The Financial Presentation of Alzheimer's Disease and Related Dementias

Lauren Hersch Nicholas, PhD MPP[1]

Johns Hopkins School of Public Health & School of Medicine, Institute for Social Research

Kenneth M. Langa, MD PhD

University of Michigan Medical School, Institute for Social Research, Veterans Affairs Center for Clinical Management Research, Institute for Healthcare Policy and Innovation

Julie P.W. Bynum, MD MPH

University of Michigan Medical School, Institute for Healthcare Policy and Innovation

Joanne W. Hsu, PhD

Federal Reserve Board of Governors & Howard University

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[1] Correspondence: lauren.nicholas@jhu.edu. 624 N. Broadway, Baltimore, MD 21205. (443) 287 – 5680 (phone).

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Key Points

Question: Is Alzheimer's Disease and Related Dementia (ADRD) associated with adverse financial outcomes in the years before and after diagnosis?

Findings: Compared to Medicare beneficiaries not diagnosed, those with ADRD were more likely to miss bill payments up to 6 years prior to diagnosis and started to develop subprime credit scores 2.5 years prior to diagnosis. These negative financial outcomes persisted after ADRD diagnosis, accounted for 10 - 15% of missed payments in our sample, and were more prevalent in census tracts with less college education.

Meaning: ADRD is associated with adverse financial events starting years prior to clinical diagnosis.

TWEET: Alzheimer's Disease and Related Dementias linked to increased risk of missed bill payments and subprime credit scores years prior to formal diagnosis; financial problems persist after diagnosis and are worse in less-educated areas.

@lhnicholas, @fedresearch

Abstract

Importance: Alzheimer's Disease and Related Dementias (ADRD), currently incurable neurodegenerative diseases, can threaten patients' financial status due to memory deficits and changes in risk perception. Deteriorating financial capabilities are among the earliest signs of cognitive decline, but the frequency and extent of adverse financial events before and after diagnosis have not been characterized.

Objectives: To describe the financial presentation of ADRD using administrative credit data.

Design: Retrospective secondary data analysis of consumer credit report outcomes from 1999 – 2018 linked to Medicare claims data.

Setting: Population-based study of older adults appearing in a 5% sample of US households with Social Security numbers and a 20% sample of Medicare beneficiaries.

Participants: 81,364 Medicare beneficiaries living in single-person households.

Exposure: Time from ADRD diagnosis in comparison to beneficiaries not diagnosed with ADRD.

Main Outcomes: Missed payments on credit accounts (30 or more days late) and subprime credit scores.

Results: Single Medicare beneficiaries diagnosed with ADRD were more likely to miss payments on credit accounts as early as 6 years prior to diagnosis in comparison to demographically similar beneficiaries without ADRD (7.7% versus 7.3%; absolute difference 0.4 percentage points (pp), 95% CI 0.07 – 0.7;) and to develop subprime credit scores 2.5 years prior to diagnosis (8.5% vs. 8.1%, absolute difference 0.4 pp, 95% CI 0.05 – 0.7). By the quarter after diagnosis, ADRD patients remained more likely to miss payments than similar beneficiaries who do not develop ADRD (7.9% versus 6.9%; absolute difference 1pp, 95% CI 0.7 – 1.4) and more likely to have subprime credit scores than those without ADRD (8.2% vs. 7.5%; absolute difference 0.7, pp 95% CI 0.3 – 1.1). Adverse financial events were more common among ADRD patients in lower-education census tracts. The patterns of adverse events associated with ADRD were unique compared to other medical conditions (e.g., glaucoma, hip fracture).

Conclusions and Relevance: ADRD is associated with adverse financial events years prior to clinical diagnosis that become more prevalent after diagnosis and are most common in

lower-education census tracts.

INTRODUCTION

About 14.7 percent of American adults over the age of 70 have Alzheimer's Disease and Related Dementias (ADRD), neurodegenerative conditions characterized by deteriorating cognitive function that impedes independence in daily activities through deficits in memory and other cognitive domains.[1] Common ADRD symptoms, including memory problems and decreased attention and judgment, frequently impair personal financial management. Erratic bill payments, risky financial decisions, and susceptibility to financial fraud are widely recognized as early indicators of ADRD, though families and physicians often do not detect these behaviors until later in the course of the disease.[2-6] Despite limited research regarding the full extent of dementia-related losses, there have been numerous lay press anecdotes of loved ones first learning of a patient's decline through catastrophic financial events including foreclosure and asset depletion.[7] Cognitively impaired older adults may be particularly vulnerable to financial exploitation, estimated to impact between 3% and 14% of older adults annually.[8,9]

Cognitive impairment often leads patients to overestimate their abilities and continue potentially inappropriate financial roles; 80 percent of primary financial decision-makers in couples maintain this role after cognitive decline consistent with dementia.[10,11] Self-reported difficulties managing money and poor performance on financial capability tests predict increased risk of dementia.[3,12-14] However, little is known about the overall prevalence and magnitude of ADRD-related financial errors. To date, ADRD studies have typically relied on survey assessment of financial abilities and outcomes in small samples. A 2017 meta-analysis summarizing the literature on financial capabilities and dementia included just 10 studies with a cumulative 1,050 subjects.[14] The only study to our knowledge to examine the effects of ADRD on realized financial outcomes measured in administrative data for a large sample of Medicare beneficiaries found that beneficiaries were less likely to choose the

lowest-cost prescription drug plan both before and after a formal diagnosis in comparison to people without ADRD.[15]

If undiagnosed ADRD leads to costly financial errors, earlier diagnosis could be valuable even without effective treatments or cures. Most Americans routinely use credit products, generating real-time information on borrowing and repayment behavior. Early signs of impaired capabilities may manifest as missing payment on routine bills or inappropriate credit use. We linked administrative healthcare and demographic data from Medicare, the federal health insurance program for the elderly, to the Federal Reserve Bank of New York/Equifax Consumer Credit Panel (CCP/Equifax) to characterize the financial presentation of ADRD before and after diagnosis.

METHODS

DATA

Medicare Claims Data

We obtained Medicare beneficiary summary files and exact address data for a 20% sample of Medicare beneficiaries who were alive for at least part of 2014, including all beneficiaries who had one or more claim with a diagnostic code indicating ADRD and a comparison group without ADRD.[16] We sampled entire zip codes to observe beneficiaries sharing addresses. We kept beneficiaries in our sample if they joined a Medicare Advantage (MA) plan after developing ADRD. Comparison group beneficiaries were included for all quarters that they were in Fee-for-Service (FFS) Medicare.

We used beneficiaries' last known exact address from the Medicare Vital Status June 2018 file to identify beneficiaries living in single-person households (no other beneficiary at exact address). Single-beneficiary households are best-suited to our study because the link between ADRD and financial outcomes is not be obscured by an unimpaired spouse taking over financial management.[10] Single-beneficiary households have lower income and wealth

than couples on average and may be particularly vulnerable to financial harms from ADRD.

We used previously validated algorithms to identify Medicare beneficiaries with arthritis, glaucoma, heart attack, and hip fracture so that we could determine whether adverse credit outcomes around an ADRD diagnosis were unique to ADRD or were related to hospitalization or deteriorating health more broadly.[17] Sex and race/ethnicity (Black, Hispanic, and other including missing) were based on Medicare administrative reports.

Federal Reserve Bank of New York/Equifax Consumer Credit Panel

The Federal Reserve Bank of New York/Equifax Consumer Credit Panel (CCP/Equifax) tracks credit files of all individuals residing with a randomly selected 5% sample of the US credit file population from 1999 - present.[18,19] Credit data are primarily collected to inform lending decisions and summarize personal financial characteristics related to borrowing and debt repayment. These data are increasingly used to understand financial predictors and consequences of health events.[20-24] We used two key indicators of deteriorating financial self-management. The first is an indicator of payment delinquency, meaning one or more accounts at least 30 days past due. These individuals failed to make at least a minimum payment for two or more consecutive months. The second is an indicator for subprime credit scores based on the Equifax Risk Score, a proprietary calculation summarizing a person's predicted risk of defaulting on loans over the next 24 months based on their credit history. Scores below 620 are considered subprime, indicating higher default risk. Our CCP/Equifax sample included all members living in single-person households (based on exact address) in the second quarter of 2018 or the year of their death and were born before 1947.

Linked Sample

We linked the Medicare and CCP/Equifax samples using census block, birth month and year, and 2012 – 2015 zip codes. Since creditors may not immediately process death, we

used an iterative process to link datasets. We first merged Medicare beneficiaries who were alive in June 2018, living in a single-beneficiary household, and uniquely identified by census block, birth year, and zip code history (N = 5,843,037) to the 1,305,711 CCP/Equifax sample members meeting these criteria. We then used CCP/Equifax sample members who did not merge to a beneficiary alive in 2018 who were also present in the data in 2017 as potential matches to Medicare beneficiaries dying in 2017. We repeated this process for beneficiaries dying in 2016, 2015, and 2014. Additional details, including a participant flow diagram (Appendix Figure 1) appear online.

The linked analysis sample contained 95,234 unique beneficiaries. We excluded 10,220 beneficiaries who entered an MA plan prior to developing ADRD because claims necessary to identify ADRD are not collected once a beneficiary moves into MA, precluding us from observing health conditions. We excluded 3,482 beneficiaries who are diagnosed before 2006 because we lacked their MA enrollment information before diagnosis and could not confirm an exact date. We linked the Medicare dates that a beneficiary first exhibited ADRD and other conditions to the quarterly panel of credit data spanning 1999 – 2018, dropping an additional 168 respondents with no credit activity during the study period. Thus, we observed beneficiaries with ADRD before and after they triggered the algorithm and follow comparison beneficiaries over time to account for other factors affecting financial outcomes among all beneficiaries over time. Appendix Table 1 describes our data timeline. Our secondary analysis of deidentified administrative data was exempt from review by the Johns Hopkins School of Public Health IRB.

Statistical Analysis

Adverse Financial Events and ADRD Diagnosis

We studied adverse credit outcomes before and after an ADRD diagnosis using flexible, non-parametric linear probability models. Similar methods have been used to study

economic consequences of health events.[21,22] We estimated the probability that a Medicare beneficiary had a delinquent account at least 30 days past due or subprime credit score as a function of time from ADRD diagnosis. We used quarterly indicator variables spanning 28 quarters (7 years) prior to 16 quarters (4 years) after diagnosis in comparison to Medicare beneficiaries who never developed ADRD during the study period. We adjusted for beneficiary age, sex, race/ethnicity, average credit score at age 65, state of residence to account for geographic differences in ADRD diagnosis and economic conditions and year and quarter of observation to account for cyclical trends in consumer behavior and shocks affecting all consumers. To better isolate financial complications of ADRD, we controlled for comorbid conditions including diabetes, stroke and transient ischemic attack, hypertension, congestive heart failure, ischemic heart disease, chronic obstructive pulmonary disease, chronic kidney disease, atrial fibrillation, and cancer.[17] Standard errors were clustered at the beneficiary level.

To test whether results were unique to ADRD and not characteristic of aging or illness more broadly, we repeated our analysis using negative control diagnoses. These models examine financial outcomes relative to two gradual-onset conditions (arthritis and glaucoma), and two acute-onset conditions (heart attack and hip fracture). To test the robustness of our findings, we estimated models that restricted our sample to beneficiaries observed for at least 4 quarters before and after diagnosis, excluded beneficiaries with any MA enrollment, and excluded comorbid health conditions.

Since education can protect against ADRD and more highly educated older adults may have additional resources and better financial literacy that protect against adverse financial events, we also stratified our analysis by education.[25-29] We used 2010 American Community Study data to compare beneficiaries living in census tracts with rates of adults 65 and above with more than a high school education above the median level of 38.8% to those

living in census tracts with lower levels of older adult education. Education correlates with other measures of socioeconomic status; 2010 median income among elderly households was $30,199 in the lower education tracts and $47,182 in the higher education tracts. All analysis was conducted using Stata 16 MP, with p-values of 0.05 considered statistically significant.

RESULTS

Our matched sample included 5,004,842 quarterly observations from 81,364 Medicare beneficiaries. In unadjusted comparisons averaging across the entire study period, compared to those never diagnosed with ADRD during our study period (n = 54,062), beneficiaries who developed ADRD (n = 27,302) were similarly likely to miss payments (7.8% vs 7.8%, p = 0.58) and less likely to have subprime credit scores (8.5% versus 9.3%, p < 0.001) (Table 1). Ever-ADRD beneficiaries were slightly older (79.4 versus 74.8; p < 0.001) and more likely to be Hispanic (2.4% versus 1.1%, p < 0.001). Our linked sample of single beneficiaries was older, more likely to be female, and had higher rates of chronic conditions than a random sample of Medicare beneficiaries (Appendix Table 2).

Timing of Adverse Credit Events Relative to ADRD

After adjusting for demographic and health characteristics, we found important differences in adverse financial events among Medicare beneficiaries who did versus did not develop ADRD that emerged prior to clinical diagnosis. Beneficiaries who developed ADRD were at significantly higher risk of payment delinquency in comparison to similar beneficiaries who never developed ADRD beginning 6 years prior to diagnosis (7.7% versus 7.3%; absolute difference 0.4 percentage points (pp), 95% CI 0.07 – 0.7;) (Figure 1). By the quarter after diagnosis, this absolute difference increased to 1.0 pp (95% CI 0.7 to 1.4; 7.9% vs. 6.9%). These relationships account for a large share of the overall delinquency rate in our sample; 5.2% at 6 years prior to diagnosis and 17.9% three quarters after diagnosis.

Similarly, beneficiaries who developed ADRD were more likely to have subprime credit scores starting 2.5 years prior to diagnosis (8.5% vs. 8.1%, absolute difference 0.4 pp, 95% CI 0.05 – 0.7), reaching a maximum absolute difference of 1.1 pp (95% CI 0.7 – 1.4; 8.4% vs. 7.3%) three quarters after diagnosis (Figure 2). Beneficiaries with ADRD remained at elevated risk of missed payments and subprime credit scores for at least 3.5 years after diagnosis.

Figure 3 and Appendix Figure 2 suggest that the increased credit difficulties observed with ADRD are not reflective of a more general problem paying bills related to hospitalization or financial struggles driven by healthcare costs. There was no evidence of increased delinquency or subprime credit scores prior to diagnosis for arthritis, glaucoma, or hip fracture. Glaucoma was frequently associated with lower risk of missed payments and subprime scores.[30] Heart attacks, which can be caused by financial stress, were preceded by elevated payment delinquency and subprime scores only in the year immediately prior to the event.[31,32]

Increased rates of payment delinquency and subprime credit scores were more prevalent among single Medicare beneficiaries in census tracts with lower levels of educational attainment (Figure 4). Both indicators of impaired financial management emerged years earlier for Medicare beneficiaries eventually diagnosed with ADRD in the lower education tracts relative to those in more highly educated tracts and impacted a larger share of beneficiaries. Payment delinquency rates were higher for ADRD beneficiaries in the lower education tracts starting almost 7 years prior to diagnosis ($p < 0.05$), compared to 2.5 years prior to diagnosis in the higher-education tracts. Coefficients in the lower-education models are generally outside the confidence intervals of the higher-education models, indicating a significantly larger adverse financial impact of ADRD among beneficiaries in low-education census tracts ($p < 0.05$).Our results were robust to sample exclusions including

omitting Medicare beneficiaries with any MA enrollment, restricting our sample to a more balanced panel, and limiting the study to 2005 – 2014 when we could also control for Medicaid enrollment. The ADRD coefficients were generally larger in magnitude and more precisely estimated when we did not include controls for any of comorbid health conditions (Appendix Figures 3 – 6). There was no relationship between adverse financial events and timing of cancer diagnosis (Appendix Figure 7).

DISCUSSION

Using a novel administrative data linkage including twenty years of data on over 80,000 Medicare beneficiaries in single-person households, we found that a diagnosis of ADRD was associated with higher rates of missed payments and subprime credit scores years prior to diagnosis. ADRD-linked missed payments and subprime credit scores were sufficiently common to be detected in our population-based study; at their peak representing nearly 20% of missed payments and subprime scores in our sample, and disproportionately affected residents of census tracts with lower levels of college education. Many beneficiaries continued to experience adverse financial outcomes after ADRD diagnosis, suggesting persistent unmet needs managing financial obligations. Our results represent the first large-scale evidence of financial harms related to preclinical and diagnosed ADRD.

