Information Processing Frictions and Suboptimal Investment in 529 College Savings Plans

James J. Li, Olivia S. Mitchell, and Christina Zhu

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Abstract

We investigate how information processing frictions contribute to household suboptimal investment behavior. In the context of college 529 savings plans, we find that 60% of open accounts held in such plans are invested suboptimally due to high expenses and tax inefficiency. Our model of expected differences in account payoffs demonstrates that such investments yield an expected loss of 9% over the accounts' projected lifetimes. Using data on realized payoffs, we confirm that households earn less when holding suboptimal home-state plans. Consistent with information processing frictions contributing to inefficient investment, we show that the extent of investment in suboptimal home-state accounts decreases with household financial literacy and increases with plan document disclosure complexity. Overall, our results suggest that information processing frictions shape households' suboptimal investment in college savings plans and reduce their financial well-being.

Keywords: life cycle saving; household finance; 529 plans; information frictions; financial literacy
JEL Classifications: G11, G14, G23, G53

James J. Li
The Wharton School, University of Pennsylvania
jjli@wharton.upenn.edu

Olivia S. Mitchell
The Wharton School, University of Pennsylvania and NBER
mitchelo@wharton.upenn.edu

Christina Zhu
The Wharton School, University of Pennsylvania
chrzhu@wharton.upenn.edu

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I. Introduction

We study Americans' investment patterns in 529 college savings plans, which are state-sponsored accounts designed to encourage household savings for their beneficiaries' (often children's or grandchildren's) future education costs. As of December 2021, households across all 50 states and the District of Columbia held over $480 billion of assets in these accounts, up dramatically from $22 billion in June 2002. Despite this economically important choice for lifecycle financial planning, few studies have explored the factors influencing household 529 decisions.[1] We investigate the extent to which households prefer home-state investments despite receiving lower risk-adjusted returns. We then investigate the role of household information processing frictions in these suboptimal decisions.

The 529 college savings plan setting offers several advantages for our analysis. First, only households can open 529 accounts; our analysis thus focuses exclusively on household investment patterns, unconfounded by intermediation from institutional investors. Second, many states offer more than one plan, allowing us to exploit within-state differences in plan characteristics. Third, many states offer both direct-sold (i.e., bought directly from plan sponsors) and advisor-sold (i.e., bought only from financial advisors) plans, enabling us to examine alternative explanations based on information frictions and advice-seeking.

We define a *suboptimal home-state investment* as the opening of an in-state account when the household can earn a higher expected payoff by opening an out-of-state account. We model representative household 529 plan choices by computing expected payoffs across all plans available to the household. Our model incorporates all observable plan characteristics: variation in portfolio offerings, state tax deductions, state matching grants, residency restrictions, asset-based percentage fees, and dollar-based account maintenance fees. For each state, the plan with the highest expected terminal payoff is designated as the "optimal" plan for that representative household. Critically, households are not restricted to investing in plans in their own states of residence. As a result, the optimal plan for one household may be located in its home state, due to

[1] Existing studies largely examine how moral hazard between plan sponsors and household investors can lead to inefficient outcomes (e.g., Alexander and Luna 2005; Bullard 2006; Bogan 2014; Curtis 2020, Balthrop and Cici 2022).

a combination of low fees and tax savings. The optimal plan for a household in another state may be an out-of-state plan, due to high fees and lack of tax-savings for its home-state plan.

To implement our model, we obtain data on all 529 plan characteristics, assets under management, open accounts, and state-level data from 2010 to 2020 taken from plan disclosure documents, the College Savings Plan Network, Morningstar, the National Financial Capability Survey, the Census Bureau, and the National Bureau of Economic Research. Our sample consists of 803 plan-years comprising 117 unique plans across the 50 U.S. states and the District of Columbia. In the final year of our sample, 2020, households held 14.9 million open accounts with a total of $425.2 billion in assets.

We document several key results. First, we find that suboptimal home-state investment is very widespread. In 2020, $281.0 billion of assets and 8.9 million open accounts were held in suboptimal home-state accounts, representing 66% of assets under management and 60% of open accounts that year. Second, the percentage of assets and open accounts in suboptimal plans has fallen since 2012, when 82% of assets under management and 79% of open accounts were held in suboptimal plans.

Third, we demonstrate that these patterns of home-state household investment in 529 plans are indeed suboptimal and do not reflect local information advantages. We specifically examine whether households possess value-relevant information advantages about their home-state plans compared to out-of-state plans. For example, households could hold a local information advantage regarding the investing skill of their state's plan trustee or local asset management company's portfolio manager. Such an advantage would manifest as higher risk-adjusted returns when investing in home-state 529 plans. To address this alternative explanation, we compare the realized risk-adjusted returns of suboptimal plans to those of optimal plans. We find that model-identified ex-ante suboptimal plans underperform, compared to model-identified ex-ante optimal plans. These differences in ex-post performance are consistent with our model's predictions and inconsistent with local information advantages increasing performance. In the case where local information advantages arise specifically from geographic proximity to local asset management companies, we compare the risk-adjusted returns of suboptimal plans managed by in-state asset management companies to risk-adjusted returns of optimal plans managed by out-of-state asset management companies. We again confirm that in-state suboptimal plans underperform optimal plans managed by out-of-state asset management companies. Both results suggest that local

information advantages are unlikely to explain household preferences for suboptimal home-state plans.

Fourth, we investigate potential explanations for the observed suboptimal home-state holdings. We find that the extent of suboptimal investment is negatively associated with household information processing frictions, for which we implement two proxies. First, we use household financial literacy, motivated by the idea that more financially literate households should find it less costly to understand how state tax deductions, residency restrictions, asset-based management fees, and other factors affect terminal payoffs, given the menu of potential investment options. To test this hypothesis, we isolate a subsample of states offering both a suboptimal and an optimal plan. We find that, in states with higher levels of financial literacy, households invest less in suboptimal plans compared to the optimal plan. We further find that home-state suboptimal plans are typically advisor-sold plans and have higher fees than direct-sold plans. This result suggests that a likely channel through which financial literacy affects suboptimal asset locations is through less financially literate households seeking more costly financial advice.

Our second proxy for information processing frictions is the complexity of plan disclosure documents. States advertise and disclose information via multiple channels, some of which have faced criticism and lawsuits for being complicated and misleading (e.g., Baldwin v. Merrill Lynch 2019; Sommer 2022). Our analysis focuses on plan disclosure documents, which constitute participation agreements and can be compared across states. The average 529 plan disclosure statement and participation agreement comprises more than 60 pages of financial and accounting-related information. Furthermore, unlike open-end mutual funds, 529 plans are not mandated to provide a summary section.[2] We expect that plan disclosure complexity, which increases information processing frictions, exacerbates households' tendency to make suboptimal investments. Indeed, we find that when state 529 plans have more linguistically complex disclosure documents, their optimal plans receive a relatively lower proportion of assets. Taken together, our findings provide evidence that financial literacy and plan disclosure transparency affect household portfolio choice and help explain suboptimal asset locations.

[2] Prior literature studying the disclosure complexity of mutual fund prospectuses finds that simplified disclosures such as summaries can improve retail investor decision making (Beshears et al. 2010; deHaan et al. 2021).

In additional analyses, we investigate how information processing frictions affect household 529 plan participation rates.[3] We show that households in states with higher measures of objective financial literacy and less complex plan disclosures have higher participation rates in 529 plans. These results suggest that information processing frictions also adversely affect the *decision* to participate in 529 plans, in addition to affecting *where* households locate assets once they decide to participate.

Our study contributes to the literature in two principal areas. First, we add to the household finance literature by demonstrating that households make suboptimal investment choices in their lifecycle financial planning. Relatedly, Clark, Lusardi, and Mitchell (2017) find that investors' suboptimal choices in retirement plans appear to be influenced by their financial knowledge. We extend this finding to financial planning for investors' beneficiaries.[4] In addition, we find that households make these suboptimal investments in their home states, and thus our findings are related to the literature on investor preferences for local assets.[5] Our results indicate that the preference for home-state assets can be driven by factors beyond local information advantages, and local preferences can produce inferior investment outcomes.

Second, our study informs policymakers concerned with household financial well-being. The rise in defined contribution plans and individual retirement accounts has shifted portfolio choice and rebalancing decision making away from employers (in defined benefit pension plans) to households (e.g., Lusardi and Mitchell 2011). The finding that households' life-cycle financial decision making in the 529 context is often suboptimal indicates that policymakers should also be alert to the impact of savings for the next generation of beneficiaries. Moreover, we also show that household savings location decisions deviate from simple models of expected investment payoffs and create an aggregate decrease in household financial well-being (e.g., Calvet, Campbell, and Sodini 2007). Accordingly, our investigation seeks to inform future research and policy, and to suggest new tools – for example, educational guides and disclosure principles (e.g., Alexander et

[3] Household non-participation in risky asset markets despite the existence of a positive risk premium is termed the participation puzzle in the household finance literature (c.f., Mankiw and Zeldes 1991; Campbell 2006).
[4] Hastings et al. (2013), Lusardi and Mitchell (2014), and Kaiser et al. (2021) review the literature on financial literacy, financial education, and their downstream effects.
[5] For evidence of U.S. institutional investor home bias, see Coval and Moskowitz (1999), Hau and Rey (2008), and Baik et al. (2010). For evidence of U.S. retail investors' home bias, see Ivkovic and Weisbenner (2005) and Seasholes and Zhu (2010). Studies also document home bias other countries including Finland (Grinblatt and Keloharju 2001), Sweden (Massa and Simonov 2006), and China (Feng and Seasholes 2004).

al. 2015) – that could enhance household decision making for college savings and, as a result, overall financial welfare.

The remainder of this paper proceeds as follows. Section II describes the key institutional framework for investing in 529 plans and our methodology for modeling asset allocation. Section III outlines our empirical findings on optimal and suboptimal asset location. Section IV investigates several potential explanations for the observed suboptimal investment patterns. Section V provides additional analyses and robustness tests using alternate model specifications. Section VI concludes.

