Size and Investment Performance: Defined Benefit vs. Defined Contribution Pension Plans

Donghyeok Jang Youchang Wu*

April 20, 2021

Abstract

Using a comprehensive sample of over 160 thousand U.S. private pension plans, we find significant economies of scale in investment performance and administrative expenses that are more prominent for defined benefit (DB) than for defined contribution (DC) plans. Small DB plans underperform size-matched DC plans and face the highest termination probability, and the majority of both types underperform passive benchmarks. Small plans and small sponsors prefer the DC structure more strongly than large ones do. Our results highlight the inefficiency of small DB plans, which is consistent with the secular shift toward DC plans and the recent trend of consolidation.

JEL codes: G11, G23, G50, J32, D14

Keywords: pension fund, 401(k) plan, asset management, performance measurement, economy of scale

*Donghyeok Jang and Youchang Wu (corresponding author) are at the Lundquist College of Business, University of Oregon. They can be reached by emails at djang@uoregon.edu (Jang) and ywu2@uoregon.edu (Wu). We thank Aleksandar Andonov, Paul Malatesta, Jie Ying (discussant), seminar and conference participants at the University of Oregon, Southern Illinois University, the China International Risk Forum 2020, and the Pacific Northwest Finance Conference 2020 for helpful comments. Declarations of interest: none.

Pension plans are classified into two broad categories: defined benefit (DB) plans and defined contribution (DC) plans. In a DB plan, pension benefits are paid by employers based on a formula that accounts for an employee's wages and years of service with the employer. In a DC plan, each employee has an account to which a certain percentage of her wage incomes is regularly contributed, and pension benefits are determined by the total account balance at the time of retirement. Pension assets in these two types of plans are managed very differently. While assets in DB plans are managed by the employer, either internally or through contracted external managers, each employee is responsible individually for the investment of money in her DC plan, often in the form of choosing among a menu of mutual funds put together by the employer. Although DB plans were the majority in the early 1980s, there has been a great shift to DC plans since then.[1]

The coexistence of DB and DC plans and the large shift toward DC plans since the 1980s have posed several important questions. Do individually managed DC plans perform as well as institutionally managed DB plans in terms of investment returns? Do small plans perform as well as large plans? Does plan size affect DB and DC plans differently and does it drive the sponsor's choice between the DB and DC structure? Finally, how is the secular shift toward DC plans in recent decades related to the shift of the distribution of plan size? While the answers to these questions are important for understanding the nature of the pension asset management business and the causes and welfare implications of the increasing dominance of DC plans, insights from the existing literature are rather limited. Prior studies typically rely on small samples of data self-reported by fund managers to a pension consulting firm, and they have generally focused on defined-benefit plans. To the best of our knowledge, no previous study has made a thorough comparison of investment performance between DB and DC plans.

We aim to fill this gap by analyzing a comprehensive sample of both DB and DC plans. Using the Internal Revenue Service (IRS) Form 5500 filings, we obtain the entire universe of U.S. private pension plans with 100 or more participants. After some basic filtering procedures, our final sample consists of over 160 thousand single-employer plans from 1990 to 2018, with a total of over 1.3 million annual observations and an aggregate asset size of \$6.3 trillion at the end of the sample period. Taking advantage of this comprehensive database, we obtain several

[1] According to the U.S. Department of Labor (2020), from 1980 to 2018, the number of participants in private DB plans decreases from 38 million to 34 million in the U.S., while the number of participants in private DC plans increases from 20 million to 106 million; the total assets in DB plans increase from \$401 billion to \$2.97 trillion, while the total assets in DC plans increase from \$162 billion to \$6.26 trillion.

novel findings.

First, there is a positive and concave relation between plan size and investment performance, and the positive size effect in performance is more pronounced among DB plans. The portfolio formed by largest 10% DB (DC) plans outperforms the portfolio formed by the smallest 10% DB (DC) plans by a statistically significant margin of 1.88% (0.77%) per annum. The differential size effects also show up strongly in plan-level cross-sectional regressions using benchmark- or risk-adjusted performance measures. According to our preferred model specification, which controls for both the performance measurement period fixed effects and the sponsor fixed effects, a DB (DC) plan that enters our sample with an initial log asset size one standard deviation above the cross-sectional mean outperforms a DB (DC) plan with an initial asset size close to the mean by 20 (8) basis points per annum in benchmark-adjusted returns. The differential size effects can only be partially explained by a faster decline of DB plan expense ratio as size increases. These results suggest that the degree of returns to scale in asset management is a function of the organizational form.

Second, DB plans underperform size-matched DC plans in benchmark-adjusted returns in most size ranges. For plans with the average size, the underperformance ranges between 32 to 86 basis points per year depending on model specifications. This result holds consistently under four different benchmarking approaches. In terms of the Sharpe ratio and raw returns, our regression analysis shows that small DB plans underperform while large DB plans outperform their size-matched DC counterparts. Given the limited financial knowledge of typical plan participants, these findings are somewhat surprising. They suggest that the potential issues of DC plans may be outweighed by agency and administrative costs of DB plans.

Third, the majority of both types of plans underperform their passive benchmarks. Out of the 20 size portfolios formed by DB and DC plans separately, only the one formed by the largest 10% DB plans has a non-negative point estimate of alpha against its benchmark formed by the Vanguard Index Funds. The portfolio formed by the smallest 10% DB plans underperforms its passive benchmark by 1.52% per annum. Since the index funds are highly liquid investment opportunities readily available to both retail and institutional investors, the underperformance reflects inefficiency in the pension asset management.