The emergence of adverse credit events years before ADRD diagnosis and their persistence after diagnosis have important implications for patient and family financial security. Payment delinquency triggers penalty interest and fees, which we estimate would cost households in our sample $383 - $670 in the four years prior to dementia diagnosis alone. Credit for subprime borrowers is more difficult and costly to access; compared to those with prime scores, subprime borrowers pay an estimated $1,085 - $1,426 more in credit card interest annually due to higher rates.[33] Credit data do not include utility payments,

where non-payment could result in a loss of service. The extended period between financial indicators of ADRD and its diagnosis raises concerns about catastrophic financial events resulting from preclinical or undiagnosed ADRD for older adults. Rates of adverse financial events continued to increase for single adults after diagnosis, suggesting a role for financial guidance following diagnosis.

Financial difficulties emerged earliest relative to time of ADRD diagnosis for Medicare beneficiaries living in census tracts with lower levels of education. We were unable to determine whether this is due to later ADRD detection, fewer financial resources, or a combination of factors, though both interpretations raise particular concerns about the health and financial well-being of this especially vulnerable population.

Our findings join a growing literature characterizing the links between consumer behavior and underlying health status.[20,24] We show that ADRD is associated with adverse financial outcomes even in the pre-diagnosis stage, raising concern that patients with compromised financial abilities may also be at high risk and susceptible to financial fraud. As the number of older adults living with dementia continues to increase, so does the need to develop policies that protect these patients from harms of poor financial self-management and financial fraud and abuse. For example, financial institutions could potentially play a larger role in tracking uncharacteristic transactions and other behaviors consistent with cognitive impairment similar to the data we put together in this study. Tools for screening patients for financial self-management difficulty could be useful to improve detection of dementia in clinical practice.

Limitations

Our study has several limitations. First, our claims-based ADRD metric can only identify Medicare beneficiaries with ADRD if they have a healthcare claim with the

diagnosis.[16,34] Thus, it is likely that our non-ADRD group includes patients who truly do not have ADRD and those who have not yet been diagnosed or were diagnosed outside of Medicare-reimbursed care (for example, at a Veterans Affairs clinic), while the ADRD cohort also includes false-positives. However, Medicare claims generally capture the most severe ADRD cases. We excluded people who entered Medicare Advantage before developing ADRD because their utilization cannot be observed; thus, our study is only representative of FFS Medicare beneficiaries. MA beneficiaries are typically less well-off, and may have different characteristic financial behaviors.[35,36]

We only included people in single-person households at their most recent address, which likely excluded people living in assisted living and other facilities where social support or assistance may be available. Findings may not generalize to married couples and those in group living quarters. However, the majority of Medicare beneficiaries with ADRD live in single-person households (Supplementary Appendix). In addition, the relationship between ADRD and financial outcomes would be confounded by the presence of a spouse who may be managing finances and studying single beneficiaries highlights this subgroup's particular financial vulnerability. Finally, our payment delinquency measure was limited to consumer debts reported to credit bureaus and excludes accounts such as utilities, rent, and medical collections. Because it is unlikely that ADRD differentially impacts payment delinquencies for some types of accounts versus others, this omission leads us to understate financial losses due to dementia but does not bias our comparison of beneficiaries with and without ADRD. We study debts, and lack access to bank and brokerage accounts where signs of financial exploitation might be observed. Data availability could help monitor financial trajectories of ADRD, potentially helping the growing population of the oldest old retain financial independence.

CONCLUSION

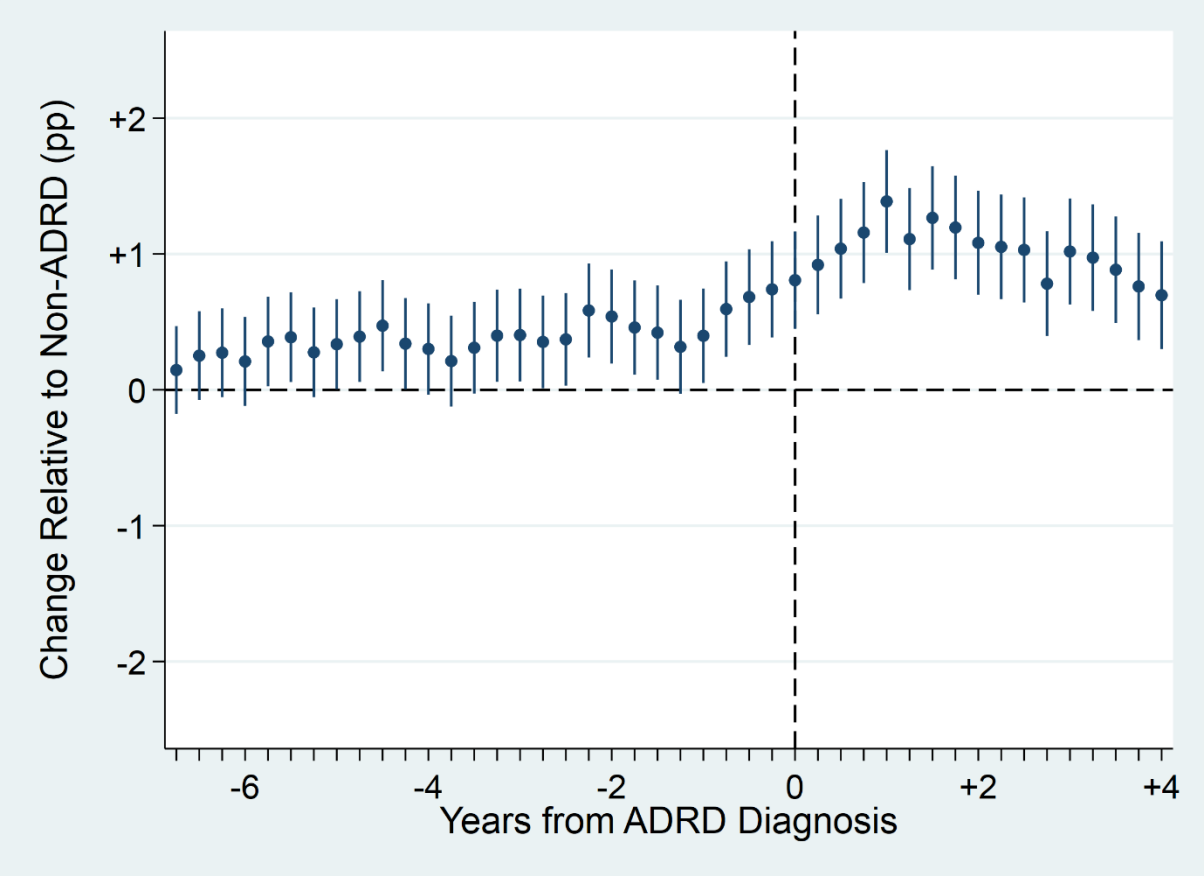
Medicare beneficiaries in single-person households begin to miss bill payments and experience other adverse financial events several years prior to ADRD diagnosis and adverse financial events persist after diagnosis. Our findings highlight the important adverse financial consequences of cognitive decline and impairment. Even without effective medical treatments, earlier detection of cognitive impairment might help protect older adults and their families from adverse financial outcomes. Families should be counseled about the potential need to help with financial management following ADRD diagnosis.

Table 1: Average Sample Characteristics by Ever-Alzheimer's Disease and Related Dementias Status

	Never-ADRD (N = 54,062)	Ever-ADRD (N = 27,302)
Any Delinquency -- % (± sd)	7.8 (15.9)	7.8 (17.8)
Subprime Credit Scores-- % (± sd)	9.3 (21.0)	8.5 (21.3)
Equifax Risk Score -- score (± sd)	747 (70.1)	754 (71.1)
Male -- no. (%)	18,196 (33.7)	8,586 (31.4)
Age -- yrs (± sd)	74.8 (7.3)	79.4 (7.52)
Black -- no. (%)	5,226 (9.7)	2,701 (9.9)
Hispanic -- no. (%)	606 (1.1)	648 (2.4)
Other Race -- no. (%)	1,344 (2.5)	1,069 (3.9)
Arthritis Ever -- no. (%)	29,973 (55.4)	21,130 (77.4)
Cancer Ever -- no. (%)	8,082 (14.9)	5,533 (20.3)
Diabetes Ever -- no. (%)	17,820 (33.0)	13,449 (49.3)
CHF Ever -- no. (%)	14,363 (26.6)	14,491 (53.1)
Stroke Ever -- no. (%)	7,205 (13.3)	10,263 (37.6)
Heart Attack Ever -- no. (%)	2,871 (5.3)	2,607 (9.6)
Glaucoma Ever -- no. (%)	13,159 (24.3)	9,045 (332)
Hip Fracture Ever -- no. (%)	2,159 (4.0)	3,957 (14.5)

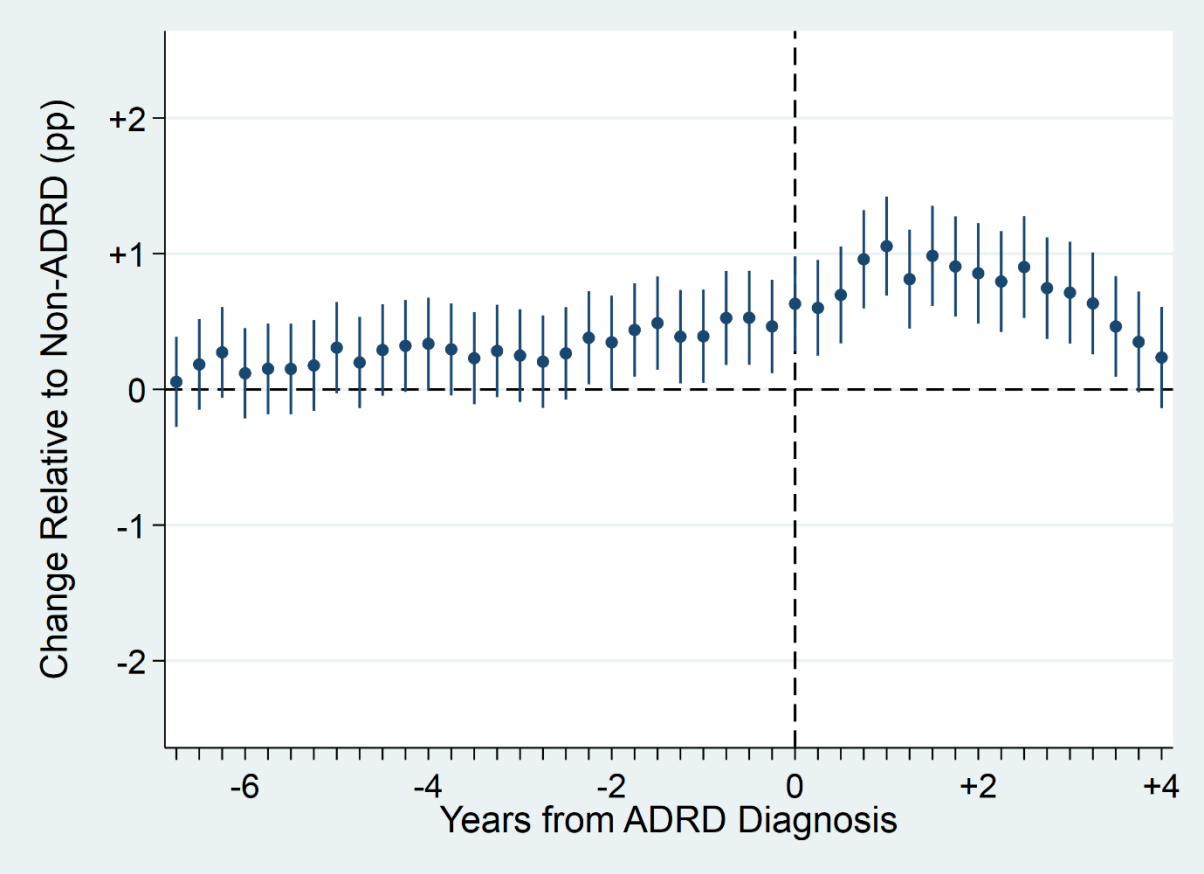
Average characteristics of Medicare beneficiaries who do and do not develop ADRD during our study period (1999 – 2018). Credit score used is the Equifax Risk Score. FRBNY CCP/Equifax (credit and age variables) and Medicare Beneficiary Summary File (age, sex, race/ethnicity, and health variables).

Figure 1. Change in Proportion with Missed Credit Payments Before and After Alzheimer's Disease and Related Dementias Diagnosis Relative to Never-Diagnosed, 1999 to 2018.



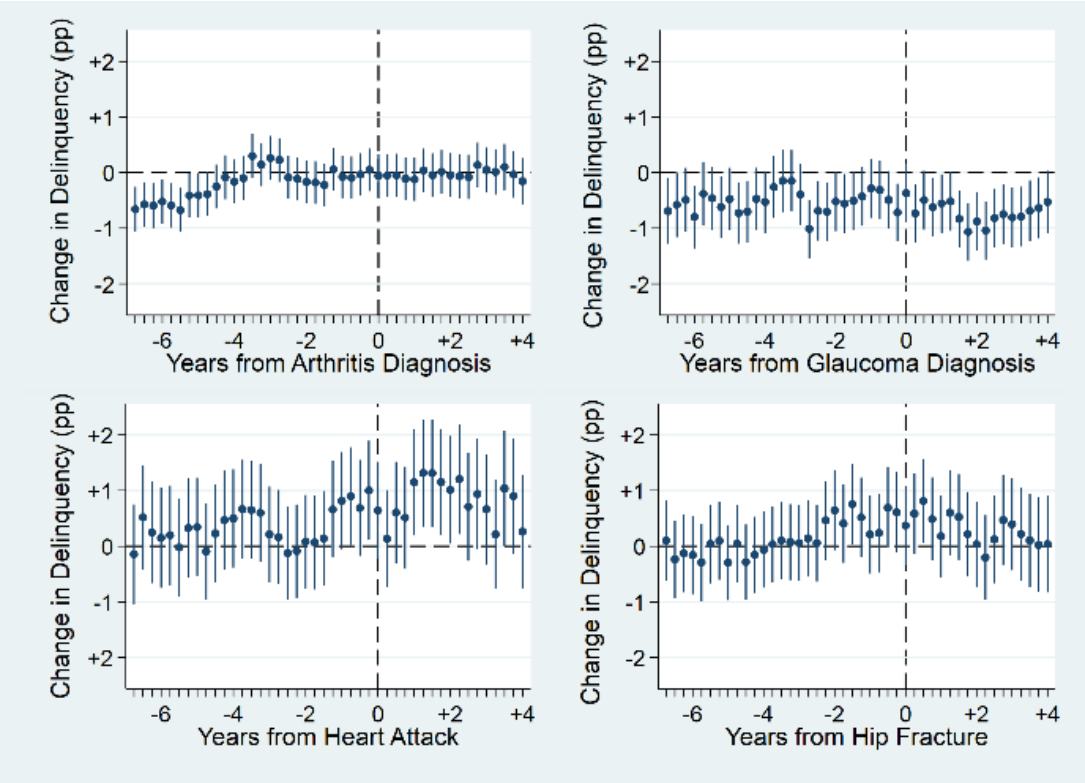
Medicare beneficiaries who eventually develop ADRD experienced higher rates of delinquency than those who never developed ADRD, and these elevated rates were detectable years before diagnosis. Circles are regression coefficients representing the percentage point (pp) increase in payment delinquency at each time point in comparison to payment delinquency rates among Medicare beneficiaries who are never diagnosed with ADRD. The mean rate of missed payment (payment delinquency) was 7.8%. Vertical lines represent 95% confidence intervals. Data sources: FRBNY CCP/Equifax and Medicare Beneficiary Summary File.

Figure 2. Change in Proportion with Subprime Credit Scores Before and After Alzheimer's Disease and Related Dementias Diagnosis Relative to Never-Diagnosed, 1999 to 2018.