II. Institutional Background and Modeling Suboptimal Investment

A. Institutional Background

In the United States, 529 plans are state-sponsored, tax-advantaged savings accounts designed to encourage household savings for beneficiaries' future education costs named for Section 529 of the U.S. tax code, which confers their favorable tax treatment. Such plans are an economically important component of household saving, sponsored by state governments which oversee them through politically appointed boards. States contract with program managers who administer the plan to design the menu of available investment options.[6]

While the precise menu of investment options provided differs across plans, all plans include two main types of investment options: age-based/target-enrollment investments, where the asset allocation changes over time based on the age of the beneficiary or their expected year of college enrollment; and static investments, where the asset allocation remains static over the period of investment. Program managers are not subject to the fiduciary responsibilities relevant to retirement plan advisers, so some plans may be built using high-cost funds (Bullard 2006, Curtis 2020, Balthrop and Cici 2022).

Each household selects which state plan it wishes to use as its preferred savings and investment vehicle. Critically, households are not restricted to investing in their own state plans, since most plans permit investments by out-of-state households. Furthermore, households can use distributions from plans to pay out-of-state college or university costs. Thus, comparing home-state vs. optimal 529 plan asset locations provides a powerful setting to examine investment behavior.

[6] The program manager can be a record keeper, asset management company, bank, or in-house government agency.

Households contribute to 529 plans after paying federal income tax, and withdrawals from these plans are exempt from federal income and capital gains taxation when used for qualified higher education expenses. Nevertheless, states differ in offering tax deductions/credits for contributions. Twenty-eight states offer tax deductions/credits for contributions only to in-state plans; seven states offer tax parity, where contributions to any plan can earn tax deductions; seven states offer no tax benefits; and the remaining nine states have no state income taxes.[7] The state-level tax treatment of resident households is therefore a key dimension potentially shaping asset location choice.

There are two types of 529 plans: prepaid tuition plans, and education savings plans. Prepaid tuition plans allow the account holder to purchase units or credits for future tuition and mandatory fees at current prices for participating colleges and universities (usually public and in-state). Prepaid tuition plans thus provide a direct hedge against tuition inflation. In contrast, education savings plans allow the account holder to open an investment account to save for a beneficiary's future qualified higher education expenses at any educational institution: tuition, mandatory fees, room and board, and books and supplies. Households can then build portfolios from the mutual funds and exchanged-traded funds included in education savings plans.

Education savings plans can be either direct-sold or advisor-sold. In direct-sold plans, a household must open an account through the state and use its contracted plan manager. In advisor-sold plans, a household may only open an account through a financial advisor. As shown below, fees and other benefits and costs differ substantially between direct-sold and advisor-sold plans, as well as across state plans, thus making plan type and associated characteristics another key dimension of asset location choice.

B. Modeling the Terminal Payoff

We model terminal payoffs from the perspective of a representative household making a prospective investment for its beneficiaries' future education. The objective of the household is to maximize its beneficiaries' terminal payoffs from its 529 contributions. Our model uses only publicly available – but costly to process – information relevant to household financial decisions. In particular, households have access to plan disclosure and participation agreement documents describing all plan features: how to and who can open an account, portfolios available, fees, etc.

[7] The District of Columbia (DC) offers a 529 plan. DC offers tax deductions on in-state contributions, so we include DC in our set of 28 states offering tax deductions.

To characterize each state's households, we apply assumptions drawn from plan disclosure documents. Such documents routinely assume that a household makes a $10,000 investment, the investment earns a 5% annual compounded rate of return on the amount invested throughout the holding period, and investments are redeemed only at the end of the period for qualified higher education expenses. Appendix A shows examples of disclosure documents describing these assumptions, which have remained consistent across plans and years. We further assume that the account is opened at a beneficiary's birth, implying an 18-year investment period (Leung and Wendell 2020).

Our model for the payoff of a 529 investment, defined recursively for each time $t \in \{0, \dots, T\}$, is:

$$\begin{aligned} Payoff_0^{s,p} &= Contribution^{s,p} \\ Payoff_t^{s,p} &= \left(Payoff_{t-1}^{s,p}\right)(1 + Return^{s,p}) - a^p \\ Terminal\ Payoff^{s,p} &= \left(Payoff_T^{s,p} - Contribution^{s,p}\right)(Distribution^{s,p}) + Contribution^{s,p} \end{aligned}$$

where s is the household's state of residence, p is the plan where the household can open an account, and a^p is the annual dollar-based account maintenance fee. The terminal payoff is calculated at time $t = T$. Because a household in state s can invest in all plans lacking residency requirements, we evaluate $Terminal\ Payoff^{s,p}$ for the cross-product of each state s and plan p.

We define $Contribution^{s,p}$, $Return^{s,p}$, and $Distribution^{s,p}$ as follows:

1) Contribution

We assume a one-time $10,000 investment made after the household pays federal taxes on income but before paying state taxes, as the household may earn a state tax deduction/credit from the contribution:

$$Contribution^{s,p} = 10{,}000(1 - \tau^s) + \begin{cases} \pi^s \tau^s & \text{if} \quad \pi^s \leq 10{,}000 \\ 10{,}000\tau^s & \text{if} \quad \pi^s > 10{,}000 \end{cases} + Matching\ Grant^{s,p}\ ,$$

where τ^s represents the effective tax rate for a household in state s. π^s represents the state limit on the amount of contributions available to be used for tax deductions: if the limit is > $10,000, then the full amount will be deducted; if the limit is ≤ $10,000, then only the limit amount will be deducted. Savings from the tax deduction are invested in the 529 plan.

Some states offer matching grants for their plans, where the state matches a resident household's contributions up to a cap. $Matching\ Grant^{s,p}$ represents the match amount (if

any) for a household in state s contributing to plan p. Appendix B presents a breakdown of how state taxes, matching grants, and other state and plan characteristics affect the terminal payoff.

2) Return

In education savings plans, the contribution is assumed to earn a 5% annualized return as seen in typical prospectus illustrations. An annual asset-based percentage fee is also levied on the account's assets as well as an annual dollar-based account maintenance fee. In prepaid tuition plans, the contribution grows at the rate of tuition growth of the state's flagship public university. The return is thus calculated as:

$$Return^{s,p} = \begin{cases} 0.05 - f^p & \text{if } p \text{ is } education\ savings \\ u^{s'} & \text{if } p \text{ is } prepaid \end{cases},$$

where f^p represents the annual asset-based percentage fee for plan p, while $u^{s'}$ represents the annualized tuition increase of the flagship university of the state s' that sponsors plan p. If p is education savings, then plan p is an education savings plan, while p is prepaid indicates that plan p is a prepaid tuition plan. We apply the annual account maintenance fee in the payoff function previously defined.

3) Distribution

The household redeems the account at the end of the period. We assume that the household spends the amount withdrawn for qualified education expenses, so capital gains are not taxed, and the full account balance is available to spend on educational expenses at withdrawal. The exception is Alabama, which taxes capital gains on out-of-state plans. Accordingly, distributions are calculated as:

$$Distribution^{s,p} = \begin{cases} 1 - \tau^s & \text{if } s \text{ is } Alabama \text{ and } p \text{ not in } Alabama \\ 1 & \text{otherwise} \end{cases}.$$

C. Optimal Plan, Home-State Plan, and Dollar Welfare Loss

The optimal plan for the household in state s is the plan with the highest terminal payoff across all plans accessible to the household. The home-state plan for a household in state s is the in-state plan with the highest terminal payoff. We define the dollar welfare loss for investing in the suboptimal plan as the difference in payoffs between the home-state plan and the optimal plan (following Calvet et al. 2007):

$$Dollar\ Welfare\ Loss^{s,p} = Terminal\ Payoff^{s,optimal} - Terminal\ Payoff^{s,home-stat\ \ p}$$

The home-state suboptimal plans are the home-state plans where $Dollar\ Welfare\ Loss^{s,p} > 0$.

III. Model Predictions and Empirical Findings on Optimal vs. Suboptimal Asset Locations

A. *Data and Sample Selection*

To implement the model, we obtain state tax rates from the National Bureau of Economic Research and fees and state tax distribution limits from plan disclosure documents made available on state websites and through the Municipal Securities Rulemaking Board (MSRB) database. Appendix C provides more detail about the data sources. To compare model predictions with the actual locations of 529 plan assets, we collect data on plans' open accounts and assets under management from the College Savings Plan Network (CSPN).

We identify 120 unique plans across all 50 states including the District of Columbia between 2010 and 2020.[8] We record 803 plan-year observations and 109 state-year observations. Tables 1A and 1B show summary statistics of plan-level and state-level variables, respectively, which are defined in the relevant sections hereafter.

[Insert Table 1 here]

B. Model Predictions

The model produces optimal and suboptimal plan labels for each state-plan-year and projected dollar losses between 2010 and 2020. For descriptive purposes, we focus on the model's classifications for the most recent year in our sample and then describe historical deviations from the focal year.

Tables 2A and 2B present optimal home-state plans and suboptimal home-state plans, respectively, based on the model's classifications. In optimal home-state plans, a household from state s has the highest expected terminal payoff for investing in a plan offered by state s. In suboptimal home-state plans, a household from state s can earn a higher expected terminal payoff for investing in a plan not offered by state s; investing in home state s's plans therefore represents suboptimal investment.

[Insert Table 2 Here]

[8] Wyoming is the only state that did not offer a 529 plan during our sample period.

