"Health Insurance Design Meets Saving Incentives: Consumer Responses to Complex Contracts," Adam Leive, Online Appendices

Appendix A: Background on Health Savings Accounts [For Online Publication]

Created with the 2003 Medicare Modernization Act, an HSA is a portable financial account that must be paired with a HDHP. In 2020, the statutory minimum deductible for a HDHP is $1,400 for employee-only coverage and $2,800 for family coverage. HSA contributions roll over each year, unlike Flexible Spending Accounts (FSAs) in which the enrollee loses at least some portion of unused balance at year's end. HSAs are also distinguished from Health Reimbursement Arrangements (HRAs). HRAs are owned by the employer, not the employee, and cannot be invested. Employers may decide whether HRA funds roll over from year to year or are forfeited at year's end. HRAs do not have to be paired with a HDHP.

HSAs, which are owned by individuals, closely resemble 401(k)s. Contributions to HSAs are deductible from taxable income ("above the line"), interest grows tax-deferred, and withdrawals for non-medical consumption are subject to income taxation and a penalty if before age 65. The penalty for early withdrawals was 10 percent before 2011, equal to that of 401(k) withdrawals, and increased to 20 percent beginning in 2011. HSAs also offer survivor benefits; if the beneficiary is a spouse, then withdrawals for qualified medical expenses remain exempt from taxes. If the beneficiary is someone else, withdrawals are taxed. HSAs obtained through employers may or may not qualify as an ERISA plan, depending on the employer's involvement in the plan. HSAs not opened through an employer are considered personal savings vehicles by the Department of Labor and not protected under ERISA.

Qualified expenses, which must be incurred after the HSA has been established, include out-of-pocket payments associated with a HDHP while working, as well as premiums for Medicare, COBRA, or long-term care insurance. Until 2011, over-the-counter drugs without a prescription were considered qualified medical expenses. Starting January 1, 2011, a prescription was needed for over-the-counter drugs to be financed tax-free with HSA funds. HSAs cannot be used tax-free to finance premiums for employer health insurance or Medigap.

In 2020, the annual HSA contribution limit including both employer and employee contributions is $3,550 for employee-only coverage and $7,100 for family coverage. These limits, which the IRS increases over time for cost of living adjustments, rose from $2,850 and $5,650, respectively, in 2007. Individuals over age 55 can also make annual "catch-up" contributions of an extra $1,000, up from $800 per year in 2007.[1] These limits are lower than those for other savings vehicles. The IRS's annual limit on employee 401(k) elective deferrals is $19,000 in 2019 and the overall limit on defined contributions, including employer contributions, is $56,000. The limit on 529s for education expenses varies by state but range between $235,000 and $529,000. The lower contribution limits for HSAs may imply the incidence of the tax expenditures is less concentrated at the top of the income distribution, at least compared to other tax-advantaged savings accounts.

Since their creation in 2004, HSAs have grown to include 25 million accounts and assets of over $50 billion, with the majority of accounts opening since 2011 (Fronstin 2017, 2019; Devenir 2019). The take-up of HDHPs and HSAs has increased dramatically over the last decade, covering almost 30 percent of people who obtain insurance through their

[1]Between 2004 and 2006, annual HSA contributions were limited to the lesser of the statutory maximum or the chosen deductible. This rule was repealed on December 20, 2006 by the Tax Relief and Health Care Act of 2006.

employer (Claxton et al. 2019). Over one-quarter of firms now offer an HDHP/HSA option, and nearly half of firms with over 1,000 workers do. Despite their increased popularity, HSA contributions have been modest. Based on the Employee Benefits Research Institute (EBRI) database, the average contribution (including employer contributions) in 2018 was about $2,800 (Fronstin 2018). Roughly half of accounts had any employer contribution. Two-thirds of account holders withdrew HSA assets, and the average withdrawal was $1,725 that year. Assets in the large majority of accounts (95 percent) are not invested in financial markets. Using tax records, Helmchen et al. (2015) find older and higher-income workers opened and fully funded their HSAs more often than did younger and lower-income workers.

Limited research exists on how employees fund HSAs in relation to 401(k)s. Parente and Feldman (2008) find a weak positive correlation between contributions to HSAs and other tax-deferred retirement saving vehicles among one set of University employees. Yet their sample includes just 63 HSA accounts from a sample of 16,000 and their results are sensitive to the regression specification. Analyzing over 160,000 accounts held at United Health Group and OptumHealth Bank, Chen, Lo Sasso and Nandam (2013) find HSA contributions are negatively correlated with employer contributions and positively correlated with age, income, education, and health care spending. They lack data on 401(k)s or other saving accounts. Other studies on HSAs focus on the choice of insurance plan, comparing traditional insurance to a high-deductible health plan (Cardon and Showalter, 2007; Steinorth, 2011), but do not study saving decisions. Peter, Soika and Steinorth (2016) theoretically analyze how HSA saving may influence insurance decisions, but do not consider HSAs in the context of other retirement saving.

References

Cardon, James, and Mark Showalter. 2007. "Insurance Choice and Tax-Preferred Health Savings Accounts." *Journal of Health Economics*, 26(2): 373–399.

Chen, Song, Anthony Lo Sasso, and Aneesh Nandam. 2013. "Who Funds Their Health Savings Account and Why?" *International Journal of Health Care Finance and Economics*, 13(3-4): 219–232.

Claxton, Gary, Matthew Rae, Anthony Damico, Gregory Young, Daniel McDermott, and Heidi Whitmore. 2019. "2019 Employer Health Benefits Survey." Kaiser Family Foundation, Washington, Dc.

Devenir. 2019. "2018 Year-End HSA Market Statistics and Trends." Devenir Research.

Fronstin, Paul. 2017. "Trends in Health Savings Account Balances, Contributions, Distributions, and Investments, 2011â2016: Statistics from the EBRI HSA Database." Employee Benefits Research Institute 434, Washington, DC.

Fronstin, Paul. 2018. "Trends in Health Savings Account Balances, Contributions, Distributions, and Investments, 2011â2017: Statistics from the EBRI HSA Database." Employee Benefits Research Institute 463, Washington, DC.

Fronstin, Paul. 2019. "Enrollment in HSA-Eligible Health Plans: Slow and Steady Growth Continued into 2018." Employee Benefits Research Institute 478, Washington, DC.

Helmchen, Lorens, David Brown, Ithai Lurie, and Anthony Lo Sasso. 2015. "Health Savings Accounts: Growth Concentrated Among High-Income Households and Large Employers." *Health Affairs*, 34(9): 1594–1598.

Parente, Stephen, and Roger Feldman. 2008. "Do HSA Choices Interact with Retirement Savings Decisions?" In *Tax Policy and the Economy*. Vol. 22, , ed. James Poterba, 81–108.

Peter, Richard, Sebastian Soika, and Petra Steinorth. 2016. "Health Insurance, Health Savings Accounts, and Healthcare Utilization." *Health Economics*, 357–371.

Steinorth, Petra. 2011. "Impact of Health Savings Accounts on Precautionary Savings, Demand for Health Insurance, and Prevention Effort." *Journal of Health Economics*, 30(2): 458–465.

Appendix B: Life-Cycle Model of HSA Saving [For Online Publication]

This Appendix provides details of the life-cycle model described in Section I that incorporates HSA saving. The setup is first presented before discussing the assumptions in detail and how the model is solved. The two sources of uncertainty considered are longevity risk and health care expenditure risk. While other sources of uncertainty could be added, the model is intentionally parsimonious to sharpen focus on how the HSA's tax preferences influence saving and withdrawal decisions.

Model Setup

To model the impact of HSA availability in a life-cycle setting, assume an individual has constant relative risk aversion (CRRA) preferences over consumption, $u(c) = \frac{c^{1-\gamma}}{1-\gamma}$, where γ is her coefficient of relative risk aversion. While working, she earns labor income y, which is subject to the income tax rate τ^y and the payroll tax rate τ^p. Each period, she faces uncertain out-of-pocket expenses, $\tilde{x}$. She chooses HSA saving h, HSA withdrawals w, and other saving s to maximize expected discounted utility from consumption over an uncertain lifespan:

$$\max_{c_t} \sum_{t=0}^{T} \delta^t \left(\prod_{j=0}^{t} (1-\rho_j) \right) u(c_t) \tag{B 1}$$

$$c_t = (y_t - h_t)(1 - \tau_t^y - \tau_t^p) - \tilde{x}_t + w_t - s_t \tag{B 2}$$

subject to the constraints described below. Here, δ denotes her discount rate and ρ_j denotes the probability that an $(j-1)$-year-old will die before age j. She dies by time $T+1$ with probability 1. For simplicity of notation, s records the sum of all other forms of saving, including in tax-preferred accounts such as 401(k) and IRAs, as well as in taxable accounts. A dollar contributed in a 401(k) or traditional IRA would reduce that period's consumption by $1-\tau_t^y$ since contributions are deductible from income taxes but not payroll taxes. She can borrow against her future labor income, and loans are permitted from the 401(k) but not from the HSA. She is endowed with initial assets A_0 and faces the lifetime budget constraint:

$$A_0 + \sum_{t=0}^{T} \frac{s_t}{(1+r)^t} \geq 0 \tag{B 3}$$

HSA assets and other savings grow at the same rate r, which is assumed to be certain. The state variable H_t denotes available HSA funds at the beginning of period t and evolves according to:

$$H_t = \sum_{j=0}^{t-1} (h_j - w_j)(1+r)^{t-j} \tag{B 4}$$

HSA withdrawals can finance up to the sum of all current and previous out-of-pocket expenses (without inflation adjustments), provided there are sufficient HSA assets:

$$0 \le w_t \le \min\left\{ H_t + h_t \,, \sum_{j=0}^{t} \tilde{x}_j \right\} \tag{B 5}$$

Annual HSA contributions cannot exceed the statutory limit h^L. The individual's problem is to maximize (1) subject to the constraints defined in equations (3), (4), (5), and $h_t \le h^L,\ H_t \ge 0,\ c_t \ge 0$.