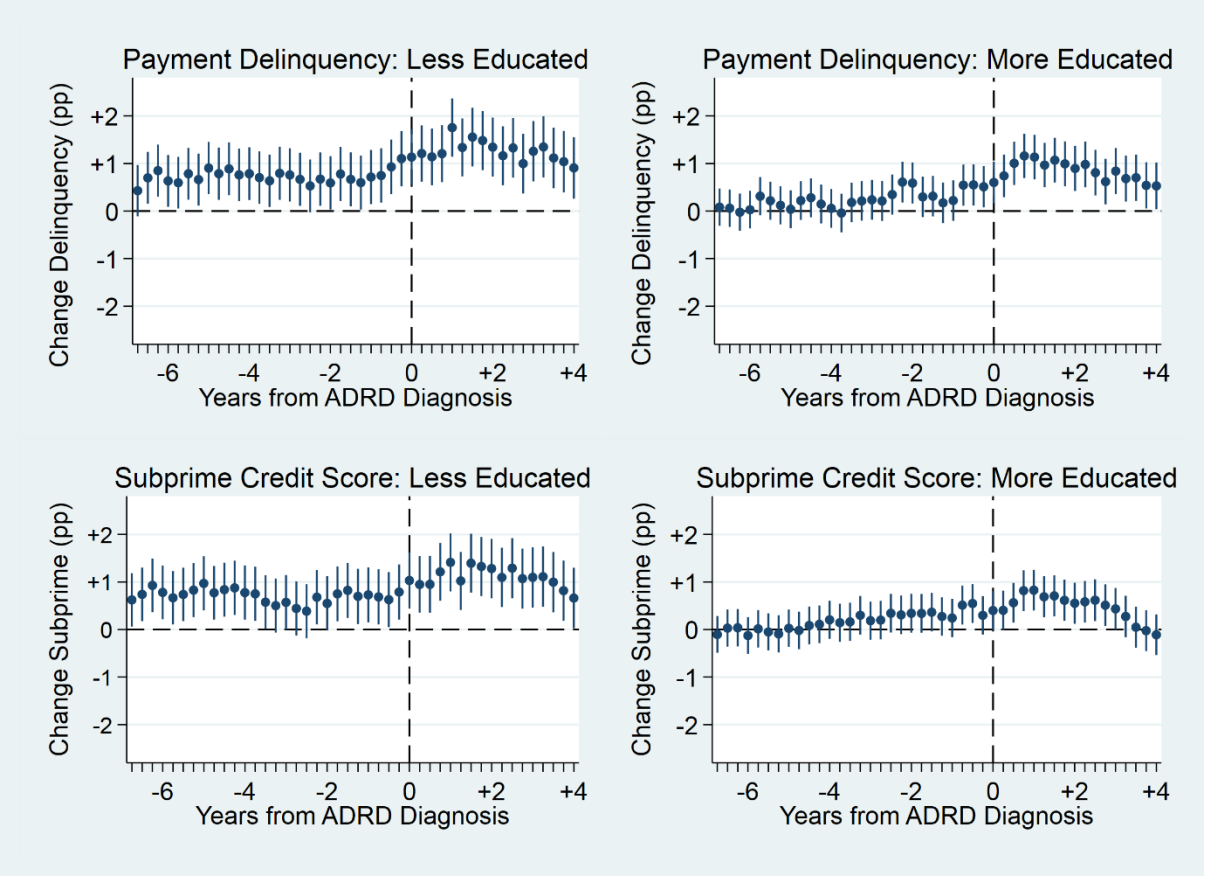
Medicare beneficiaries who eventually developed ADRD experienced higher rates of subprime credit scores (Equifax Risk Scores) than those who never developed ADRD, and these elevated rates were detectable roughly two years before diagnosis. Circles are regression coefficients representing the percentage point (pp) increase in subprime credit scores associated with each time point relative to no ADRD. The mean rate of subprime credit scores in our sample was 9.1%. Vertical lines represent 95% confidence intervals. Data sources: FRBNY CCP/Equifax and Medicare Beneficiary Summary File.

Figure 3. Change in Proportion with Missed Credit Payments Before and After Acute and Chronic Health Conditions Relative to Never-Diagnosed, 1999 to 2018.



In contrast to ADRD (Figures 1 - 2), beneficiaries who develop these acute or chronic health conditions do not exhibit systematically elevated delinquency rates before or after diagnosis. Subprime credit follows a similar pattern (Appendix Figure 2). Plotted coefficients are regression coefficients representing the percentage point (pp) change in rates of missed payments relative to Medicare beneficiaries who are never diagnosed with each of the placebo conditions during our study period. Vertical lines represent 95% confidence intervals. Data sources: FRBNY CCP/Equifax and Medicare Beneficiary Summary File.

Figure 4. Change in Proportion with Missed Credit Payments and Subprime Credit Scores Before and After ADRD Diagnosis Relative to Never-Diagnosed, 1999 to 2018: More versus Less Education Census Tracts.



Payment delinquency and subprime credit scores (Equifax Risk Scores) were more common among single Medicare beneficiaries who eventually developed ADRD compared to those who did not in census tracts above and below median education, though a larger share of ADRD beneficiaries in lower education tracts experienced adverse financial outcomes and these difficulties spanned a longer time horizon. Plots show percentage point (pp) change in payment delinquency and subprime credit scores relative to Medicare beneficiaries never diagnosed with ADRD among Medicare beneficiaries in more educated census tracts (more than 38.8% of adults 65+ had more than a high school education in the 2010 American Community Survey) in comparison to less educated census tracts (<=38.8% of 65+ have more than a high school education). Vertical lines indicate 95% confidence intervals. Regression models follow Figures 1 and 2. Our sample averaged 7.8% payment delinquency and 9.1% had subprime credit scores.

References

1. Alzheimer's Association. 2018 Alzheimer's disease facts and figures. *Alzheimer's & Dementia.* 2018;14(3):367-429.
2. Boyle PA, Yu L, Wilson RS, Gamble K, Buchman AS, Bennett DA. Poor decision making is a consequence of cognitive decline among older persons without Alzheimer's disease or mild cognitive impairment. *PLoS One.* 2012;7(8):e43647.
3. Marson DC. Loss of financial competency in dementia: Conceptual and empirical approaches. *Aging, Neuropsychology, and Cognition.* 2001;8(3):164-181.
4. Okonkwo OC, Wadley VG, Griffith HR, et al. Awareness of Deficits in Financial Abilities in Patients With Mild Cognitive Impairment: Going Beyond Self-Informant Discrepancy. *The American Journal of Geriatric Psychiatry.* 2008;16(8):650-659.
5. Widera E, Steenpass V, Marson D, Sudore R. Finances in the older patient with cognitive impairment: "he didn't want me to take over". *JAMA.* 2011;305(7):698-706.
6. Spreng RNP, Karlawish JM, Marson DCM. Cognitive, social, and neural determinants of diminished decision-making and financial exploitation risk in aging and dementia: A review and new model. *J Elder Abuse Negl.* 2016;28(4-5):320-344.
7. Kolata G. Money Woes Can Be Early Clues to Alzheimer's. *New York Times.* October 31, 2010: 1.
8. Peterson JC, Burnes DP, Caccamise PL, et al. Financial exploitation of older adults: a population-based prevalence study. *Journal of general internal medicine.* 2014;29(12):1615-1623.
9. Burnes D, Henderson CR, Jr., Sheppard C, Zhao R, Pillemer K, Lachs MS. Prevalence of Financial Fraud and Scams Among Older Adults in the United States: A Systematic Review and Meta-Analysis. *American Journal of Public Health.* 2017;107(8):e13-e21.
10. Hsu JW, Willis R. Dementia risk and financial decision making by older households: The impact of information. *Journal of human capital.* 2013;7(4):340-377.
11. Triebel KL, Marson DC. The Warning Signs of Diminished Financial Capacity in Older Adults. *Generations-J Am Soc Aging.* 2012;36(2):39-45.
12. Barnes DE, Beiser AS, Lee A, et al. Development and validation of a brief dementia screening indicator for primary care. *Alzheimer's & Dementia.* 2014;10(6):656-665. e651.
13. Boyle PA, Yu L, Schneider JA, Wilson RS, Bennett DA. Scam Awareness Related to Incident Alzheimer Dementia and Mild Cognitive Impairment: A Prospective Cohort StudyScam Awareness, Alzheimer Dementia, and Mild Cognitive Impairment. 2019.
14. Sudo FK, Laks J. Financial capacity in dementia: a systematic review. *Aging & mental health.* 2017;21(7):677-683.
15. Bishop KC, Ketcham JD, Kuminoff NV. *Hazed and confused: the effect of air pollution on dementia.* National Bureau of Economic Research;2018.
16. Taylor DH, Fillenbaum GG, Ezell ME. The accuracy of medicare claims data in identifying Alzheimer's disease. *Journal of Clinical Epidemiology.* 2002;55(9):929-937.
17. CMS Chronic Condition Warehouse. Chronic Condition Algorithms. 2020; https://www2.ccwdata.org/web/guest/condition-categories. Accessed March 1, 2020.
18. Avery RB, Calem PS, Canner GB, Bostic RW. An Overview of Consumer Data and Credit Reporting. *Fed Res Bull.* 2003;89:47.
19. Lee D, Van der Klaauw W. An introduction to the frbny consumer credit panel. *FRB of New York Staff Report.* 2010(479).

20. Dean LT, Nicholas LH. Using Credit Scores to Understand Predictors and Consequences of Disease. American Public Health Association; 2018.
21. Dobkin C, Finkelstein A, Kluender R, Notowidigdo MJ. The Economic Consequences of Hospital Admissions. *American Economic Review.* 2018;108(2):308-352.
22. Dobkin C, Finkelstein A, Kluender R, Notowidigdo MJ. Myth and Measurement — The Case of Medical Bankruptcies. *New England Journal of Medicine.* 2018;378(12):1076-1078.
23. Hu L, Kaestner R, Mazumder B, Miller S, Wong A. The effect of the affordable care act Medicaid expansions on financial wellbeing. *Journal of Public Economics.* 2018;163:99-112.
24. Houle JN, Collins JM, Schmeiser MD. Flu and Finances: Influenza Outbreaks and Loan Defaults in US Cities, 2004-2012. *Am J Public Health.* 2015;105(9):e75-80.
25. Ott A, Breteler MM, Van Harskamp F, et al. Prevalence of Alzheimer's disease and vascular dementia: association with education. The Rotterdam study. *Bmj.* 1995;310(6985):970-973.
26. Stern Y, Gurland B, Tatemichi TK, Tang MX, Wilder D, Mayeux R. Influence of education and occupation on the incidence of Alzheimer's disease. *JAMA.* 1994;271(13):1004-1010.
27. Stern Y. Cognitive reserve in ageing and Alzheimer's disease. *The Lancet Neurology.* 2012;11(11):1006-1012.
28. Card D. Estimating the return to schooling: Progress on some persistent econometric problems. *Econometrica.* 2001;69(5):1127-1160.
29. Lusardi A, Mitchell OS. How ordinary consumers make complex economic decisions: Financial literacy and retirement readiness. *Quarterly Journal of Finance.* 2017;7(03):1750008.
30. Ko Y-C, Hwang D-K, Chen W-T, Lee C-C, Liu CJ. Impact of Socioeconomic Status on the Diagnosis of Primary Open-Angle Glaucoma and Primary Angle Closure Glaucoma: A Nationwide Population-Based Study in Taiwan. *PLOS ONE.* 2016;11(2):e0149698.
31. Moran KE, Ommerborn MJ, Blackshear CT, Sims M, Clark CR. Financial stress and risk of coronary heart disease in the Jackson heart study. *American Journal of Preventive Medicine.* 2019;56(2):224-231.
32. Currie J, Tekin E. Is There a Link between Foreclosure and Health? *American Economic Journal: Economic Policy.* 2015;7(1):63-94.
33. Albanesi S, Vamossy DF. *Predicting consumer default: A deep learning approach.* National Bureau of Economic Research;2019. 0898-2937.
34. Taylor DJ, Ostbye T, Langa KM, Weir DR, Plassman B. The Accuracy Of Medicare Claims As An Epidemiological Tool: The Case Of Dementia Revisited. *Journal of Alzheimer's Disease* 2009;17(4):807-815
35. Neuman P, Jacobson GA. Medicare advantage checkup. *New England Journal of Medicine.* 2018;379(22):2163-2172.
36. Newhouse JP, McGuire TG. How successful is Medicare Advantage? *Milbank Quarterly.* 2014;92(2):351-394.

Supplementary Appendix: The Financial Presentation of Alzheimer's Disease and Related Dementias

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Table 8: Change in Proportion with Missed Credit Payments Before and After Alzheimer's Disease and Related Dementias Diagnosis by Census Tract Education Relative to Never-Diagnosed, 1999 to 2018

Table 9: Change in Proportion with Subprime Credit Scores Before and After Alzheimer's Disease and Related Dementias Diagnosis by Census Tract Education Relative to Never-Diagnosed, 1999 to 2018

Additional Details on Data and Methods

Identifying Single-Person Households and Creating the Linked Dataset

We focused our study on single-person households, where the link between a Medicare beneficiary's cognitive decline and adverse credit events would not be obscured by a cognitively normal spouse's intervention. Household size was assessed using exact address data (including apartment number when appropriate/available). We defined single-person households as individuals who are not living at the same exact address with any other adult (with a credit report and a Social Security number) within 20 years of their age in the CCP/Equifax data and not living with another Medicare beneficiary in the Medicare claims data.

Since addresses included apartment numbers, we observed residents of apartment buildings, but likely missed those living in nursing homes and other facilities with large numbers of older adults sharing the same residence. 65% of Medicare beneficiaries who had triggered the ADRD algorithm by 2014 were found to reside in a single-person household in our 20% sample.

We restricted our sample to members of single-person households in both datasets. The CCP/Equifax tracks credit files of all individuals residing in the same household of a randomly selected 5% sample (the primary sample) of US persons with credit reports and Social Security numbers. We selected our address sample (20% of all Medicare beneficiaries) at the zip code level to capture entire households, selecting zip codes in counties with lower Medicare Advantage penetration to limit the number of Medicare beneficiaries whose utilization would not be observed. The Medicare claims-based measure of household size will incorrectly classify households with a spouse who is not receiving Medicare due to age or other eligibility reasons.

Since the CCP/Equifax data include all residents at an exact address, we are able to use a more comprehensive measure of household size- with Medicare claims we may incorrectly classify people as single who have a younger partner or partner who is not Medicare eligible. By requiring single-person status in both datasets, we are focusing on the sample that is most likely to lack another member of the household that could take over financial decision-making.

The CCP/Equifax includes the census block of residence in all quarters. We geocoded Medicare exact addresses from the June 2018 Vital Status File for linking to the analogous CCP/Equifax time period using ArcGIS.

We linked the CCP/Equifax and Medicare samples using census block, zip code history, birth month and year and death information as described in Appendix Table 1. Since we are combining subsets of a 5% random sample and a 20% non-random (zip code based) sample, we lose a number of potential respondents who appear in one sample but not both.

Date of Diagnosis

We used the diagnostic codes underlying the Chronic Conditions Warehouse disease algorithms for ADRD and our negative control conditions. However, we did not require that beneficiaries meet the continuous coverage requirement. We found that we correctly classified 89% of 2014 Health and Retirement Study respondents in single-person households with severe dementia using diagnostic codes only but only 71% when we imposed additional coverage and lookback requirements.[1-3]

Statistical Methods

We estimated flexible, non-parametric linear probability models of adverse credit outcomes on time from ADRD (or falsification condition) diagnosis using the following specification:

$$D_{it} = \Sigma ADRD^{*} (T - ADRD)_{it} + X_{it}'\beta + Q_t + S_{it} + Y_t + \varepsilon_{it} \qquad (1)$$

$(T - ADRD)_{it}$ is a vector of dummy variables indicating time (in quarters) from the quarter when a Medicare beneficiary first met the ADRD algorithm, relative to a comparison group that never develops ADRD. We include up to seven years of financial history pre-diagnosis and follow beneficiaries for up to four years post-diagnosis. The post-diagnosis period is comparatively short because more than half of the Medicare beneficiaries in our sample die within five years of diagnosis.

Our comparison group, which never developed ADRD during our study period, was treated as the reference time period (> 7 years prior to ADRD), allowing us to differentiate between ADRD-induced changes and normal aging patterns. Our model included quarter and year fixed effects, Q_t and Y_t, to account for cyclical trends in consumer behavior and common shocks

affecting all consumers, state fixed effects to account for geographic differences in ADRD diagnosis and economic conditions, and a vector of beneficiary controls including age, sex, race, comorbid health conditions, and the average credit score at age 65 to account for each beneficiary's credit risk type. We clustered standard errors at the beneficiary level. Since our Medicare claims data only extend through 2014, we carried comorbidities through 2014 forward through 2018. Our models estimate average differences at each point in time between our ADRD group and our never-ADRD comparison group with similar characteristics, and do not require individual-level matches between members of each group.