Fourth, plan size strongly affects the plan termination probability, especially for DB plans, and the plan structure adopted by new plans. Consistent with the comparative disadvantage of the DB structure for small plans, small DB plans faces the highest probability of being terminated, and small new plans are significantly more likely to adopt the DC structure than large ones. Furthermore, the rise of DC plans in the U.S. pension system is accompanied by a downward shift of the median plan size relative to the aggregate size of the stock and bond markets. A univariate regression shows that 47% of the variation in the annual changes in the percentage of DC plans in all pension plans can be explained by the changes in the scaled median plan size.

Last but not least, we examine the effects of plan sponsors on pension plans by merging our pension plan data with the Compustat company data. While our baseline results are largely unaffected after we control for sponsor characteristics, sponsor characteristics have additional explanatory power for plan performance, termination rate, and the choice between the DC and DB structures. Holding the plan size constant, a larger sponsor size is associated with better plan performance, especially for DB plans, and a lower probability that a new plan adopts the DC structure. In addition, sponsors with low profitability or high leverage are more likely to terminate their DB plans.

Taken together, our results demonstrate comparative advantages of the DC structure relative to the DB structure as an organizational form for small pension plans in both cost efficiency and investment performance. Compared to small DC plans, small DB plans are more costly to manage, and have poorer performance even after controlling for expenses. This means that to achieve the same level of employee retirement benefits, or the same degree of employee satisfaction, sponsors of small DB plans have to contribute more to employee retirement plans than sponsors of small DC plans, which implies a bigger financial burden for their shareholders. No surprisingly, small plan sponsors have a preference for the DC structure. Combined with the evidence of a downward trend in the plan size distribution, our findings suggest that the relative inefficiency of the DB structure for small plans may be a contributing factor to the shift from DB to DC plans in recent decades. Our results are also relevant to pension sponsors regarding pension designs. They demonstrate that the choice of the pension structure should be size-dependent.

Our findings of strong economies of scale in pension asset management help to explain the recent trend of consolidation in the pension sector, especially among DB plans. As a result of plan liquidation and consolidation, the number of DB plans in our sample drops by 55% from 1990 to 2018, but the size ratio of an average DB plan to an average DC plan increases from

2.4 to 4.9. A similar trend of consolidation is also observed in other countries.[2] In the DC plan sector, although the number of plans continues to grow in the U.S., inefficiency associated with small plan size has led to the development of the so-called collective defined contribution schemes in Canada, Denmark and the Netherlands, in which money is pooled for investment purpose and investment risk is borne by plan participants. The most recent addition to the list of countries embracing this new type of pension plans is the U.K., where collective defined contribution scheme is introduced through the newly passed Pension Schemes Act 2021.

Our paper contributes to the literature on pension plan performance. Lakonishok et al. (1992) examine the performance of 769 DB equity pension funds and find that they underperform the S&P 500 index by 130 basis points even before management fees are deducted, which is worse than the average performance of equity mutual funds. They attribute the underperformance to agency issues in DB plans. Coggin et al. (1993) study a sample of 71 equity pension fund managers and find the average stock selection ability to be positive and the average market timing ability to be negative. Christopherson et al. (1998) examine a sample of 185 large equity pension fund managers and find performance persistence concentrated in managers with poor past performance. Bergstresser et al. (2006) find that asset allocations of DB plans are affected by earnings manipulation incentives. Goyal and Wahal (2008) find that DB plan sponsors choose investment managers in a suboptimal way. As to DC plans, Huberman and Jiang (2006), Benartzi and Thaler (2007), and Tang et al. (2010) document behavioral biases such as naive asset allocation and inertia of DC plan participants. Chalmers and Reuter (2020) find that financial advice provided by brokers to DC plan participants are counterproductive. Cohen and Schmidt (2009), Pool et al. (2016), and Pool et al. (2020) highlight the agency issues associated with mutual fund families acting as corporate 401(k) plan trustees or services providers. On the positive side, Del Guercio and Tkac (2002) find that compared to mutual fund investors, pension fund sponsors use more sophisticated performance measures in evaluating fund managers, and that they are more likely to withdraw money from underperforming fund managers and less likely to flock to recent winners. Sialm et al. (2015) mutual fund flows attributed to DC plans are more discerning than non-DC flows, suggesting active monitoring by plan sponsors.

Given the agency issues and investment problems documented for both DB and DC plans,

[2] For example, according to Dutch Central Bank (2017), there were 1,060 pension funds in the Netherlands in 1997, mostly in the DB form, but only 268 were left in 2017 because of liquidations, mergers, and transfers of pension assets and liabilities from independent pension funds to general pension funds.

it is unclear which type of plans deliver better performance. However, we are not aware of any existing study that has systematically examined the performance difference between these two types of pension plans.[3] Our analysis at both the portfolio and individual plan levels shows that plan performance is strongly size-dependent. Although the unconditional mean of raw returns is higher for DB plans, small DC plans compare favorably with size-matched DB plans in various performance measures. Furthermore, the majority of both types of plans underperform passive benchmarks formed by index funds..