Parametrization of Uncertainty

Survival risk and health care expenditure risk are both treated as exogenous and independent risks. They each depend only on age and I assume that individuals possess beliefs about these risks that match the empirical distributions. First, the probability of surviving to the next year drawn from the period life tables calculated by the Center for Diseases Control and Prevention (CDC) as reported in Arias and Xu (2019). All individuals are assumed to die by age 105. Since the CDC survival probabilities stop at age 100, I use survival probabilities from the Social Security Administration for ages 101 to 105.

Second, total health expenditure (prior to insurance reimbursement) is parametrized by assuming it follows a lognormal distribution with a mean and variance specific to each age:

$$\ln(\tilde{m}_t) \sim N(\mu_t, \sigma_t^2)$$

Mean spending by age is estimated using a shape-preserving piecewise cubic interpolation between the midpoints of the 2010 age-group averages reported by the Center for Medicare and Medicaid Services Office of the Actuary from Lassman et al. (2014). The variance for each age is calculated using Medical Expenditure Panel Survey (MEPS) using surveys processed from the Integrated Public Use Microdata Series (Blewett et al. 2019). To increase sample size, I pool waves 2006 to 2017 of the MEPS and adjust spending to 2010 dollars using the medical care component of the CPI. Variances are calculated using the survey's person-level sample weights.

The individual is assumed to have HDHP coverage with an HSA while working, and to retire at age 65 and then receive Medicare coverage. To convert total health care spending $\tilde{m}$ to out-of-pocket expenses $\tilde{x}$, I assume the person has insurance with a deductible and out-of-pocket maximum of $3,000 while working (similar to the highest deductible for employee-only coverage in my empirical setting).

The model assumes people will not receive Medicaid coverage, either while working or in retirement. Many states treat HSA assets as "countable assets" and so a person's expectations about future Medicaid eligibility could conceivably influence their decisions about the amount and timing of HSA saving and withdrawals while working. Such incentives are similar to how means-tested programs can dampen saving incentives (Hubbard, Skinner, Zeldes 1995). A rigorous analysis of the links between Medicaid and HSA coverage is beyond the scope of the current paper. The model's predictions should instead be interpreted as relevant for people who have employer coverage while working and then receive Medicare coverage in retirement.

To construct out-of-pocket payments in Medicare that can be financed tax-free from the HSA, I start with the estimates from Cubanksi et al. (2019) that are derived from the

Medicare Current Beneficiary Survey (MCBS). Cubanksi et al. (2019) report the sum of out-of-pocket costs and premiums according to several characteristics, such as age, Medicaid status, etc. Information is available for each characteristic separately (rather than jointly), and so I make several adjustments to arrive at HSA-eligible costs corresponding to the population of interest. First, I construct estimates for mean costs per beneficiary by yearly ages using linear interpolation between the midpoints of the age-group averages in Cubanksi et al. (2019). These means include both Dual Eligibles and beneficiaries with only Medicare, so I use the relative costs per beneficiary and shares of the two groups to construct average costs per beneficiary by age for Medicare-only beneficiaries. The out-of-pocket cost estimates in Cubanksi et al. (2019) include those paying insurance premiums for supplemental coverage (either Medigap or employer retirement plans), which comprise 79% of Medicare-only beneficiaries. Yet these premiums cannot be financed tax-free from the HSA, so I subtract an average annual premium of $1,800 multiplied by this share of 79% to construct mean out-of-pocket costs by age for Medicare-only beneficiaries that can be financed from the HSA. Similar to case while working outlined above, out-of-pocket costs are assumed to follow a normal distribution with the age-specific mean just described and an age-specific standard deviation calculated among Medicare-only beneficiaries in the MEPS. Medicare beneficiaries incur the minimum of these costs or the base premium for Medicare Parts B and D, which can be financed from the HSA.

Discussion of Assumptions

ASSUMPTION 1. LIQUIDITY: *The individual can borrow against future labor income at the risk-free rate.*

This assumption is strong but useful as a benchmark. Liquidity allows the individual's problem to be simplified into solving for the profile of HSA saving and dissaving that minimizes the financing costs of health care expenses over the lifecycle. Since I do not observe liquidity constraints directly in the data, I do not attempt to model this constraint in the life-cycle model. Appendix E, however, provides suggestive evidence regarding liquidity constraints by examining saving patterns among employees with 401(k) loans, and by analyzing the sensitivity of monthly health spending to variation in the timing of employer contributions within the year.

People who can only borrow using credit cards or other high-interest debt are likely better off withdrawing HSA assets immediately to finance health expenses. As an example, suppose a person has $1 in their HSA and must finance $1 in out-of-pocket costs today and also $1 in out-of-pocket costs in t years. They can borrow at the rate r^b, which exceeds the risk-free rate, r. If the HSA dollar is withdrawn to finance out-of-pocket costs today, then year t's costs must be financed with after-tax dollars, equal to $\frac{1}{(1-\tau_t)(1+r)^t}$ in net present value, where τ_t is the marginal tax rate in year t. If they instead borrow to finance out-of-pocket costs today, they owe $\left(1+r^b\right)^t$ in year t while the HSA dollar has grown to $(1+r)^t$ and can be withdrawn in year t to finance out-of-pocket expenses from both periods. Any remaining out-of-pocket costs must be financed with after-tax dollars. The net present value of financing via borrowing is therefore equal to $\frac{\left(1+r^b\right)^t}{(1+r)^t} - 1 + max\left\{0, \frac{2-(1+r)^t}{(1-\tau_t)(1+r)^t}\right\}$. In this simplified example, it would be optimal to withdraw immediately rather than allowing the HSA to grow if

$$\frac{1}{(1-\tau_t)(1+r)^t} < \frac{\left(1+r^b\right)^t}{(1+r)^t} - 1 + max\left\{0, \frac{2-(1+r)^t}{(1-\tau_t)(1+r)^t}\right\} \quad \text{(B 6)}$$

For those who only have access to borrowing via credit cards, r^b may be 0.18 or greater, which makes this inequality hold under any plausible assumption about the other parameters.

It is worth noting that the HSA may provide a source of liquidity for those who are not currently constrained but face a chance of becoming liquidity constrained in the future. The ability to use the HSA to later reimburse oneself for past qualified health care expenses enables flexibility to use the account both as a retirement savings vehicle and as a way to finance unexpected expenses unrelated to health care while working. This strategy allows for tax-advantaged contributions, growth, and withdrawals, while still allowing consumers access to these funds without incurring a penalty for early withdrawals. Financing unexpected expenses unrelated to health care from taxable liquid accounts may be costly due to the required taxes. How a person who fears being liquidity constrained in the future should optimally allocate saving between an HSA and a taxable liquid account depends on several factors, including the size of the expense, its probability and timing, and the cumulative sum of qualified health care expenses that can be withdrawn tax-free from the HSA.

Assumption 2. Return on saving:*Investment opportunities are the same across HSA, 401(k), and other accounts.*

Many employers allow HSA assets to be invested once balances reach a minimum threshold, and offer a menu of mutual funds or index funds to choose between. In my setting, the minimum was $2,000 to begin investing. Not all employers offer a range of investment vehicles and expenses and fees can sometimes be high relative to 401(k) options. Employees, however, can move their HSA assets to a different administrator than the one used by their employer. Individuals are allowed one transfer per year. The original HSA administrator provides the individual with a Form 1099-SA showing the distribution, and the funds must be deposited with the new HSA administrator within 60 days. Individuals report the transfer on IRS Form 8889. There are many HSA administrators offering low-cost index funds and no setup or maintenance fees. It is thus reasonable to assume that investment opportunities are similar, although some employees may need to make annual transfers between two different HSA accounts.

Assumption 3. Future tax policy: *The individual believes that IRS rules on the HSA's tax preferences will not change in the future.*

It is reasonable to take current policy as fixed when modeling choices about saving. Yet if a person believed that IRS rules might change in the future, there are still reasons why not withdrawing HSA funds while working may be optimal. Since a person can withdraw HSA assets to reimburse themselves for past qualified expenses they have incurred, they could do so immediately if the IRS announced the change was scheduled to occur. This feature of the HSA limits concern about how the potential for future policy changes would affect current HSA saving decisions.