Positive, statistically significant coefficients on the $(T - ADRD)_{it}$ variables in time periods prior to a formal diagnosis would indicate that beneficiaries who are not yet receiving healthcare for ADRD are more likely to experience payment delinquency than those who never develop ADRD during our study period who are the same age, sex, race, state of residence, and credit risk type.

Our primary analytic sample used all available observations from the linked sample and a comprehensive set of control variables. We examined the robustness of our results to alternative samples and specifications including a more balanced panel, which restricted the ADRD sample to those observed for at least 4 quarters before and after diagnosis (Appendix Figure 3), omitting those with any Medicare Advantage enrollment (Appendix Figure 4), and focusing on a shorter time period where we could also control for Medicaid receipt (Appendix Figure 5).

Falsification Tests/Negative Control Conditions

A concern with our research design is that the coefficients on $(T - ADRD)_{it}$ could reflect the credit consequences of correlates of an ADRD diagnosis such as aging and hospitalization rather than patterns unique to ADRD. We accounted for this possibility in two ways. The first was to control for as many of these factors as we could in our regression models. The second was to contrast our results for ADRD with a series of models that replaced the $(T - ADRD)_{it}$ in Equation (1) with time from other acute (heart attack and hip fracture) and gradual onset chronic conditions (arthritis and glaucoma). The acute conditions are diagnoses that typically trigger hospitalizations and can require expensive rehabilitation including nursing home stays, while the gradual onset conditions, like ADRD, may trigger initial symptoms years prior to diagnosis similar to ADRD. The contrast between Figures 1-2 versus Figure 3 suggests that the long ramp-up period prior to diagnosis is characteristic of ADRD, but ADRD is not the only clinical

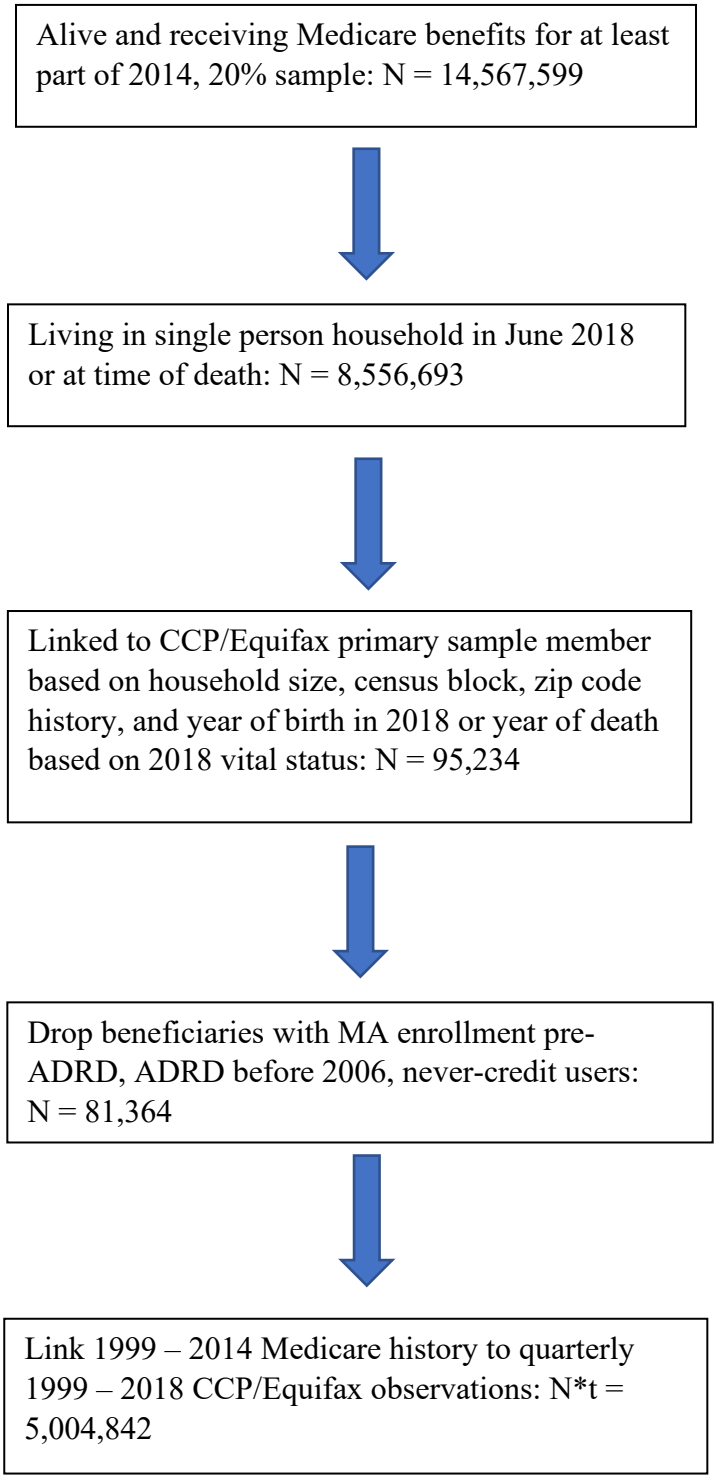
condition linked to changes in credit outcomes. We used cancer as an additional negative control in a robustness check (Appendix Figure 7).

Calculating the cost of a late payment:

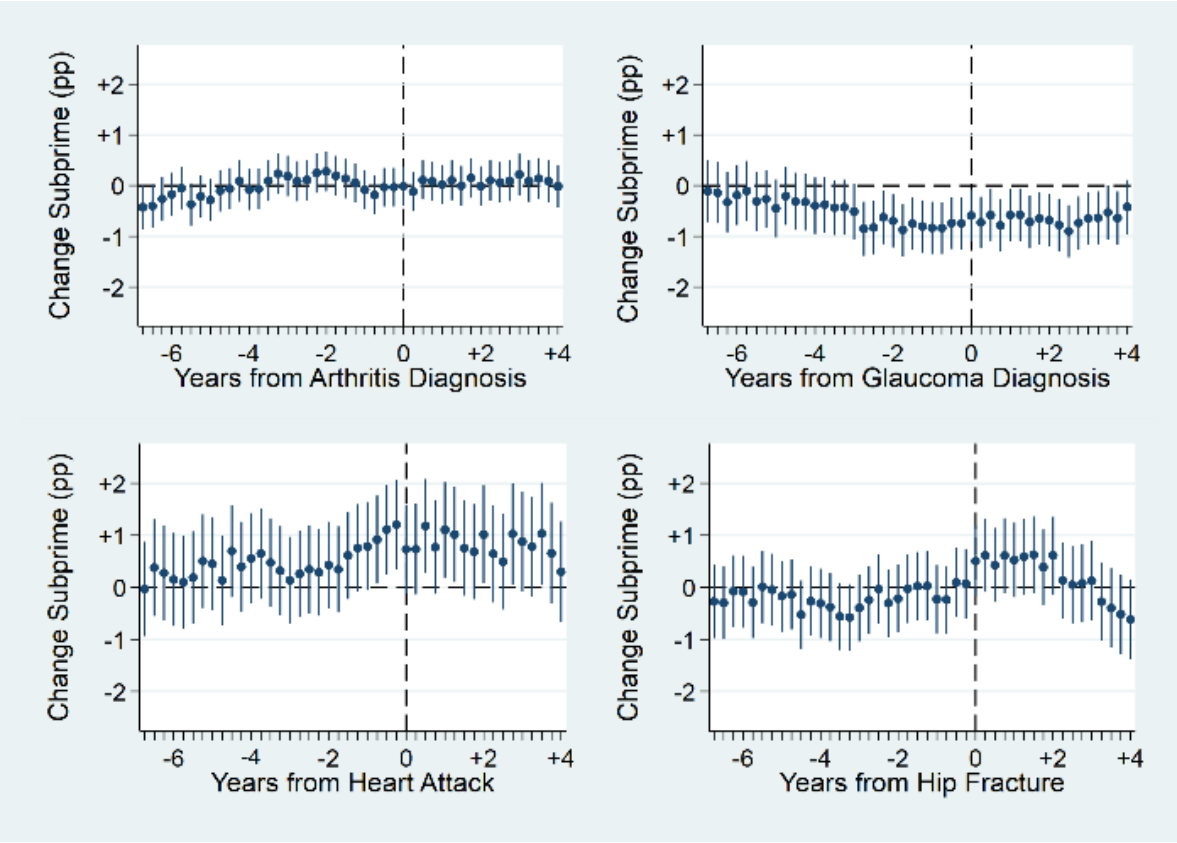
Since 80% of delinquent accounts in our sample were credit card accounts, we based our estimates of the costs of payment delinquency on characteristics of credit accounts. We limited our estimates of the cost of late payments to the period ranging from four years prior to diagnosis to 4 years after. We first estimated the number of Fee-for-Service Medicare beneficiaries with an ADRD-linked delinquent payment in each time period using the percentage point increases in the rates of beneficiaries with missed payments implied by our regression coefficients from Equation 1.

We used the average late fee of $35/month and assumed that interest rates increase from 13% APR to a penalty rate of 29.99% for accounts at the median ($2,800) and mean ($6,350) account balance in our sample conditional on having a delinquent account balance. Conditional on missing at least 1 payment in a year, on average members of our sample missed 4.7 payments during the year. We conservatively estimated that all missed payments are missed for the same account rather than applying penalty interest rates to multiple accounts. Thus, the reported figures represent a lower bound on the fees that a typical beneficiary would pay.

Appendix Figure 1: Sample Construction Process/Participant Flow Diagram

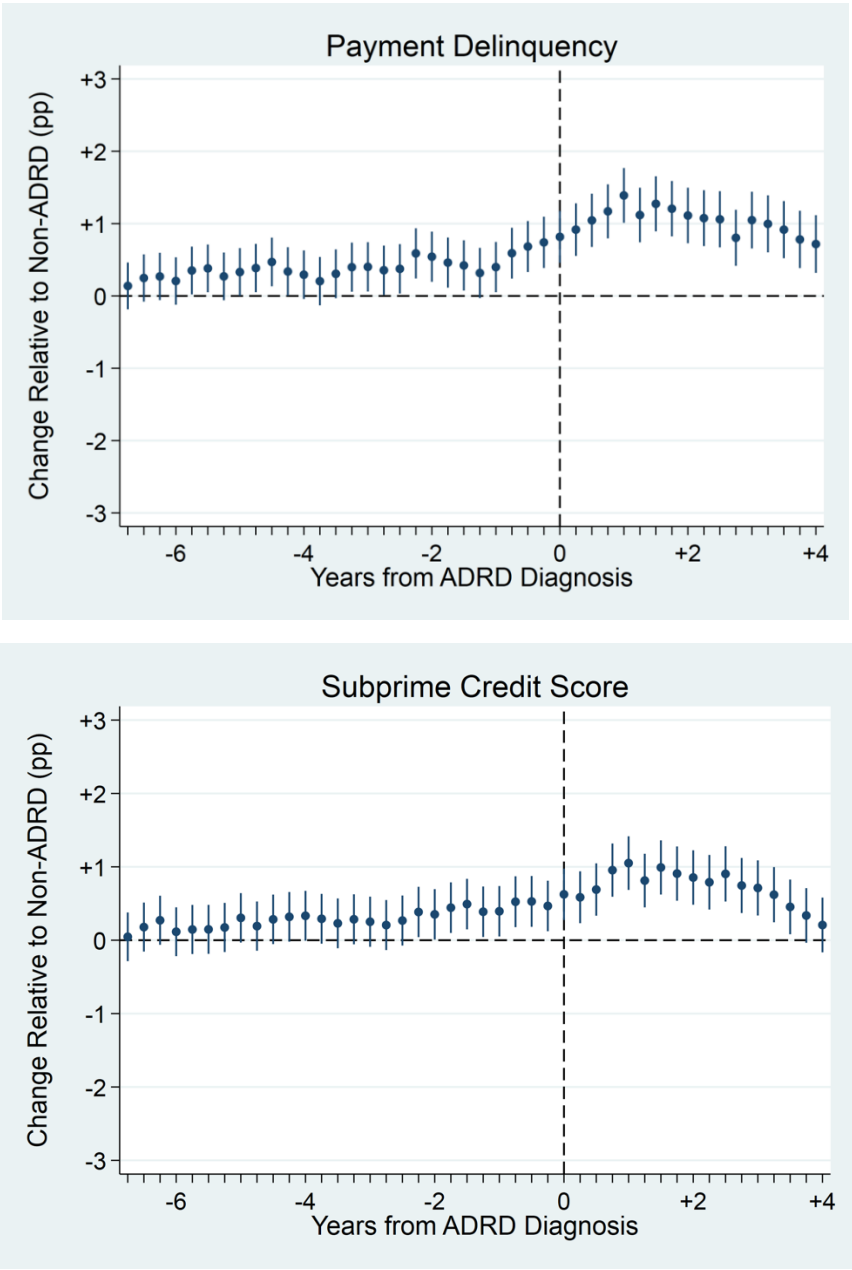


Appendix Figure 2: Change in Proportion with Subprime Credit Score Before and After Acute and Chronic Health Conditions Relative to Never-Diagnosed, 1999 to 2018



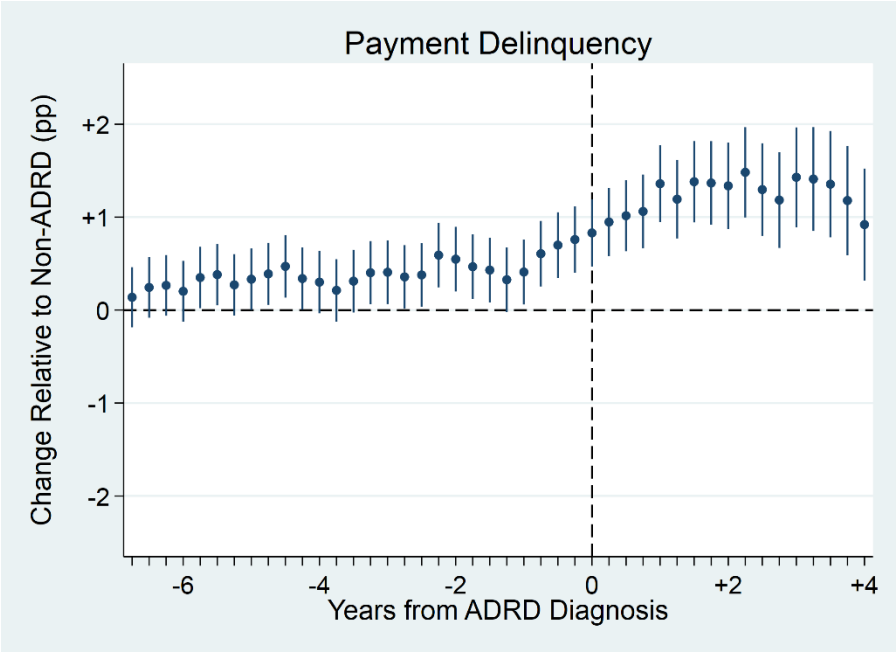
In contrast to ADRD (Figure 2), beneficiaries who develop these acute or chronic health conditions do not exhibit systematically elevated rates of subprime credit scores (Equifax Risk Score) before or after diagnosis. Plotted coefficients are regression coefficients representing the percentage point change in rates of subprime credit scores relative to Medicare beneficiaries who are never diagnosed with each of the negative control conditions during our study period. Vertical lines represent 95% confidence intervals. Data sources: FRBNY CCP/Equifax and Medicare Beneficiary Summary File.