Our study also contributes to the literature on returns to scale in asset management. Previous studies based on mutual funds have produced conflicting findings.[4] Studying returns to scale using mutual funds faces a fundamental challenge: fund size is endogenously determined by investors' perception of managerial ability because they can easily move into and out of a fund. This is not the case for pension funds, which are tied to employment. Therefore, the size of a pension plan is largely determined by exogenous factors such as firm age and scale of the workforce. This provides a better setting for testing returns to scale in asset management. Using self-reported samples of DB funds collected by CEM Benchmarking Incorporated, Dyck and Pomorski (2012) and Andonov et al. (2012) find evidence of cost saving associated with larger fund size. However, they reach opposite conclusions on net performance. While Dyck and Pomorski (2012) show that the largest DB plans outperform smaller ones by 43-50 basis points per year in terms of net abnormal performance, Andonov et al. (2012) show that large DB plans underperform small plans due to size-induced liquidity constraints. We contribute to this debate by exploiting a comprehensive sample of both DB and DC plans. We find strong evidence of economies of scale, not only in administrative costs but also in net returns. The net return gap between large and small DB plans we find is much bigger than the gap reported by Dyck and Pomorski (2012), and it can only be partially explained by the difference in expenses. More importantly, by studying DB and DC plans jointly, we demonstrate significantly different size effects in these two types of plans, which provides insights into the effect of organizational forms on returns to scale in asset management.[5]

[3]Munnell et al. (2006) and Munnell et al. (2015) make some simple comparisons and find that DB plans outperform DC plans in raw returns. They do not consider any risk or benchmark adjustment.

[4]While Chen et al. (2004), Yan (2008), Wu et al. (2016), Zhu (2018), and McLemore (2019) find that size of assets under management erodes investment performance, Reuter and Zitzewitz (2015) find little evidence of decreasing returns to scale. Pastor et al. (2015) find evidence of decreasing returns at the industry level, but not at the fund level.

[5]The difference between our result and the finding of Andonov et al. (2012) is likely due to different sample coverages. While they analyze self-reported samples of a few hundred large DB plans, we examine a comprehen-

Lastly, our paper contributes to the literature on the causes and consequences of the shift from DB to DC plans. Various explanations have been proposed for this great shift. For example, the shift of employment from large hierarchic firms and unionized industries to small firms and non-unionized, less-stable, high-tech industries (Gustman and Steinmeier (1992), Ippolito (1995)), enhanced pension regulations that increase the costs of DB plans for sponsors (Clark and McDermed (1990)), and inefficiency in risk sharing by DB plans relative to DC plans (Li et al. (2020)). Petersen (1992) and Rauh et al. (2019) show that firms can save significant financial costs in terms of future compensation to employees by replacing DB plans with DC plans, implying that such a replacement represents a wealth transfer from workers to shareholders. Poterba et al. (2004) find higher saving and wealth accumulation under 401(k) than under DB plans. Samwick and Skinner (2004) show that the trend toward 401(k) has strengthened the retirement security for workers. We contribute to this literature by demonstrating the comparative disadvantages of small DB plans in both cost efficiency and investment performance. Combined with the evidence of a downward shift of the scaled median plan size and a strong influence of plan size on the plan structure choice, our findings offer a size-based explanation for the overall decline of DB plans, which complements instead of contradicting the existing explanations. Because retirement incomes in DB plans are not directly determined by investment returns, our results do not speak about which pension system is more favorable to employees. However, they provide insight into the relative efficiency of the DB and DC plans as two alternative organizational structures of pension asset management, which has valuable implications for the pension design.

The remainder of this paper is organized as follows. Section 1 outline the hypotheses and describes the data. Section 2 presents results based on size-sorted portfolios. Section 3 presents the evidence for the differential effects of plan size on DB and DC plan performance, expenses, and termination probability based on regression analysis. Section 4 shows how size drives the choice between DB and DC plans. Section 5 examines how pension sponsor characteristics affect plan performance, termination probability, and the choice of pension structure. Section 6 shows the extent to which the rise of DC plans can be explained by the downward shift of the scaled median plan size and present the results from robustness tests. Section 7 concludes.

sive sample representative of the universe of the U.S. private pension plans, which includes many small plans. The average plan size in the sample of Andonov et al. (2012) is \$10 billion, which is equivalent to the average in the top 1% of plan size distribution in our sample.

1. Hypotheses and Data

In this section, we first briefly discuss the hypotheses that motivate our tests and then describe our data.

1.1. Hypotheses

Whether private pension plans in general outperform passive benchmarks is an open empirical question that can only be answered by data. Similarly, we do not have a strong prior about whether individually managed DC plans can perform as well as institutionally managed DB plans. On the one hand, the DB structure has several advantages. First, the trustees of DB plans should have better financial knowledge than typical DC plan participants and be less subject to behavioral biases. Therefore, they should be able to make more informed decisions about investment or asset allocation among outside managers. Second, because pension sponsors bear the financial outcome of DB plan performance, they may have a stronger incentive to monitor DB plan managers, which should translate into better performance. On the other hand, it is well-known that DB plans are subject to many agency problems, as studies discussed in Introduction have shown. Furthermore, administrative costs of DB plans are likely to be higher, which hurts the plan performance. Which force is more dominant is an empirical question.

Given the comprehensive pension plan sample we study, we conjecture that larger plans are likely to perform better than small plans. Unlike mutual funds, whose sizes are determined endogenously by market force, and whose managers have an incentive to grow the funds beyond the optimal size in order to generate more fee incomes, pension plan size is limited by the size of workforce of the plan sponsor. For the majority of plans in our sample, diseconomies of scale caused by liquidity costs of large trades or hierarchy costs of large organizations, as postulated by Berk and Green (2004) and documented by Chen et al. (2004), are unlikely to be a big concern. On the contrary, most plans may suffer from a below-optimal size, which makes it difficult to amortize the fixed administrative and investment costs. Presumably, performance is a concave function of asset size, first increasing and then decreasing as the size increases. We expect that most plans in our sample are still located in a range where the effect of economies of scale dominates.[6] Furthermore, large pension plans often split their assets among many outside fund managers. This further allows them to avoid diseconomies of scale due to centralized management (see Blake et al. (2013)).