Assumption 4. Hassle costs: *The hassle costs of filing paperwork related to HSA reimbursements are minimal.*

Unless people use their HSA debit card to pay for services, there is some hassle cost involved in keeping track of receipts paid with a credit card or check. Maintaining complete records is particularly important if HSA funds are withdrawn to reimburse yourself for expenses incurred years or decades earlier. The IRS requires that the expenses were not previously reimbursed from another source and had not been taken as an itemized deduction. Scanning receipts and maintaining electronic and physical copies likely involves similar costs to other budgeting and record-keeping.

Assumption 5. Lifetime out-of-pocket costs: *The amount of lifetime out-of-pocket expenses eligible for HSA reimbursement exceeds the maximum that can ever be accumulated in the HSA.*

This assumption is supported by estimates of lifetime health care spending compared to annual HSA contribution limits. The net present value of out-of-pocket expenses not covered by Medicare at age 65 has been estimated around \$200,000-\$300,000 including long-term care, on average (Webb and Zhivan 2010; Fidelity 2014; Bailey Jones et al. 2018). Expenses twice the mean are estimated to occur with between 1 and 5 percent probability. Given the expenses incurred prior to 65, fully funding an HSA each year for 40 years and assuming a rate of return of 3 percent would not be sufficient to finance lifetime health care expense using the HSA alone. This observation implies that 401(k) saving or other accounts must be used to finance some portion of lifetime out-of-pocket expenses.

Issues related to household formation or intra-household bargaining should not by themselves affect the key result that the MPC from the HSA should be zero, at least in my empirical setting. Consider divorce, which may engender a demand for liquidity. A rational saver should first reduce their 401(k) before withdrawing from their HSA. Yet in my setting, 401(k) contributions are rarely zero and so HSA withdrawals should rarely be positive. Regarding the threat of divorce, HSAs are handled the same way as other retirement accounts in divorce. One might also question whether a non-zero MPC could result from intra-household bargaining in which members have different discount factors. A non-zero MPC from HSA is inconsistent with exponential discounting as long as 401(k) saving is positive. So the MPC from the HSA should still be zero if they jointly decide to make any retirement saving.

Solution Method and Value Function

The solution to the life-cycle savings problem specifies the decision rules of saving and withdrawals each period. The policy function can then be used to simulate the profile of consumption, HSA assets, and other savings over the life-cycle, given the consumer's preferences. Only the profile of HSA assets over the life-cycle is of direct interest for this paper, however. For this reason, I make use of the assumptions listed above and the similarities between the HSA and 401(k) to simplify the problem and solve for the optimal path of HSA assets.

Specifically, the optimal solution will necessarily minimize the lifetime costs of financing health care expenses because the individual is not liquidity constrained. Other non-HSA assets can adjust to reach the desired consumption profile based on the person's risk aversion, time preferences, and beliefs about the income process. This is an important insight since it allows the optimal solution for HSA saving to be characterized without requiring consumer preferences or beliefs to be calibrated. It also limits the number of assumptions on other inputs to the life-cycle model, although assumptions about tax rates and interest rates are still necessary. The disadvantage of this approach is that the full path of consumption cannot be recovered, but that is not an object of interest because my data only includes information from payroll records on HSA and 401(k) saving. Other assets and the income of other family members are not observed.

Since HSA assets alone will not be enough to finance all of lifetime expenses (by assumption B5), the individual's problem is how to minimize the costs of financing via the 401(k). The individual's choice is how much money to withdraw from the HSA to finance out-of-pocket expenses while working versus instead financing these expenses by reducing 401(k) contributions, and allowing HSA assets to grow. I now describe the financing costs while working and in retirement from these different choices.

First, consider a person facing $\tilde{x}$ in out-of-pocket expenses while working. They can withdraw $\tilde{x}$ from the HSA, which reduces future HSA balances. They could also finance the expense by reducing their chosen amount of 401(k) saving that year by $\frac{\tilde{x}}{1-\tau^y_{work}}$, denoting τ^y_{work} as the income tax rate when working. Doing so would result in $\frac{\tilde{x}\left(1-\tau^y_{retire}\right)}{\left(1-\tau^y_{work}\right)}$ less (in present value) in retirement, with τ^y_{retire} denoting the tax rate in retirement. Recall that payroll taxes are still paid on 401(k) contributions. Some portion of HSA assets could also be withdrawn to finance a fraction of $\tilde{x}$, leaving the remainder to be financed via reduced 401(k) saving.

Now consider financing $\tilde{x}$ in out-of-pocket expenses during retirement. If this amount will be financed from the 401(k), then the person must contribute an additional $\frac{\tilde{x}}{(1-\tau^p)\left(1-\tau^y_{retire}\right)}$ while working to their 401(k). This reflects that fact that payroll taxes are paid on 401(k) contributions and that income taxes are paid upon withdrawal.

Collecting these possible cases, the costs (as measured in the reduction of 401(k) assets) to finance $\tilde{x}$ in out-of-pocket expenses in period t by making an HSA withdrawal of size w is

$$f(w_t|\tilde{x}_t, \tau^p, \tau^y_{work}, \tau^y_{retire}) = \begin{cases} \frac{(\tilde{x}_t - w_t)\left(1-\tau^y_{retire}\right)}{\left(1-\tau^y_{work}\right)} & \text{if working} \\ \frac{(\tilde{x}_t - w_t)}{(1-\tau^p)\left(1-\tau^y_{retire}\right)} & \text{if retired} \end{cases} \tag{B 7}$$

The control variable HSA withdrawals w determines next period's state variable H from the law of motion (equation B4) and the constraint that withdrawals cannot exceed cumulative out-of-pocket expenses or HSA balances (equation B5). The cost minimization problem can then be represented recursively in terms of the value function using the Bellman equation:

$$V_t(H_t) = \min_{w_t} f(w_t) + \delta V_{t+1}(H_{t+1}) \tag{B 8}$$

This dynamic programming problem is solved via backward induction for 20,000 simulations, with realizations for longevity and health expenditure drawn independently from the distributions described above. For each simulation, I discretize the state space using a grid of \$50 increments of HSA assets from \$0 to \$100,000 and \$250 increments from \$100,000 to \$200,000. I linearly interpolate between grid points in computing the value function. After recovering the policy function for HSA withdrawals, I calculate the optimal path of HSA assets over time. These profiles are then averaged across simulations to construct the solution to the individual's life-cycle problem.

Finally, the MPC from the HSA is calculated as the change in withdrawals for a small change in the state variable, HSA assets. The MPC can be calculated at different phases of the life-cycle, and provides a single parameter to describe optimal behavior according to a neoclassical benchmark.

It is worth noting that the model above does not incorporate matching or unconditional contributions by the employer to the HSA or 401(k) into equations B1 - B5. Doing so keeps the setup general and these inputs do not impact the key finding that the MPC from the HSA equals zero while working. In terms of employer contributions to the HSA, a fully funded HSA by the employer is the most extreme case in favor of withdrawing HSA assets prior to age 65. This would increase the optimal MPC prior to retirement compared to no contribution from the employer. Figure 1 in the text shows that even with a \$3,000 employer contribution, the optimal MPC is zero while working. Regarding 401(k) matching, employees facing a 50 percent match rate, as in my empirical setting, will find it optimal to obtain the full match. To see why, consider a person who is below the 401(k) match deciding to contribute \$100 to the 401(k) or not. If they do not contribute, this \$100 will translate to $\$100(1-\tau_t^y-\tau_t^p)$ of consumption after taxes. If they do contribute, they will have \$150 in their 401(k) after the employer's matched contribution. Withdrawing early from the 401(k) without an exemption incurs a 10 percent penalty. So it would be optimal to contribute so long as they can immediately withdraw $\$z(1-\tau_t^y-\tau_t^p-0.1)=\$100(1-\tau_t^y-\tau_t^p)$ and still have at least some of the \$150 remaining in the 401(k). For any plausible set of marginal tax rates, it is possible to satisfy $\$z(1-\tau_t^y-\tau_t^p-0.1)=\$150(1-\tau_t^y-\tau_t^p)$ with $z<\$150$, which implies that obtaining the full employer match is part of the optimal solution. For example, suppose $\tau_t^y+\tau_t^p=0.5$. A person could contribute \$100 to the 401(k) and receive \$50 from employer matching funds for a total of \$150. They could then withdraw \$125, which would yield \$50 after taxes and penalties—equal to the original \$100 after taxes—and still have \$25 leftover in "free" 401(k) dollars from the employer match. This observation allows equation B7 to omit matching in calculating the financing costs. Since the objective of the model is to produce a benchmark value of the MPC from the HSA over the life-cycle, these simplifications still enable the model to deliver the key result without introducing unnecessary complexity.

