., 401K, 403b). For consistency in our analyses across waves, financial assets include any money or assets held in stocks (publicly held corporations, mutual funds, or investment trusts), cash-equivalent (checking, savings, and money market accounts), retirement accounts (Individual Retirement Account (IRA), Keogh account), DC pension accounts from current employers,[2] certificates of deposit (CDs) (government savings bonds, or treasury bills), bonds (corporate, municipal, government, foreign bonds, or any bond funds), and other financial assets (any other savings or other assets such as jewelry, money owed, a collection for investment purposes, rights in a trust or estate, or an annuity). We use each value provided in the RAND HRS wealth file. After adjusting for consumer price index (CPI), all values are expressed in 2014 dollars.

Table 2 shows the mean, 10^{th}, 25^{th}, 50^{th}, 75^{th}, and 90^{th} percentiles of total financial assets and each financial instruments. The mean value for financial assets, stocks, cash equivalent, IRAs, DC pension plans, CDs, bonds, other financial assets is \$343,000, \$105,221, \$40,936, \$105,390, \$31,990, \$21,655, \$16,210, and \$21,598, respectively. Unsurprisingly, the distribution of each type of assets is highly skewed so that the value of each asset for the median household is much lower. Holdings of each type of asset for the median household are \$115,686, \$0, \$11,617, \$10,996, \$0, \$0, \$0, and \$0, respectively. For

[2] The HRS does not provide detailed portfolio allocations in DC pension, IRAs, and Keogh accounts in every wave. We do not re-classify financial assets by different types of securities (e.g., stocks, bonds).

some financial instruments, only a few individuals hold such assets (e.g., the percentage of individuals who own bonds is 9.97%). The majority of our sample holds at least one type of financial asset (96.57%) and cash-equivalents (92.79%).

III. Method

We adopt a simple method. We first specify a model of each household's (log) assets of several different types. These include all financial assets, stocks, cash, IRAs, DC pensions, CDs, bonds, and other financial assets. Each model includes the respondent's and his/her spouse's Alzheimer's Disease PGS and a set of standard control variables. We include: the first ten principal components of the genetic data,[3] the PGS for general cognition, age, age-squared, education, self-reported health status, number of medical conditions diagnosed by a doctor, number of difficulties with performing ADLs and IALDs, employment status, and total number of years worked of both respondents and spouses, household income, number of living children, and year dummies. We use random-effect regression models for all specifications, and cluster standard errors by households. Unless otherwise indicated, we always include the same set of control variables.

We then extend the models to include potentially omitted variables. In our first extension, we include in the model whether a respondent's parents and his/her spouse's parents have been diagnosed with memory-related diseases.

From 1998 through 2008 the HRS asked whether a respondent's (living) mother or father had ever been told to have a memory-related disease by a doctor. Beginning in the 2010 wave, the HRS documented whether a doctor had ever diagnosed the respondent's mother and father with Alzheimer's or Dementia. To create a consistent measure and ensure a large sample size we create a time-invariant dummy variable indicating whether a respondent has at least one parent who has ever had a memory-related disease.[4] We create the same dummy variable for his/her spouse. In the full sample (8,140 respondents), approximately 12 percent and 4 percent of individuals have a mother or a father that has been diagnosed with a memory-related disease, respectively.

[3] Researchers recommended controlling for the ten principal components of the genetic data to account for a potential association between genetic factors and ancestry groups and population stratification in GWAS (Price et al., 2006; Benjamin et al., 2012; Barth et al., 2017).

[4] For the 2010-2014 waves, we coded the indicator as one if a person's mother or father has diagnosed with Alzheimer's disease or/and dementia and as zero otherwise.

We interact the reference person's Alzheimer's Disease PGS with an indicator of his (her) parents with memory problems and his/her spouse's Alzheimer's Disease PGS and an indicator of his/her parents were diagnosed with memory problems.

In our second extension, we control the general cognition PGS for both the respondent and his/her spouse and the interaction of those scores with the Alzheimer's disease PGS. In our third extension, we interact the person's PGS for Alzheimer's Disease with his/her age. We posit that, as people age, they make increasingly better (more precise) guesses about the probability that they will develop Alzheimer's Disease. The logic behind this test is that people who forget more (often) will rationally choose to save in assets that require them to pay less attention.

IV. Results

In our basic specification, if it is true that the genetic endowment is exogenous to economic and financial outcomes, a respondent's and his/her spouse's Alzheimer's Disease PGS should not be related to the amount and type of assets he/she holds. In Table 3 suggest that Alzheimer's Disease PGS is significantly associated with asset holdings of two types - asset holdings in IRA and CDs. A one-standard deviation increase in a respondent's and his/her spouse's Alzheimer's Disease PGS are associated with approximately a 15 and 12 percent decrease in the amount assets held in IRAs. If he/she has a one-standard deviation higher Alzheimer's Disease PGS, then he/she holds roughly 8 percent more wealth in CDs.

Table 4 presents coefficient estimates from our extended models. People save more in financial assets, cash-equivalent, IRAs, and other financial assets when they have parents who have been diagnosed with memory problems. In particular, if a person has a parental history of memory problems, he/she saves statistically significantly more in total financial assets by 15 percent, in cash-equivalent by 15 percent, and other financial assets by 31 percent while his/her spouse's parental history of memory-related disease is associated with increases in total financial assets by 27 percent, cash-equivalent by 24 percent, IRAs by 36 percent, and other financial assets by 28 percent. However, even after including both a respondent's and his/her spouse's parental history of memory-related disease, a person with higher genetic risk of Alzheimer's Disease saves less in IRAs (16 percent) and saves more in CDs (9 percent); these relationship remain statistically significant. Thus, the first hypothesis does not fully explain the association between savings and the Alzheimer's Disease PGS.

Table 5 presents the results from the model of savings in each type of assets. PGS for general cognition is not correlated with savings in any type of financial assets. Even after interacting the PGS for general cognition and AD, a person with higher polygenic risk for Alzheimer's Disease save less in IRAs

by 15 percent and more in CDs by 8 percent. The effect size of Alzheimer's Disease PGS on savings in IRAs and CDs is almost identical to one presented in Table 3. Thus, the second hypothesis does not explain the correlation between the Alzheimer's Disease PGS and saving decisions.

Table 6 reports results from the extended model that interacts age with the Alzheimer's Disease PGS. Results suggest that this interaction term fully accounts for the correlation between savings and the Alzheimer's Disease PGS. After controlling for the interaction, people with different Alzheimer's Disease PGS do not save more or less overall or in IRAs versus CDs. That is, we find supporting evidence for the third hypothesis: if we account for the interplay between age and Alzheimer's Disease PGS, the Alzheimer's Disease PGS can be considered to be an exogenous assignment. Instead, age remains positively correlated with savings in financial assets, stocks, cash-equivalent, IRAs, and bonds.