Table 2A also shows that the large majority of optimal home-state plans is found in states offering 529 deductions. When a state tax deduction is granted only for contributing to in-state plans, this creates higher payoffs with which the household can offset the higher investment fees relative to the cheapest out-of-state plan. Eighteen of the 28 states with tax deductions have optimal home plans. Of these 18 states, 14 have multiple plans, and the optimal home-state plan is consistently the direct-sold plan rather than the advisor-sold plan offered by the same state. Direct-sold plans almost always have lower fees than advisor-sold plans.[9]

There are also four states with optimal home plans that did not offer tax deductions. California offered the best plan nationwide in 2020 without residency restrictions; it had the lowest asset-based fees and no additional fees (no maintenance, application, cancellation, etc.). California's plan is thus the default optimum for California residents. Maine offered multiple matching grants for in-state residents, thus making its direct-sold plan optimal for Maine residents. Florida offered a lower-cost plan relative to California's; however, Florida's plan was only available to in-state residents.[10] Lastly, Nevada faced tuition increases of greater than 5% annualized between 2010 and 2020, so Nevada's prepaid tuition plan was classified as optimal for Nevada residents.

In examining suboptimal home-state plans in Table 2B, we find 10 states that offered tax deductions that did not offset the higher cost of investment in those states' plans. In these 10 states, households could earn higher payoffs by investing in an out-of-state plan (i.e., the best plan nationwide without residency restrictions). For the seven states offering tax parity, the tax deduction does not produce a relative financial gain, because the household could earn a tax deduction for contributing to any plan nationwide. Likewise, for the remaining 11 states neither offering tax deductions nor having a state income tax, the household cannot earn a tax deduction. Thus, for households residing in states offering tax parity, no tax deductions, or having no state tax, choosing a home-state plan with worse characteristics compared to the nationwide best plan represents suboptimal investment.

[9] The 14 states are AL, CT, IA, IL, IN, ME, MI, NM, NY, RI, SC, VA, WI, and WV. The other four states with optimal home-state plans only offer one plan.

[10] Other plans with residency restrictions are LA's START plan, NJ's NJBEST plan, RI's CollegeBoundfund Direct-sold plan, SC's Future Scholar Direct-sold plan, SD's CollegeAccess Direct-sold plan, and WV's SMART529 Direct-sold plan.

Over the sample period, our model's classifications are quite stable, in that plans change their optimal status across years in only a few instances. A few states offering tax deductions sponsored plans with higher historical costs of investment relative to other states' plans: while residents of these states plans invested optimally by investing in-state in 2020, they would have invested suboptimally if they had chosen home-state plans in previous years.[11] In addition, a few states offering tax deductions sponsored plans with historically lower costs of investment relative to other states' plans: while these states' plans represented suboptimal home investment in 2020, they represented optimal home investment in previous years.[12]

C. Empirical Findings

After generating optimal and suboptimal classifications, we compare the model's classifications to the actual location of 529 plan assets. We again use 2020 as the focal year for descriptive purposes and describe historical deviations. For the $425.2 billion of assets and 14.9 million open accounts in 529 plans at year-end 2020, the per-account average 529 plan balance was $28,500. Of these, $281.0 billion of assets and 8.9 million open accounts were held in suboptimal home-state plans, representing 66% of assets under management and 60% of open accounts.

Figure 1A shows the proportion of assets under management and open accounts in suboptimal plans over time. Over our sample period, the average proportion of assets under management and open accounts held in suboptimal plans was 74% and 71%, respectively.[13] Both proportions have trended down over time, suggesting a reduction in household suboptimal investment over time. Moreover, the average size of the household account is similar across suboptimal and optimal plans.[14]

[Insert Figure 1 Here]

The aggregate projected dollar loss for households contributing to suboptimal plans was $37.7 billion in 2020, representing 9% of projected terminal payoffs. That is, households investing suboptimally could have earned an extra 9% return on investment over the modeling period of 18

[11] These states are FL and MD prior to 2020; LA prior to 2019; NM prior to 2018; MA prior to 2017; and CT, GA, MI, VA, and WI prior to 2015; and ME prior to 2014.
[12] These states are OR prior to 2017; ID prior to 2016; NE prior to 2015; and AZ, DC, KS, DE, and NH prior to 2013.
[13] A few states have rollover recapture provisions, where a household must repay a portion of previously earned tax deductions on invested principal if they rollover the account to an out-of-state plan. The counts of suboptimal assets and accounts here are adjusted for these "captured" assets by removing year 2010 beginning assets and accounts.
[14] This assumes returns on assets are similar between suboptimal and optimal accounts. In Section IV.A., we find that optimal plans actually outperform suboptimal plans on a realized basis.

years, if they had instead placed their assets in optimal plans. Figure 1B shows trends in the aggregate projected dollar loss and as a percentage of the aggregate projected terminal payoff. The average projected dollar loss was 11% over this period. While the absolute amount of the dollar loss grew over time, the proportion of total assets it represents declined. This also suggests a reduction in the prevalence of suboptimal household investments over time.

IV. Hypotheses and Tests for Suboptimal Asset Locations

In this section, we examine potential explanations for the observed patterns of suboptimal investment.

A. Information Asymmetry and Local Informational Advantages

We first examine whether household suboptimal asset locations arise from information asymmetry and local information advantages for investing in home-state plans. Prior studies suggest that both institutional and individual investors incorporate local information in their non-529 plan investment decisions (e.g., Coval and Moskowitz 1999, Ivkovic and Weisbenner 2005, Hau and Rey 2008, Baik et al. 2010). Geographic proximity may represent a relative information advantage to local investors when they have easier access to information about companies located near them (Grinblatt and Keloharju 2001). This literature compares the returns of investors' local portfolio holdings – companies headquartered in the same state as the investor – to the returns of investors' non-local holdings, and it generally finds that local holdings earn an additional abnormal return relative to non-local holdings.[15]

We conduct an analogous examination of potential household local information advantages by comparing the risk-adjusted returns of suboptimal home-state 529 plans to the risk-adjusted returns of optimal plans selected by our model. If households have an information advantage regarding their in-state plan's investment strategies, then the risk-adjusted returns of predicted suboptimal home-state plans should outperform those of the predicted optimal plans. We gather individual monthly portfolio returns from Morningstar and aggregate them to the plan-level weighted by portfolio net assets.

Table 3A shows the results of a *t*-test comparing the Sharpe ratios of optimal versus suboptimal plans at 3-, 5-, and 10-year time horizons. We find that *ex-ante* optimal plans

[15] This result is largely consistent throughout this literature, though conflicting evidence does exist (e.g., Seasholes and Zhu 2010).

outperform *ex-ante* suboptimal plans throughout our sample period. This result validates our model and suggests that households investing in suboptimal home-state plans do not maintain a local information advantage that generates greater terminal payoffs for their beneficiaries.

[Insert Table 3 Here]

A stricter formulation of information advantages is that the household maintains a local informational advantage only for plans managed by a local asset management company, as opposed to plans managed by out-of-state asset management companies. In this case, the local information advantages might occur through access to the local company managing the assets (as opposed to the state office offering the plan). Table 3B shows a *t*-test of the difference between the forward-looking realized Sharpe ratios of optimal plans with out-of-state program managers and those of suboptimal home-state plans with in-state program managers. We find that suboptimal home-state plans with in-state program managers underperform optimal plans with out-of-state program managers. This result implies that households investing suboptimally in our setting do not maintain a local information advantage that would generate greater terminal payoffs for their beneficiaries.

B. Information Processing Costs: Household Financial Literacy

One potential reason that households invest poorly is information processing frictions associated with low levels of financial literacy. Savvier households may better understand how state tax deductions, residency restrictions, asset-based management fees, and other components affect terminal payoffs within a menu of investment options. For example, Hastings and Tejeda-Ashton (2008) and Hastings and Mitchell (2020) find positive correlations between financial literacy and investment in lower-cost funds. Generally, the financial literacy literature shows that less savvy individuals make less optimal decisions regarding choosing and paying off loans, as well as contributing to savings and retirement plans (Hastings et al. 2013; Lusardi and Mitchell 2014).

If financial literacy does enhance household understanding of the costs and benefits of different plans, we expect a positive relationship between state levels of household financial literacy and the relative proportion of open accounts invested in the optimal home plans. To test this, we gather data on household financial literacy from FINRA's National Financial Capability Study (NFCS). The state-by-state NFCS surveys are conducted among a nationally representative sample of American adults covering approximately 500 individuals per state (including the District

of Columbia). The NFCS uses two indices of financial literacy: (1) an objective measure based on the proportion of correct responses to several objective test questions, and (2) a subjective measure based on peoples' self-assessed financial literacy levels. We anticipate that the more objective measure will measure knowledge more accurately than the subjective self-confidence measure (Lusardi and Mitchell 2014).

To examine whether financial literacy is related to suboptimal 529 asset locations, we focus on states with multiple plan offerings, where one plan is an optimal home plan according to our model, and the others are suboptimal home plans. Focusing on this set of states allows us to isolate the extent of suboptimal investment, without confounds such as variation across states in the participation decision.

Table 4 presents results of regressing the within-state proportion of optimal accounts on our financial literacy measures. We find that states with higher levels of financial literacy have a higher proportion of open accounts invested in optimal home-state plans. Specifically, a one-percent increase in a state's financial literacy level, measured by the proportion of NFCS questions answered correctly, corresponds to a 4.0% increase in the proportion of open accounts held in the state's optimal plan. We further note that the suboptimal plans in this set of states are all advisor-sold plans with higher fees. Therefore, these results also suggest that less financially literate households are more likely to use costly financial advice. Thus, lower financial literacy can help explain household suboptimal asset locations and reliance on costly financial advice. By contrast, the self-assessed financial literacy index is not significantly related to the proportion of optimal accounts in that state.

[Insert Table 4 Here]

C. Information Processing Costs: Disclosure Complexity

Information processing frictions also vary with the complexity of the information in plan disclosure documents. Plan disclosure and participation documents describe key features of the plans – how to and who can open an account, portfolios available, fees, tax-deductions, legal information, etc. – and thus they provide information fundamental for 529 plan decision making. The average plan disclosure statement and participation agreement, however, comprises over 60 pages of financial and accounting information, and these plans rarely contain a summary section similar to the one the SEC mandates for mutual funds. In other contexts, it has been shown that such complexity can impede households' ability to analyze such disclosures and assess investment

costs (e.g., Hortaçsu and Syverson 2004; Stango and Zinman 2016; Célérier and Vallée 2017). Accordingly, we hypothesize that increased complexity of the optimal home plan's disclosure document relative to the suboptimal home plan's disclosure document is associated with lower investment in the optimal home plan compared to the suboptimal home plan.