References

Arias, Elizabeth, and Jiaquan Xu. 2019. "United States Life Tables, 2017." National Center for Health Statistics 68(7), Hyattsville, MD.

Bailey Jones, John, Mariacristina DeNardi, Eric French, Rory McGee, and Justin Kirschner. 2018. "The Lifetime Medical Spending of Retirees." *NBER Working Paper 24599.*

Blewett, Lynn, Julia Rivera Drew, Risa Griffin, and Kari Williams. 2019. "IPUMS Health Surveys: Medical Expenditure Panel Survey, Version 1.1 [dataset]." IPUMS, Minneapolis, MN.

Cubanksi, Juliette, Wyatt Koma, Anthony Damico, and Tricia Neuman. 2019. "How Much do Medicare Beneficiaries Spend Out of Pocket on Health Care?" Kaiser Family Foundation.

Fidelity. 2014. "Retiree Health Costs Hold Steady."

Lassman, David, Micah Hartman, Benjamin Washington, Kimberly Andrews, and Aaron Catlin. 2014. "Health Spending Trends by Age and Gender: Selected Years 2002-2010." *Health Affairs*, 33(5): 815–822.

Webb, Anthony, and Natalia Zhivan. 2010. "What is the Distribution of Lifetime Health Care Costs from Age 65?" Boston College Center for Retirement Research 10-4, Chestnut Hill, MA.

Appendix C: Construction of Health Expenditure Distributions [For Online Publication]

This Appendix describes in detail the procedure for constructing distributions of health expenditures for each insured family (employee only or the employee and dependents), which is used in testing for balance in the RD. It follows similar methods as Handel (2013) and Handel and Kolstad (2015). This cost model assumes that there is no moral hazard and that each person in the same risk group holds the same beliefs about his or her ex ante health expenditure risk. There are three steps to construct the distributions from the inputs of expenditure claims and the employer's severity score:

1. Group each insured individual i into risk group z based on age, sex, and quintile of severity score
2. For each risk group, construct a Weibull distribution, G_z, that is modified to allow for the possibility of zero expenditure using observed total health expenditure m from the following year
3. For each person in risk group z, simulate expenditure draws from G_z and add up the draws within each family k to create an ex ante distribution of total health expenditure risk G_k for family k

Risk groups: Each individual i is first categorized into risk group z based on their age, sex, and quintile of the severity score. The age bins used are 0-14, 15-24, 25-34, 45-64, 65 and older. The severity score, which is recorded on each insurance claim, is a risk score measure based on a proprietary formula constructed by the company. The score is not used for payment purposes, but rather represents the employer's actuarial forecast about that person's expenditure risk. I use the severity score captured on the last claim before the start of the plan year as a measure of health status during the open enrollment period. For each age bin and each sex, I classify individuals into quintiles of the severity score within that age-sex cell. I pool years 2007 through 2010 together to ensure adequate sample sizes.

Expenditure distributions by risk group: After the risk groups are defined, the observed expenditures for each person in the group the following year are used to estimate an ex ante expenditure distribution for that group. Denote the empirical distribution of claims the following year by $\widehat{G}_{I_z}$. In constructing this distribution, expenditures on preventive care are excluded since such services are covered free of charge by all plans. Only claims from in-network providers are considered, which comprise over 95 percent of all spending. I continuously fit this empirical distribution using a Weibull distribution with a mass of claims at zero to generate an ex ante distribution of expenditure risk.

The creation of this ex ante distribution of expenditure by risk group involves two steps to deal with the mass of expenditure at zero. First, for each risk group k, the empirical probability of zero expenditure is used to construct the mass of expenditure realizations at zero, denoted $\widehat{G}_{I_z}(0)$. Second, a Weibull distribution is fit to the observed expenditures that are positive in that risk group by maximizing the following likelihood with respect to the scale parameter α and shape parameter β:

$$\prod_{i \in I_z} \frac{\beta_z}{\alpha_z} \left(\frac{m_i}{\alpha_z} \right)^{\beta_z - 1} e^{-\left(\frac{m_i}{\alpha_z}\right)^{\beta_z}}$$

Denote $\widehat{\alpha_z}$ and $\widehat{\beta_z}$ as the estimated parameters and $W\left(\widehat{\alpha_z}, \widehat{\beta_z}\right)$ as the distribution of positive expenditure in risk group z. The (ex ante) distribution for expenditure in risk group z is then:

$$G_z = \begin{cases} \widehat{G}_{I_z}(0) & \text{if } m = 0 \\ \widehat{G}_{I_z}(0) + \frac{W\left(\widehat{\alpha_z}, \widehat{\beta_z}\right)}{1 - \widehat{G}_{I_z}(0)} & \text{if } m > 0 \end{cases}$$

Simulated expenditures: For each insured individual within each risk group, 100 draws are simulated from the corresponding expenditure distribution G_z. Then within each family k, the expenditures for each draw from each member are summed, so that each family has 100 draws corresponding to the family's total expenditure. This statistical object, denoted G_k, represents the beliefs of family k about its total health expenditure risk. Since families differ in their compositions by age, sex, severity score, and size, this classification by risk group results in over 2,500 different combinations of expected spending in the sample.

References

Handel, Ben, and Jonathan Kolstad. 2015. "Health Insurance for Humans: Information Frictions, Plan Choice, and Consumer Welfare." *American Economic Review*, 105(8): 2449–2500.

Handel, Benjamin. 2013. "Adverse Selection and Inertia in Health Insurance Markets: When Nudging Hurts." *American Economic Review*, 103(7): 2643–82.

Appendix D: Additional analyses [For Online Publication]

Table D.1: Sample Means of Other Variables and Outcomes

	All employees	Employee-only coverage	Family coverage
Deductible ($)	3,324	2,123	4,151
Married (share)	0.559	0.288	0.745
White (share)	0.717	0.704	0.726
Number of dependents	1.322	-	2.233
Job: Finance or Actuary (share)	0.043	0.043	0.043
Years with HSA	2.913	2.770	3.011
Zero HSA contribution (share)	0.010	0.014	0.007
Obtain full employer HSA match (share)	0.973	0.969	0.976
Contribute HSA maximum (share)	0.056	0.060	0.053
Zero 401(k) contribution (share)	0.057	0.054	0.058
Obtain full employer 401(k) match (share)	0.490	0.494	0.488
Contribute 401(k) maximum (share)	0.031	0.020	0.039

Note: This table presents means and standard deviations of additional variables for the analysis sample between 2008 and 2010 by type of coverage. Ninety-seven percent of employees receive the full employer HSA match, while 5.6 percent contribute the maximum to their HSA. Fewer than 6 percent do not contribute to the 401(k). Slightly less than half receive the full employer match for the 401(k).

Table D.2: Characteristics of Early and Late HSA Adopters

	Early adopters	Late adopters
HSA employee contribution ($)	1,715	1,284
HSA employer contribution ($)	639	659
HSA balance ($)	1,357	541
HSA withdrawal ($)	2,105	1,660
401(k) employee contribution ($)	4,531	3,354
401(k) employer contribution ($)	2,030	1,595
401(k) balance ($)	51,703	35,188
Total health spending ($)	9,553	7,823
Out-of-pocket health spending ($)	2,240	2,086
Deductible ($)	3,375	3,235
Salary ($)	65,214	56,181
Tenure with employer (years)	7.29	7.35
Age (years)	40.03	39.98
Female (share)	0.65	0.71
Married (share)	0.58	0.52
White (share)	0.74	0.68
Number of dependents	1.41	1.17
Job: Finance or Actuary (share)	0.05	0.04
Years with HSA	3.43	2.01
Zero HSA contribution (share)	0.010	0.010
Obtain full employer HSA match (share)	0.977	0.966
Contribute HSA maximum (share)	0.068	0.034
Zero 401(k) contribution (share)	0.050	0.068
Obtain full employer 401(k) match (share)	0.529	0.423
Contribute 401(k) maximum (share)	0.039	0.018

Note: This table presents means between 2008-2010 for employees who adopted the HSA prior to 2008 ("early adopters") and employees who adopted the HSA in 2008 or later after the full replacement of traditional plans ("late adopters"). On average, early adopters earn higher salaries, contribute and withdraw more from their HSA, have higher expected health spending, and have higher 401(k) saving. The two groups are very similar in terms of age and tenure with the employer. Part of the higher spending among employees who switched early is explained by higher incomes and other demographics, but a statistically significant difference in spending remains conditional on observables. Early switchers have significantly higher spending for all major categories except inpatient care.

Table D.3: Estimates from Reduced Form and First Stage Regressions of the MPC

	\$30,000 bandwidth (corresponds to Fig. 2)		MSE-optimal bandwidth (corresponds to Fig. 3)	
	HSA contributions	HSA withdrawals	HSA contributions	HSA withdrawals
1(Salary over \$50,000)	-162.214	-148.788	-259.768	-222.090
	(40.136)	(41.995)	(54.955)	(59.316)
N	26281	26281	9643	9643
R-squared	0.066	0.030	0.010	0.004

Note: This table presents regression results of the first stage (HSA contributions) and reduced form (HSA withdrawals) corresponding to Figures 2 and 3 in the text. The MPC is the ratio of coefficients from the reduced form to the first stage. Standard errors clustered by employee are shown in parentheses.