An important reason for economies of scale in pension plan management is the fixed costs of professional services, such as the legal, accounting, bookkeeping, appraisal, and administrative fees. These costs are likely to be higher for DB plans, because more services are required for them. For example, the estimation of the present value of pension liability, which is necessary for a DB plan but not for a DC plan, is a challenging task. It requires a lot of expertise and is not necessarily easier for small plans. Therefore, we expect expense ratios of DB plans to decline faster as plan size increases. Furthermore, we expect plan size to have a bigger impact on investment performance of DB plans, because a large plan size may not only allow sponsors to retain better outside managers and negotiate better investment management contracts, it may also make it cost efficient to maintain an internal asset management team.[7] In contrast, the involvement of sponsors in DC plans is limited, mainly confined to the setting and monitoring of the investment menu. Although a larger plan may allow sponsors to hire better trustees and consultants to create and maintain a better investment menu, or provide more education and assistance to help employees make better investment decisions, the fact that these decisions are ultimately made by individual employees suggests that the benefits of a large plan size may be more limited.

Weaker economies of scale also mean that DC plans do not suffer as much when the size is small, which makes them more suitable for small plans. Therefore, we expect that small DB plans are more likely to be terminated than small DC plans, and small new plans are more likely to adopt the DC structure. Furthermore, because sponsors bear liabilities of DB plans, we expect sponsors with lower profitability and higher leverage to be more likely to terminate DB plans. Furthermore, even holding constant the plan size, small sponsors, which are more likely to be financially constrained, may still prefer the DC structure as it allows them to preserve debt capacity. These conjectures also imply that as more and more workers migrate

[6] The largest plan at the end of 2018 in our sample is the Boeing Company Voluntary Investment Plan, a DC plan sponsored by the Boeing Company and Consolidated Subsidiaries, which has a total of $58.7 billion. By comparison, the two largest U.S. public pension funds (other than the Social Security Trust Funds), the Military Retirement Fund and the Federal Employees Retirement System, hold total assets of $814 billion and $680 billion, respectively, at the end of the 2018 fiscal year.

[7] Dyck and Pomorski (2012) show that larger plans are 13 times more likely to manage their active assets internally than smaller plans, and they estimate the costs under internal management to be at least three times lower than under external management.

from large manufacturing firms to small service and technology firms, the DC structure will play an increasingly important role in the pension system.

1.2. Sample Construction

Our pension plan data are extracted from the IRS Form 5500 filings. Form 5500 was jointly developed by the U.S. Department of Labor (DOL), Internal Revenue Service (IRS), and Pension Benefit Guaranty Corporation (PBGC) for annual reporting required by the Employee Retirement Income Security Act of 1974 (ERISA). It is intended to ensure that employee retirement and benefit plans are properly managed, and that rights and interests of plan participants and beneficiaries are properly protected. Other than a few exceptions, all plans covered by ERISA are required to file Form 5500 on an annual basis, which provides basic information such as the names of the plan sponsor and the administrator. Plans with 100 or more participants are further required to file Schedule H as an attachment, which reports the assets and liabilities both at the beginning and the end of a plan year, as well as incomes, expenses, and transfers during the year. In addition, a plan is required to file a final report when it is terminated.[8] Each plan is identified by a sponsor, which has an employer identification number (EIN), and a permanent plan number designated by the sponsor. For the period from 1999 to 2018, the IRS keeps the Form 5500 data available on its website.[9] Older data covering the years from 1990 to 1998 are available upon request from the Department of Labor. We combine data from both sources to form a sample covering the years from 1990 to 2018.

Compared to other sources of pension plan information, Form 5500 filings have several important advantages. First, because the filing is compulsory, the coverage is comprehensive and there is no selection bias. In contrasts, databases from other sources often rely on voluntary self-reporting and usually cover only the big plans. Second, financial information in Schedule H must be audited by an independent qualified public accountant before being submitted. This ensures the data reliability.

We focus on plans with 100 or more participants so that the necessary financial information is available form Schedule H. We apply a number of filters to ensure data accuracy and consistency. (1) We delete all filings with a "FILING_ERROR" or a "PROCESSING_STOPED"

[8]ERISA covers most retirement plans in private industry, but it does not cover retirement plans set up and administrated by government entities. Therefore, our sample does not include public pension plans.

[9]The web address is https://www.dol.gov/agencies/ebsa/employers-and-advisers/plan-administration-and-compliance/reporting-and-filing/form-5500.

flag. (2) Given our focus on pension plans, we exclude all welfare plans, which are required to file the same report (such as health plans). (3) A small fraction of pension plans are sponsored by multiple employers or file as a direct filing entity. Since these plans may be operated differently and their terminations may be driven by different factors, we exclude them from our analysis and focus only on single-employer plans.[10] (4) When a plan has multiple filings for the same year, we first delete redundant filings with identical contents. If the contents of the filings are not identical and some filings are indicated as amended or final, we keep the indicated ones and delete the rest. There are a small number of plan years with conflicting filings and there is no possibility to determine which one is correct, we exclude those plan years from our analysis.[11] (5) While most plan years coincide with calendar years, about 13% of them do not. To ensure time consistency and return comparability, we keep only plan years that are the same as the calendar years, and refer to them as regular plan years. When a plan is terminated before the year end, we record such a termination at the end of the prior regular plan year. Plan termination is identified by the filing of a final report. (6) If a plan files a final report, we discard its subsequent filings because those may be filings of a new plan reusing the same plan number. Less than 0.5% annual observations are removed because of this filter. (7) We require a minimum of $1 million assets (measured in year 2018 dollars) at the beginning of the year for a plan year to be included in our sample. Our final sample include 166,235 unique plans. Each on average has 7.9 years of data. The total assets in the plans amounts to $6.3 trillion at the end of year 2018, which account for 78% of the total assets in the universe of U.S. single-employer private pension plans and 68% of the total assets in the U.S. private pension system.