To account for cognitive ability and an aging process simultaneously, we estimate a model of savings that includes two- and three-way interaction terms between the Alzheimer's Disease PGS, PGS for general cognition, and age. Results are provided in Table 7. The empirical findings strongly support the last hypothesis that aging is an underlying explanation for the correlation between the Alzheimer's Disease PGS and savings. After including interaction terms (age*AD PGS, Alzheimer's Disease PGS*cognition PGS, age*cognition PGS, and age*AD PGS*cognition PGS), the correlation between the Alzheimer's Disease PGS and the amount a person saves in IRAs and CDs disappears.

IV. Robustness checks

Cognitive ability

As a robustness test, we also include a measure for a person's and his/her spouses' cognitive abilities and interact them with the Alzheimer's Disease PGS. The HRS provides total cognition scores by summing the total word recall (a sum of the immediate and delayed word recall scores, ranging from 0 to 20) and mental status (a sum of serial 7's, backward counting from 20, object, date, and President/Vice-President naming tasks, ranging from 0 to 15) scores, which ranges from 0 to 35. More details about each of these measures are available in Ofstedal, Fisher, and Herzog (2005). We use an imputed measure for cognitive functioning provided by the RAND version of the HRS. Imputations for missing data could be necessary because those who choose not to respond to questions may be systematically different from those who answer the questions. The imputation was performed only for self-respondents (excluding proxy respondents or non-participants in a given wave) using a multivariate regression-based procedure including time-invariant baseline demographics, wave-specific demographics, and other time-variant factors associated with cognitive functioning, and prior and current wave cognitive scores. Additional information is documented in Fisher, Hassan, Faul, and Rodgers (2017) in detail. In our model of savings,

we standardized the total cognition scores. The average total cognition score of our sample is 23.60 (S.D.= 3.65).

Table 8 presents estimates from models of savings after controlling for total cognition score and interacting it with the Alzheimer's Disease PGS. A person's total cognition score is positively associated with savings in total financial assets, stocks, cash-equivalent, IRAs, CDs, and other financial assets. This result is consistent with previous literature showing that cognitive ability is correlated with financial decisions, especially stock market participation (Grinblatt et al., 2011; Christelis et al., 2010). His/her spouse's cognition score is positively correlated with asset holdings in the same financial instruments except for CDs. The cognitive functioning partially explains the correlation between the Alzheimer's Disease PGS and savings, but does not fully account for the relations. After the inclusion of the total cognition score and the interaction term between the score and the Alzheimer's Disease PGS, a person with higher genetic risk of developing Alzheimer's Disease saves less in financial assets, IRAs, and other financial assets. In particular, a one-standard deviation increase in the Alzheimer's Disease PGS is associated with a decrease in savings in financial assets by 6 percent, IRAs by 16 percent, and other financial assets by 10 percent. The Alzheimer's Disease PGS remains associated with an increase in asset holdings in CDs by 9 percent, but the correlation is no longer statistically significant.

Risk tolerance

Some may argue that individual heterogeneity in savings (portfolio allocation) is attributable to a person's willingness take financial risk (Cohn, Lewellen, Lease, & Schlarbaum, 1975; Friend & Blume, 1975; Morin & Suarez, 1983; Pålsson, 1996; Guisso, Haliassos, & Bertaut, 2002; Palme, Sundén, & Söderlind, 2007). Researchers have found evidence that cognitive abilities partly explain variations in a person's willingness to take risks (Dohmen et al., 2010; Bonsang & Dohmen, 2015), and thus his/her portfolio choices. To test whether the Alzheimer's Disease PGS operate through a person's willingness to take risk, we include a measure for risk aversion and interact this with the Alzheimer's Disease PGS. The HRS measures a respondent's risk aversion based on a set of income gamble questions asking him/her to choose between pairs of jobs where one guarantee current family income and the other offers a chance to increase income but also carries the risk of loss of income. The second job would double income with even chances (50-50) or cut it by X. The income loss scenarios provided in the HRS are: "10 percent, 20 percent, a third, half, and 75 percent." The set of questions are asked only in the 1992 and 1998-2006 waves of the HRS. We create a dummy variable of whether a respondent is risk averse by coding the variable as one if he/she choose to take a job that guarantees current income over the second job that may double income or cut it by 10 percent and as zero otherwise. Approximately 41 percent of our sample

exhibit risk averse preferences. For missing data for risk aversion, we impute the value using the previous wave's degree of risk aversion if a person had participated in the survey.

Table 9 presents results. The results suggest that risk aversion may explain some of the correlation between the Alzheimer's Disease PGS and savings in a particular type of assets such as IRAs but not CDs. The effect of the Alzheimer's Disease PGS on the amount savings in IRAs is no longer statistically significant and the size of the effect decreases from 15 to 6 percent compared to the baseline model presented in Table 3. However, the effect of a person's Alzheimer's Disease PGS and his/her spouse's Alzheimer's Disease PGD on the amount saved in CDs remains statistically different from zero ($p< 0.05$) and the magnitude of the effect becomes even greater. Specifically, the person's Alzheimer's Disease PGS and his/her spouse's Alzheimer's Disease PGS are associated with increases in asset holdings in CDs by 15 percent and 16 percent, respectively. The result indicates that a person's willingness to take risk may account for the correlation between the Alzheimer's Disease PGS and savings in IRAs but not savings in CDs, and thus the third hypothesis (the learning by aging process) might be a better explanation for the association.

Planning horizon

Another possible mechanism that might explain the correlation between the Alzheimer's Disease PGS and savings is the planning horizon. If a person with high polygenic risk of developing Alzheimer's Disease has a systematically shorter or longer time horizon, it may affect his/her portfolio allocation. In order to measure a person's financial planning horizon, the HRS asks the question, "In planning your family's saving and spending, which time period is more important to you?" The responses are: "next few months (10.41%)," "next year (12.03%)," "next few years (29.91%)," "next 5-10 years (35.09%)," and "longer than 10 years (12.56%)." We include dummy variables for these responses ("next few months" is the omitted variable) and interact them with the Alzheimer's Disease PGS. The results presented in Table 10 show that people with longer planning horizons allocate more wealth in total financial assets, stocks, cash-equivalent, IRAs, DCs, CDs, and other financial assets. This result is similar to results presented in Barth et al. (2017). We find a similar pattern for the relation between his/her spouse's time horizon and household savings. The inclusion of these variables does not account for the correlation between the Alzheimer's Disease PGS and savings in IRAs but savings in CDs. We no longer observe the statistically significant positive association between the Alzheimer's Disease PGS and savings in CDs, and the marginal effect is only 3 percent. However, a one-standard deviation increase in the person's Alzheimer's Disease PGS is associated with a decrease in savings in IRAs by 18 percent (the magnitude of the effect is greater than one derived from the baseline model). Thus, we conclude that the planning horizon does not fully account for the correlation between the Alzheimer's Disease PGS and savings.