To test this, we use our sample of states with multiple plan offerings, where one plan is an optimal home plan according to our model and the other plans are suboptimal as defined in Section IV.C. We use two measures of disclosure complexity: the Gunning Fog Index and the Flesch Reading Ease score (Li 2008; Dougal et al. 2012; Loughran and McDonald 2014; Loughran and McDonald 2020). Both measures are based on sentence length and word length. They differ in that the Gunning Fog Index applies a binary classification of word length based on syllable count, and the Flesch Reading Ease score counts the average number of syllables across the entire document. A higher score on the Gunning Fog Index indicates greater disclosure complexity; the mean score of 10.2 across all plan documents represents readability at the high school sophomore level. We code Reverse Flesch Reading Ease as 101 less the document's Flesch Reading Ease score, such that a higher score for Reverse Flesch Reading Ease indicates greater disclosure complexity. The mean score of 62.1 across all plan documents represents readability at the college graduate level. We further control for asset-based fees because they may be correlated with disclosure complexity and affect asset location decisions (deHaan et al. 2021).

Table 4 presents results of regressing the within-state proportion of optimal accounts on our disclosure complexity measures. We find that a higher Gunning Fog score for the optimal home plan's relative to the suboptimal home plan's disclosure document is associated with lower investment in the optimal home plan compared to the suboptimal home plan. Specifically, a one percent increase in the Gunning Fog Index of a state's optimal plan's disclosure document relative to its suboptimal plan's disclosure document corresponds to a 1.6% decrease in the proportion of open accounts held in the state's optimal plan. Likewise, we find that a higher Reverse Flesch Reading Ease score for the optimal home plan's disclosure document relative to the suboptimal home plan's disclosure document is associated with lower investment in the optimal home plan compared to the suboptimal home plan. Specifically, there is a negative 2.0% correspondence between the optimally located account proportion and the ratio of disclosure documents' Reverse Flesch Reading Ease scores. These results imply that plan disclosure complexity does deter

optimal household investment: households prefer plans with simpler disclosures, such that optimal plans' disclosure complexity may nudge households to invest in second-best plans.

V. Additional Analyses and Robustness Tests

A. The Participation Puzzle: Determinants of Opening a 529 Plan

Saving for beneficiaries' future college expenses involves at least three steps: deciding to save; given the decision, where to open the account; and given an open account, how much to save. Sections III and IV above presented our analyses of households' suboptimal asset location choices. In this section, we investigate the factors shaping whether households save for their beneficiaries' education.

As noted above, non-participation in risky asset markets despite a positive risk premium is known as the participation puzzle. In our setting, we expect that information processing costs affect the decision to open a 529 account in ways similar to how they affect where to locate the 529 account. Specifically, we expect individuals in states with lower financial literacy and higher disclosure complexity to have lower rates of 529 plan participation. For this test, we expand our sample of state-years to include all state-years with available data and do not require that each state-year have both an optimal and suboptimal plan. We also control for state education budget deficits to proxy for real risks: households may be inclined to save more for their beneficiaries' education if their home states face education budget shortfalls. We measure a state's 529 participation rate as its number of open accounts divided by the size of its under-age 20 population. We gather data on state population and budgets from the Census Bureau's American Community Survey and State and Local Government Finances datasets, respectively.

[Insert Table 5 Here]

Table 5 presents results of regressing state levels of 529 savings on our measures of financial literacy and disclosure complexity. We find that higher levels of NFCS objective financial literacy are positively associated with 529 plan participation rates, while higher subjective financial literacy as measured by household self-assessment is unrelated to state 529 participation rates. Specifically, a one percent increase in households' measured objective financial literacy corresponds to a 4.9% increase in the state's 529 plan participation rate. This suggests that financial literacy affects household decisions to save, and financial literacy is better measured by the objective test questions versus the self-assessed scale.

In Table 5, we further find that the Gunning Fox Index and the Reverse Flesch Reading Ease measures of disclosure complexity are negatively related to state 529 participation rates. Specifically, a one-point increase in a plan document's Gunning Fog Index (Reverse Flesch Reading Ease score) corresponds to a 11.4% (1.4%) decrease in the state's 529 plan participation rate. This suggests that more readable plan documents facilitate households' decision to invest. For example, more readable disclosures motivate households to invest by making clear the tax benefits of saving and the long-term benefits of investment.

Lastly, we find that the state education deficit, defined as the difference between its annual revenue and expenditures in the education category, is unrelated to 529 participation rates. This suggests that households do not consistently consider state-level education budget deficits in their 529 savings decisions. Therefore, hedging state-level education-related real risks does not appear to be salient in household 529 decision making, in contrast to information processing frictions.

B. Robustness Tests: Variations of the Representative Household

Our model assumes that a representative household makes a $10,000 one-time contribution to a 529 plan of choice, consistent with how most 529 disclosure documents present examples. The model also assumes that a household opens an account for its beneficiaries when they are born, as in Leung and Wendell (2020). In reality, households can make contributions in several different ways: $1,000 annually over 10 years; $5,000 or even $75,000 in one lump sum; or invest for shorter time horizons.[16] They can also have different adjusted gross incomes that subject them to different state effective tax rates.[17] While we cannot model all possible combinations, we do conduct robustness tests with key variations in assumptions. To this end we consider (1) a shorter account life, and (2) spreading contributions over time.

B.1 Variation in the Investment Time Horizon

Households may open accounts for their beneficiaries several years after their births, especially if there is uncertainty about the beneficiaries' desires and propensities to attend college.

[16] 529 plans do not have annual contribution limits. Nevertheless, 529 plan contributions are considered completed gifts for federal tax purposes: up to $15,000 per donor per beneficiary qualified for the annual gift tax exclusion (in 2020). Alternatively, a donor can 'superfund' the account by making the equivalent of 5 years' worth of contributions ($75,000) at once, as allowed by the tax code.

[17] We find the labeling of optimal plans slightly differs at or below the $50,000 gross household income mark, as matching grants (state tax deductions) play a larger (smaller) role below that threshold. However, Hannon et al. (2016) finds that the 529 participation rate is very small (0.3%) at or below this threshold, compared to 16% in the highest income percentiles. Therefore, we do not expect different modeling outcomes for low-income households to significantly affect our results. More accurately, we interpret our empirical findings as based on the actions of household incomes above $50,000 (national median ≈ $59,200 throughout our sample period).

Naturally, changing the investment time horizon changes the relative impact of the model's parameters on the expected terminal payoff: as the investment time horizon decreases, the asset-based percentage fee has a smaller impact on the terminal payoff compared to account maintenance fees and the state tax-deduction on contributions.

Plan disclosure documents typically project the effect of annual asset-based fees to a 10-year horizon, so we use a 10-year period as an alternative investment horizon ($T = 10$).[18] Tables 6A, 6B, and 6C repeat the analyses of Sections III and IV using this alternative investment horizon assumption. We find that 63% of assets under management and 56% of open accounts are held in suboptimal plans in 2020, both figures only slightly lower than the 66% of assets and 60% of open accounts described in Section III. Seven states change from having suboptimal home plans to having an optimal home plan.[19]

[Insert Table 6 Here]

Overall, our inferences from testing the hypotheses in Section IV remain qualitatively consistent. Table 6A shows that the choice set of optimal plans continues to outperform suboptimal plans on a realized risk-adjusted basis, reaffirming that households do not maintain a local informational advantage in their 529 savings choices. Likewise, Table 6B shows that the choice set of optimal plans managed by out-of-state asset management companies continues to outperform suboptimal plans with in-state asset management companies, on a realized risk-adjusted basis. Table 6C shows that states with higher objective, but not subjective, levels of financial literacy have more accounts open in the optimal home plan than the suboptimal home plan. In addition, states with higher Gunning Fog Index and Reverse Flesch Reading Ease scores for the optimal home plan's disclosure document relative to the suboptimal home plan's disclosure document have fewer accounts in the optimal home plan compared to the suboptimal home plan. These results continue to show that information processing frictions drive household suboptimal financial decisions under this alternate model specification.

B.2 Variation in the Amount and Timing of Contributions

Households may also contribute to plans on a repeated basis over many years, as opposed to making one-time contributions, especially if they choose to contribute a portion of their annual incomes. Surprisingly, education savings plans' disclosure documents rarely project the fee

[18] Unfortunately, we are not aware of any available data on beneficiaries' ages when the accounts were opened.
[19] These states are CO, DC, ID, NE, OK, OR, and VT.

consequences of a periodic contribution schedule (see Appendix D for an example from a prepaid tuition plan).

We conduct a robustness test assuming a household makes a $10,000 total contribution but the payments are equally distributed over 18 calendar year-ends ($555 each year). We do not expect the timing of contributions to drive major differences in results, since, keeping plan characteristics stable over time to make projections, a plan which is optimal in the first year will remain optimal in subsequent years, thus producing the same inferences as before. By contrast, a smaller contribution increases the relative value of the state tax-deduction: a greater proportion of the contribution now qualifies for a tax-deduction in states with limits on the amount of a contribution eligible for tax deductions.