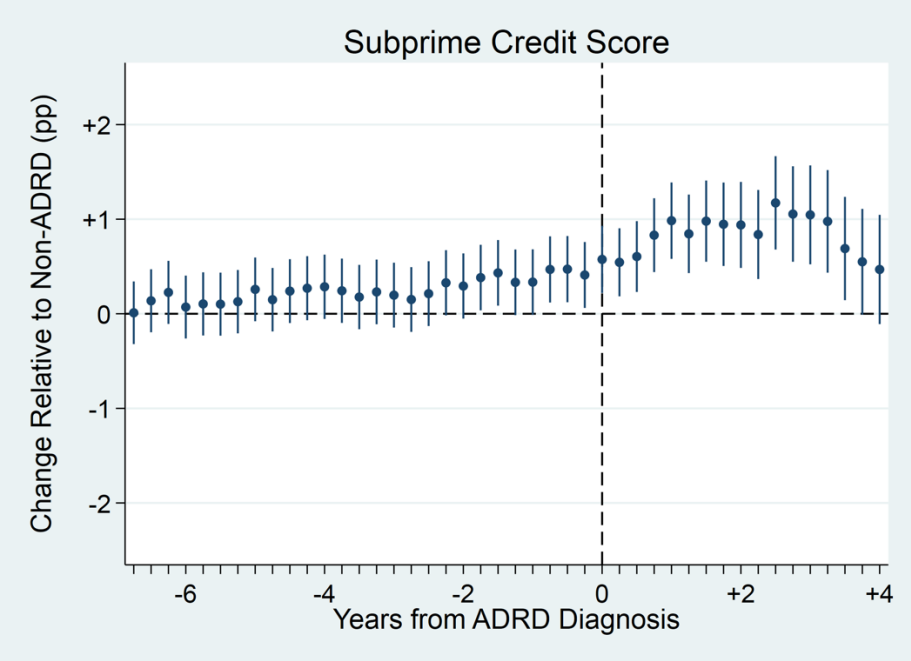
Appendix Figure 3: Change in Proportion with Missed Credit Payments/Subprime Credit Score Before and After Alzheimer's Disease and Related Dementias Diagnosis Relative to Never-Diagnosed, 1999 to 2018; Balanced Panel Specification



Notes: N*t = 5,002,357. Points represent the change in the share with a payment delinquency or subprime credit score (Equifax Risk Score) relative to Medicare beneficiaries who are never diagnosed with ADRD during our study period. The balanced panel restriction requires that ADRD patients are observed for at least 4 quarters before and after diagnosis. Data sources: FRBNY CCP/Equifax and Medicare Beneficiary Summary File.

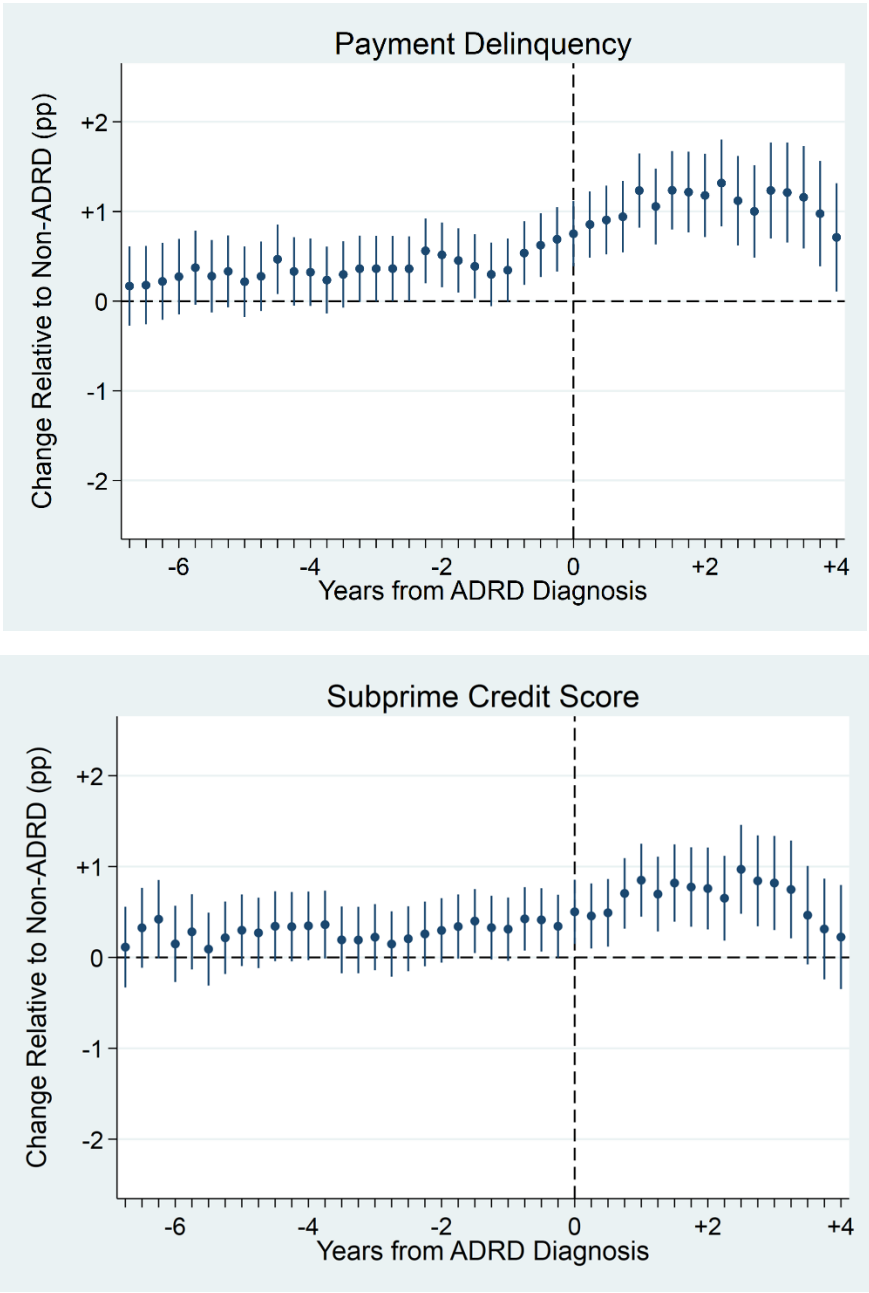
Appendix Figure 4: Change in Proportion with Missed Credit Payments/Subprime Credit Score Before and After Alzheimer's Disease and Related Dementias Diagnosis Relative to Never-Diagnosed, 1999 to 2018; Never-Medicare Advantage Sample Only





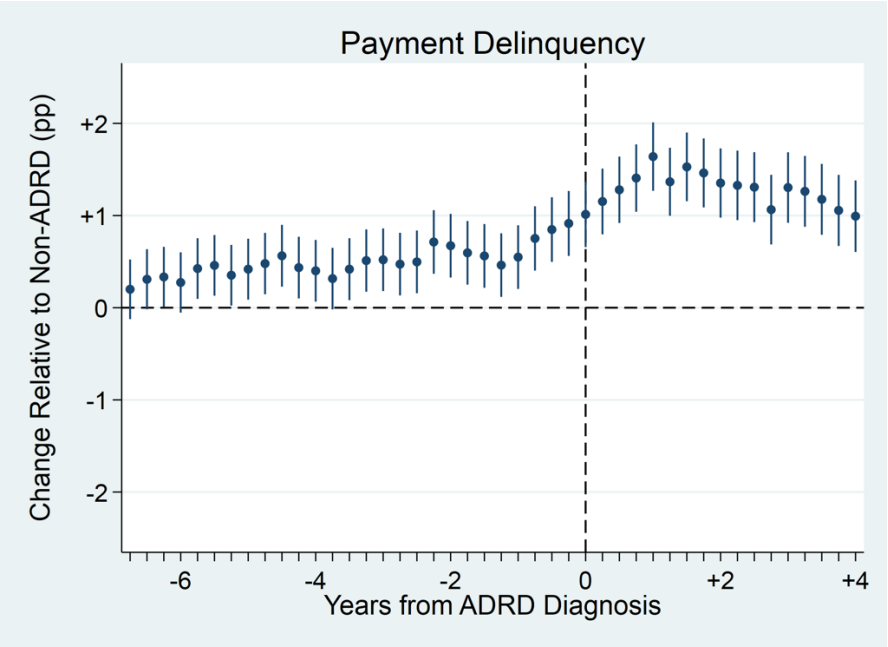
Notes: N*t = 4,199,612. Points represent the change in the share with a payment delinquency or subprime credit score (Equifax Risk Score) relative to Medicare beneficiaries who are never diagnosed with ADRD during our study period. Specifications control for comorbidities and omit respondents who were ever enrolled in a Medicare Advantage plan. Data sources: FRBNY CCP/Equifax and Medicare Beneficiary Summary File.

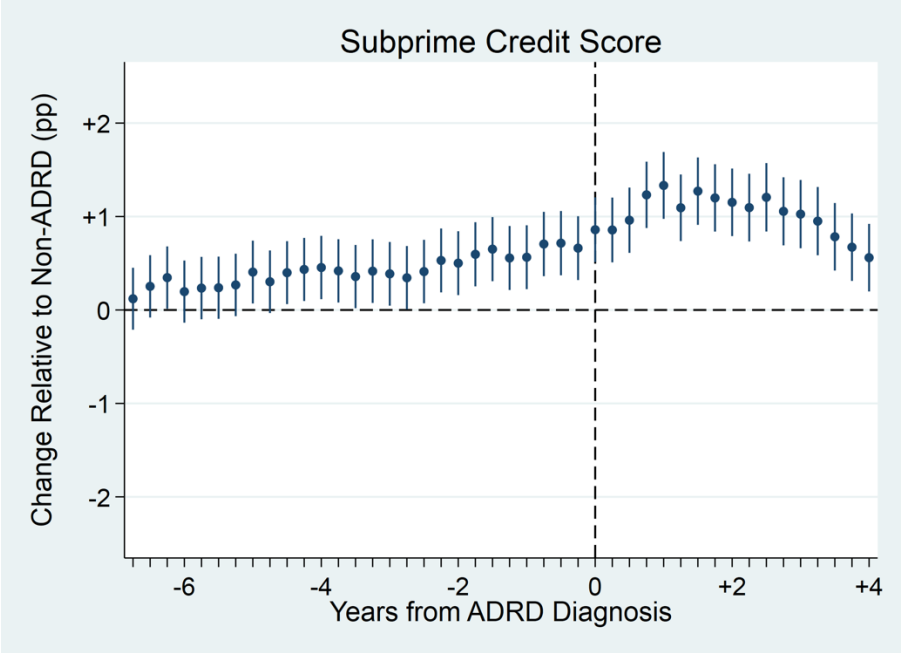
Appendix Figure 5: Change in Proportion with Missed Credit Payments/Subprime Credit Score Before and After Alzheimer's Disease and Related Dementias Diagnosis Relative to Never-Diagnosed, 2005 to 2014



Notes: N*t = 2,738,320. Points represent the change in the share with a payment delinquency or subprime credit score (Equifax Risk Score) relative to Medicare beneficiaries who are never diagnosed with ADRD during our study period. Specifications control for comorbidities and Medicaid eligibility. Data sources: FRBNY CCP/Equifax and Medicare Beneficiary Summary File.

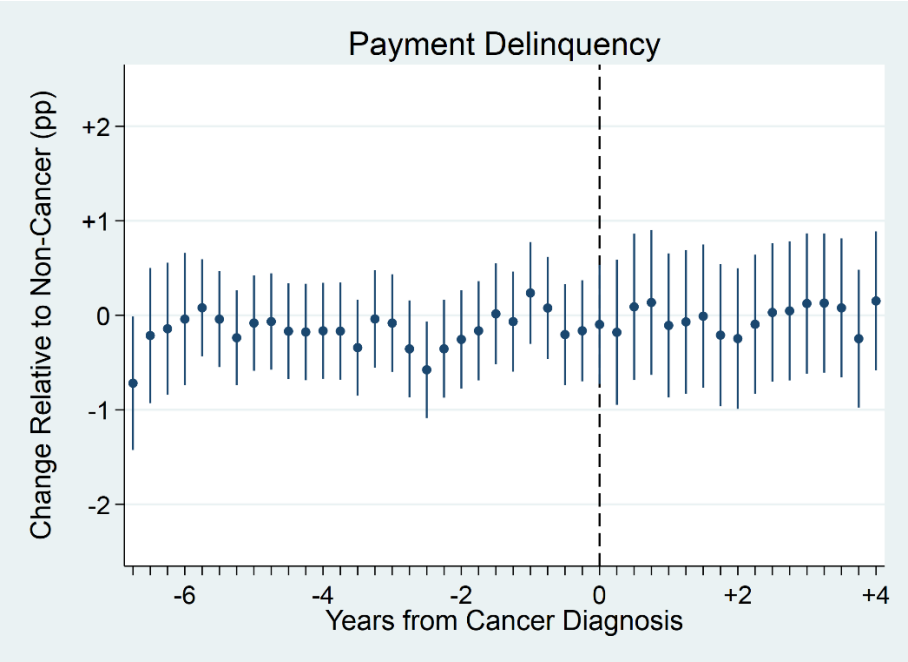
Appendix Figure 6: Change in Proportion with Missed Credit Payments/Subprime Credit Score Before and After Alzheimer's Disease and Related Dementias Diagnosis Relative to Never-Diagnosed, 1999 to 2018; No Cormorbid Health Conditions

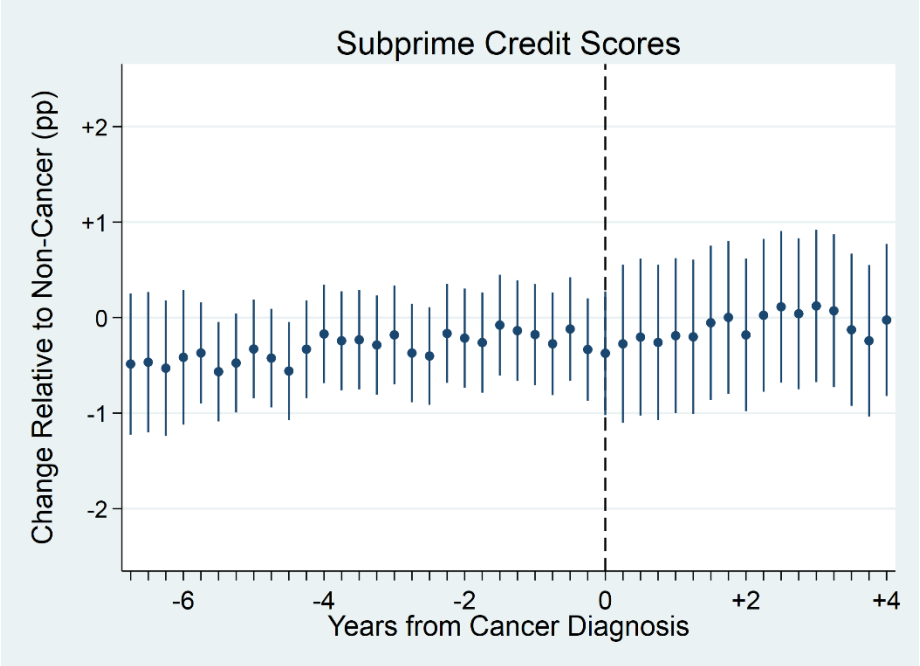




Notes: N*t = 5,004,842. Points represent the change in the share with a payment delinquency or subprime credit score (Equifax Risk Score) relative to Medicare beneficiaries who are never diagnosed with ADRD during our study period. Specifications omit comorbidity controls. Data sources: FRBNY CCP/Equifax and Medicare Beneficiary Summary File.

Appendix Figure 7: Change in Proportion with Missed Credit Payments/Subprime Credit Score Before and After Cancer Diagnosis Relative to Never-Diagnosed, 1999-2018





Notes: N*t = 4,651,902. Points represent the change in the share with a payment delinquency or subprime credit score (Equifax Risk Score) relative to Medicare beneficiaries who are never diagnosed with cancer (breast, colorectal, prostate, endometrial) during our study period. Data sources: FRBNY CCP/Equifax and Medicare Beneficiary Summary File.

Appendix Table 1: Data Timeline

Dataset:	Medicare	Medicare	Medicare	CCP/Equifax	Medicare
Variables:	Zip code of residence	Most recent address	Diagnostic History	Financial; Location	ADRD Diagnosis
1999			Medicare diagnostic history available quarterly 1999-2014	CCP/Equifax financial outcomes, census block and zip code of residence available quarterly 1999-2018	DROP cases with earliest ADRD indication in 1999-2006 (unknown managed care utilization)
2000					
2001					
2002					
2003					
2004					
2005					
2006					
2007					
2008					
2009					
2010					
2011					
2012	2012-2015 zip code history of sampled Medicare beneficiaries				
2013					
2014		last known address, 2014 deaths			
2015		last known address, 2015 deaths	2014 values carried forward		
2016		last known address, 2016 deaths			
2017		last known address, 2017 deaths			
2018		current address, alive in 2018			

2014: Cohort of Medicare beneficiaries alive as of January 1 selected

June 2018: Current address or address at time of death provided for Medicare beneficiaries above

Linked Cohort matched based on June 2018 address if still alive in June 2018, otherwise June 2017 if dying in 2017, June 2016 if dying in 2016, June 2015 if dying in 2015, June 2014 if dying in 2014.