V. Conclusion

We start with a basic result that suggested that one observes different savings behavior between people with lower and higher genetic risk of developing Alzheimer's Disease. In our basic models we find that people with higher risk of developing Alzheimer's Disease save more in assets that require less active management and less in assets that need to be managed more. This patterns seems consistent with several possible mechanisms that we explore. We explored whether people might know their potential for developing Alzheimer's disease from their family histories; whether they were cognitively limited; and, in a variant of knowing their risks, whether the process of aging revealed their impending potential for Alzheimer's Disease.

Our results suggest that the last explanation accounts for the observed correlations between savings (of a given type) and the genetic risk of developing Alzheimer's Disease. We find that once on controls for the correlation between age and the Alzheimer's PGS, the direct association between savings and the Alzheimer's PGS disappears.

This finding suggests that, as they age, people with higher Alzheimer's Disease PGS alter their savings type and amounts. Such changes in behavior may simply reflect a person's recognition of accumulating forgetfulness or it may be a more complicated process that involves adult children more actively intervening. Overall the results suggest that people might adjust their savings behavior if they knew that they faced a higher risk of developing ADRD later in life.

References

Agarwal, S., & Mazumder, B. (2013). "Cognitive Abilities and Household Financial Decision Making." *American Economic Journal: Applied Economics* 5(1): 193-207.

Alzhiemer's Association (2016). "Medicare Current Beneficiary Survey Report." *Unpublished Report*.

Alzhiemer's Association (2017). "2017 Alzheimer's Disease Facts and Figures." *Alzheimer's & Dementia* 13(4): 325-373.

Barnea, A., Cronqvist, H., & Siegel, S. (2010). "Nature or Nurture: What Determines Investment Behavior?" *Journal of Financial Economics* 98(3): 583-604.

Barth, D., Papageorge, N. W., & Thom, K. (2017). "Genetic Ability, Wealth, and Financial Decision-Making." IZA Discussion Papers 10567, Forschungsinstitut zur Zukunft der Arbeit. Available at https://www.econstor.eu/handle/10419/161190

Benjamin, D. J., Brown, S. A., & Shapiro, J. M. (2013). "Who Is 'Behavioral'? Cognitive Ability and Anomalous Preferences." *Journal of the European Economic Association* 11(6): 1231-1255.

Benjamin, D. J., Cesarini, D., Chabris, C. F., Glaeser, E. L., Laibson, D. I., Guðnason, V., Harris, T. B., Launer, L. J., Purcell, S., Smith, A. V., et al. (2012). "The Promises and Pitfalls of Genoeconomics." *Annual Review of Economics* 4: 627-662.

Cesarini, D., Johannesson, M., Lichtenstein, P., Sandewall, Ö., & Wallace, B. (2010). "Genetic Variation in Financial Decision-Making." *Journal of Finance* 65(5): 1725-1754.

Christelis, D., Jappelli, T., & Padula, M. (2010). "Cognitive Abilities and Portfolio Choice." *European Economic Review* 54: 18-38.

Cohn, R. A., Lewellen, W. G., Lease, R. C., Schlarbaum, G. G. (1975). "Individual Investor Risk Aversion and Investment Portfolio Composition." *Journal of Finance* 30: 605-620.

Cronqvist, H., & Siegel, S. (2014). "The Genetics of Investment Biases." *Journal of Financial Economics* 113(2): 215-234.

Davies, G., Armstrong, N., Bis, J. C., Bressler, J., Chouraki, V., Giddaluru, S., …, & Van Der Lee, S. J. (2015). "Genetic Contributions to Variation in General Cognitive Function: A Meta-Analysis of Genome-Wide Association Studies in the CHARGE Consortium (N= 53,949)." *Molecular Psychiatry* 20(2): 183.

Dohmen, T., Falk, A., Huffman, D., & Sunde, U. (2010). "Are Risk Aversion and Impatience Related to Cognitive Ability?" *American Economic Review* 100(3): 1238-1260.

Faul, J., & Smith, J. A. (2017). "Health and Retirement Study: Genetic Data Consortia Collaboration." Institute for Social Research, University of Michigan, Ann Arbor, MI.

Fisher, G. G., Hassan, H., Faul, J. D., & Rodgers, W. L. (2017). "Health and Retirement Study Imputation of Cognitive Functioning Measures: 1992-2014." Survey Research Center, University of Michigan, Ann Arbor, MI.

Frederick, S. (2005). "Cognitive Reflection and Decision Making." *Journal of Economic Perspectives* 19(4): 25-42.

Friend, I., & Blume, M. E. (1975). "The Demand for Risky Assets." *American Economic Review* 65: 900-922.

Galama, T., Lillard, D.R., Thom, K. (2018). "An Economic Analysis of Smoking, Polygenic Risk, Information, and Behavioral Responses." unpublished manuscript. Department of Human Sciences, Ohio State University.

Genworth. (2017). "Genworth 2017 Cost of Care Survey." Available at https://www.genworth.com/aging-and-you/finances/cost-of-care.html

Grinblatt, M., Keloharju, M., & Linnainmaa, J. (2011). "IQ and Stock Market Participation." *Journal of Finance* 66(6): 2119-2164.

Guison, L., Haliassos, M., & Jappelli, T. (2002). "*Household Portfolio*." MIT Press, Cambridge, MA.

Kelly, A. S., McGarry, K., Gorges, R., & Skinner, J. S. (2015). "The Burden of Health Care Costs for Patients with Dementia in the Last 5 Years of Life." *Annals of Internal Medicine* 163:729-736.

Korniotis, G. M., & Kumar, A. (2011). "Do Older Investors Make Better Investment Decisions?" *The Review of Economics and Statistics* 93(1): 244-265.

Lambert, J-C., Ibrahim-Verbaas, C. A., Haorld, D., et al. (2013). "Meta-Analysis of 74,046 Individuals Identifies 11 New Susceptibility Loci for Alzheimer's Disease." *Nature Genetics* 45: 1452-1458.