1.3. Return and Performance Measures

Following Munnell et al. (2015), we define the raw return of pension plan i in year t as

$$R_{i,t} = \frac{\text{Net Assets}_{i,t} - \text{Net Assets}_{i,t-1} - \text{Contribution}_{i,t} + \text{Distribution}_{i,t} + \text{Net Transfer}_{i,t}}{\text{Net Assets}_{i,t-1} + 0.5\text{Contribution}_{i,t} - 0.5 * \text{Distribution}_{i,t} - 0.5 * \text{Net Transfer}_{i,t}}, \tag{1}$$

[10] For Form 5500 reporting purpose, a group of employers under common control is generally considered one employer. In 2018, 94% of the pension plans with a minimum of $1 million assets file as a single-employer plan.

[11] This problem exists mostly in the 1999-2018 period. About 1.3% of the plan-year observations during this period drop out of the sample because of this filter.

where Net $\text{Assets}_{i,t-1}$ and Net $\text{Assets}_{i,t}$ are the net assets at the beginning and the end of the year t, respectively;[12] $\text{Contribution}_{i,t}$ and $\text{Distribution}_{i,t}$ are the amount contributed to the plan and the amount paid out to beneficiaries during the year t, respectively; and Net $\text{Transfer}_{i,t}$ is the amount transferred out of the plan minus the amount transferred into the plan, which often occur when a plan is merged or terminated. An assumption underlying this return formula is that contributions, distributions, and transfers are made in the middle of the year. Following Rauh (2009), we treat returns above 500% or below -80% as data errors and exclude them from analysis (this truncation reduces the number of observations only by 0.2%). We winsorize the remaining observations at the 1st and the 99th percentiles.

Schedule H provides information about asset allocations of each plan, both at the beginning and the end of the year. Following Munnell et al. (2015), we group the allocations into five categories. We define *SafeAssets* as the investments in cash, government bonds, and funds held in insurance company general accounts; *Equity* as the investments in preferred and common stocks (including the stock issued by the sponsor); *MutualFund* as the funds invested in registered investment companies; *Trust* as the sum of investments in common/collective trusts, pooled separate accounts, master trust investment accounts, and 103-12 investment entities; and *Other* as the sum of all other investments. We divide the dollar values of these investments by the total assets of the plan at the beginning of the year to obtain the fraction of assets in each class, and winsorize these ratios at the 1st and the 99th percentiles to mitigate the influences of outliers and potential data errors.

We use three different metrics to measure the investment performance of a pension plan or plan portfolio: alpha, Sharpe ratio, and geometric mean return. Following Berk and van Binsbergen (2015), we use the Vanguard index funds as the benchmark to estimate fund alpha. Risk factors such as the popular Fama and French (1992) size factor (small-minus-big) and book-to-market factor (high-minus-low) do not include trading costs. Therefore, they do not represent investment opportunities directly available to investors. In contrast, the Vanguard index funds are passive investment vehicles readily available to both institutional and retail investors, and their returns are net of trading costs and management expenses. This makes them a more appropriate benchmark. We consider two alternative models.[13] The first model

[12] A plan may have some liabilities such as benefit claims payable and operating payable, which creates a difference between total assets and net assets. However, for 95% of the observations, the liabilities are less than 1.5% of the total assets. For the return calculation, we do not adjust asset values for inflation, although we do so when we use asset values to measure fund size. Therefore, the returns are in nominal instead of real term.

[13] As robustness checks, in our cross-sectional regressions, we also use an augmented Fama and French (1992)

uses the Vanguard 500 Stock Market Index Fund (ticker VFINX) and the Vanguard Total Bond Market Index Fund (ticker VBMFX), which represent the equity market and bond market returns, respectively, as the benchmark. Specifically, we estimate the plan alpha by running the following regression:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_{e,i}(R_{e,t} - R_{f,t}) + \beta_{b,i}(R_{b,t} - R_{f,t}) + \epsilon_{i,t}, \tag{2}$$

where $R_{i,t}$ is the annual return of a pension plan or plan portfolio; $R_{f,t}$ is the one-year constant maturity Treasury rate; and $R_{e,t}$ and $R_{b,t}$ are annualized returns of the Vanguard stock and bond funds mentioned above.[14] The second model includes two additional funds in the benchmark portfolio: the Vanguard Extended Market Index Fund (ticker VEXMX) and the Vanguard Balanced Index Fund (ticker VBINX). The first fund represents the exposure to the U.S. mid- and small-capitalization stocks and the second invests roughly 60% in stocks and 40% in bonds. A popular choice for retirement money investment is target date mutual funds, which holds a mix of stocks and bonds based on the expected retirement time. Including the balance fund in the benchmark portfolio helps to capture the risk exposure of such investment strategies.[15]

The Sharpe ratio is calculated as the time-series mean of the annual excess returns (over the one-year Treasury rate) divided by the standard deviation. The geometric mean return is the N-th root of the cumulative gross return minus one, where N is the number of years over which the cumulative return is calculated. We use the geometric instead of arithmetic mean to measure the return over multiple years because of the well-known upward bias of arithmetic mean arising from return volatility.