Medicare diagnostic history and CCP/Equifax credit histories from as much of the period 1999 – 2018 as available attached to linked sample members. Appendix Figure 5 displays results omitting observations after 2014.

We dropped ADRD cases with earliest indication dates 1999 – 2006 because their managed care utilization between 1999 – 2005 is unknown, implying that the earliest indication dates reported in the Chronic Condition Warehouse could be artificially late if patients were first diagnosed while in Medicare Advantage.

Appendix Table 2: Comparison of Linked Singles Sample and Medicare 5% Sample

	CCP/Equifax Linked (N = 81,364)	Medicare 5% Sample (N = 15,882,184)
Age	77.8	75.4
Male	0.33	0.43
Black	0.10	0.08
Hispanic	0.01	0.02
Medicaid	0.12	0.13
ADRD	0.31	0.11
Diabetes	0.30	0.24
Stroke	0.13	0.04
Heart Disease	0.44	0.30
COPD	0.22	0.10
Non-Urban MSA	0.25	0.27

Data sources: FRBNY CCP/Equifax (age), Medicare Beneficiary Summary File—Medicare 5% Sample 2005-2014 (age, sex, race/ethnicity, Medicaid, health conditions), and American Community Survey (urbanicity).

Appendix Table 3: Change in Proportion with Missed Credit Payments/Subprime Credit Scores Before and After Alzheimer's Disease and Related Dementias Diagnosis Relative to Never-Diagnosed, 1999 to 2018

	Payment Delinquency (N = 81,364, N*t = 5,004,842)	Subprime Credit Score (N = 81,364, N*t = 5,004,842)
	Coefficient (95% CI)	Coefficient (95% CI)
Quarters from Diagnosis (reference: +16)		
-28	0.0015 (-0.0018, 0.0047)	0.00055 (-0.0028, 0.0039)
-27	0.0025 (-0.00075, 0.0058)	0.0018 (-0.0015, 0.0052)
-26	0.0027 (-0.00054, 0.0060)	0.0027 (-0.00061, 0.0061)
-25	0.0021 (-0.0012, 0.0054)	0.0012 (-0.0021, 0.0045)
-24	0.0036 (0.00026, 0.0069)*	0.0015 (-0.0018, 0.0049)
-23	0.0039 (0.00057, 0.0072)*	0.0015 (-0.0018, 0.0048)
-22	0.0028 (-0.00054, 0.0061)	0.0018 (-0.0016, 0.0051)
-21	0.0034 (0.000048, 0.0067)*	0.0031 (-0.00030, 0.0064)^
-20	0.0039 (0.00058, 0.0073)*	0.0020 (-0.0014, 0.0053)
-19	0.0047 (0.0014, 0.0081)**	0.0029 (-0.00047, 0.0063)^
-18	0.0034 (0.000045, 0.0068)*	0.0032 (-0.00018, 0.0066)^
-17	0.0030 (-0.00035, 0.0064)^	0.0034 (-0.000033, 0.0068)^
-16	0.0021 (-0.0012, 0.0055)	0.0030 (-0.00044, 0.0063)^
-15	0.0031 (-0.00028, 0.0065)^	0.0023 (-0.0011, 0.0057)
-14	0.0040 (0.00059, 0.0074)*	0.0028 (-0.00058, 0.0062)
-13	0.0040 (0.00062, 0.0074)*	0.0025 (-0.00092, 0.0059)
-12	0.0035 (0.00011, 0.0069)*	0.0020 (-0.0014, 0.0054)
-11	0.0037 (0.00030, 0.0071)*	0.0027 (-0.00076, 0.0061)
-10	0.0058 (0.0024, 0.0093)***	0.0038 (0.00037, 0.0072)*
-9	0.0054 (0.0019, 0.0089)**	0.0035 (0.000039, 0.0069)*
-8	0.0046 (0.0011, 0.0081)**	0.0044 (0.00093, 0.0078)*
-7	0.0042 (0.00074, 0.0077)*	0.0049 (0.0014, 0.0083)**
-6	0.0032 (-0.00030, 0.0066)^	0.0039 (0.00044, 0.0073)*
-5	0.0040 (0.00051, 0.0074)*	0.0039 (0.00048, 0.0073)*
-4	0.0059 (0.0024, 0.0095)***	0.0053 (0.0018, 0.0087)**
-3	0.0068 (0.0033, 0.010)***	0.0053 (0.0018, 0.0087)**
-2	0.0074 (0.0039, 0.011)***	0.0046 (0.0012, 0.0081)**
-1	0.0081 (0.0045, 0.012)***	0.0063 (0.0028, 0.0098)***
0	0.0092 (0.0056, 0.013)***	0.0060 (0.0025, 0.0095)***
1	0.010 (0.0067, 0.014)***	0.0070 (0.0034, 0.011)***
2	0.012 (0.0079, 0.015)***	0.0096 (0.0060, 0.013)***
3	0.014 (0.010, 0.018)***	0.011 (0.0069, 0.014)***
4	0.011 (0.0073, 0.015)***	0.0081 (0.0045, 0.012)***
5	0.013 (0.0089, 0.016)***	0.0098 (0.0062, 0.014)***
6	0.012 (0.0081, 0.016)***	0.0091 (0.0054, 0.013)***

7	0.011 (0.0070, 0.015)***	0.0086 (0.0048, 0.012)***
8	0.011 (0.0067, 0.014)***	0.0079 (0.0042, 0.012)***
9	0.010 (0.0064, 0.014)***	0.0090 (0.0053, 0.013)***
10	0.0078 (0.0040, 0.012)***	0.0075 (0.0037, 0.011)***
11	0.010 (0.0063, 0.014)***	0.0071 (0.0034, 0.011)***
12	0.0097 (0.0058, 0.014)***	0.0063 (0.0026, 0.010)***
13	0.0088 (0.0049, 0.013)***	0.0046 (0.00091, 0.0084)*
14	0.0076 (0.0037, 0.012)***	0.0035 (-0.00022, 0.0072)^
15	0.0070 (0.0030, 0.011)***	0.0024 (-0.0014, 0.0061)
Black	0.071 (0.067, 0.076)***	0.096 (0.090, 0.10)***
Hispanic	0.041 (0.030, 0.052)***	0.058 (0.045, 0.072)***
Other Race/Ethnicity	0.0078 (0.0018, 0.014)*	0.010 (0.0032, 0.017)**
Male	-0.0030 (-0.0049, -0.0011)**	-0.0015 (-0.0037, 0.00072)
Age 65 Risk Score	1.1 (1.0, 1.1)***	1.5 (1.5, 1.5)***
Diabetes	0.0061 (0.0038, 0.0084)***	0.0070 (0.0045, 0.0095)***
Stroke	0.0024 (-0.00062, 0.0053)	0.00062 (-0.0025, 0.0038)
Hypertension	-0.00040 (-0.0025, 0.0017)	-0.00017 (-0.0024, 0.0021)
CHF	0.0068 (0.0041, 0.0095)***	0.0074 (0.0045, 0.010)***
Chronic Kidney	-0.00020 (-0.0029, 0.0025)	-0.00081 (-0.0037, 0.0020)
Atrial Fibrillation	-0.0040 (-0.0068, -0.0012)**	-0.0049 (-0.0079, -0.0020)**
Cancer	-0.0046 (-0.0073, -0.0019)***	-0.0038 (-0.0067, -0.00087)*
COPD	0.0051 (0.0026, 0.0075)***	0.0090 (0.0063, 0.012)***
Ischemic Heart Disease	0.000014 (-0.0021, 0.0021)	-0.00014 (-0.0024, 0.0022)

Notes: ^ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Coefficients represent the change in the share with a payment delinquency or subprime credit score (Equifax Risk Score) relative to Medicare beneficiaries who are never diagnosed with ADRD during our study period. Models also control for year of age, state, quarter and year fixed effects, and indicators for imputed risk score. All information on health conditions, race/ethnicity, and sex are drawn from the Medicare data; these are not available in the CCP/Equifax. Data sources: FRBNY CCP/Equifax and Medicare Beneficiary Summary File.

Appendix Table 4: Change in Proportion with Missed Credit Payments/Subprime Credit Scores Before and After Arthritis Diagnosis Relative to Never-Diagnosed, 1999 to 2018

	Payment Delinquency (N = 53,593, N*t = 2,871,436)	Subprime Credit Score (N = 53,593, N*t = 2,871,436)
	Coefficient (95% CI)	Coefficient (95% CI)
Quarters from Diagnosis (reference: +16)		
-28	-0.0066 (-0.011, -0.0025)**	-0.0043 (-0.0086, 0.000025)^
-27	-0.0057 (-0.0098, -0.0017)**	-0.0040 (-0.0083, 0.00024)^
-26	-0.0059 (-0.0100, -0.0019)**	-0.0026 (-0.0069, 0.0016)
-25	-0.0052 (-0.0092, -0.0012)*	-0.0017 (-0.0059, 0.0025)
-24	-0.0059 (-0.0099, -0.0019)**	-0.00055 (-0.0048, 0.0037)
-23	-0.0067 (-0.011, -0.0028)***	-0.0037 (-0.0079, 0.00049)^
-22	-0.0041 (-0.0081, -0.00011)*	-0.0021 (-0.0063, 0.0020)
-21	-0.0041 (-0.0081, -0.000098)*	-0.0029 (-0.0070, 0.0012)
-20	-0.0038 (-0.0078, 0.00012)^	-0.0010 (-0.0051, 0.0031)
-19	-0.0025 (-0.0065, 0.0015)	-0.00061 (-0.0047, 0.0035)
-18	-0.00083 (-0.0048, 0.0031)	0.00091 (-0.0032, 0.0050)
-17	-0.0016 (-0.0056, 0.0023)	-0.00079 (-0.0048, 0.0032)
-16	-0.00100 (-0.0049, 0.0029)	-0.00067 (-0.0047, 0.0033)
-15	0.0030 (-0.00100, 0.0069)	0.00095 (-0.0031, 0.0050)
-14	0.0014 (-0.0025, 0.0054)	0.0024 (-0.0017, 0.0064)
-13	0.0026 (-0.0013, 0.0066)	0.0019 (-0.0021, 0.0059)
-12	0.0023 (-0.0017, 0.0062)	0.00086 (-0.0031, 0.0048)
-11	-0.00085 (-0.0047, 0.0030)	0.0011 (-0.0029, 0.0051)
-10	-0.0012 (-0.0050, 0.0027)	0.0025 (-0.0014, 0.0064)
-9	-0.0017 (-0.0055, 0.0022)	0.0028 (-0.0011, 0.0067)
-8	-0.0018 (-0.0056, 0.0020)	0.0020 (-0.0019, 0.0059)
-7	-0.0022 (-0.0060, 0.0016)	0.0014 (-0.0025, 0.0052)
-6	0.00059 (-0.0033, 0.0044)	0.00053 (-0.0033, 0.0044)
-5	-0.00075 (-0.0046, 0.0031)	-0.00082 (-0.0046, 0.0030)
-4	-0.00093 (-0.0047, 0.0029)	-0.0019 (-0.0057, 0.0020)
-3	-0.00035 (-0.0042, 0.0035)	-0.00032 (-0.0041, 0.0035)
-2	0.00050 (-0.0033, 0.0043)	-0.00031 (-0.0041, 0.0035)
-1	-0.00055 (-0.0044, 0.0033)	-0.00013 (-0.0040, 0.0037)
0	-0.00049 (-0.0043, 0.0034)	-0.0012 (-0.0051, 0.0026)
1	-0.00044 (-0.0043, 0.0034)	0.0011 (-0.0028, 0.0050)
2	-0.0011 (-0.0050, 0.0028)	0.00084 (-0.0031, 0.0047)
3	-0.0012 (-0.0051, 0.0027)	0.00020 (-0.0037, 0.0041)
4	0.00042 (-0.0035, 0.0043)	0.0011 (-0.0028, 0.0050)
5	-0.00045 (-0.0043, 0.0035)	-0.000047 (-0.0040, 0.0039)
6	0.00014 (-0.0038, 0.0041)	0.0015 (-0.0024, 0.0055)
7	-0.00045 (-0.0044, 0.0035)	-0.00011 (-0.0041, 0.0038)

8	-0.00065 (-0.0046, 0.0033)	0.0010 (-0.0029, 0.0050)
9	-0.00079 (-0.0048, 0.0032)	0.00062 (-0.0034, 0.0046)
10	0.0014 (-0.0027, 0.0054)	0.00094 (-0.0031, 0.0050)
11	0.00048 (-0.0036, 0.0046)	0.0022 (-0.0019, 0.0063)
12	0.00015 (-0.0039, 0.0042)	0.00089 (-0.0032, 0.0050)
13	0.0010 (-0.0031, 0.0051)	0.0014 (-0.0027, 0.0055)
14	-0.00035 (-0.0045, 0.0038)	0.00088 (-0.0032, 0.0050)
15	-0.0015 (-0.0057, 0.0026)	-0.00015 (-0.0043, 0.0040)
Black	0.062 (0.056, 0.068)***	0.084 (0.077, 0.091)***
Hispanic	0.028 (0.014, 0.041)***	0.045 (0.029, 0.061)***
Other Race/Ethnicity	0.0060 (-0.0011, 0.013)^	0.0072 (-0.00082, 0.015)^
Male	-0.0031 (-0.0054, -0.00077)**	-0.0025 (-0.0052, 0.00026)^
Age 65 Risk Score	1.1 (1.1, 1.1)***	1.5 (1.5, 1.6)***
Diabetes	0.0037 (0.00055, 0.0068)*	0.0039 (0.00054, 0.0074)*
Stroke	0.0027 (-0.0017, 0.0072)	-0.00041 (-0.0051, 0.0042)
Hypertension	-0.00054 (-0.0032, 0.0021)	0.00039 (-0.0025, 0.0033)
CHF	0.0051 (0.0011, 0.0091)*	0.0063 (0.0019, 0.011)**
Chronic Kidney	-0.00055 (-0.0045, 0.0034)	-0.00089 (-0.0051, 0.0033)
Atrial Fibrillation	-0.0039 (-0.0080, 0.00016)^	-0.0058 (-0.010, -0.0014)**
Cancer	-0.0044 (-0.0081, -0.00071)*	-0.0040 (-0.0080, 0.000070)^
COPD	0.0047 (0.0011, 0.0082)*	0.0089 (0.0050, 0.013)***
Ischemic Heart Disease	-0.0014 (-0.0043, 0.0015)	-0.00084 (-0.0040, 0.0023)
Pre-ADRD	0.0045 (0.0013, 0.0076)**	0.0032 (-0.00027, 0.0066)^
Post-ADRD	0.010 (0.0058, 0.015)***	0.0081 (0.0036, 0.013)***

Notes: ^ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Coefficients represent the change in the share with a payment delinquency or subprime credit score (Equifax Risk Score) relative to Medicare beneficiaries who are never diagnosed with arthritis during our study period. Models also control for year of age, state, quarter and year fixed effects, and indicators for imputed risk score. All information on health conditions, race/ethnicity, and sex are drawn from the Medicare data; these are not available in the CCP/Equifax. Data sources: FRBNY CCP/Equifax and Medicare Beneficiary Summary File.