Martin A. R., Gignoux, C. R., Walters, R. K., Wojcik, G. L., Neale, B. M., Gravel, S., Daly, M. J., Bustamante, C. D., & Kenny, E. E. (2017). "Human demographic history impacts genetic risk prediction across diverse populations." *The American Journal of Human Genetics* 100(4), 635-649.

McArdle, J. J., Smith, J. P., & Willis, R. (2009). "Cognition and Economic Outcomes in the Health and Retirement Survey." NBER Working Paper 15266, National Bureau of Economic Research, Cambridge, MA.

Morin, R. A., & Suarez, A. F. (1983). "Risk Aversion Revisited." *Journal of Finance* 38: 1201-1216.

Ofstedal, M. B., Fisher, G. G., & Herzong, A. R. (2005). "Documentation of Cognitive Functioning Measures in the Health and Retirement Study." HRS Documentation Report DR-006. Survey Research Center, University of Michigan, Ann Arbor, MI.

Palme, M., Sundén, A., & Söderlind, P. (2007). "Investment Choice in the Swedish Premium Pension Plan." *Journal of the European Economic Association* 5: 636-646.

Pålsson, A.-M. (1996). "Does the Degree of Relative Risk Aversion Vary with Household Characteristics?" *Journal of Economic Psychology* 17: 771-787.

Price, A. L., Patterson, N. J., Plenge, R. M., Weinblatt, M. E., Shadick, N. A., & Reich, D. (2006). "Principal Components Analysis Corrects for Stratification in Genome-Wide Association Studies." *Nature Genetics* 38 (8): 904-909.

Servais, M. A. (2004). "Overview of HRS Public Data Files for Cross-Sectional and Longitudinal Analysis." Institute for Social Research, University of Michigan, Ann Arbor, MI.

Ware, E., Schmitz, L. L., & Faul, J. D. (2017). "HRS Documentation Report. HRS Polygenic Scores 2006-2010 Genetic Data." Institute for Social Research, University of Michigan, Ann Arbor, MI.

Ware, E., Schmitz, L. L., Faul, J. D., Gard, A. M., Smith, J. A., Mitchell, C. M., Weir, D. R., & Kardia, S. L. R. (2017). "Heterogeneity in Polygenic Scores for Common Human Traits." *BiorXiv*. Available at https://doi.org/10.1101/106062

Wolff, J. L., Spillman, B. C., Freedman, V. A., & Kasper, J. D. (2016). "A National Profile of Family and Unpaid Caregivers Who Assist Older Adults with Health Care Activities." *JAMA Internal Medicine* 176(3): 372-379.

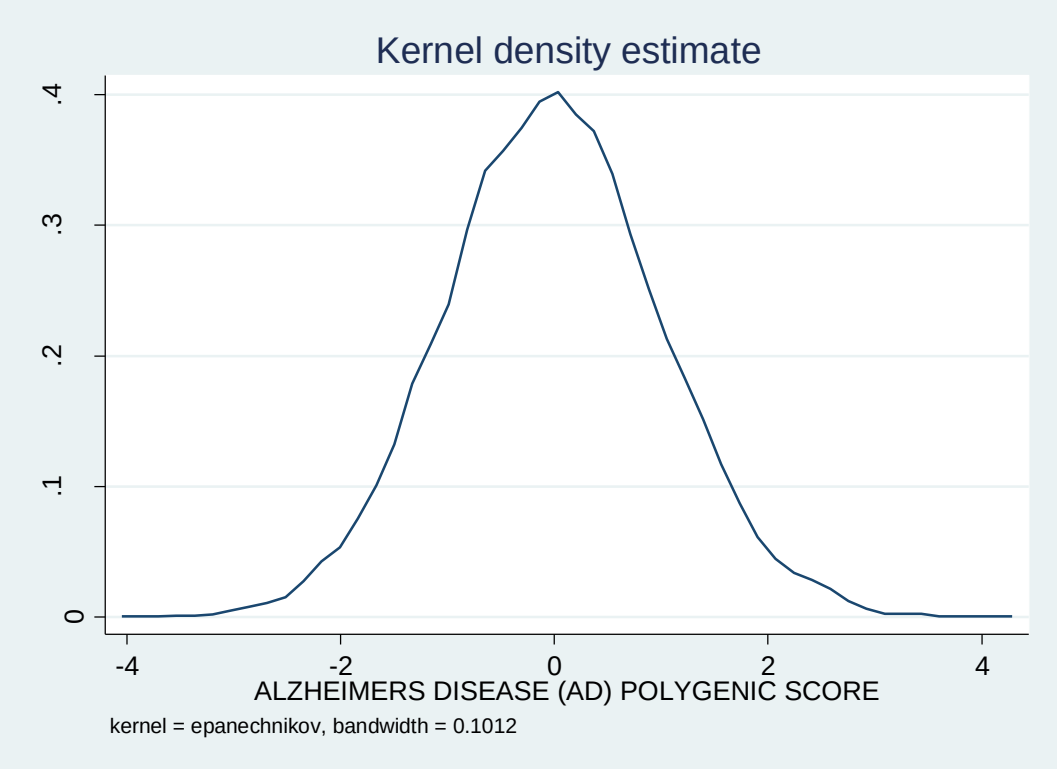

Figure 1. Distribution of Alzheimer's Disease PGS.

Table 1. Sample Characteristics, 1992-2014 HRS.

Variables	%/ Mean Respondent	%/ Mean Spouse
Age	65.61	65.94
(S.D.)	(8.90)	(9.06)
Educational attainment		
Less than HS	0.12	0.13
HS	0.38	0.38
SC	0.24	0.24
BA+	0.26	0.25
Health status		
Poor	0.04	0.06
Fair	0.13	0.14
Good	0.31	0.31
Very good	0.37	0.35
Excellent	0.15	0.14
No. of medical condition	0.20	0.21
(S.D.)	(0.23)	(0.24)
No. of difficulties with performing ADLs	0.19	0.27
(S.D.)	(0.52)	(0.73)
No. of difficulties with performing IADLs	0.21	0.27
(S.D.)	(0.46)	(0.69)
Employment status		
Employed	0.33	0.33
Retired	0.57	0.58
Not working	0.10	0.96
No. of years of work	35.04	35.53
(S.D.)	(14.13)	(14.07)
Household characteristics		
No. of living children	3.29	
(S.D.)	(1.94)	
Household income (2014 $)	98,400	
(S.D.)	(108,779)	

Notes. Summary statistics are unweighted. (N=8,140)

Table 2. Components of Financial Assets. (2014$)

	10%	25%	50%	75%	90%	Mean	S.D.	% ownership
Financial assets	2,062	22,554	115,686	369,042	841,298	343,000	605,775	96.57
Stocks	0	0	0	43,986	250,602	105,221	335,080	41.13
Cash Equiv.	251	3,016	11,617	36,302	98,988	40,936	71,154	92.79
IRAs	0	0	10,996	100,000	319,461	105,390	192,791	56.21
DC pension	0	0	0	0	50,120	31,990	124,613	19.58
CDs	0	0	0	2,529	48,113	21,655	68,079	28.65
Bonds	0	0	0	0	0	16,210	87,249	9.97
Others	0	0	0	0	32,989	21,598	76,468	23.33

Note. Summary statistics are unweighted. The full sample is 8,140 individuals and 54,106 observations.