Table D.4: Robustness to Regression Specification: RD Estimates of MPC

Polynomial	Kernel	Controls	MPC	S.E.
Linear	Uniform	No	0.855	(0.130)
Linear	Triangular	No	0.843	(0.127)
Linear	Uniform	Yes	0.840	(0.121)
Linear	Triangular	Yes	0.820	(0.120)
Quadratic	Uniform	No	0.824	(0.153)
Quadratic	Triangular	No	0.831	(0.147)
Quadratic	Uniform	Yes	0.810	(0.150)
Quadratic	Triangular	Yes	0.776	(0.151)

Note: This table presents results of alternative RD models for the matching discontinuity at $50,000. Standard errors clustered by employee are shown in parentheses. The top row presents the preferred specification (linear polynomial, uniform kernel, and no controls) for comparison that is presented in Figure 3. All regressions use the same bandwidth. The other specifications yield estimated MPCs that are close in magnitude. The confidence interval for each estimate includes 1. The lower bounds of the confidence intervals all exceed 0.45.

Table D.5: RD Estimates of MPC for Subsamples

Subsample	MPC	S.E.	N
Ages < 40	0.968	(0.168)	6016
Ages 40-59	0.776	(0.194)	5222
Auto-enrolled in 401(k)	1.047	(0.329)	1595
Employee-only coverage	0.693	(0.245)	4292
Family coverage	0.908	(0.181)	5351
Early HSA adopter	0.859	(0.152)	5951
Late HSA adopter	0.831	(0.253)	3692
Below 401(k) match	0.847	(0.125)	7198
Above 401(k) match	0.823	(0.478)	2445
Tenure < 5 years	0.935	(0.182)	4074
Tenure ≥ 5 years	0.821	(0.172)	5569
Years with HSA ≥ 3	0.795	(0.146)	6960
Years with HSA < 3	1.055	(0.243)	4278
HSA balances under $1,000 (beginning of year)	0.966	(0.092)	8517
HSA balances over $1,000 (beginning of year)	0.478	(0.643)	2721

Note: This table presents results of RD models using local linear regression for the matching discontinuity at $50,000 corresponding to different subsamples displayed in rows. The first column reports the estimated MPC and the second column reports the standard error (clustered by employee). The third column displays the number of observations within the MSE-optimal bandwidth. In the majority of cases, the estimated MPC is over 0.8. One exception is for employees with HSA balances over $1,000 at the beginning of the year, though this is partly mechanical as beginning-year balances are the result of past saving decisions. The estimated MPC exceeds 1 for those who are auto-enrolled into the 401(k) as well as those with less than 3 years of experience with the HSA.

Table D.6: Probability that Total Health Spending Exceeds Different Dollar Thresholds

Dependent variable	Estimate	S.E.	Control Mean
$\mathbf{1}(\text{Spending} \geq 500)$	-0.014	(0.018)	0.848
$\mathbf{1}(\text{Spending} \geq 1000)$	0.004	(0.020)	0.729
$\mathbf{1}(\text{Spending} \geq 2000)$	0.002	(0.020)	0.583
$\mathbf{1}(\text{Spending} \geq 4000)$	-0.005	(0.022)	0.419
$\mathbf{1}(\text{Spending} \geq 8000)$	-0.014	(0.020)	0.278
$\mathbf{1}(\text{Spending} \geq 12000)$	-0.033	(0.019)	0.225
$\mathbf{1}(\text{Spending} \geq 16000)$	-0.031	(0.016)	0.157
$\mathbf{1}(\text{Spending} \geq 20000)$	-0.026	(0.014)	0.112
$\mathbf{1}(\text{Spending} \geq 40000)$	-0.007	(0.008)	0.042
$\mathbf{1}(\text{Spending} \geq 60000)$	0.003	(0.006)	0.016

Note: This table presents results corresponding to whether total health spending exceeds dollar thresholds from $500 to $60,000. The first column reports the estimated jump in the outcome at the cutoff and the second column reports the standard error (clustered by employee). The negative sign indicates a reduction in spending for employees without the more generous HSA match. The control mean can be interpreted as the share of employees with spending above that dollar amount.

Table D.7: RD Results: Spending by Category and Service Type, without Controls

	Estimate	S.E.
Panel A. Total spending		
Total spending	-3006.3	(986.2)
Total spending, 95% winsorized	-1285.2	(458.3)
△ Total spending / △ HSA	10.35	(3.71)
△ Total spending, 95% winsorized / △ HSA	4.89	(1.74)
Panel B. Spending by category		
Primary Care	-68.0	(44.8)
Specialty Care	-462.3	(165.5)
Other Outpatient	-751.1	(330.7)
Inpatient	-1341.1	(677.0)
Prescription drugs	-5.3	(231.8)
Emergency Room	-52.8	(83.9)
Other	-51.0	(33.9)
Panel C. Spending by service type		
Radiology	-198.0	(128.4)
Mental health	-47.5	(52.5)
Behavioral health	-16.2	(48.8)
Preventive care	8.3	(28.4)

Note: Note: This table presents results of RD models using local linear regression with a uniform kernel for the matching discontinuity at $50,000 corresponding to different categories or services of health care. The first column reports the estimated jump in the outcome at the cutoff and the second column reports the standard error (clustered by employee). Panel A reports total spending. For winsorized spending, spending has been top-coded at the 95th percentile to reduce the influence of outliers. Panel B reports spending by broad service category, which are mutually exclusive. Office visits are recorded under the outpatient category in the medical claims. Panel C reports results for select service types, which are recorded as a separate category on the claims.

Table D.8: RD Results: Quantities of Services Consumed, without Controls

	Estimate	S.E.	Control mean
Panel A. Visits, Tests, and Prescriptions			
PCP visits, all	-0.398	(0.406)	6.720
PCP visits, non-preventive care	-0.517	(0.346)	5.346
PCP visits, preventive care	0.172	(0.191)	3.392
Mammograms	-0.106	(0.040)	0.412
Specialist visits	-1.712	(0.660)	9.310
Mental health visit	-0.769	(0.472)	3.879
Behavioral health visits	-0.292	(0.228)	1.274
ER visits	-0.014	(0.023)	0.276
CT scans	-0.072	(0.053)	0.462
MRIs	-0.034	(0.039)	0.290
Prescription fills	-2.795	(1.877)	27.318
Panel B. Low-value care			
Head imaging for uncomplicated headache	-0.183	(0.112)	0.637
Back imaging for non-specific low back pain	-0.576	(0.283)	1.488
Antibiotics for acute respiratory infection	0.028	(0.029)	0.239
Concurrent Rx for opioids and benzodiazepines	-0.038	(0.014)	0.077
Long-term use of opioids, non-cancer patients	-0.061	(0.023)	0.247
Standardized index of low-value care	-0.046	(0.018)	
Panel C. High-value care			
Preventive visits	0.172	(0.191)	3.392
Physical Therapy visits	-0.311	(0.244)	1.628
Diabetes drugs	-0.086	(0.214)	0.873
Antidepressants	-0.134	(0.272)	2.097
Hypertension drugs	-0.183	(0.213)	1.555
Lipid-lowering drugs	-0.238	(0.192)	1.224
Standardized index of high-value care	0.012	(0.019)	

This table presents results of RD models using local linear regression for the matching discontinuity at $50,000 corresponding to changes in the quantities of services consumed, excluding controls. The control mean is calculated as the predicted value of the dependent variable immediately to the left of the discontinuity. Classifications for low-value care and high-value care use procedure and diagnosis codes following the definitions from Schwartz et al. (2014) and the National Quality Forum (2019). The standardized indexes summarize the effects for high- and low-value care, accounting for covariance between the estimates, using the seemingly unrelated regression approaches from Kling, Liebman and Katz (2007); Clingsmith, Khwaja and Kremer (2009). The standardized indexes are interpreted in terms of standard deviations of health care consumption within each domain (high- or low-value care).

Table D.9: Difference-in-Differences Spending Regression

	Year 1 of HDHP		Years 1-2 of HDHP	
	(1)	(2)	(3)	(4)
Post x late HDHP adopter	0.061	0.035	0.058	0.047
	(0.048)	(0.046)	(0.044)	(0.042)
Controls	No	Yes	No	Yes
N	24876	24876	36464	36464
R-squared	0.002	0.181	0.002	0.181

This table presents difference-in-difference results that compare spending between late adopters of the HDHP/HSA to early adopters. Columns 1 and 2 present results from the first year after the switch, and columns 3 and 4 include the first two years. For annual spending y, the dependent variable is the inverse hyperbolic sine of spending, measured as $\ln(y + \sqrt{y^2 + 1})$. Controls include lagged diagnoses of chronic conditions, number of dependents, indicators for coverage type, state of residence, deciles in age, female, married, white, firm tenure, and plan year.