Tables 7A, 7B, and 7C repeat the analyses of Sections III and IV using $555 annual contributions in our model. We find that 61% of assets under management and 54% of open accounts are held in suboptimal plans in 2020, both figures only slightly lower than the 66% of assets and 60% of open accounts described in Section III. Seven states change from having suboptimal home plans to having an optimal home plan.[20]

[Insert Table 7 Here]

Moreover, our inferences from our hypothesis tests in Section IV remain consistent with previously reported findings. Table 7A shows that the choice set of optimal plans continues to outperform suboptimal plans on a realized risk-adjusted basis, reaffirming that households do not maintain a local informational advantage in their 529 savings choices under this second set of alternate assumptions. Likewise, Table 7B shows that shows that the choice set of optimal plans managed by out-of-state asset management companies continues to outperform suboptimal plans with in-state asset management companies on a realized risk-adjusted basis. Table 7C shows that states with higher objective, but not subjective, levels of financial literacy have more accounts open in the optimal home plan than the suboptimal home plan. In addition, states with higher Gunning Fog Index and Reverse Flesch Reading Ease scores for the optimal home plan's disclosure document relative to the suboptimal home plan's disclosure document have lower investments in the optimal home compared to the suboptimal home plan. In sum, our finding that information processing frictions contribute to household suboptimal financial decisions remains robust to alternative modeling assumptions for the representative household.

[20] These states are CO, DC, NE, OH, OK, OR, and VT.

VI. Conclusions

We model households' decision making for investments into 529 college savings plans and show that a substantial amount of 529 plan assets is invested in ex-ante suboptimal plans. Specifically, we find that 66% of assets under management, or 60% of open accounts, are located in expensive home-state plans without offsetting tax benefits or matching grants. In 2020, the aggregate projected dollar loss for households contributing to suboptimal plans was $37.7 billion, representing 9% of projected terminal payoffs over an 18-year holding period. These losses are greater for residents of states with lower financial literacy and more complex plan disclosures.

Our results suggest that information processing frictions are important contributors to household suboptimal financial choices in the educational saving marketplace. We show that governance and transparency (e.g., disclosure complexity) and behavioral explanations (e.g., perceived vs. objective financial competency) are strong drivers of household suboptimal investment in the 529 context. Given the size and complexity of 529 plan assets, these explanations are critical considerations for designing policies and interventions that improve household financial well-being not only over the life cycle but across generations.

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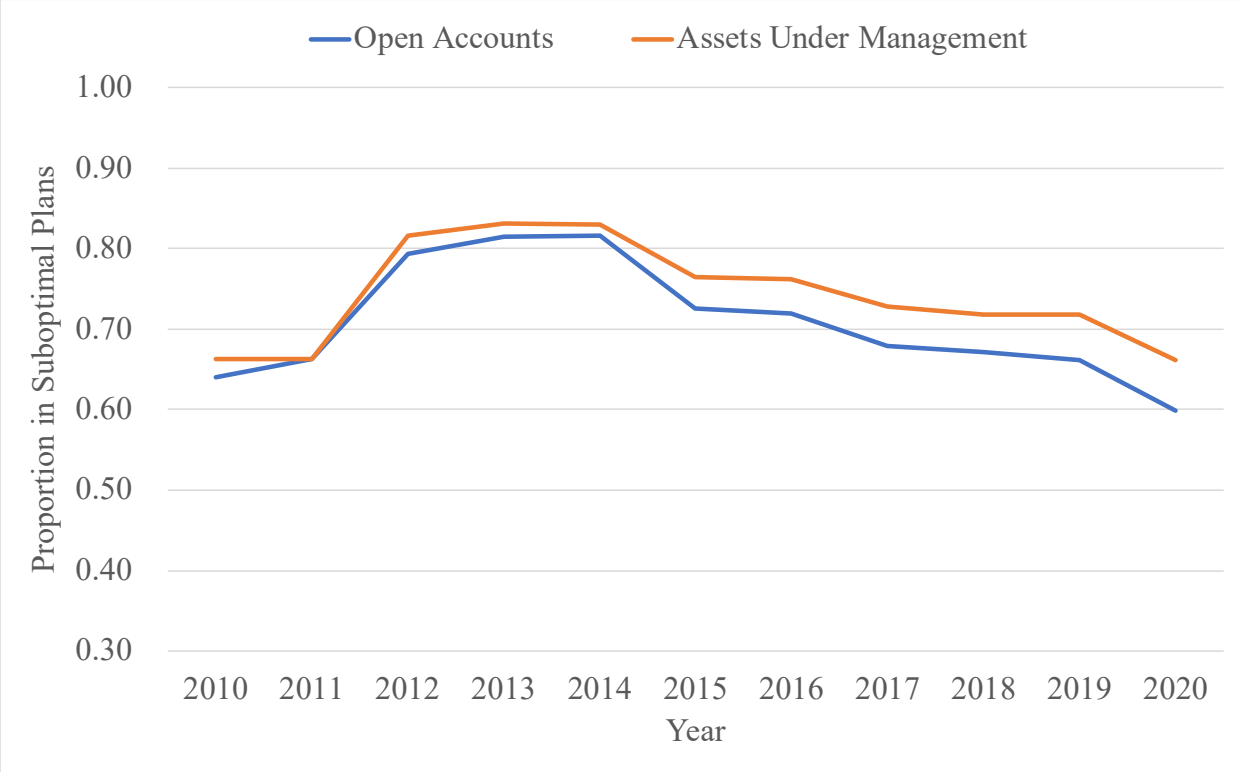
Figure 1: Assets Under Management, Open Accounts, and Dollar Loss

Figure 1A shows the proportions of 529 plan assets under management and open accounts in suboptimal plans over time. The denominators of these proportions include total assets under management and open accounts in both optimal and suboptimal plans. Despite a majority of assets and accounts being held in home-state suboptimal plans, both proportions have trended down, suggesting a reduction in household suboptimal investment over time. Figure 1B shows the aggregate dollar loss due to account holders placing their assets into suboptimal plans as opposed to optimal plans. While the dollar amount of dollar loss has grown over time, the proportion of total assets it represents has fallen over time, therefore also suggesting a reduction in household suboptimal investment over time.[21] All variables are defined in Appendix C.

Panel A: Suboptimal Plan Proportion



[21] The perceived jump in Figure 1B is due to six states charging the same lowest fee in 2010 and 2011. This changed in 2012 when one plan lowered its fees and broke the tie.

Panel B: Dollar Welfare Loss

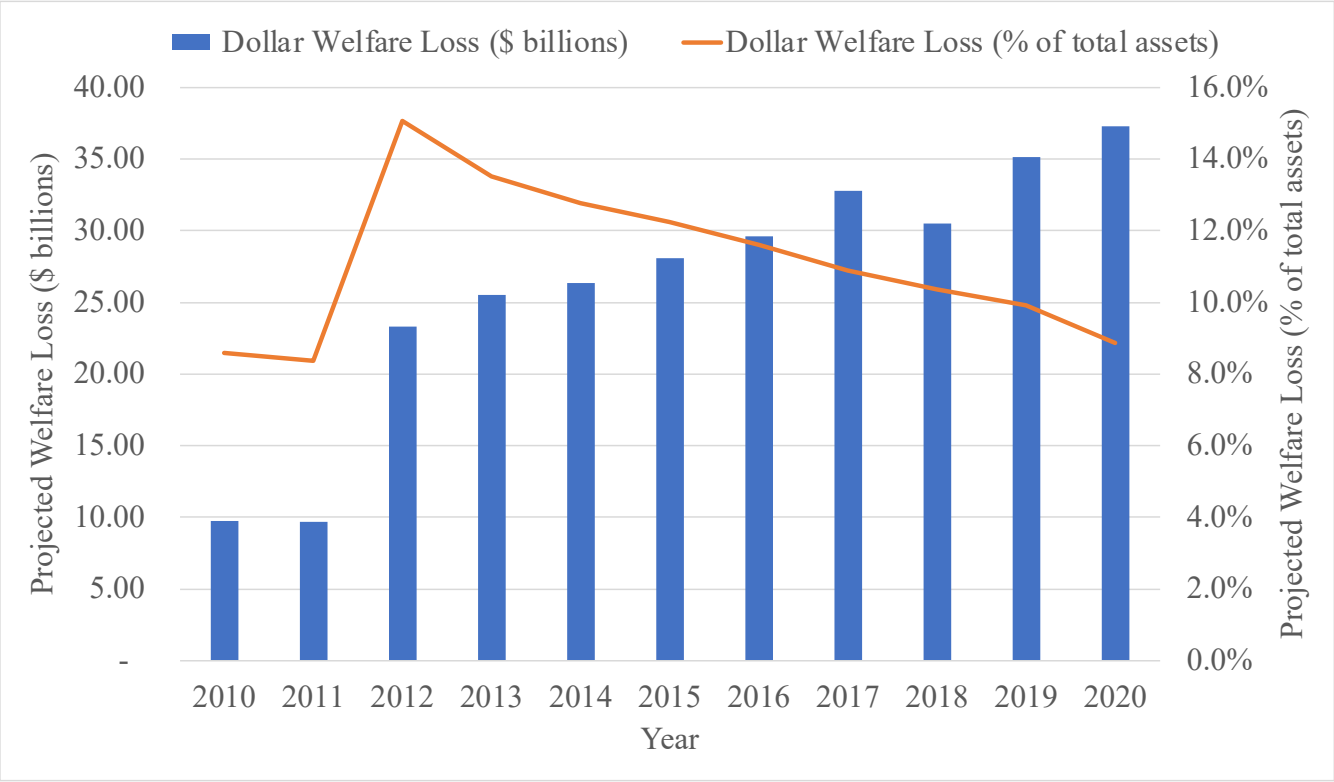


Table 1: Summary Statistics

Tables 1A and 1B show summary statistics from our dataset on 529 plans. Table 1A shows summary statistics for variables measured at the plan-year level. The sample size for the Sharpe Ratio measurements decreases for longer time horizons due to the requirement of more years of data. Table 1B shows summary statistics for variables measured at the state-year level. Variable names in Table 1B appended with "(proportion)" represent the value of the state's optimal 529 plan relative to the state total. Variable names in Table 1B appended with "(ratio)" represent the ratio of the value for the optimal home-state plan to the value for the suboptimal home-state plan(s). All variables are defined in Appendix C.