Table 3. Baseline Model: The Alzheimer's Disease PGS and Financial Decisions.

	log (fin)	log (stock)	log (cash)	log (IRA)	log (DC)	log (CD)	log (bond)	log (other)
	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)
Respondent factors								
Alzheimer's Disease PGS	-0.0428 (0.0234)	-0.0865 (0.0442)	-0.0040 (0.0204)	-0.1490** (0.0492)	-0.0153 (0.0286)	0.0786* (0.0358)	-0.0234 (0.0246)	-0.0546 (0.0295)
Spouse factors								
Alzheimer's Disease PGS	-0.0266 (0.0280)	-0.0505 (0.0539)	0.0149 (0.0231)	-0.1249* (0.0626)	-0.0287 (0.0358)	0.0728 (0.0427)	-0.0071 (0.0291)	-0.0518 (0.0360)
Obs.	54,106	54,106	54,106	54,106	54,106	54,106	54,106	54,106
N	8,140	8,140	8,140	8,140	8,140	8,140	8,140	8,140
R^2	0.2742	0.1598	0.1502	0.1397	0.2627	0.0690	0.0779	0.0717

Notes. * p<0.05, ** p<0.01, *** p<0.001. We control for first ten principal components of the genetic data, polygenic scores for general cognition, age, age-squared, education, self-reported health status, number of medical conditions diagnosed by a doctor, number of difficulties with performing ADLs and IALDs, employment status, and total number of years worked of both respondents and spouses, household income, number of living children, and year dummies. Standard errors are clustered at the household level.

Table 4 The Alzheimer's Disease PGS, Parental History of Memory-related Disease, and Financial Decisions.

	log (fin)	log (stock)	log (cash)	log (IRA)	log (DC)	log (CD)	log (bond)	log (other)
	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)
Respondent factors								
Alzheimer's Disease PGS	-0.0298	-0.0911	0.0057	-0.1611**	-0.0254	0.0865*	-0.0248	-0.0546
	(0.0258)	(0.0480)	(0.0225)	(0.0534)	(0.0288)	(0.0391)	(0.0269)	(0.0312)
Parental history	0.1454*	-0.0784	0.1523**	0.0657	0.0138	0.0149	0.0606	0.3148***
	(0.0653)	(0.1254)	(0.0576)	(0.1379)	(0.0960)	(0.0973)	(0.0667)	(0.0912)
AD PGS * parental history	-0.0929	0.0322	-0.0682	0.0748	0.0603	-0.0426	0.0100	-0.0104
	(0.0586)	(0.1213)	(0.0519)	(0.1378)	(0.0968)	(0.0990)	(0.0606)	(0.0903)
Spouse factors								
Alzheimer's Disease PGS	-0.0134	-0.0608	0.0269	-0.1275	-0.0396	0.0897	-0.0026	-0.0410
	(0.0312)	(0.0592)	(0.0256)	(0.0687)	(0.0363)	(0.0466)	(0.0321)	(0.0383)
Parental history	0.2701***	0.1788	0.2395***	0.3581*	-0.0623	0.1969	0.0882	0.2775**
	(0.0655)	(0.1305)	(0.0563)	(0.1481)	(0.0972)	(0.1005)	(0.0695)	(0.0931)
AD PGS * parental history	-0.0701	0.0550	-0.0637	-0.0157	0.0695	-0.1042	-0.0199	-0.0653
	(0.0677)	(0.1409)	(0.0579)	(0.1677)	(0.1152)	(0.1176)	(0.0672)	(0.1062)
Obs.	54,106	54,106	54,106	54,106	54,106	54,106	54,106	54,106
N	8,140	8,140	8,140	8,140	8,140	8,140	8,140	8,140
R^2	0.2761	0.1599	0.1516	0.1403	0.2628	0.0694	0.0780	0.0730

Notes. * p<0.05, ** p<0.01, *** p<0.001. We control for first ten principal components of the genetic data, polygenic scores for general cognition, age, age-squared, education, self-reported health status, number of medical conditions diagnosed by a doctor, number of difficulties with performing ADLs and IALDs, employment status, and total number of years worked of both respondents and spouses, household income, number of living children, and year dummies. Standard errors are clustered at the household level.

Table 5. The Alzheimer's Disease PGS, General Cognition PGS, and Financial Decisions.

	log (fin)	log (stock)	log (cash)	log (IRA)	log(DC)	log (CD)	log (bond)	log (other)
	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)
Respondent factors								
Alzheimer's Disease PGS	-0.0434	-0.0856	-0.0035	-0.1480**	-0.0161	0.0764*	-0.0235	-0.0548
	(0.0234)	(0.0442)	(0.0204)	(0.0492)	(0.0285)	(0.0358)	(0.0246)	(0.0295)
Cognition PGS	-0.0050	0.0306	-0.0231	-0.0030	0.0394	0.0014	0.0030	-0.0076
	(0.0248)	(0.0472)	(0.0219)	(0.0523)	(0.0302)	(0.0380)	(0.0255)	(0.0335)
Alzheimer's Disease PGS	0.0151	-0.0185	-0.0112	-0.0372	0.0198	0.0606	0.0029	0.0101
* cognition PGS	(0.0226)	(0.0458)	(0.0197)	(0.0488)	(0.0281)	(0.0359)	(0.0252)	(0.0300)
Spouse factors								
Alzheimer's Disease PGS	-0.0269	-0.0511	0.0147	-0.1235*	-0.0287	0.0722	-0.0071	-0.0522
	(0.0280)	(0.0539)	(0.0231)	(0.0624)	(0.0358)	(0.0426)	(0.0291)	(0.0360)
Cognition PGS	0.0010	0.0084	-0.0131	-0.0056	0.0092	0.0417	0.0005	-0.0401
	(0.0295)	(0.0591)	(0.0251)	(0.0685)	(0.0364)	(0.0466)	(0.0305)	(0.0415)
Alzheimer's Disease PGS	0.0155	0.0059	-0.0013	-0.0537	0.0123	0.0527	0.0034	0.0172
* cognition PGS	(0.0277)	(0.0585)	(0.0223)	(0.0635)	(0.0340)	(0.0441)	(0.0304)	(0.0380)
Obs.	54,106	54,106	54,106	54,106	54,106	54,106	54,106	54,106
N	8,140	8,140	8,140	8,140	8,140	8,140	8,140	8,140
R^2	0.2745	0.1598	0.1503	0.1400	0.2627	0.0690	0.0779	0.0717

Notes. * p<0.05, ** p<0.01, *** p<0.001. We control for first ten principal components of the genetic data, age, age-squared, education, self-reported health status, number of medical conditions diagnosed by a doctor, number of difficulties with performing ADLs and IALDs, employment status, and total number of years worked of both respondents and spouses, household income, number of living children, and year dummies. Standard errors are clustered at the household level.