Appendix Table 5: Change in Proportion with Missed Credit Payments/Subprime Credit Scores Before and After Glaucoma Diagnosis Relative to Never-Diagnosed, 1999 to 2018

	Payment Delinquency (N = 68,924, N*t = 4,061,233)	Subprime Credit Score (N = 68,924, N*t = 4,061,233)
	Coefficient (95% CI)	Coefficient (95% CI)
Quarters from Diagnosis (reference: +16)		
-28	-0.0069 (-0.013, -0.0010)*	-0.0011 (-0.0072, 0.0050)
-27	-0.0058 (-0.012, 0.000037)^	-0.0014 (-0.0074, 0.0046)
-26	-0.0049 (-0.011, 0.00087)^	-0.0033 (-0.0092, 0.0027)
-25	-0.0080 (-0.014, -0.0023)**	-0.0019 (-0.0078, 0.0040)
-24	-0.0038 (-0.0095, 0.0019)	-0.0010 (-0.0069, 0.0049)
-23	-0.0046 (-0.010, 0.0010)	-0.0031 (-0.0089, 0.0027)
-22	-0.0062 (-0.012, -0.00061)*	-0.0026 (-0.0084, 0.0031)
-21	-0.0048 (-0.010, 0.00088)^	-0.0045 (-0.010, 0.0012)
-20	-0.0072 (-0.013, -0.0017)*	-0.0021 (-0.0078, 0.0036)
-19	-0.0070 (-0.013, -0.0015)*	-0.0031 (-0.0088, 0.0025)
-18	-0.0047 (-0.010, 0.00090)^	-0.0032 (-0.0088, 0.0023)
-17	-0.0053 (-0.011, 0.00026)^	-0.0040 (-0.0095, 0.0016)
-16	-0.0026 (-0.0082, 0.0030)	-0.0037 (-0.0092, 0.0018)
-15	-0.0015 (-0.0071, 0.0041)	-0.0043 (-0.0098, 0.0011)
-14	-0.0015 (-0.0070, 0.0041)	-0.0043 (-0.0097, 0.0012)
-13	-0.0039 (-0.0094, 0.0015)	-0.0051 (-0.011, 0.00033)^
-12	-0.010 (-0.015, -0.0048)***	-0.0085 (-0.014, -0.0032)**
-11	-0.0069 (-0.012, -0.0015)*	-0.0083 (-0.014, -0.0030)**
-10	-0.0070 (-0.012, -0.0018)**	-0.0063 (-0.012, -0.00099)*
-9	-0.0052 (-0.011, 0.00013)^	-0.0070 (-0.012, -0.0017)**
-8	-0.0055 (-0.011, -0.00026)*	-0.0087 (-0.014, -0.0036)***
-7	-0.0051 (-0.010, 0.00026)^	-0.0075 (-0.013, -0.0024)**
-6	-0.0043 (-0.0096, 0.00099)	-0.0080 (-0.013, -0.0029)**
-5	-0.0028 (-0.0082, 0.0025)	-0.0083 (-0.013, -0.0032)**
-4	-0.0031 (-0.0084, 0.0022)	-0.0084 (-0.013, -0.0033)**
-3	-0.0049 (-0.010, 0.00029)^	-0.0074 (-0.013, -0.0023)**
-2	-0.0072 (-0.012, -0.0020)**	-0.0074 (-0.013, -0.0023)**
-1	-0.0037 (-0.0090, 0.0016)	-0.0059 (-0.011, -0.00080)*
0	-0.0073 (-0.012, -0.0022)**	-0.0072 (-0.012, -0.0022)**
1	-0.0049 (-0.010, 0.00032)^	-0.0058 (-0.011, -0.00073)*
2	-0.0062 (-0.011, -0.00099)*	-0.0079 (-0.013, -0.0028)**
3	-0.0055 (-0.011, -0.00030)*	-0.0058 (-0.011, -0.00064)*
4	-0.0052 (-0.010, 0.000083)^	-0.0058 (-0.011, -0.00060)*
5	-0.0083 (-0.013, -0.0031)**	-0.0072 (-0.012, -0.0021)**
6	-0.011 (-0.016, -0.0055)***	-0.0065 (-0.012, -0.0013)*
7	-0.0088 (-0.014, -0.0035)**	-0.0068 (-0.012, -0.0017)**

8	-0.010 (-0.016, -0.0052)***	-0.0078 (-0.013, -0.0026)**
9	-0.0082 (-0.013, -0.0029)**	-0.0090 (-0.014, -0.0039)***
10	-0.0075 (-0.013, -0.0022)**	-0.0073 (-0.013, -0.0021)**
11	-0.0081 (-0.013, -0.0027)**	-0.0065 (-0.012, -0.0013)*
12	-0.0079 (-0.013, -0.0025)**	-0.0063 (-0.012, -0.0011)*
13	-0.0069 (-0.012, -0.0014)*	-0.0053 (-0.011, 0.0000043)*
14	-0.0064 (-0.012, -0.00084)*	-0.0064 (-0.012, -0.0011)*
15	-0.0053 (-0.011, 0.00035)^	-0.0042 (-0.0096, 0.0012)
Black	0.067 (0.062, 0.072)***	0.093 (0.087, 0.100)***
Hispanic	0.040 (0.027, 0.052)***	0.055 (0.040, 0.070)***
Other Race/Ethnicity	0.0070 (0.00032, 0.014)*	0.0093 (0.0017, 0.017)*
Male	-0.0031 (-0.0051, -0.0011)**	-0.0012 (-0.0036, 0.0012)
Age 65 Risk Score	1.1 (1.0, 1.1)***	1.5 (1.5, 1.5)***
Diabetes	0.0053 (0.0028, 0.0079)***	0.0063 (0.0034, 0.0091)***
Stroke	0.0024 (-0.0010, 0.0058)	0.0014 (-0.0023, 0.0050)
Hypertension	0.000061 (-0.0022, 0.0023)	-0.000019 (-0.0025, 0.0025)
CHF	0.0057 (0.0026, 0.0087)***	0.0076 (0.0043, 0.011)***
Chronic Kidney	-0.00088 (-0.0040, 0.0022)	-0.0013 (-0.0046, 0.0019)
Atrial Fibrillation	-0.0037 (-0.0069, -0.00055)*	-0.0051 (-0.0085, -0.0017)**
Cancer	-0.0044 (-0.0074, -0.0013)**	-0.0037 (-0.0071, -0.00043)*
COPD	0.0052 (0.0025, 0.0080)***	0.0093 (0.0062, 0.012)***
Ischemic Heart Disease	0.00017 (-0.0022, 0.0025)	-0.00025 (-0.0028, 0.0023)
Pre-ADRD	0.0049 (0.0022, 0.0075)***	0.0039 (0.0010, 0.0068)**
Post-ADRD	0.011 (0.0071, 0.014)***	0.0081 (0.0045, 0.012)***

Notes: ^ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Coefficients represent the change in the share with a payment delinquency or subprime credit score (Equifax Risk Score) relative to Medicare beneficiaries who are never diagnosed with glaucoma during our study period. Models also control for year of age, state, quarter and year fixed effects, and indicators for imputed risk score. All information on health conditions, race/ethnicity, and sex are drawn from the Medicare data; these are not available in the CCP/Equifax. Data sources: FRBNY CCP/Equifax and Medicare Beneficiary Summary File.

Appendix Table 6: Change in Proportion with Missed Credit Payments/Subprime Credit Scores Before and After Heart Attack Relative to Never-Diagnosed, 1999 to 2018

	Payment Delinquency (N = 79,784, N*t = 4,841,225)	Subprime Credit Score (N = 79,784, N*t = 4,841,225)
	Coefficient (95% CI)	Coefficient (95% CI)
Quarters from Diagnosis (reference: +16)		
-28	-0.0014 (-0.010, 0.0075)	-0.00031 (-0.0094, 0.0088)
-27	0.0052 (-0.0042, 0.015)	0.0038 (-0.0055, 0.013)
-26	0.0025 (-0.0067, 0.012)	0.0028 (-0.0064, 0.012)
-25	0.0015 (-0.0075, 0.011)	0.0015 (-0.0075, 0.010)
-24	0.0020 (-0.0070, 0.011)	0.00097 (-0.0079, 0.0099)
-23	-0.00022 (-0.0090, 0.0085)	0.0019 (-0.0070, 0.011)
-22	0.0033 (-0.0057, 0.012)	0.0050 (-0.0039, 0.014)
-21	0.0035 (-0.0054, 0.012)	0.0045 (-0.0044, 0.013)
-20	-0.00095 (-0.0096, 0.0077)	0.0013 (-0.0073, 0.0100)
-19	0.0023 (-0.0065, 0.011)	0.0070 (-0.0019, 0.016)
-18	0.0047 (-0.0042, 0.014)	0.0040 (-0.0047, 0.013)
-17	0.0050 (-0.0038, 0.014)	0.0056 (-0.0031, 0.014)
-16	0.0066 (-0.0023, 0.016)	0.0065 (-0.0022, 0.015)
-15	0.0065 (-0.0023, 0.015)	0.0048 (-0.0038, 0.013)
-14	0.0060 (-0.0028, 0.015)	0.0032 (-0.0054, 0.012)
-13	0.0021 (-0.0064, 0.011)	0.0014 (-0.0070, 0.0097)
-12	0.0016 (-0.0068, 0.010)	0.0026 (-0.0058, 0.011)
-11	-0.0012 (-0.0096, 0.0071)	0.0035 (-0.0050, 0.012)
-10	-0.00089 (-0.0093, 0.0075)	0.0029 (-0.0055, 0.011)
-9	0.00081 (-0.0076, 0.0093)	0.0043 (-0.0041, 0.013)
-8	0.00065 (-0.0078, 0.0091)	0.0035 (-0.0048, 0.012)
-7	0.0014 (-0.0070, 0.0099)	0.0061 (-0.0022, 0.015)
-6	0.0066 (-0.0021, 0.015)	0.0076 (-0.00083, 0.016)^
-5	0.0082 (-0.00062, 0.017)^	0.0079 (-0.00060, 0.016)^
-4	0.0090 (0.00016, 0.018)*	0.0092 (0.00070, 0.018)*
-3	0.0069 (-0.0018, 0.016)	0.011 (0.0025, 0.020)*
-2	0.010 (0.0011, 0.019)*	0.012 (0.0035, 0.021)**
-1	0.0064 (-0.0023, 0.015)	0.0073 (-0.0012, 0.016)^
0	0.0014 (-0.0074, 0.010)	0.0074 (-0.0013, 0.016)^
1	0.0061 (-0.0031, 0.015)	0.012 (0.0028, 0.021)*
2	0.0051 (-0.0041, 0.014)	0.0077 (-0.0013, 0.017)^
3	0.011 (0.0019, 0.021)*	0.011 (0.0019, 0.020)*
4	0.013 (0.0035, 0.023)**	0.010 (0.0010, 0.019)*
5	0.013 (0.0035, 0.023)**	0.0076 (-0.0016, 0.017)
6	0.012 (0.0020, 0.021)*	0.0069 (-0.0023, 0.016)
7	0.010 (0.00049, 0.020)*	0.010 (0.00071, 0.020)*

8	0.012 (0.0022, 0.022)*	0.0064 (-0.0029, 0.016)
9	0.0071 (-0.0026, 0.017)	0.0050 (-0.0042, 0.014)
10	0.0094 (-0.00052, 0.019)^	0.010 (0.00061, 0.020)*
11	0.0066 (-0.0033, 0.017)	0.0088 (-0.00078, 0.018)^
12	0.0021 (-0.0077, 0.012)	0.0078 (-0.0018, 0.017)
13	0.010 (0.000015, 0.021)*	0.010 (0.00050, 0.020)*
14	0.0090 (-0.0013, 0.019)^	0.0066 (-0.0032, 0.016)
15	0.0026 (-0.0076, 0.013)	0.0030 (-0.0067, 0.013)
Black	0.070 (0.066, 0.075)***	0.095 (0.089, 0.10)***
Hispanic	0.040 (0.029, 0.051)***	0.058 (0.045, 0.071)***
Other Race/Ethnicity	0.0070 (0.0010, 0.013)*	0.0090 (0.0023, 0.016)**
Male	-0.0033 (-0.0052, -0.0014)***	-0.0019 (-0.0041, 0.00035)^
Age 65 Risk Score	1.1 (1.0, 1.1)***	1.5 (1.5, 1.5)***
Diabetes	0.0065 (0.0041, 0.0088)***	0.0070 (0.0045, 0.0096)***
Stroke	0.0020 (-0.0010, 0.0051)	0.00049 (-0.0027, 0.0037)
Hypertension	-0.00045 (-0.0025, 0.0016)	-0.00028 (-0.0026, 0.0020)
CHF	0.0064 (0.0036, 0.0091)***	0.0063 (0.0034, 0.0093)***
Chronic Kidney	-0.00048 (-0.0032, 0.0023)	-0.0012 (-0.0041, 0.0017)
Atrial Fibrillation	-0.0038 (-0.0067, -0.00092)**	-0.0047 (-0.0077, -0.0017)**
Cancer	-0.0046 (-0.0073, -0.0020)***	-0.0039 (-0.0069, -0.00099)**
COPD	0.0050 (0.0025, 0.0076)***	0.0090 (0.0063, 0.012)***
Ischemic Heart Disease	-0.00057 (-0.0027, 0.0016)	-0.00085 (-0.0032, 0.0015)
Pre-ADRD	0.0042 (0.0017, 0.0066)***	0.0029 (0.00025, 0.0055)*
Post-ADRD	0.010 (0.0073, 0.014)***	0.0076 (0.0045, 0.011)***

Notes: ^ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Coefficients represent the change in the share with a payment delinquency or subprime credit score (Equifax Risk Score) relative to Medicare beneficiaries who never had a heart attack during our study period. Models also control for year of age, state, quarter and year fixed effects, and indicators for imputed risk score. All information on health conditions, race/ethnicity, and sex are drawn from the Medicare data; these are not available in the CCP/Equifax. Data sources: FRBNY CCP/Equifax and Medicare Beneficiary Summary File.

Appendix Table 7: Change in Proportion with Missed Credit Payments/Subprime Credit Scores Before and After Hip Fracture Relative to Never-Diagnosed, 1999 to 2018

	Payment Delinquency (N = 80,427, N*t = 4,879,274)	Subprime Credit Score (N = 80,427, N*t = 4,879,274)
	Coefficient (95% CI)	Coefficient (95% CI)
Quarters from Diagnosis (reference: +16)		
-28	0.0010 (-0.0062, 0.0082)	-0.0027 (-0.0098, 0.0043)
-27	-0.0024 (-0.0093, 0.0046)	-0.0030 (-0.0099, 0.0040)
-26	-0.0013 (-0.0083, 0.0057)	-0.00076 (-0.0077, 0.0062)
-25	-0.0016 (-0.0086, 0.0054)	-0.00083 (-0.0078, 0.0061)
-24	-0.0029 (-0.0099, 0.0040)	-0.0029 (-0.0097, 0.0039)
-23	0.00040 (-0.0067, 0.0075)	0.00011 (-0.0069, 0.0071)
-22	0.00099 (-0.0061, 0.0080)	-0.00046 (-0.0074, 0.0065)
-21	-0.0030 (-0.0097, 0.0038)	-0.0017 (-0.0085, 0.0051)
-20	0.00047 (-0.0065, 0.0074)	-0.0014 (-0.0081, 0.0054)
-19	-0.0029 (-0.0096, 0.0039)	-0.0053 (-0.012, 0.0013)
-18	-0.0015 (-0.0084, 0.0053)	-0.0027 (-0.0094, 0.0040)
-17	-0.00064 (-0.0075, 0.0062)	-0.0031 (-0.0097, 0.0036)
-16	0.00035 (-0.0065, 0.0072)	-0.0038 (-0.010, 0.0027)
-15	0.0010 (-0.0058, 0.0079)	-0.0056 (-0.012, 0.00082)^
-14	0.00073 (-0.0061, 0.0076)	-0.0057 (-0.012, 0.00064)^
-13	0.00057 (-0.0063, 0.0074)	-0.0039 (-0.010, 0.0025)
-12	0.0014 (-0.0055, 0.0083)	-0.0024 (-0.0090, 0.0041)
-11	0.00053 (-0.0064, 0.0074)	-0.00032 (-0.0070, 0.0063)
-10	0.0046 (-0.0025, 0.012)	-0.0030 (-0.0095, 0.0034)
-9	0.0065 (-0.00072, 0.014)^	-0.0022 (-0.0087, 0.0043)
-8	0.0041 (-0.0030, 0.011)	-0.00026 (-0.0069, 0.0063)
-7	0.0076 (0.00031, 0.015)*	0.00021 (-0.0064, 0.0068)
-6	0.0052 (-0.0020, 0.012)	0.00027 (-0.0064, 0.0069)
-5	0.0021 (-0.0049, 0.0092)	-0.0023 (-0.0088, 0.0043)
-4	0.0024 (-0.0047, 0.0094)	-0.0024 (-0.0089, 0.0041)
-3	0.0069 (-0.00030, 0.014)^	0.00092 (-0.0057, 0.0076)
-2	0.0061 (-0.0012, 0.013)^	0.00069 (-0.0060, 0.0074)
-1	0.0037 (-0.0034, 0.011)	0.0050 (-0.0019, 0.012)
0	0.0059 (-0.0014, 0.013)	0.0061 (-0.00089, 0.013)^
1	0.0081 (0.00058, 0.016)*	0.0043 (-0.0028, 0.011)
2	0.0049 (-0.0026, 0.012)	0.0061 (-0.0011, 0.013)^
3	0.0018 (-0.0056, 0.0092)	0.0053 (-0.0019, 0.012)
4	0.0060 (-0.0016, 0.014)	0.0059 (-0.0014, 0.013)
5	0.0053 (-0.0024, 0.013)	0.0063 (-0.0011, 0.014)^
6	0.0022 (-0.0054, 0.0098)	0.0039 (-0.0034, 0.011)
7	0.00036 (-0.0073, 0.0080)	0.0062 (-0.0013, 0.014)