While we include all available return observations for portfolio analysis, to calculate the above performance measures at the individual plan level, we require a plan to have at least five annual return observations. Furthermore, the plan-level estimates of alphas, betas, and Sharpe ratios are truncated at the 1st and 99th percentiles to mitigate the effects of potential estimation errors.

three-factor model and a model that accounts for exposure to international equity markets to estimate alpha.

[14] We have also used the annual return of the Vanguard Federal Money Market Fund as a measure of the risk-free rate $R_{f,t}$, and the results are almost identical.

[15] The Vanguard Balanced Index Fund was launched in November 1992. We backfill returns in 1990 to 1992 using the fitted values of a regression of its returns on the returns of the Vanguard 500 Stock Market Fund and the Vanguard Total Bond Market Fund.

1.4. Summary Statistics: DB vs. DC Plans

It is well-known that there has been a shift from DB to DC plans in the U.S. pension system. Our sample allows us to take a closer look at this transition. Panel A of Table 1 provides the numbers of DB vs. DC plans and sponsors, as well as total assets in each type of plans, year by year from 1990 to 2018. Figure 1 shows the evolution graphically. The assets values are converted into year 2018 dollars using the GDP deflator. The transition from DB plans to DC is steady throughout the sample period. The number of DB plans decreases by 55%, from over 10,000 in 1990 to less than 5,000 in 2018, and the number of sponsors with only DB plans drops by three quarters. In contrast, the number of DC plans more than triples, from around 13,000 to nearly 57,000, and the number of firms sponsoring only DC plans increases fivefold.[16] Correspondingly, while the aggregate asset value of DB plans is 1.61 times as large as the aggregate asset value of DC plans in 1990 ($933 billion vs $579 billion), the former is only 40% of the latter in 2018 ($1.8 trillion vs. $4.5 trillion).

However, the number of firms sponsoring both DB and DC plans, which are usually older and larger firms, remains remarkably stable in the past three decades. By dividing the total assets by the total number of plans, one can also see that the average size of DB plans has increased substantially relative to the average size of DC plans, as shown in Panel D of Figure 1. In 1990, the size ratio of an average DB plan to an average DC plan is 2.4. However, this ratio has increased to 4.9 by 2018 ($387 million vs. $79 million). This suggests that the great shift from DB to DC plans is accompanied by a trend of consolidation in the DB sector and the births of many new DC plans that are relatively small.

Panel B of Table 1 presents summary statistics at the plan-year level. It reveals more differences between DB and DC plans. DB plans are bigger, older, and have higher administrative costs, relative to DC plans. In particular, its expenses-to-asset ratio is 45 basis points higher (0.69% vs. 0.24%). The administrative expenses include all costs incurred in the general operations of the plan and paid by or charged to the plan, from fees and expenses paid for accounting/bookkeeping, actuarial, legal, valuation/appraisal, investment management, investment advice, and administrative services, to salaries and other compensation for plan trustees and employees, as well as other expenses such as office supplies and equipment. It is worth

[16] The temporary drop in the number of plans in 1999 is most likely caused by the changes in filing requirements and data sources. 1999 is the first year for which data become available on the IRS website. It is possible that the switch leads to some data losses.

noting that they generally do not include fees and expenses charged indirectly, such as investment management fees paid by mutual funds that pension plans invest in. The expense ratio should be higher once such expenses are factored in, especially for DC plans.[17] Despite the higher administrative costs, the average raw return of DB plans is 88 basis points higher than that of DC plans, consistent with the finding of Munnell et al. (2015).

In terms of asset allocation, about one half of DC plan assets are invested in mutual funds, while nearly one half of DB plan assets are invested through various investment trusts. The faction of assets invested in safe securities is similar for both types of plans (15% vs. 11%), while the fraction of assets directly invested in stocks is higher for DB plans (11% vs. 6%).

Panel C of Table 1 presents the performance-related summary statistics at the plan level, using plans with at least five years of return data (a total of 96,170 plans satisfy this requirement). $\text{Beta}_{\text{Equity}}$ and $\text{Beta}_{\text{Bond}}$ measure a pension plan's exposures to the aggregate stock market and the aggregate bond market, respectively. DB plans are exposed to both stock and bond markets, with an average beta of 0.49 and 0.30, respectively. While DC plans have a higher exposure to the stock market (with an average beta of 0.65) than DB plans, they have virtually no exposure to bond market (with beta of 0.01). This is somewhat surprising given that a large number of bond mutual funds are available for DC investment. The mean values of the alpha estimated using two Vanguard funds as the benchmark, Alpha2, is -0.80% per annum for DB plans and -0.98% per annum for DC plans, suggesting that the majority of both types of plans underperform their passive benchmarks formed. Since the benchmark portfolios are highly liquid investment opportunities readily available to both institutional and retail investors, this underperformance reflects the inefficiency in pension asset management. In terms of the geometric mean of raw returns, DB plans outperform DC plans on average by 1.3% per annum, but the average Sharpe ratios (SR) of the two types are identical.