Table 6. The Alzheimer's Disease PGS, Age, and Financial Decisions.

	log (fin)	log (stock)	log (cash)	log (IRA)	log (DC)	log (CD)	log (bond)	log (other)
	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)
Respondent factors								
Alzheimer's Disease PGS	0.0673	-0.1701	0.1002	-0.0687	-0.0407	0.0656	-0.1903	0.0489
	(0.1076)	(0.2086)	(0.1064)	(0.2461)	(0.1860)	(0.1953)	(0.1201)	(0.1673)
Age	0.0675***	0.1007**	0.0390*	0.2620***	-0.0244	0.0385	0.0693***	0.0321
	(0.0165)	(0.0338)	(0.0176)	(0.0327)	(0.0263)	(0.0292)	(0.0188)	(0.0270)
Alzheimer's Disease PGS * age	-0.0017	0.0013	-0.0016	-0.0012	0.0004	0.0002	0.0026	-0.0016
	(0.0017)	(0.0032)	(0.0016)	(0.0038)	(0.0026)	(0.0030)	(0.0019)	(0.0025)
Spouse factors								
Alzheimer's Disease PGS	0.0664	-0.1692	0.0381	0.0371	-0.0877	0.0232	-0.2693	0.0262
	(0.1225)	(0.2439)	(0.1194)	(0.2946)	(0.2261)	(0.2230)	(0.1393)	(0.1982)
Age	0.0307*	0.0485	0.0097	0.2444***	-0.0451	0.0426	0.0460*	0.0408
	(0.0157)	(0.0336)	(0.0171)	(0.0326)	(0.0277)	(0.0283)	(0.0186)	(0.0266)
Alzheimer's Disease PGS * age	-0.0014	0.0018	-0.0004	-0.0025	0.0009	0.0008	0.0040	-0.0012
	(0.0019)	(0.0037)	(0.0019)	(0.0045)	(0.0032)	(0.0034)	(0.0022)	(0.0030)
Obs.	54,106	54,106	54,106	54,106	54,106	54,106	54,106	54,106
N	8,140	8,140	8,140	8,140	8,140	8,140	8,140	8,140
R^2	0.2741	0.1598	0.1502	0.1397	0.2627	0.0690	0.0779	0.0717

Notes. * p<0.05, ** p<0.01, *** p<0.001. We control for first ten principal components of the genetic data, polygenic scores for general cognition, age-squared, education, self-reported health status, number of medical conditions diagnosed by a doctor, number of difficulties with performing ADLs and IALDs, employment status, and total number of years worked of both respondents and spouses, household income, number of living children, and year dummies. Standard errors are clustered at the household level.

Table 7. The Alzheimer's Disease PGS, Cognition PGS, Age, and Financial Decisions.

	log (fin)	log (stock)	log (cash)	log (IRA)	log(DC)	log (CD)	log (bond)	log (other)
	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)
Respondent factors								
Alzheimer's Disease PGS	0.0549	-0.1751	0.0935	-0.0739	-0.0382	0.0556	-0.1998	0.0443
	(0.1088)	(0.2085)	(0.1072)	(0.2479)	(0.1867)	(0.1960)	(0.1202)	(0.1672)
Age	0.0681***	0.1009**	0.0394*	0.2625***	-0.0252	0.0332	0.0700***	0.0322
	(0.0165)	(0.0339)	(0.0176)	(0.0327)	(0.0264)	(0.0292)	(0.0189)	(0.0271)
Alzheimer's Disease PGS * age	-0.0015	0.0014	-0.0015	-0.0011	0.0003	0.0003	0.0027	-0.0015
	(0.0017)	(0.0032)	(0.0017)	(0.0038)	(0.0026)	(0.0030)	(0.0019)	(0.0025)
Cognition PGS	-0.0993	-0.0181	-0.0433	0.0088	0.1180	-0.1290	-0.1425	-0.1284
	(0.1041)	(0.2145)	(0.1105)	(0.2426)	(0.1818)	(0.1936)	(0.1313)	(0.1757)
Alzheimer's Disease PGS * Alzheimer's Disease PGS	0.1113	-0.0323	0.0801	0.1690	-0.0248	0.0901	-0.0457	-0.0945
	(0.1055)	(0.2134)	(0.1067)	(0.2298)	(0.1805)	(0.1863)	(0.1288)	(0.1633)
Cognition PGS * age	0.0015	0.0008	0.0003	-0.0002	-0.0012	0.0020	0.0022	0.0019
	(0.0016)	(0.0033)	(0.0017)	(0.0037)	(0.0026)	(0.0030)	(0.0021)	(0.0026)
AD PGS*cognition	-0.0015	0.0002	-0.0014	-0.0032	0.0007	-0.0005	0.0008	0.0016
PGS*age	(0.0016)	(0.0033)	(0.0016)	(0.0035)	(0.0025)	(0.0029)	(0.0020)	(0.0024)
Spouse factors								
Alzheimer's Disease PGS	0.0590	-0.1766	0.0360	0.0430	-0.0906	0.0133	-0.2812*	0.0248
	(0.1226)	(0.2441)	(0.1198)	(0.2974)	(0.2270)	(0.2236)	(0.1390)	(0.1980)
Age	0.0312*	0.0489	0.0100	0.2448***	-0.0452	0.0428	0.0410*	0.0407
	(0.0156)	(0.0336)	(0.0171)	(0.0326)	(0.0278)	(0.0283)	(0.0187)	(0.0266)
Alzheimer's Disease PGS * age	-0.0013	0.0019	-0.0003	-0.0026	0.0010	0.0009	0.0042	-0.0012
	(0.0019)	(0.0037)	(0.0019)	(0.0046)	(0.0032)	(0.0035)	(0.0022)	(0.0030)
Cognition PGS	-0.1073	-0.1186	-0.0828	0.0022	-0.0875	0.0115	-0.1577	-0.0521
	(0.1155)	(0.2457)	(0.1255)	(0.2948)	(0.2162)	(0.2330)	(0.1605)	(0.2101)
Alzheimer's Disease PGS * Alzheimer's Disease PGS	-0.0240	-0.0578	-0.0003	-0.0013	-0.1413	0.1402	-0.0920	-0.1124
	(0.1178)	(0.2501)	(0.1181)	(0.2875)	(0.2187)	(0.2193)	(0.1554)	(0.1952)
Cognition PGS * age	0.0017	0.0020	0.0011	-0.0001	0.0015	0.0005	0.0024	0.0002
	(0.0018)	(0.0038)	(0.0019)	(0.0045)	(0.0030)	(0.0036)	(0.0025)	(0.0032)
AD PGS*cognition	0.0006	0.0010	0.0000	-0.0008	0.0023	-0.0013	0.0015	0.0020
PGS*age	(0.0018)	(0.0038)	(0.0018)	(0.0044)	(0.0031)	(0.0034)	(0.0024)	(0.0029)