Panel A: Summary Statistics of Plan-Level Variables

Variable	Mean	Median	25th Percentile	75th Percentile	Obs.
Advisor-Sold	0.39	0.00	0.00	1.00	803
Assets Under Management ($ thousands)	3,019,217	1,235,525	388,687	3,254,438	803
Disclosure Page Count	67	64	48	80	803
Gunning Fog Index	10.15	10.17	9.58	10.79	803
Open Accounts	137,977	73,413	22,419	171,856	803
Reverse Flesch Reading Ease	62.11	61.63	59.71	63.46	803
Sharpe Ratio (36-month)	0.28	0.28	0.20	0.33	602
Sharpe Ratio (60-month)	0.26	0.25	0.21	0.30	444
Sharpe Ratio (120-month)	0.27	0.27	0.25	0.30	109
Total Asset-Based Fee	0.73%	0.70%	0.43%	1.01%	803
Underlying Fund Fee	0.38%	0.30%	0.15%	0.59%	803

Panel B: Summary Statistics of State-Level Variables

Variable	Mean	Median	25th Percentile	75th Percentile	Obs.
529 Participation Rate	0.28	0.11	0.04	0.23	469
Education Short-Fall Per Capita ($ thousands)	7.02	2.69	2.04	5.10	469
Expected 529 Investment	0.69	0.69	0.66	0.73	469
Gunning Fog Index	10.15	10.22	9.66	10.74	469
Literacy: Correct Answers	0.54	0.54	0.51	0.58	469
Literacy: Self-Assessed High	0.73	0.73	0.71	0.75	469
Married Household Income ($ thousands)	103.78	101.07	89.45	113.36	469
Reverse Flesch Reading Ease	62.19	61.63	59.86	64.14	469
Assets Under Management (proportion)	0.48	0.47	0.13	0.83	109
Gunning Fog Index (ratio)	1.01	1.01	0.97	1.11	109
Open Accounts (proportion)	0.47	0.41	0.21	0.80	109
Reverse Flesch Reading Ease (ratio)	1.01	1.01	0.99	1.03	109
Total Asset-Based Fee (ratio)	0.31	0.30	0.16	0.43	109

Table 2: Optimal and Suboptimal 529 Plans

Tables 2A and 2B show optimal and suboptimal home-state 529 plans, as classified by our model. The first column presents a representative household's home state, and the second column presents that state's tax status for 529 plan contributions. The third and fourth columns present the model's output of the state that offers the optimal plan and the optimal plan's name, respectively, for a household residing in the state in the first column. In Table 2A, which provides the list of optimal home-state plans, the resident state and optimal plan state are equivalent. In Table 2B, which provides the list of suboptimal home-state plans, the resident state and optimal plan state are not equivalent. The tables reflect model predictions for year-end 2020.

Panel A: Optimal Home-State Plans

Resident State	Resident State Tax Status	Optimal Plan State	Optimal Plan Name
AL	Tax Deduction	AL	Collegecounts 529 Fund Direct-Sold Plan
CT	Tax Deduction	CT	Chet Direct College Savings Plan
GA	Tax Deduction	GA	Path2College 529 Plan
IA	Tax Deduction	IA	College Savings Iowa 529 Plan
IL	Tax Deduction	IL	Bright Start Direct-Sold College Savings
IN	Tax Deduction	IN	Collegechoice 529 Direct Savings Plan
LA	Tax Deduction	LA	The Louisiana START Saving For College
MA	Tax Deduction	MA	U.Fund College Investing Plan
MD	Tax Deduction	MD	Md Sen Edward J. Kasemeyer Clg Inv Plan
MI	Tax Deduction	MI	Michigan Education Savings Program
NM	Tax Deduction	NM	The Education Plan
NY	Tax Deduction	NY	New York's 529 Program (Direct)
RI	Tax Deduction	RI	Collegebound Saver
SC	Tax Deduction	SC	Future Scholar 529 (Direct)
UT	Tax Deduction	UT	My529
VA	Tax Deduction	VA	Invest529
WI	Tax Deduction	WI	Edvest 529 Plan
WV	Tax Deduction	WV	Smart529 Wv Direct College Savings Plan
CA	No Deduction	CA	Scholarshare College Savings Plan
ME	No Deduction	ME	Nextgen College Investing Plan Direct
FL	No State Tax	FL	Florida 529 Savings Plan
NV	No State Tax	NV	Nevada Prepaid

Panel B: Suboptimal Home-State Plans

Resident State	Resident State Tax Status	Optimal Plan State	Optimal Plan Name
CO	Tax Deduction	CA	Scholarshare College Savings Plan
DC	Tax Deduction		
ID	Tax Deduction		
MS	Tax Deduction		
ND	Tax Deduction		
NE	Tax Deduction		
OH	Tax Deduction		
OK	Tax Deduction		
OR	Tax Deduction		
VT	Tax Deduction		
AR	Tax Parity		
AZ	Tax Parity		
KS	Tax Parity		
MN	Tax Parity		
MO	Tax Parity		
MT	Tax Parity		
PA	Tax Parity		
DE	No Deduction		
HI	No Deduction		
KY	No Deduction		
NC	No Deduction		
NJ	No Deduction		
AK	No State Tax		
NH	No State Tax		
SD	No State Tax		
TN	No State Tax		
TX	No State Tax		
WA	No State Tax		

Table 3: Sharpe Ratio Test for Local Information Advantage

Panel A presents a *t*-test of the difference between the forward-looking realized Sharpe ratios of optimal 529 plans and those of suboptimal plans. Panel B presents a *t*-test of the difference between the forward-looking realized Sharpe ratios of optimal plans with out-of-state program managers and those of suboptimal home-state plans with in-state program managers. Sharpe ratios are calculated using monthly plan returns. Each observation represents one plan-year: 3-year forward-looking Sharpe ratios are calculated annually for years starting in 2010 to 2018; 5-year forward-looking Sharpe ratios are calculated annually for years starting in 2010 to 2016, and 10-year forward-looking Sharpe ratios are calculated annually for years starting in 2010 to 2011. All variables are defined in Appendix C. *t*-statistics appear in parentheses and are based on standard errors clustered by year. Statistical significance at the 10%, 5%, and 1% levels are indicated by *, **, and ***, respectively.

Panel A: Sharpe Ratios of Optimal Plans vs. Suboptimal Plans

***t*-test**	**Sharpe Ratio (3-Year)**	**Sharpe Ratio (5-Year)**	**Sharpe Ratio (10-Year)**
Difference (Optimal – Suboptimal)	0.052***	0.052***	0.051***
	(21.176)	(20.860)	(14.266)
Observations	484	357	74

Panel B: Sharpe Ratios of Optimal Plans with Out-of-State Program Managers vs. Suboptimal Plans with In-State Program Managers

***t*-test**	**Sharpe Ratio (3-Year)**	**Sharpe Ratio (5-Year)**	**Sharpe Ratio (10-Year)**
Difference (Optimal – Suboptimal)	0.053***	0.050***	0.053***
	(10.109)	(9.250)	(9.750)
Observations	81	61	11

Table 4: Analysis of Information Processing Frictions

This table presents the results of a multiple regression of the within-state proportion of optimal 529 accounts on measures of financial literacy and plan document disclosure complexity. The proportion of optimal accounts is measured as the number of open accounts held in a state's optimal home plan divided by the total number of open accounts across that state's plans. Our two measures of financial literacy are the proportion of financial literacy test questions answered correctly, and self-assessed financial literacy level, as measured by FINRA's National Financial Capability Survey. The two measures of relative disclosure complexity are the Gunning Fog Index and Reverse Flesch Reading Ease score, each measured as the ratio of the measure for the optimal plan to the measure for the suboptimal plan. Asset-based fee is a control variable representing a plan's asset-weighted annual asset-based fee, measured as the ratio of the fee for the optimal plan to the fee for the biased plan. All variables are defined in Appendix C. *t*-statistics appear in parentheses and are based on standard errors clustered by year. Statistical significance at the 10%, 5%, and 1% levels are indicated by *, **, and ***, respectively.

	Dependent Variable: Proportion of Optimal Accounts			
Variable	(a)	(b)	(c)	(d)
Literacy: Test Questions Correct	3.972***		3.941***	
	(6.007)		(8.820)	
Literacy: Self-Assessed High		1.501		0.742
		(1.259)		(0.536)
Disclosure: Gunning Fog Index (ratio)	-1.559***	-1.199***		
	(-5.468)	(-4.699)		
Disclosure: Reverse Flesch Reading Ease (ratio)			-2.002***	-1.765***
			(-5.514)	(-4.298)
Total Asset-Based Fee (ratio)	-0.862***	-0.849***	-0.603**	-0.585**
	(-5.182)	(-5.781)	(-2.987)	(-2.978)
Observations	109	109	109	109
Year Fixed Effects	Y	Y	Y	Y
Adjusted R^2	0.237	0.123	0.355	0.230

Table 5: The Participation Puzzle: Determinants of Opening a 529 Plan

This table presents the results of a regression of state 529 participation rates on measures of financial literacy, plan document disclosure complexity, and state education budget deficits. A state's 529 participation rate is measured as the number of open accounts in a state divided by the size of its under-age 20 population. The two measures of financial literacy are the proportion of financial literacy test questions answered correctly, and self-assessed financial literacy level, both measured by FINRA's National Financial Capability Survey. The two measures of disclosure complexity are the Gunning Fog Index and Reverse Flesch Reading Ease score, each measured as average for all plans within a state. A state's education shortfall per capita is measured as the difference between education revenues and expenditures divided by the size of its under-age 20 population. Married household income is a state's average married-couple household income. Education shortfall per capita and married household income are scaled to units of $10,000 to display at least one significant digit. Expected 529 investment level is a control variable representing the proportion of a state's age 25-to-65 population having at least some college education, from the Census Bureau's American Community Survey. All variables are defined in Appendix C. *t*-statistics appear in parentheses and are based on standard errors clustered by year. Statistical significance at the 10%, 5%, and 1% levels are indicated by *, **, and ***, respectively.