To summarize, the summary statistics of our sample reflects a pronounced trend of shifting

[17] Expenses incurred by mutual funds that pension plans invest in are not regarded as administrative expenses paid by the plan because mutual fund assets are not deemed "plan assets" for the purposes of ERISA. They are treated as indirect expenses. Generally speaking, the underlying assets of a pooled investment vehicle are deemed to be plan assets if plan participants own 25% or more of the equity interests in the vehicle. However, there are exceptions, which include mutual funds. Starting from 2009, pension plans are required to disclose both direct and indirect compensation to service providers in Schedule C of Form 5500. However, most indirect compensation is eligible for exemption from this requirement under the condition that the sponsor receives written disclosures about it from service providers. Furthermore, for the disclosed indirect compensation, most plans report the compensation formula of each service provider instead of the actual payment amount, which is hard to aggregate to the plan level due to the lack of information about how plan assets and services are allocated among the service providers.

from DC to DB plans from 1990 to 2018, but the average size of DB plans has doubled relative to the average size of DC plans. The unconditional means of performance appear to be higher for DB plans than for DC plans. However, this comparison ignores the heterogeneity in the time period over which the performance is measured and other fund characteristics. As we show in the next sections, the results are quite different after we condition on the measurement period as well as size and other plan characteristics.

2. Size and Performance: Portfolio Analysis

In this section, we conduct our analysis at the portfolio level. To get the first impression about the size effect in pension performance, we plot in Figure 2 the cumulative returns of the aggregate DB and DC portfolios from 1990 to 2018, using both the equal-weighting scheme and the value-weighted scheme, in which the annual return of each plan is weighted by the total asset value of the plan at the beginning of the year. The average value-weighted return of DB plans exceeds that of the DC plans by 62 basis points (8.28% vs. 7.65% per annum), but the difference is statistically insignificant (t=0.22). The average equal-weighted returns of the two types are almost identical (6.86% vs. 6.84% per annum). Notably, the value-weighted return is significantly higher than the equal-weighted for both types, suggesting the existence of economies of scale in both. The difference is 1.41% per annum (t=4.32) for DB plans and 0.81% per annum (t=3.19) for DC plans. The bigger gap for DB plans suggests that economies of scale are more pronounced in this type of plans.

We now investigate economies of scale in pension management by examining the performance, expense ratio, and termination rate of pension plan portfolios sorted on asset size.

2.1. Alpha Spread in Size-sorted Portfolios

At the beginning of each year, we evenly sort both DB and DC plans into ten size portfolios. A separate sorting for each type ensures that both types of plans are split evenly across portfolios. We then compute the value-weighted return of each portfolio in each year, with each plan weighted by its asset size at the beginning of the year. Using the time series of the returns, we compute four performance measures for each portfolio: alphas estimated using two alternative Vanguard benchmarks, Sharpe ratio, and geometric mean return. We also form a zero-investment portfolio by longing the top decile portfolio (the biggest) and shorting the bottom decile (the smallest). Furthermore, for Alpha2 and Alpha4, we also form zero-investment portfolios by longing a DB portfolio and shorting a DC portfolio in the same size bucket. This allows us to compare the performance of DB and DC plans conditional on relative size within a plan type. Finally, we test the existence of differential size effects for DB and DC plans by comparing the difference between the long-short portfolios separately formed using DB plans and DC plans (a difference-in-difference analysis).

Panel A of Table 3 presents alphas of size-sorted DB and DC portfolios. The results for alphas estimated using two alternative Vanguard benchmarks are similar. With the exception of the largest DC plan portfolio, the estimated alphas increase monotonically as the size increases. The economies of scale appear to be much stronger in DB plans than in DC plans. The long-short portfolio constructed using DB plans generates a positive Alpha2 (Alpha4) of 1.88% (1.79%) per annum, significant at the 1% level, while the similar portfolio constructed using DC portfolio generates an Alpha2 (Alpha4) of only 0.77% (0.58%) per annum. The difference in the Alpha4, which amounts to 1.21% per annum, is significant at the 10% level, despite that the number of annual observations is small (29). The table also shows that the alphas of the bottom two DB portfolios are significantly negative, suggesting that those plans suffer most from a below-optimal size.

The alphas of the long-short portfolios constructed using DB and DC plans in the same size bucket, reported in the third section of Panel A, show that DB portfolios underperform the size-matched DC portfolios in all size groups except the largest one, and the underperformance in Alpha4 is statistically significant for most size groups. These results cast a favorable picture for DC plans.

To examine whether economies of scale exist even for the largest plans, we further sort separately DB and DC plans in the top size decile into ten groups. Each group now represents 1% of plans in its category. The alphas and other characteristics these size-sorted portfolios are presented in Table A.1 in Internet Appendix. Strikingly, among the 10% largest DC plans, there is no longer economies of scale. If anything, there appears to be a negative relation between size and portfolio alpha. However, economies of scale are still very strong among the largest DB plans. Alphas still increase monotonically as the size increases, and the spreads in Alpha2 and Alpha4 between portfolios 10 and 1 are 1.32% and 1.19% per annum, respectively, both statistically significant at the 1% level. Correspondingly, the differences in the large-minus-small spreads between DC and DB plans are even bigger: 1.56% in Alpha2 and 1.49%

in Alpha4, both significant at the 1% level. These results further demonstrate that economies of scale are more pronounced in DB plans.

2.2. Other Characteristics of the Size-Sorted Portfolios

Panel B of Table 3 presents other characteristics of size-sorted pension plan portfolios. A comparison of the average asset size across DB and DC plans reveals that the average DB plan size is larger than the average DC plan size in all size groups. Given the evidence of economies of scale we uncover, this suggests that the within-size group performance comparison reported in last section of Panel A is biased against DC plans. This is not an issue when we analyze the size-performance relation using regressions in the next sections.