Table D.10: RD Crowd-Out Results: 401(k) saving

	Controls	Estimate	S.E.
Panel A. Crowd-out ratio: △ 401(k) / △ HSA			
Crowd-out ratio	No	-0.337	(0.458)
Crowd-out ratio	Yes	-0.305	(0.400)
Panel B. Levels of 401(k) and combined tax-preferred saving			
401(k) contributions (employer + employee)	No	95.861	(146.866)
401(k) contributions (employer + employee)	Yes	81.290	(141.333)
Net tax-preferred saving	No	44.507	(109.048)
Net tax-preferred saving	Yes	39.873	(144.931)

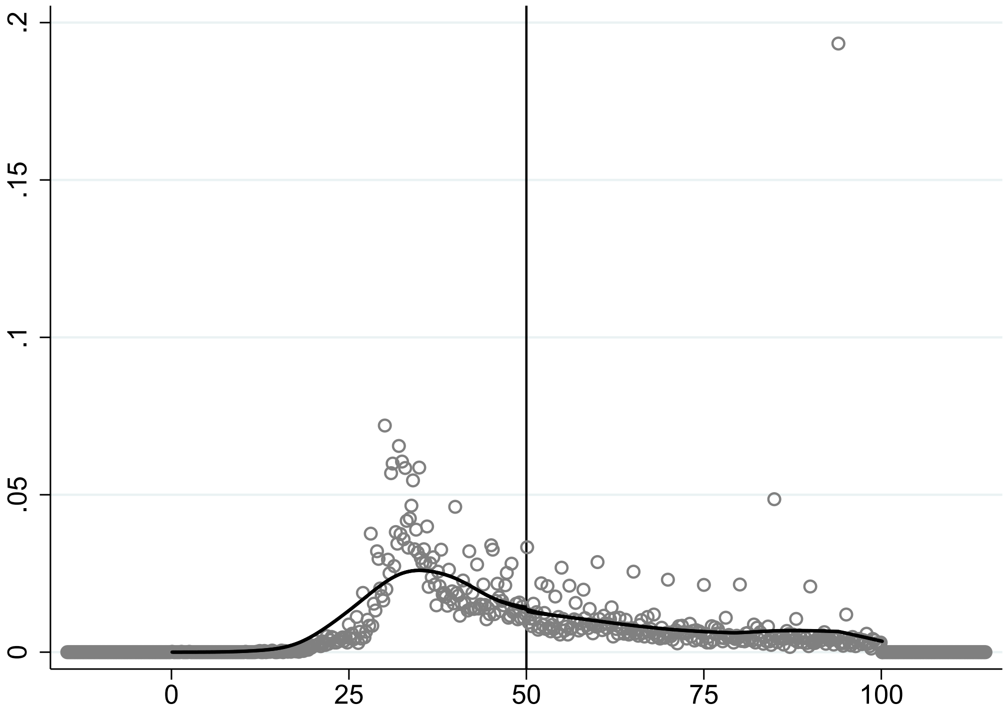
Note: Note: This table presents results of RD models using local linear regression for the matching discontinuity at $50,000 corresponding to changes in 401(k) saving. Panel A presents the results of estimating equations (1) and (2) via IV, using the match discontinuity to instrument for HSA contributions. 401(k) contributions include the sum of employer and employee contributions. In Panel B, net tax-preferred saving is defined as 401(k) contributions + total HSA contributions - HSA withdrawals. Controls include the number of dependents, indicators for coverage type, state of residence, deciles in age, female, married, white, firm tenure, and plan year.

Table D.11: Change in Total Health Spending vs. Change in Tenure-Based Retirement Account after 2 years

	Dep. Var: Monthly health spending (1)	(2)
Tenure-based retirement account employer contribution	0.044 (0.128)	-0.069 (0.138)
Month effects	Yes	Yes
Employee effects	Yes	Yes
Age cubic polynomial	No	Yes
Salary cubic polynomial	No	Yes
N	299714	299714
R-squared	0.130	0.130

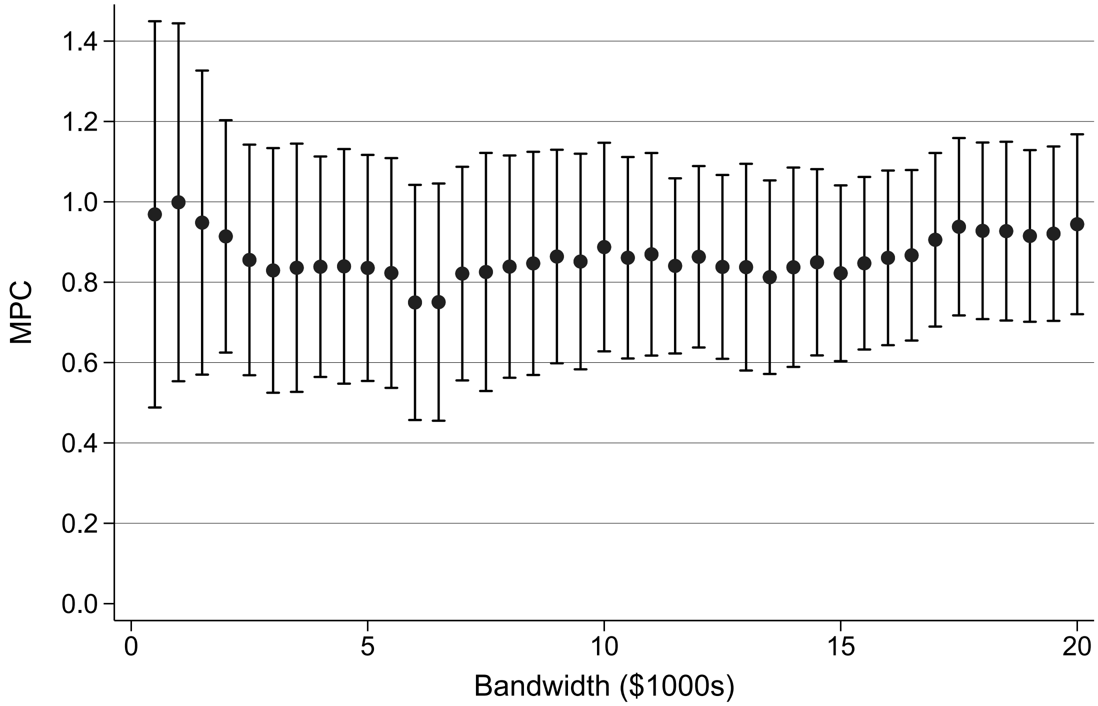
Note: This table presents OLS regression results of monthly health spending against the monthly amount of tenure-based retirement account, which is zero prior to two years of tenure and then equal to 4 percent of salary thereafter. The regression includes data from the first four years of employee tenure over the sample period. The coefficient estimate is near zero and not statistically significant, indicating no strong relationship between the tenure-based retirement account assets and total health spending.

Figure D.1: Manipulation Test



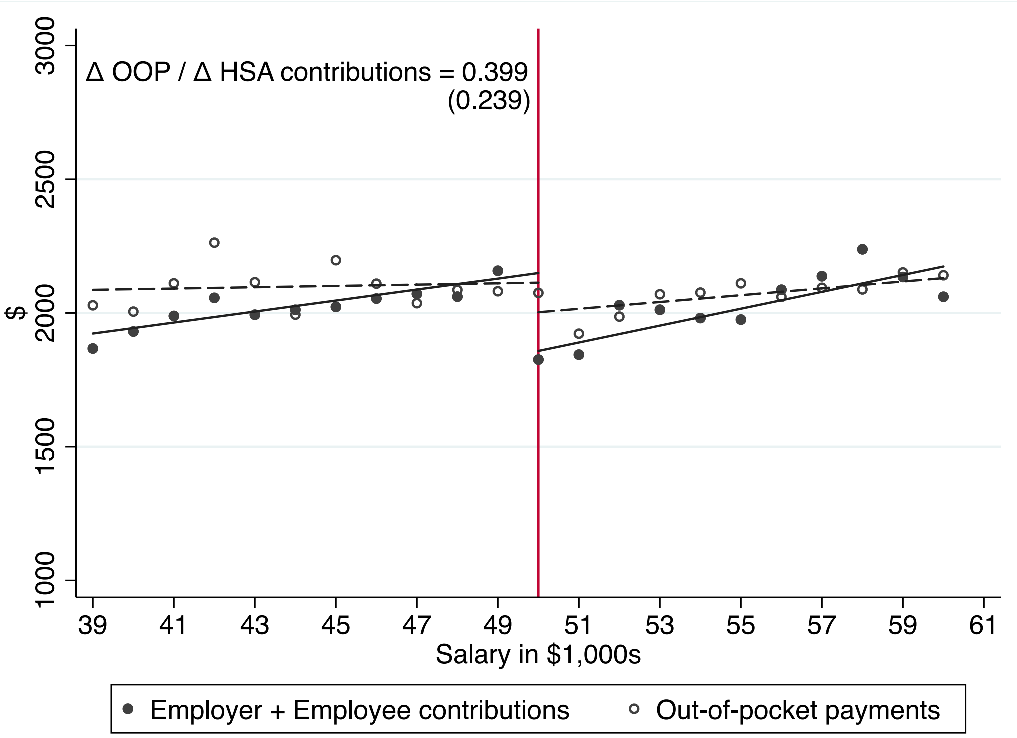
Note: This figure presents the McCrary (2008) test that the density of salary is smooth across the match discontinuity. The estimated log difference in the density's height at the discontinuity is 0.0007 with a standard error of 0.033. The test uses a bin size of $189.8 and a bandwidth of $14.5. There is no evidence of manipulation of the running variable on either side of the threshold, providing support to the validity of the RD design.