Obs.	54,106	54,106	54,106	54,106	54,106	54,106	54,106	54,106
N	8,140	8,140	8,140	8,140	8,140	8,140	8,140	8,140
R squared	0.2739	0.1598	0.1502	0.1400	0.2627	0.0691	0.0778	0.0718

Notes. * p<0.05, ** p<0.01, *** p<0.001. We control for first ten principal components of the genetic data, age-squared, education, self-reported health status, number of medical conditions diagnosed by a doctor, number of difficulties with performing ADLs and IALDs, employment status, and total number of years worked of both respondents and spouses, household income, number of living children, and year dummies. Standard errors are clustered at the household level.

Table 8. The Alzheimer's Disease PGS, Cognitive Ability, and Financial Decisions.

	log (fin)	log (stock)	log (cash)	log (IRA)	log (DC)	log (CD)	log (bond)	log (other)
	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)
Respondent factors								
Alzheimer's Disease	-0.0613*	-0.1061	-0.0247	-0.1581*	-0.0181	0.0892	-0.0025	-0.0997*
PGS	(0.0302)	(0.0592)	(0.0276)	(0.0642)	(0.0271)	(0.0531)	(0.0378)	(0.0394)
Cognition	0.0915***	0.1762***	0.1249***	0.0898*	-0.0067	0.0984*	0.0416	0.1269***
	(0.0195)	(0.0404)	(0.0251)	(0.0371)	(0.0213)	(0.0397)	(0.0303)	(0.0350)
Alzheimer's Disease	0.0043	0.0105	0.0213	0.0327	-0.0019	-0.0217	0.0084	-0.0009
PGS * cognition	(0.0181)	(0.0350)	(0.0211)	(0.0355)	(0.0188)	(0.0359)	(0.0245)	(0.0316)
Spouse factors								
Alzheimer's Disease	-0.0327	-0.1302	-0.0411	-0.2267*	-0.0177	0.1809	-0.0329	-0.0776
PGS	(0.0585)	(0.1028)	(0.0619)	(0.1142)	(0.0461)	(0.1020)	(0.0630)	(0.0810)
Cognition	0.2175***	0.4741***	0.2616***	0.4029***	-0.0004	0.1580	0.1322	0.3908***
	(0.0490)	(0.1022)	(0.0635)	(0.0954)	(0.0536)	(0.1001)	(0.0753)	(0.0873)
Alzheimer's Disease	0.0068	0.0946	0.0450	0.1232	-0.0330	-0.1277	0.0682	-0.0249
PGS * cognition	(0.0529)	(0.1034)	(0.0610)	(0.1060)	(0.0573)	(0.1068)	(0.0726)	(0.0957)
Obs.	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915
N	5,233	5,233	5,233	5,233	5,233	5,233	5,233	5,233
R squared	0.2628	0.1763	0.1314	0.1291	0.2230	0.0611	0.1039	0.0871

Notes. * p<0.05, ** p<0.01, *** p<0.001. We control for first ten principal components of the genetic data, age, age-squared, education, self-reported health status, number of medical conditions diagnosed by a doctor, number of difficulties with performing ADLs and IALDs, employment status, and total number of years worked of both respondents and spouses, household income, number of living children, and year dummies. Standard errors are clustered at the household level.

Table 9. The Alzheimer's Disease PGS, Risk Tolerance, and Financial Decisions.

	log (fin)	log (stock)	log (cash)	log (IRA)	log (DC)	log (CD)	log (bond)	log (other)
	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)
Respondent factors								
Alzheimer's Disease	-0.0029	-0.0744	0.0482	-0.0619	-0.0108	0.1489*	0.0352	-0.0521
PGS	(0.0406)	(0.0899)	(0.0393)	(0.0987)	(0.0785)	(0.0707)	(0.0543)	(0.0726)
Risk aversion	-0.0776	-0.1390	-0.1037*	-0.0168	0.0241	0.0716	-0.0573	-0.1520
	(0.0441)	(0.0984)	(0.0472)	(0.1089)	(0.0869)	(0.0829)	(0.0573)	(0.0825)
Alzheimer's Disease	-0.0317	-0.0067	-0.0680	-0.0840	0.0081	-0.1622	-0.0418	-0.0582
PGS * risk aversion	(0.0445)	(0.1003)	(0.0468)	(0.1106)	(0.0934)	(0.0825)	(0.0613)	(0.0854)
Spouse factors								
Alzheimer's Disease	-0.0160	-0.0972	0.0453	-0.0413	-0.0827	0.1570*	0.0145	-0.0227
PGS	(0.0457)	(0.0980)	(0.0420)	(0.1139)	(0.0882)	(0.0787)	(0.0586)	(0.0822)
Risk aversion	-0.0339	-0.3152**	-0.0609	0.1033	0.0839	0.0064	-0.0355	-0.1153
	(0.0449)	(0.0998)	(0.0467)	(0.1105)	(0.0889)	(0.0851)	(0.0556)	(0.0817)
Alzheimer's Disease	-0.0424	0.0083	-0.0630	-0.1325	0.0516	-0.1488	-0.0411	-0.0908
PGS * risk aversion	(0.0507)	(0.1049)	(0.0509)	(0.1283)	(0.1049)	(0.0899)	(0.0643)	(0.0963)
Obs.	25,456	25,456	25,456	25,456	25,456	25,456	25,456	25,456
N	3,701	3,701	3,701	3,701	3,701	3,701	3,701	3,701
R squared	0.3035	0.1601	0.1672	0.1593	0.2423	0.0694	0.0646	0.0686

Notes. * p<0.05, ** p<0.01, *** p<0.001. We control for first ten principal components of the genetic data, age, age-squared, education, self-reported health status, number of medical conditions diagnosed by a doctor, number of difficulties with performing ADLs and IALDs, employment status, and total number of years worked of both respondents and spouses, household income, number of living children, and year dummies. Standard errors are clustered at the household level.