	Dependent Variable: Participation Rate			
Variable	(a)	(b)	(c)	(d)
Literacy: Test Questions Correct	5.283***		5.532***	
	(9.780)		(11.009)	
Literacy: Self-Assessed High		-0.089		0.433
		(-0.247)		(0.914)
Disclosure: Gunning Fog Index	-0.114***	-0.123***		
	(-8.200)	(-9.959)		
Disclosure: Reverse Flesch Reading Ease			-0.014***	-0.015***
			(-7.325)	(-9.790)
Education Shortfall Per Capita	-0.001	0.005**	0.001	0.007***
	(-0.609)	(2.696)	(0.804)	(7.119)
Married Household Income	0.040***	0.006	0.046***	0.011**
	(10.645)	(1.173)	(12.543)	(2.378)
Expected 529 Investment	0.040***	0.006	0.046***	0.011**
	(10.645)	(1.173)	(12.543)	(2.378)
Observations	469	469	469	469
Year Fixed Effects	Y	Y	Y	Y
Adjusted R^2	0.151	0.082	0.118	0.043

Table 6: Robustness Test: Variations in Investment Time Periods

Panels A, B, and C of this table repeat the tests presented in Tables 3A, 3B, and 4, respectively, using a one-time $10,000 contribution for a 10-year account life as an alternate formulation of a representative household's 529 contribution schedule. Panel A presents a *t*-test of the difference between the forward-looking realized Sharpe ratios of optimal plans and those of suboptimal plans. Panel B presents a *t*-test of the difference between forward-looking realized Sharpe ratios of optimal plans with out-of-state program managers and those of suboptimal plans with in-state program managers. Panel C presents the results of a regression of the within-state proportion of optimal accounts on measures of financial literacy, disclosure complexity, and controls. All variables are defined in Appendix C. *t*-statistics appear in parentheses and are based on standard errors clustered by year. Statistical significance at the 10%, 5%, and 1% levels are indicated by *, **, and ***, respectively.

Panel A: Sharpe Ratios of Optimal Plans vs. Suboptimal Plans

***t*-test**	**Sharpe Ratio (3-Year)**	**Sharpe Ratio (5-Year)**	**Sharpe Ratio (10-Year)**
Difference (Optimal – Suboptimal)	0.053***	0.053***	0.051***
	(20.242)	(20.062)	(13.955)
Observations	443	333	71

Panel B: Sharpe Ratios of Optimal Plans with Out-of-State Program Managers vs. Suboptimal Plans with In-State Program Managers

***t*-test**	**Sharpe Ratio (3-Year)**	**Sharpe Ratio (5-Year)**	**Sharpe Ratio (10-Year)**
Difference (Optimal – Suboptimal)	0.067***	0.061***	0.053***
	(10.376)	(9.521)	(9.750)
Observations	56	45	11

Panel C: Analysis of Information Processing Frictions

	Dependent Variable: Proportion of Optimal Accounts			
Variable	**(a)**	**(b)**	**(c)**	**(d)**
Literacy: Test Questions Correct	2.501***		2.774***	
	(4.919)		(6.328)	
Literacy: Self-Assessed High		1.192		0.396
		(1.124)		(0.345)
Disclosure: Gunning Fog Index (ratio)	-1.526***	-1.432***		
	(-4.042)	(-4.484)		
Disclosure: Reverse Flesch Reading Ease (ratio)			-2.078***	-1.953***
			(-8.526)	(-6.449)
Total Asset-Based Fee (ratio)	-0.493***	-0.450***	-0.363**	-0.310**
	(-3.565)	(-3.656)	(-2.738)	(-2.960)
Observations	137	137	137	137
Year Fixed Effects	Y	Y	Y	Y
Adjusted R^2	0.158	0.107	0.345	0.274

Table 7: Robustness Test: Variations in the Amount and Timing of 529 Contributions

Panels A, B, and C repeat the tests presented in Tables 3A, 3B, and 4, respectively, using a $10,000 contribution divided equally over 18 years ($555 per year) as an alternate formulation of a representative household's 529 contribution schedule. Panel A presents a *t*-test of the difference between forward-looking realized Sharpe ratios of optimal plans and those of suboptimal plans. Panel B presents a *t*-test of the difference between forward-looking realized Sharpe ratios of optimal plans with out-of-state program managers and those of suboptimal plans with in-state program managers. Panel C presents the results of a regression of the within-state proportion of optimal accounts on measures of financial literacy, disclosure complexity, and controls. All variables are defined in Appendix C. *t*-statistics appear in parentheses and are based on standard errors clustered by year. Statistical significance at the 10%, 5%, and 1% levels are indicated by *, **, and ***, respectively.

Panel A: Sharpe Ratios of Optimal Plans vs. Suboptimal Plans

***t*-test**	**Sharpe Ratio (3-Year)**	**Sharpe Ratio (5-Year)**	**Sharpe Ratio (10-Year)**
Difference (Optimal – Suboptimal)	0.052***	0.052***	0.052***
	(19.561)	(19.309)	(13.808)
Observations	441	328	69

Panel B: Sharpe Ratios of Optimal Plans with Out-of-State Program Managers vs. Suboptimal Plans with In-State Program Managers

***t*-test**	**Sharpe Ratio (3-Year)**	**Sharpe Ratio (5-Year)**	**Sharpe Ratio (10-Year)**
Difference (Optimal – Suboptimal)	0.068***	0.063***	0.053***
	(10.161)	(9.652)	(8.146)
Observations	52	41	9

Panel C: Analysis of Information Processing Frictions

	Dependent Variable: Proportion of Optimal Accounts			
Variable	**(a)**	**(b)**	**(c)**	**(d)**
Literacy: Test Questions Correct	2.403***		2.729***	
	(4.088)		(6.264)	
Literacy: Self-Assessed High		0.605		-0.005
		(0.661)		(-0.005)
Disclosure: Gunning Fog Index (ratio)	-1.484***	-1.382***		
	(-4.223)	(-4.658)		
Disclosure: Reverse Flesch Reading Ease (ratio)			-2.146***	-2.028***
			(-8.891)	(-6.851)
Total Asset-Based Fee (ratio)	-0.236***	-0.192**	-0.180***	-0.132**
	(-3.833)	(-2.994)	(-3.276)	(-2.515)
Observations	139	139	139	139
Year Fixed Effects	Y	Y	Y	Y
Adjusted R^2	0.096	0.043	0.310	0.240

Appendices

Appendix A: Representative Household Assumptions

The following exhibits show the assumptions used by 529 plan documents. The first figure is from the year 2009 disclosure document of the Michigan 529 Advisor Plan. The second figure is from the year 2009 disclosure document of the Colorado Scholar's Choice Education Savings Plan, showing that key assumptions remain consistent across plans. The third figure is from the year 2020 disclosure document of the Michigan 529 Advisor Plan, showing that the assumptions remain consistent across time.

Exhibit A: 2009 Michigan 529 Advisor Plan assumptions

Examples.
The following Examples are intended to help you compare the cost of investing in Class A or C Units of the various Investment Portfolios with the costs of investing in other 529 plans.

The Examples assume: (i) you invest $10,000 in the noted class of Units for the time periods indicated, (ii) your investment has a 5% return each year, (iii) the Investment Portfolio's operating expenses remain the same (including the operating expenses of the Underlying Funds), (iv) all units redeemed are used to pay Qualified Higher Education Expenses (the table does not consider the impact of any potential state or federal taxes on the redemption), (v) you pay the applicable maximum initial sales charge on Class A Units and any Contingent Deferred Sales Charge applicable to Units invested for the applicable periods in Class C Units and (vi) in the case of the "Year 10" investment period. Although your actual costs may be higher or lower, the Examples show what your costs would be based on these assumptions.

Exhibit B: Colorado Scholar's Choice Education Savings Plan assumptions

Fee Examples
The "Estimated Investment Costs" chart helps you compare the costs of investing in the various Unit Classes under the Program. Your actual costs may be higher or lower. The examples assume:

- A $10,000 investment invested for the time periods shown.
- A 5% annually compounded rate of return on the net amount invested throughout the period.
- Except to the extent indicated, all Units are redeemed at the end of the period shown for qualified higher education expenses (the table does not consider the impact of any potential state or federal taxes on the redemption).
- The investor pays a 1% redemption fee on the proceeds of units of a Zero-Coupon Bond Portfolio redeemed within one year (inclusive) of purchase.
- Total estimated annual asset-based fees remain the same as those shown in the tables under "Overview of Account Owner Costs."
- The Account is not subject to the annual Account maintenance fee of $20 because of the amount invested.
- The investor pays the applicable maximum initial sales charge for Class A Units and any contingent deferred sales charges applicable to units invested for the applicable periods for Class B Units.

Exhibit C: 2020 Michigan 529 Advisor Plan assumptions

COST EXAMPLES

The following examples are intended to help you compare the cost of investing in Class A, Class C, Class I, and Class AR Units of the various Investment Portfolios with the costs of investing in other qualified tuition programs under Section 529.

The examples assume:

a. You invest $10,000 in the noted class of Units in the noted Investment Portfolio for the time periods indicated;

b. Your investment has a 5% return each year;

c. The Investment Portfolio's operating expenses remain the same (including the operating expenses of the Underlying Fund(s));

d. All Units redeemed, if any as noted, are used to pay Qualified Higher Education Expenses (the tables do not consider the impact of any potential state or federal taxes on the redemption);

e. You pay the applicable maximum Initial Sales Charge on Class A Units and any CDSC applicable to Units invested for the applicable periods in Class C Units or Class AR Units;

f. For the Class C Units Example, the Class C Units converted to Class A Units at the end of the sixth year and were thereafter subject to the costs associated with Class A Units; and

g. For the Class AR Units Example, the Class AR Units converted to Class A Units at the end of the first year and were thereafter subject to the costs associated with Class A Units.