8	-0.0020 (-0.0097, 0.0056)	0.0013 (-0.0060, 0.0087)
9	0.0012 (-0.0067, 0.0091)	0.00050 (-0.0069, 0.0079)
10	0.0047 (-0.0034, 0.013)	0.00082 (-0.0067, 0.0084)
11	0.0039 (-0.0043, 0.012)	0.0013 (-0.0064, 0.0089)
12	0.0022 (-0.0062, 0.011)	-0.0028 (-0.010, 0.0048)
13	0.0010 (-0.0074, 0.0095)	-0.0040 (-0.012, 0.0037)
14	0.00026 (-0.0082, 0.0088)	-0.0052 (-0.013, 0.0024)
15	0.00037 (-0.0083, 0.0091)	-0.0062 (-0.014, 0.0014)
Black	0.071 (0.066, 0.076)***	0.095 (0.090, 0.10)***
Hispanic	0.041 (0.030, 0.052)***	0.058 (0.044, 0.071)***
Other Race/Ethnicity	0.0076 (0.0015, 0.014)*	0.0098 (0.0029, 0.017)**
Male	-0.0031 (-0.0050, -0.0012)**	-0.0016 (-0.0038, 0.00069)
Age 65 Risk Score	1.1 (1.0, 1.1)***	1.5 (1.5, 1.5)***
Diabetes	0.0059 (0.0036, 0.0082)***	0.0067 (0.0042, 0.0093)***
Stroke	0.0024 (-0.00062, 0.0054)	0.00021 (-0.0030, 0.0034)
Hypertension	-0.00038 (-0.0025, 0.0017)	-0.000094 (-0.0024, 0.0022)
CHF	0.0065 (0.0038, 0.0093)***	0.0073 (0.0044, 0.010)***
Chronic Kidney	0.000087 (-0.0027, 0.0028)	-0.00063 (-0.0035, 0.0023)
Atrial Fibrillation	-0.0039 (-0.0068, -0.0011)**	-0.0047 (-0.0077, -0.0016)**
Cancer	-0.0047 (-0.0074, -0.0020)***	-0.0037 (-0.0066, -0.00069)*
COPD	0.0051 (0.0026, 0.0076)***	0.0091 (0.0063, 0.012)***
Ischemic Heart Disease	-0.00015 (-0.0023, 0.0020)	-0.00031 (-0.0026, 0.0020)
Pre-ADRD	0.0041 (0.0016, 0.0066)**	0.0034 (0.00073, 0.0061)*
Post-ADRD	0.010 (0.0070, 0.013)***	0.0076 (0.0044, 0.011)***

Notes: ^ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Coefficients represent the change in the share with a payment delinquency or subprime credit score (Equifax) relative to Medicare beneficiaries who never had a hip fracture during our study period. Models also control for year of age, state, quarter and year fixed effects, and indicators for imputed risk score. All information on health conditions, race/ethnicity, and sex are drawn from the Medicare data; these are not available in the CCP/Equifax. Data sources: FRBNY CCP/Equifax and Medicare Beneficiary Summary File.

Appendix Table 8: Change in Proportion with Missed Credit Payments Before and After Alzheimer's Disease and Related Dementias Diagnosis by Census Tract Education Relative to Never-Diagnosed, 1999 to 2018

	Less Education (N = 43,983, N*t = 2,783,421)	More Education (N = 37,364, N*t = 2,220,297)
	Coefficient (95% CI)	Coefficient (95% CI)
Quarters from Diagnosis (reference: +16)		
-28	0.004 (-0.001, 0.010)	0.001 (-0.003, 0.005)
-27	0.007* (0.002, 0.012)	0.001 (-0.003, 0.005)
-26	0.008** (0.003, 0.014)	0.000 (-0.004, 0.004)
-25	0.006* (0.001, 0.012)	0.000 (-0.004, 0.004)
-24	0.006* (0.001, 0.011)	0.003 (-0.001, 0.007)
-23	0.008** (0.002, 0.013)	0.002 (-0.002, 0.006)
-22	0.007* (0.001, 0.012)	0.001 (-0.003, 0.005)
-21	0.009** (0.004, 0.015)	0.000 (-0.004, 0.004)
-20	0.008** (0.002, 0.013)	0.002 (-0.002, 0.006)
-19	0.009** (0.003, 0.014)	0.003 (-0.001, 0.007)
-18	0.008** (0.002, 0.013)	0.001 (-0.003, 0.006)
-17	0.008** (0.002, 0.013)	0.001 (-0.004, 0.005)
-16	0.007* (0.002, 0.013)	0.000 (-0.004, 0.004)
-15	0.006* (0.001, 0.012)	0.002 (-0.002, 0.006)
-14	0.008** (0.002, 0.014)	0.002 (-0.002, 0.006)
-13	0.008** (0.002, 0.013)	0.002 (-0.002, 0.007)
-12	0.007* (0.001, 0.012)	0.002 (-0.002, 0.006)
-11	0.005^ (-0.000, 0.011)	0.003 (-0.001, 0.008)
-10	0.007* (0.001, 0.012)	0.006** (0.002, 0.010)
-9	0.006* (0.000, 0.012)	0.006** (0.002, 0.010)
-8	0.008** (0.002, 0.013)	0.003 (-0.001, 0.007)
-7	0.007* (0.001, 0.012)	0.003 (-0.001, 0.007)
-6	0.006* (0.000, 0.012)	0.002 (-0.003, 0.006)
-5	0.007* (0.001, 0.013)	0.002 (-0.002, 0.006)
-4	0.007* (0.002, 0.013)	0.005* (0.001, 0.010)
-3	0.009** (0.004, 0.015)	0.006* (0.001, 0.010)
-2	0.011*** (0.005, 0.017)	0.005* (0.001, 0.009)
-1	0.011*** (0.005, 0.017)	0.006** (0.002, 0.010)
0	0.012*** (0.006, 0.018)	0.007** (0.003, 0.012)
1	0.011*** (0.005, 0.017)	0.010*** (0.005, 0.015)
2	0.012*** (0.006, 0.018)	0.012*** (0.007, 0.016)
3	0.018*** (0.011, 0.024)	0.011*** (0.007, 0.016)
4	0.013*** (0.007, 0.019)	0.010*** (0.005, 0.014)
5	0.016*** (0.009, 0.022)	0.011*** (0.006, 0.015)
6	0.015*** (0.009, 0.021)	0.010*** (0.005, 0.015)

7	0.013*** (0.007, 0.020)	0.009*** (0.004, 0.014)
8	0.012*** (0.005, 0.018)	0.010*** (0.005, 0.015)
9	0.013*** (0.007, 0.020)	0.008*** (0.003, 0.013)
10	0.010** (0.004, 0.016)	0.006* (0.001, 0.011)
11	0.013*** (0.006, 0.019)	0.008*** (0.004, 0.013)
12	0.013*** (0.007, 0.020)	0.007** (0.002, 0.012)
13	0.011*** (0.005, 0.018)	0.007** (0.002, 0.012)
14	0.010** (0.004, 0.017)	0.005* (0.001, 0.010)
15	0.009** (0.003, 0.016)	0.005* (0.000, 0.010)
Black	0.073*** (0.067, 0.079)	0.061*** (0.053, 0.069)
Hispanic	0.041*** (0.027, 0.055)	0.027** (0.009, 0.046)
Other Race/Ethnicity	0.011* (0.000, 0.021)	0.004 (-0.003, ,0.011)
Male	-0.003^ (-0.005, ,0.000)	-0.003* (-0.005, -0.000)
Age 65 Risk Score	1.1*** (1.0, 1.1)	1.0*** (1.0, 1.1)
Diabetes	0.008*** (0.005, 0.011)	0.003* (0.000, 0.006)
Stroke	0.003 (-0.002, ,0.007)	0.002 (-0.002, ,0.006)
Hypertension	0.000 (-0.003, ,0.003)	-0.001 (-0.004, ,0.002)
CHF	0.007*** (0.003, 0.011)	0.006*** (0.003, 0.010)
Chronic Kidney	-0.001 (-0.005, ,0.003)	0.001 (-0.003, ,0.004)
Atrial Fibrillation	-0.003 (-0.007, ,0.001)	-0.005* (-0.008, -0.001)
Cancer	-0.003 (-0.007, ,0.001)	-0.006*** (-0.009, -0.003)
COPD	0.005** (0.001, 0.008)	0.005** (0.001, 0.008)
Ischemic Heart Disease	-0.001 (-0.004, ,0.002)	0.001 (-0.001, ,0.004)

Notes: ^ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Coefficients represent the change in the share with a payment delinquency relative to Medicare beneficiaries who were never diagnosed with ADRD during our study period. Education level is defined as whether the proportion of a beneficiary's census tract age 65 or older with more than a high school education was above vs below the national population-weighted median. Models also control for year of age, state, quarter and year fixed effects, and indicators for imputed risk score. All information on health conditions, race/ethnicity, and sex are drawn from the Medicare data; these are not available in the CCP/Equifax. Data sources: FRBNY CCP/Equifax and Medicare Beneficiary Summary File.

Appendix Table 9: Change in Proportion with Subprime Credit Scores Before and After Alzheimer's Disease and Related Dementias Diagnosis by Census Tract Education Relative to Never-Diagnosed, 1999 to 2018

	Less Education (N = 43,983, N*t = 2,783,421)	More Education (N = 37,364, N*t = 2,220,297)
	Coefficient (95% CI)	Coefficient (95% CI)
Quarters from Diagnosis (reference: +16)		
-28	0.006* (0.001, 0.012)	-0.001 (-0.005, ,0.003)
-27	0.007* (0.002, 0.013)	0.000 (-0.004, ,0.004)
-26	0.009** (0.004, 0.015)	0.000 (-0.004, ,0.004)
-25	0.008** (0.002, 0.013)	-0.001 (-0.005, ,0.003)
-24	0.007* (0.001, 0.012)	0.000 (-0.004, ,0.004)
-23	0.007** (0.002, 0.013)	-0.001 (-0.004, ,0.003)
-22	0.008** (0.003, 0.014)	-0.001 (-0.005, ,0.003)
-21	0.010*** (0.004, 0.015)	0.000 (-0.004, ,0.004)
-20	0.008** (0.002, 0.013)	0.000 (-0.004, ,0.004)
-19	0.008** (0.003, 0.014)	0.001 (-0.003, ,0.005)
-18	0.009** (0.003, 0.014)	0.001 (-0.003, ,0.005)
-17	0.008** (0.002, 0.013)	0.002 (-0.002, ,0.006)
-16	0.008** (0.002, 0.013)	0.001 (-0.003, ,0.005)
-15	0.006* (0.000, 0.011)	0.002 (-0.002, ,0.006)
-14	0.005^ (-0.001, ,0.011)	0.003 (-0.001, ,0.007)
-13	0.006^ (-0.000, ,0.011)	0.002 (-0.002, ,0.006)
-12	0.004 (-0.001, ,0.010)	0.002 (-0.002, ,0.006)
-11	0.004 (-0.002, ,0.010)	0.003^ (-0.001, ,0.007)
-10	0.007* (0.001, 0.013)	0.003 (-0.001, ,0.007)
-9	0.005^ (-0.000, ,0.011)	0.003 (-0.001, ,0.007)
-8	0.008* (0.002, 0.013)	0.003 (-0.001, ,0.007)
-7	0.008** (0.002, 0.014)	0.004^ (-0.000, ,0.008)
-6	0.007* (0.001, 0.013)	0.003 (-0.001, ,0.007)
-5	0.007* (0.002, 0.013)	0.002 (-0.002, ,0.006)
-4	0.007* (0.001, 0.013)	0.005* (0.001, 0.009)
-3	0.006* (0.000, 0.012)	0.005** (0.001, 0.010)
-2	0.008** (0.002, 0.014)	0.003 (-0.001, ,0.007)
-1	0.010*** (0.004, 0.016)	0.004^ (-0.000, ,0.008)
0	0.009** (0.004, 0.015)	0.004^ (-0.000, ,0.008)
1	0.010** (0.004, 0.015)	0.006** (0.001, 0.010)
2	0.012*** (0.006, 0.018)	0.008*** (0.004, 0.012)
3	0.014*** (0.008, 0.020)	0.008*** (0.004, 0.013)
4	0.010** (0.004, 0.016)	0.007** (0.003, 0.011)
5	0.014*** (0.008, 0.020)	0.007** (0.003, 0.011)
6	0.013*** (0.007, 0.019)	0.006** (0.002, 0.010)

7	0.013*** (0.007, 0.019)	0.006* (0.001, 0.010)
8	0.011*** (0.005, 0.017)	0.006** (0.001, 0.010)
9	0.013*** (0.007, 0.019)	0.006** (0.002, 0.011)
10	0.011*** (0.004, 0.017)	0.005* (0.001, 0.009)
11	0.011*** (0.005, 0.017)	0.004^ (-0.000, ,0.009)
12	0.011*** (0.005, 0.017)	0.003 (-0.002, ,0.007)
13	0.010** (0.004, 0.016)	0.000 (-0.004, ,0.005)
14	0.008* (0.002, 0.015)	0.000 (-0.005, ,0.004)
15	0.007* (0.000, 0.013)	-0.001 (-0.005, ,0.003)
Black	0.097*** (0.090, 0.104)	0.083*** (0.074, 0.093)
Hispanic	0.062*** (0.045, 0.079)	0.032** (0.013, 0.052)
Other Race/Ethnicity	0.014* (0.002, 0.025)	0.005 (-0.002, ,0.013)
Male	0.000 (-0.003, ,0.004)	-0.003* (-0.006, -0.000)
Age 65 Risk Score	1.6*** (1.5, 1.6)	1.4*** (1.4, 1.4)
Diabetes	0.009*** (0.005, 0.012)	0.004* (0.001, 0.007)
Stroke	0.000 (-0.005, ,0.005)	0.001 (-0.003, ,0.005)
Hypertension	0.000 (-0.003, ,0.004)	-0.001 (-0.004, ,0.002)
CHF	0.008*** (0.004, 0.013)	0.006** (0.002, 0.010)
Chronic Kidney	-0.002 (-0.006, ,0.002)	0.000 (-0.003, ,0.004)
Atrial Fibrillation	-0.004 (-0.009, ,0.001)	-0.005** (-0.009, -0.001)
Cancer	-0.002 (-0.007, ,0.002)	-0.005** (-0.008, -0.002)
COPD	0.010*** (0.006, 0.014)	0.006*** (0.003, 0.010)
Ischemic Heart Disease	-0.002 (-0.005, ,0.002)	0.001 (-0.001, ,0.004)

Notes: ^ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Coefficients represent the change in the share with a subprime credit score (Equifax Risk Score) relative to Medicare beneficiaries who were never diagnosed with ADRD during our study period. Education level is defined as whether the proportion of a beneficiary's census tract age 65 or older with more than a high school education was above vs below the national population-weighted median. Models also control for year of age, state, quarter and year fixed effects, and indicators for imputed risk score. All information on health conditions, race/ethnicity, and sex are drawn from the Medicare data; these are not available in the CCP/Equifax. Data sources: FRBNY CCP/Equifax and Medicare Beneficiary Summary File.

1. CMS Chronic Condition Warehouse. Chronic Condition Algorithms. 2020; https://www2.ccwdata.org/web/guest/condition-categories. Accessed March 1, 2020.
2. Taylor DJ, Ostbye T, Langa KM, Weir DR, Plassman B. The Accuracy Of Medicare Claims As An Epidemiological Tool: The Case Of Dementia Revisited. *Journal of Alzheimer's Disease* 2009;17(4):807-815
3. Nicholas LH, Bynum JPW, Iwashyna TJ, Weir DR, Langa KM. Advance Directives And Nursing Home Stays Associated With Less Aggressive End-Of-Life Care For Patients With Severe Dementia. *Health Affairs.* 2014;33(4):667-674.