Table 10. The Alzheimer's Disease PGS, Planning Horizon, and Financial Decisions.

	log (fin)	log (stock)	log (cash)	log (IRA)	log (DC)	log (CD)	log (bond)	log (other)
	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)	Coef. (Robust S.E.)
Respondent factors								
Alzheimer's Disease PGS	-0.0263	-0.0998	-0.0025	-0.1814*	0.0821	0.0306	-0.0226	0.0813
	(0.0527)	(0.0887)	(0.0569)	(0.0912)	(0.0619)	(0.0757)	(0.0493)	(0.0720)
Planning horizon								
Next year	0.1915**	-0.0947	0.2556***	-0.0080	0.1262	0.0364	-0.1188	0.2295*
	(0.0602)	(0.1139)	(0.0692)	(0.1184)	(0.0876)	(0.0997)	(0.0621)	(0.0949)
Next few years	0.3602***	0.3061**	0.3646***	0.2928**	0.2103**	0.1807*	-0.0068	0.2159**
	(0.0499)	(0.0996)	(0.0586)	(0.1007)	(0.0755)	(0.0842)	(0.0516)	(0.0809)
Next 5-10 years	0.3679***	0.2695**	0.4525***	0.4066***	0.2289**	0.1578	0.0709	0.3232***
	(0.0497)	(0.1001)	(0.0572)	(0.0974)	(0.0755)	(0.0845)	(0.0532)	(0.0816)
Longer than 10 years	0.3872***	0.4829***	0.4098***	0.3221**	0.2727**	0.2534*	0.1342	0.4343***
	(0.0582)	(0.1243)	(0.0696)	(0.1136)	(0.0965)	(0.1060)	(0.0736)	(0.1045)
Alzheimer's Disease PGS*planning horizon								
Alzheimer's Disease PGS*next year	-0.0334	0.0508	-0.0071	0.0242	-0.0851	0.0503	-0.0510	-0.0763
	(0.0604)	(0.1047)	(0.0689)	(0.1146)	(0.0840)	(0.0956)	(0.0639)	(0.0971)
Alzheimer's Disease PGS*next few years	-0.0390	-0.0314	-0.0114	0.0437	-0.1079	0.0127	0.0088	-0.1588
	(0.0536)	(0.0985)	(0.0631)	(0.0990)	(0.0710)	(0.0844)	(0.0526)	(0.0824)
Alzheimer's Disease PGS*next 5-10 years	0.0078	0.0422	0.0098	0.0098	-0.0988	0.1130	0.0024	-0.1762
	(0.0517)	(0.0944)	(0.0595)	(0.0935)	(0.0733)	(0.0833)	(0.0541)	(0.0834)
Alzheimer's Disease PGS*10 years+	-0.0280	-0.0114	0.0387	-0.0147	-0.0945	0.0580	0.0926	-0.0104
	(0.0586)	(0.1219)	(0.0692)	(0.1100)	(0.0952)	(0.1053)	(0.0739)	(0.1075)
Spouse factors								
Alzheimer's Disease PGS	-0.0151	-0.0074	0.0545	-0.1935	0.0224	0.0406	0.0045	0.0822
	(0.0611)	(0.1027)	(0.0641)	(0.1055)	(0.0713)	(0.0877)	(0.0561)	(0.0837)
Planning horizon								
Next year	0.2078***	-0.0649	0.1966**	0.0785	0.0714	0.0347	-0.0894	0.3075**
	(0.0606)	(0.1114)	(0.0683)	(0.1158)	(0.0849)	(0.0977)	(0.0619)	(0.0941)
Next few years	0.3570***	0.2168*	0.3270***	0.2929**	0.1395	0.1584	0.0235	0.2908***
	(0.0514)	(0.0958)	(0.0575)	(0.0971)	(0.0730)	(0.0824)	(0.0505)	(0.0795)

Next 5-10 years	0.3537***	0.2127*	0.3438***	0.4010***	0.1771*	0.1551	0.0667	0.3396***
	(0.0510)	(0.0983)	(0.0573)	(0.0946)	(0.0738)	(0.0835)	(0.0516)	(0.0800)
Longer than 10 years	0.3956***	0.3198**	0.3297***	0.4140***	0.1857*	0.3179**	0.1141	0.4738***
	(0.0579)	(0.1218)	(0.0691)	(0.1113)	(0.0939)	(0.1056)	(0.0703)	(0.1022)
Alzheimer's Disease PGS*planning horizon								
Alzheimer's Disease PGS*next year	-0.0293	0.0668	-0.0498	0.0650	-0.0360	0.0553	-0.0735	-0.0408
	(0.0675)	(0.1191)	(0.0754)	(0.1300)	(0.0951)	(0.1085)	(0.0711)	(0.1116)
Alzheimer's Disease PGS*next few years	-0.0471	-0.0990	-0.0737	0.1142	-0.0754	0.0064	-0.0032	-0.1373
	(0.0613)	(0.1123)	(0.0699)	(0.1140)	(0.0803)	(0.0957)	(0.0581)	(0.0945)
Alzheimer's Disease PGS*next 5-10 years	-0.0024	-0.0255	-0.0181	0.0576	-0.0727	0.0806	-0.0307	-0.1858
	(0.0588)	(0.1079)	(0.0673)	(0.1076)	(0.0826)	(0.0958)	(0.0592)	(0.0966)
Alzheimer's Disease PGS*10 years+	-0.0662	-0.1065	-0.0035	-0.0094	-0.0783	0.0846	0.0413	-0.0556
	(0.0663)	(0.1411)	(0.0785)	(0.1239)	(0.1083)	(0.1177)	(0.0792)	(0.1225)
Obs.	32,116	32,116	32,116	32,116	32,116	32,116	32,116	32,116
N	7,338	7,338	7,338	7,338	7,338	7,338	7,338	7,338
R squared	0.2710	0.1654	0.1731	0.1602	0.2710	0.0781	0.0757	0.0777

Notes. * p<0.05, ** p<0.01, *** p<0.001. We control for first ten principal components of the genetic data, age, age-squared, education, self-reported health status, number of medical conditions diagnosed by a doctor, number of difficulties with performing ADLs and IALDs, employment status, and total number of years worked of both respondents and spouses, household income, number of living children, and year dummies. Standard errors are clustered at the household level.