Appendix B: Contribution of State and Plan Characteristics to a 529 Plan's Terminal Payoff

Several state-level and plan-level characteristics drive the growth of a 529 contribution from its pre-state-tax amount to its expected terminal payoff. The key state-level characteristics that determine a plan's expected terminal payoff are the state's income tax rate, its tax deduction benefits for 529 plan contributions, and its matching grants for contributions. The key plan-level characteristics that determine a plan's expected terminal payoff (ETP) are the plan's underlying portfolios, asset-based management fee, and dollar-based account maintenance fee.[22] As described in Section II.B., we model these factors as influencing the $Contribution^{s,p}$, $Return^{s,p}$, or $Distribution^{s,p}$ components of a plan's terminal payoff.

This table presents the intermediate values of the model's calculations and describes how state and plan characteristics affect the expected terminal value, respectively. We assess the impact of a single state or plan characteristic by comparing the average ETP given its absence to the average ETP given its presence. As noted in Section II.B., we use a one-time $10,000 contribution made before state taxes are withdrawn. The average expected terminal payoff (ETP) is $20,577, representing an 106% cumulative growth over the account lifetime from the pre-tax contribution. If plans charged no asset-based fees nor account maintenance fees, the average ETP would be $23,432, or 13.88% higher. If all states did not offer tax deduction benefits, the average ETP would be $20,104, or 2.30% lower. If all states charged no state income taxes (and thus had no need for tax deduction benefits), then the average ETP would be $20,762 or 0.90% higher. That is, state taxes consume only an additional 0.90% of 529 plans' ETPs on average, once we account for states' tax benefits for contributions. Lastly, if states offered no matching grants for 529 plan contributions, then the average ETP would be $20,518, or 0.29% lower. Therefore, among all state- and plan-level factors, fees have the largest impact on the expected growth of a 529 plan contribution.

[22] As described in Section II.A., we find that all 529 plans offer both age-/target-year-based and static-allocation portfolios, so we do not vary the 5% return assumption across plans' portfolio option menus.

Quantity	Amount ($)	Expected Terminal Payoff Difference (%)
Pre-Tax Contribution	10,000	
Expected Terminal Payoff (ETP)	20,577	
ETP with:		
No Fees	23,432	13.88%
No State Tax Benefits	20,104	-2.30%
No State Taxes	20,762	0.90%
No State Matching Grants	20,518	-0.29%

Appendix C: Variable Definitions and Data Sources

In this appendix section, we provide variable definitions and more detail about the data sources used in constructing our set of 529 plans.

Variable Definitions

Variable	Definition	Source
529 Plan Participation Rate	Number of open accounts in a state divided by the size of its under-age 20 population	CSPN, ACS
Advisor-Sold	Indicator variable set equal to one if the plan is advisor-sold.	Morningstar
Assets Under Management	Total market value of investments in plan or portfolio.	CSPN
Assets Under Management (proportion)	Proportion of total assets under management in the state that are held in the optimal in-state plan, based on our model calculation.	CSPN
Disclosure: Gunning Fog Index	Disclosure complexity measure based on sentence length and word length. The index applies a binary classification of word length based on syllable counts. Calculated at the state-year level as the average for all plans in a state-year.	MSRB
Disclosure: Gunning Fog Index (ratio)	Ratio of the Gunning Fog Index of the optimal in-state plan disclosure to that of the suboptimal in-state plan disclosure.	CSPN
Disclosure: Reverse Flesch Reading Ease	Disclosure complexity measure calculated as 101 less Flesch Reading Ease, where Flesch Reading Ease is a readability index based on sentence length and word length. The index counts the average number of syllables across the entire document to determine word length. Calculated at the state-year level as the average for all plans in a state-year.	MSRB
Disclosure: Reverse Flesch Reading Ease (ratio)	Ratio of the Reverse Flesch Reading Ease of the optimal in-state plan disclosure to that of the suboptimal in-state plan disclosure.	CSPN
Education Shortfall Per Capita	Difference between the state's education revenues and expenditures, scaled by the size of its under-age 20 population.	ASSLGF, ACS
Expected 529 Investment	Proportion of a state’s age 25-to-65 population with at least some college education.	ACS
Home-State Investment Manager	Indicator variable for plan having a portfolio managed by an in-state investment manager.	Morningstar

Literacy: Self-Assessed High	Proportion of households in a state assessing their financial literacy to be high. Survey conducted in 2009, 2012, 2015, and 2018; linear interpolation applied for years in between.	NFCS
Literacy: Test Questions Correct	Proportion of financial literacy assessment questions correctly answered by households in a state. Survey conducted in 2009, 2012, 2015, and 2018; linear interpolation applied for years in between.	NFCS
Married Household Income	Average married-couple household income for a state.	ACS
Open Accounts	Total number of accounts open in plan.	CSPN
Open Accounts (proportion)	Proportion of total open accounts in the state that are held in the optimal in-state plan, based on our model calculation.	CSPN
Sharpe Ratio (*X*-Year)	Risk-adjusted return of the plan, calculated over the next *X* years.	Morningstar
Total Asset-Based Fee	Annual percentage cost of portfolio investment including all fees.	MSRB
Total Asset-Based Fee (ratio)	Ratio of the total-asset based fee of the optimal in-state plan to that of the suboptimal in-state plan.	MSRB
Underlying Fund Fee	Annual percentage cost of the underlying portfolio.	MSRB

Plan Data Sources

We use three data sets to extract information about plan characteristics. The College Savings Plan Network (CSPN) reports data on assets under management and number of accounts by plan. We gather assets and accounts for each year-end between 2009 and 2021. The Municipal Securities Review Board (MSRB) reports plan disclosure documents for nearly all plans. We download all disclosure documents by plan since 2009. For plans whose disclosures do not reside in the MSRB database, we manually gather their historical disclosures from plan websites and Internet searches. From each disclosure, we extract information on each plan portfolio's underlying management fees, program fees, and total asset-based fees as well as plan-level account maintenance fees. Morningstar Direct collects data on plan characteristics (direct- vs. advisor-sold, residency restrictions, matching grants, program manager, inception and obsolete dates) and portfolio characteristics (monthly returns, assets under management, and

asset management company). We asset-weight portfolio returns to calculate monthly plan returns. We download all plan and portfolio characteristics since 2009. We search asset management company websites to verify their headquarters to determine in-state vs. out-of-state status relative to each plan. Lastly, we use Saving For College data and plan websites as independent checks to verify the accuracy of our data. We merge the CSPN, MSRB, and Morningstar data sets manually by plan name.

State Data Sources

We use four data sets to extract information about states and households. The National Bureau of Economic Research (NBER) provides annual historical tax rates for representative taxpayers for each state. The Census Bureau's American Community Survey (ACS) provides annual historical data on the size, age, college attainment, and income distribution of each state's population. The Census Bureau's Annual Survey of State and Local Government Finances (ASSLGF) provides historical data on states' total revenue and expenditures as well as education-specific revenue and expenditures each year. Lastly, the Financial Industry Regulatory Authority's (FINRA) National Financial Capability Survey (NFCS) reports both objective and subjective indices of households' financial literacy in each state every three years. We merge the NBER, ACS, ASSLGF, and NFCS data sets by state and year. We linearly interpolate the NFCS data for years between survey years.

Appendix D: Example of Variation in the Amount and Timing of 529 Contributions

The following exhibit shows a 529 plan disclosure document describing monthly and annual contribution schedules as alternatives to a lump-sum contribution. This exhibit is from the Texas Tuition Promise Fund's 2021 Academic Tuition Unit Pricing Schedule and Unit Value Redemption Guide.

Type III Tuition Unit Prices and Payment Options

			Monthly Installments				Annual Installments			
Number of Units	Grade Level or Age of Beneficiary	Lump Sum	5-Year	10-Year	Extended	Number of Extended Payments	5-Year	10-Year	Extended	Number of Extended Payments
600	Newborn	$17,490.00	$335.21	$191.85	$130.41	216	$3,917.04	$2,241.82	$1,478.74	19
	0 Year	$17,490.00	$335.21	$191.85	$134.77	204	$3,917.04	$2,241.82	$1,523.88	18
	1 Year	$17,490.00	$335.21	$191.85	$139.72	192	$3,917.04	$2,241.82	$1,574.84	17
	2 Year	$17,490.00	$335.21	$191.85	$145.39	180	$3,917.04	$2,241.82	$1,632.71	16
	3 Year	$17,490.00	$335.21	$191.85	$151.91	168	$3,917.04	$2,241.82	$1,698.89	15
	4 Year	$17,490.00	$335.21	$191.85	$159.50	156	$3,917.04	$2,241.82	$1,775.15	14
	Kindergarten	$17,490.00	$335.21	$191.85	$168.42	144	$3,917.04	$2,241.82	$1,863.84	13
	1st Grade	$17,490.00	$335.21	$191.85	$179.03	132	$3,917.04	$2,241.82	$1,968.07	12
	2nd Grade	$17,490.00	$335.21	$191.85	$191.85	120	$3,917.04	$2,241.82	$2,092.08	11
	3rd Grade	$17,490.00	$335.21	N/A	$207.60	108	$3,917.04	N/A	$2,241.82	10
	4th Grade	$17,490.00	$335.21	N/A	$227.39	96	$3,917.04	N/A	$2,425.87	9
	5th Grade	$17,490.00	$335.21	N/A	$252.94	84	$3,917.04	N/A	$2,657.09	8
	6th Grade	$17,490.00	$335.21	N/A	$287.15	72	$3,917.04	N/A	$2,955.73	7
	7th Grade	$17,490.00	$335.21	N/A	$335.21	60	$3,917.04	N/A	$3,355.48	6
	8th Grade	$17,490.00	N/A	N/A	$407.50	48	N/A	N/A	$3,917.04	5
	9th Grade or Higher	$17,490.00	N/A	N/A	$528.25	36	N/A	N/A	$4,761.76	4