Figure D.2: Robustness to Bandwidth Choice



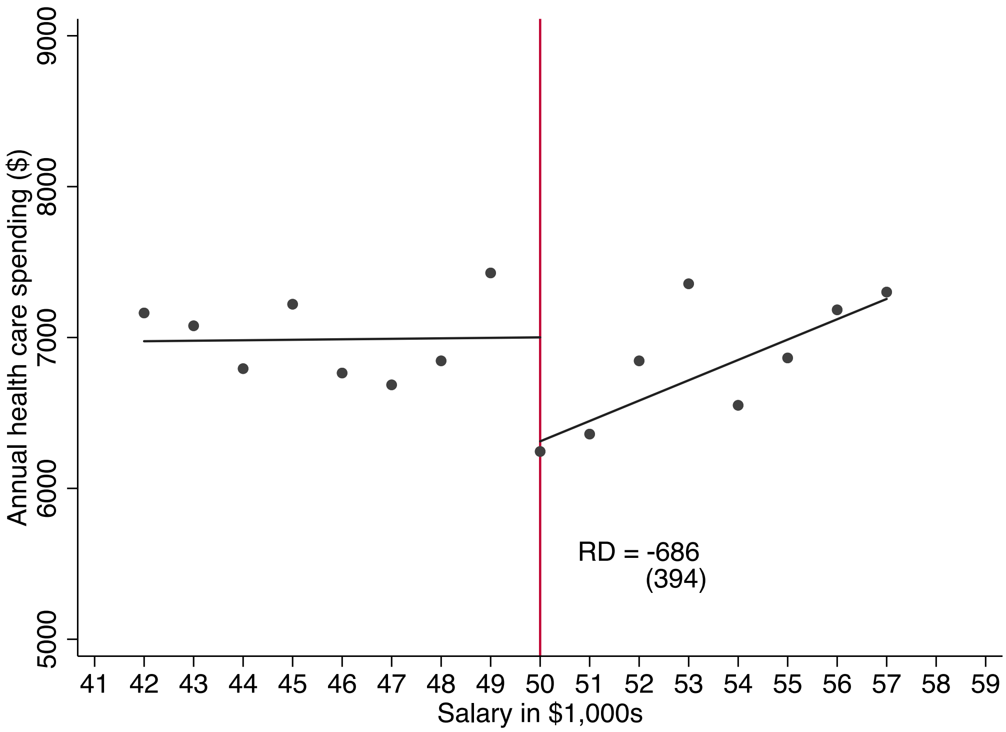
Note: This figure presents 95 percent confidence intervals for the MPC estimates under alternative bandwidths. Regressions follow the main specification in Figure 3 (local linear regression, no controls, and a uniform kernel). The point estimates for the MPCs are not sensitive to bandwidth choice, and the lower bounds of the 95 percent confidence interval are all greater than 0.4. The MSE-optimal bandwidth of $10,752 used in the main specification is in the middle of these estimates.

Figure D.3: RD Results for Out-of-Pocket Payments



Note: This figure graphically displays the RD results for estimating the change in out-of-pocket payments relative to the change in HSA contributions. The figure plots the means of out-of-pocket payments and HSA contributions within $1,000 salary bins, and fits separate linear regressions to the data below and above $50,000 match discontinuity within the MSE-optimal bandwidth. There is an estimated $108.1 jump in out-of-pocket payments at the discontinuity, and a $270.7 jump in HSA contributions. The estimated ratio of 0.39 shown on the graph is estimated via 2SLS as in the main analysis, with standard errors in parentheses clustered by employee.

Figure D.4: RD Estimate of Health Spending with Outlier Adjustment



Note: This figure presents the results of RD models (local linear regression) of total health spending, in which spending is winsorized by top-coding spending at the 95th percentile. There is an estimated $686 decrease in total health spending at the threshold, with a standard error (clustered by employee) of $394. Regressions include controls for number of dependents, indicators for coverage type, state of residence, deciles in age, female, married, white, and lagged diagnoses (from the previous year) of chronic conditions. Points plot the mean of spending within $1,000 salary bins within the MSE-optimal bandwidth after residualizing this set of controls.

References

Clingsmith, David, Asim Khwaja, and Michael Kremer. 2009. "Estimating the Impact of the Hajj: Religion and Tolerance in Islam's Global Gathering." *Quarterly Journal of Economics*, 124(3): 1133–1170.

Kling, Jeffrey, Jeffrey Liebman, and Lawrence Katz. 2007. "Experimental Analysis of Neighborhood Effects." *Econometrica*, 75(1): 83–119.

McCrary, Justin. 2008. "Manipulation of the running variable in the regression discontinuity design: A density test." *Journal of Econometrics*, 142(2): 698–714.

NQF. 2019. "Behavioral Health and Substance Use, Spring 2018 Cycle: CDP Report." National Quality Forum, Washington, DC.

Schwartz, Aaron, Bruce Landon, Adam Elshaug, Michael Chernew, and Michael McWilliams. 2014. "Measuring Low-Value Care in Medicare." *JAMA Internal Medicine*, 174: 1067–1074.

Appendix E: Other Potential Mechanisms [For Online Publication]

The MPC summarizes the potential effect of several economic fundamentals, including liquidity constraints, information frictions, present bias, and mental accounting. Mental accounting as a potential mechanism is discussed in Section V of the text. This Appendix examines the empirical support for other potential explanations, focusing on liquidity constraints, information frictions, and present bias. These results should be interpreted as suggestive evidence since they are not direct tests of each mechanism through surveys or experiments, which is beyond the scope of this paper.

Liquidity constraints

Since borrowing constraints are unobserved, I conduct two analyses to explore the role of liquidity in explaining the high MPC. First, I exploit the feature that employees receive all of the employer's contribution at the beginning of the year, rather than spread out evenly each month. This schedule of deposits enables me to test one version of liquidity constraints: If employees delay care due to the inability to finance it without the HSA, then one should expect health spending to jump in the month the employer deposits the funds. This prediction assumes that employees have insufficient HSA funds to cover out-of-pocket expenses without the employer's contribution, and that the employee treats a dollar contributed from the employer as equal to a dollar they contribute themselves. Before testing this in a regression framework, Figure E.1 below displays monthly averages of contributions and withdrawals (Panel A), and monthly HSA assets and total health spending (Panel B). Perhaps surprisingly, there is little sensitivity of health spending to the timing of employer contributions. The bulk of employer contributions are deposited in the first month because the employer matches the first \$100 or \$200 of employee contributions. Employee contributions are quite flat throughout the year because most employees do not adjust their monthly payroll deductions or make additional contributions. Withdrawals are also relatively flat by month, with slightly higher amounts in the initial months when most people are still below the deductible. Health spending rises at the end of year, particularly in the final month of the contract, but is flat for the first six months of the year. HSA assets decline slightly in the first half of the year before flattening out. The graphical evidence does not suggest that the timing of spending and HSA withdrawals is highly sensitive to the timing of the employer's HSA deposits.

I formally test this hypothesis by regressing monthly health spending against monthly HSA balances:

$$y_{imt} = \alpha + \theta H_{imt} + \kappa_m + \upsilon_t + \mu_i + X\delta + \epsilon_{imt}$$

where y_{imt} is family i's total health spending in month m of year t,and H_{imt} is HSA balances at the beginning of the month plus any contribuions. The regressions include year and month effects to compare the relationship between monthly spending and HSA balances over time across people. Employees join the firm throughout the year, and those who join the firm closer to the end of the year receive the contributions later. This variation in employee start dates enables any secular trends in spending throughout the year to be distinguished from the timing of the employer's HSA contributions. Regressions also include employee fixed effects to leverage variation within-employees over time. The control vector X includes cubics in both salary and age. The coefficient of interest is θ, which measures the change in monthly spending relative to monthly HSA assets. If $\theta = 0$, then there is no relationship between monthly balances and spending. A large and positive estimate on θ would signal that spending is highly sensitive to the timing of contributions within the year. The RD results used matching rate discontinuities to detect annual changes in spending. This analysis, by contrast, uses variation in the timing of the employer's contributions within the year to estimate whether monthly spending changes in response to monthly HSA assets.

Results are presented in Table E.1 below. Consistent with the graphical evidence in Figure E1, there is little relationship between spending and HSA balances at the monthly level. The estimated coefficients on balances are negative and are small in magnitude across specifications; the largest upper bound of any of the 95 percent confidence intervals is just 0.01.

As a second approach to examining liquidity constraints, I examine whether the MPC is different for employees with 401(k) loans. Lu and Mitchell (2010) argue that employees taking 401(k) loans are more likely to be liquidity constrained. Twenty-four percent of the sample takes a 401(k) loan in a given year, and one third ever takes a loan. If liquidity constraints drive the high MPC, one might expect a higher MPC among those with loans compared to those without loans. It is worth noting, however, that given the more generous tax preferences of the HSA, taking a loan from the 401(k) is preferred to withdrawing from the HSA. The MPC is estimated to be lower for employees with loans. The estimated MPCs are 0.710 among among employees taking a loan in that year and 0.785 among those ever taking a loan. Among employees not taking a loan, the estimated MPC is 0.903. While taking a 401(k) loan may also reflect financial sophistication, instead of simply liquidity constraints, the MPC is still well above zero for this group. Taken together, these two analyses do not offer evidence that liquidity constraints explain the high MPC.

Information Frictions

As shown in Figure E.1, there is no evidence that withdrawals spike at the end of the year, which would be consistent with believing the funds expired instead of rolling over. Employees also appear knowledgeable about the coverage provided by HDHPs. Preventive care is exempt from the deductible, and the results in Section IV show no decline in the number of preventive visits or total spending on preventive care across the match. In terms of heterogeneity by job types, one might believe that actuaries or employees who work in the finance department have more financial literacy than other employees, on average. Actuaries and those in finance have a slightly lower probability of making a dominated saving choice, but the difference is not statistically significant. These results provide indirect evidence against some particular types of information frictions, but I am unable to directly assess employee knowledge regarding different contract features as in Handel and Kolstad (2015).

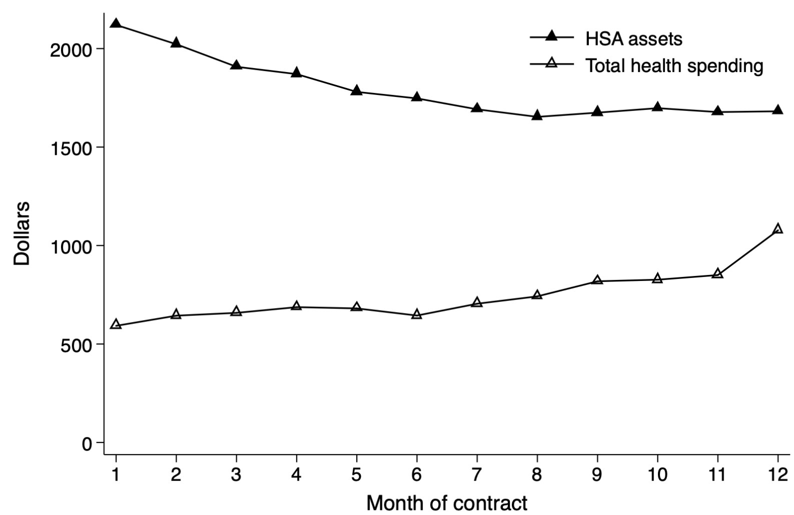
It is worth noting that the costs of acquiring and processing information on the distribution of lifetime health care expenditures is substantial. But this search cost would presumably also be undertaken when making other retirement saving decisions too and so is not specific to HSA saving.

Present Bias

If people have strong preferences for current consumption, they may choose to contribute

Figure E.1: Mean HSA Contributions and Withdrawals by Month of Contract

(a) HSA contributions and withdrawals



(b) HSA assets and health spending

Note: Panel (a) presents the mean of monthly contributions and withdrawals from the HSA by the month of the insurance contract, pooling four years together. Employer contributions are largest in the initial month since the employee's first contributions are matched. Employee contributions are relatively flat over the course of the year. Withdrawals are highest in the second to fourth months, when most employees remain below the deductible, but are relatively flat throughout the year and do not spike at the end of the year. Panel (b) presents the mean of monthly spending and HSA assets, measured at the beginning of the month prior to any contributions and withdrawals. Total health spending is flat through the first six months of the year, and then rises towards the end of the year, particularly in the final month of the contract. Beginning-month HSA assets decline for the first six months of the year and then are roughly flat through the year's end.

Table E.1: OLS Regressions of Monthly Health Spending

	Dep. Var: Monthly health spending			
	(1)	(2)	(3)	(4)
Monthly HSA balance	-0.042 (0.022)	-0.012 (0.011)		
Monthly employer HSA contribution			-0.155 (0.078)	-0.105 (0.048)
Employee effects	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes
Month effects	Yes	Yes	Yes	Yes
Sample	Within MSE-optimal bandwidth	All	Within MSE-optimal bandwidth	All
N	150463	560521	152126	567863
R-squared	0.112	0.111	0.111	0.110

Note: This table presents results of OLS regressions of monthly health spending between 2007 and 2010. Regressions also include a cubic polynomials in salary and in age. Standard errors are clustered at the employee level. The estimates on HSA balances (columns 1 and 2) and employer HSA contributions (columns 3 and 4) are generally small in magnitude and not statistically different from zero. These estimates do not provide strong evidence that monthly health spending is highly sensitive to beginning-month HSA assets or monthly employer contributions. Most employer contributions are deposited in the first two months of the contract year.

and withdraw HSA funds to finance current health care costs even though they recognize their future consumption demands in retirement. Models of present-biased preferences (Laibson 1997; O'Donoghue and Rabin 1999) help to explain the demand for commitment devices like 401(k)s for retirement saving (Laibson, Repetto and Tobacman 1998) and are one potential explanation for why households hold both high-interest credit card debt and retirement wealth (Angeletos et al. 2001; David Laibson, Andrea Repetto and Jeremy Tobacman 2003; Laibson et al. 2015). To assess the importance of present-bias, I calculate the short-term discount rate implied by an MPC of 0.85, and compare this rate to estimates from the literature. Consider the choice of using \$1 in HSA assets to finance \$1 in out-of-pocket costs today and \$1 next year. Any HSA assets not withdrawn today are used to finance next year's costs, which are discounted using the long-run, exponential discount rate δ and the short-term rate β. In this simplified example, the chosen MPC would equate the financing cost today to the financing cost next year:

$$1 - MPC = \beta\delta\left(1 - (1+r)(1 - MPC)\right)$$

With $MPC = 0.855$ and assuming $r = 0.03, \delta = 0.97$, the equation implies $\beta = 0.17$. This short-term discount rate is substantially below estimates of β from the literature using field data (Paserman 2008; Fang and Silverman 2009; Fang and Wang 2014; Laibson et al. 2015; Jones and Mahajan 2015), which generally range between 0.35 to 0.8. Present bias therefore seems unlikely to explain the high MPC from HSA assets.

References

Angeletos, George-Marios, David Laibson, Andrea Repetto, Jeremy Tobacman, and Stephen Weinberg. 2001. "The Hyperbolic Consumption Model: Calibration, Simulation, and Empirical Evaluation." *Journal of Economic Perspectives*, 15(3): 47–68.

Fang, Hanming, and Dan Silverman. 2009. "Time-Inconsistency and Welfare Program Participation: Evidence from the NLSY." *International Economic Review*, 50(4): 1043–1076.

Fang, Hanming, and Yang Wang. 2014. "Estimating Dynamic Discrete Choice Models with Hyperbolic Discounting, with an Application to Mammography Decisions." *International Economic Review.*

Handel, Ben, and Jonathan Kolstad. 2015. "Health Insurance for Humans: Information Frictions, Plan Choice, and Consumer Welfare." *American Economic Review*, 105(8): 2449–2500.

Jones, Damon, and Aprajit Mahajan. 2015. "Time Inconsistency and Saving: Experimental Evidence from Low-Income Tax Filers." *NBER Working Paper 21272.*

Laibson, David. 1997. "Golden Eggs and Hyperbolic Discounting." *Quarterly Journal of Economics*, 112(2): 443–478.

Laibson, David, Andrea Repetto, and Jeremy Tobacman. 1998. "Self-Control and Saving for Retirement." *Brookings Papers on Economic Activity*, 1: 91–196.

Laibson, David, Andrea Repetto, and Jeremy Tobacman. 2003. "A Debt Puzzle." In *Knowledge, Information, and Expectations in Modern Economics: In Honor of Edmund S. Phelps.* 228–266. Princeton University Press.

Laibson, David, Peter Maxted, Andrea Repetto, and Jeremy Tobacman. 2015. "Estimating Discount Functions with Consumption Choices over the Lifecycle."

Lu, Timothy, and Olivia Mitchell. 2010. "Borrowing from Yourself: The Determinants of 401(k) Loan Patterns."

O'Donoghue, Ted, and Matthew Rabin. 1999. "Doing It Now or Later." *American Economic Review*, 89(1): 103–124.

Paserman, M. Daniele. 2008. "Job Search and Hyperbolic Discounting: Structural Estimation and Policy Evaluation." *Economic Journal*, 118(531): 1418–1452.