Results in Panel B of Table 3 further confirms a positive size effect in performance for both DB and DC plans and a significantly stronger size effect for DB plans. The geometric mean return and the Sharpe ratio increase monotonically from portfolio 1 to portfolio 10, but the magnitudes of the increases are bigger for the DB plans. In addition, the expense ratios of both DB and DC plans decrease monotonically as the plan size increases. Due to the higher level of expense ratio of DB plans, this decrease is bigger in magnitude for DB plans. Between the bottom and the top size deciles, the difference in expense ratio is 74 basis points for DB plans, and 35 points for DC plans. Plan termination rate exhibits the same pattern, featuring a faster decline from the bottom size decline to the top size decile for DB plans (4.59% to 2.03%) than for DC plans (from 2.30% to 2.02%).

Panel B of Table A.1 in Internet Appendix shows that for the size portfolios formed using the largest 10% plans, the economies of scale are still evident among DB plans, but they are much weaker among DC plans. For example, the difference in the annual expense ratio between portfolio 10 and portfolio 1 is 23 basis points for DB plans, but it is only 4 basis points for DC plans, although both differences are statistically highly significant.

The underperformance and high administrative costs of the small DB plans, together with the high termination rate, suggest that cost inefficiency and poor investment performance may be an important reason why small DB plans are continuously giving way to DC plans.

3. Differential Size Effects in DB and DC Plans: Regression Analysis

The last section shows evidence of stronger economies of scale in DB plan than in DC plans using portfolio analysis. We now investigate the size effects in these two types of plans using regression analysis. We first investigate the cross-sectional relation between size and performance. We then examine the differential effects of plan size on administrative expenses and termination rates of DB and DC plans using panel regressions.

3.1. Size and Relative Performance of DB and DC Plans

3.1.1. Empirical Models

Since the benchmark and risk exposure of each plan are not known, the measurement of benchmark- or risk-adjusted performance requires the time series of return data. Therefore, for our baseline analysis, we use the plan as the unit of observations, and require a plan to have at least five years of return data available. We compute three performance measures for each plan: Alpha estimated using two Vanguard funds as the benchmark, Sharpe ratio, and geometric mean return. These measures are computed using all available return observations of a plan during our sample period. We use the asset size and other plan characteristics observed at the beginning of the performance measurement period as performance predictors. This ensures that our explanatory variables are not affected by the measured fund performance. To account for the fact that performance is measured more accurately for plans with a longer time series of return data, in all our specifications, we weight each plan by the number of years for which its returns are available. This ensures that our estimates are more heavily driven by the plans whose performance is measured more accurately. As robustness checks, we perform Fama-MacBeth regressions using unadjusted annual returns and estimate alpha using three alternative models in Section 6.2.

In principle, one can also run panel regressions with fixed effects to examine the relation between the plan size and the future performance, exploiting information in the time series of both size and performance. However, this strategy faces several challenges. Most importantly, plan size is function of past performance, which leads to a violation of the strict exogeneity assumption needed for the standard panel regression models with sponsor fixed effects. Intuitively, the plan assets increase when the sponsor is hit by a positive shock, but future returns tend to regress to the mean. The fixed-effect models estimate the coefficients based on deviations of variables from their sample means within each sponsor. The regression to the mean then creates a negative bias in the estimated relation between the plan size and future performance. Furthermore, since returns are only available at the annual frequency, the number of observations available to estimate risk- or benchmark-adjusted return is small, making it difficult conduct analysis to using rolling windows. To reduce the measurement error, we estimate alpha and Sharpe ratio of each plan using all observed annual returns of the plan as input. Consequently, the only size measure that does not suffer from the problem of reverse causality is the size measured at the beginning of the year in which a plan first enters our sample. Because the plan size is not updated over time, this measure biases against finding a significant size effect in plan performance, but it minimizes potential endogeneity concerns.

Using Alpha as an example, we consider the following model specification:

$$\begin{aligned} Alpha_{i,j,t_i \to T_i} \quad &= \quad a + b_1 * DC_{i,j} + b_2 * Nsize_{i,j,t_i} + b_3 * DC_i * Nsize_{i,j,t_i} \\ &\quad +b_4 * NsizeSQ_{i,j,t_i} + b_5 * Controls_{i,j,t_i} + \mathit{Fixed\ Effects} + e_{i,j,ti \to Ti}, \end{aligned} \tag{3}$$

where $\text{Alpha}_{i,j,t_i,\to T_i}$ denotes the alpha estimated for plan i sponsored by firm j over the period from year t_i to T_i, $\text{DC}_{i,j}$ is a dummy variable equal to 1 for DC plans and 0 for DB plans; Nsize_{i,j,t_i} is the normalized plan size observed at the beginning of year t_i; $\text{NsizeSQ}_{i,j,t_i}$ is the square of Nsize_{i,j,t_i}; $\text{Controls}_{i,j,t_i}$ represents a vector of other plan characteristics observed at the beginning of year t_i. For ease of interpretation, we normalize the plan size by taking a logarithm of a plan's asset value, subtracting the contemporaneous cross-sectional mean, and dividing the remaining part by the contemporaneous cross-sectional standard deviation. This means that a plan with the average size has a normalized size of zero. When both DB and DC plans are of an average size, the coefficient b_1 captures the performance difference between DC and DB plans; b_2 captures the effect of size on DB plans; b_3 captures the differential effect of size on DC relative to DB plans. Furthermore, the coefficient b_4 captures the nonlinear effect of size on performance.

We consider progressively more fixed effects. In the most basic version, we control for the fixed effect of the time period over which the performance is measured. Each time period is represented by a start and an end year. This ensures that we only compare performance observed over the same time period. This is important because performances measured over different time periods are not directly comparable.

To account for potential time-invariant unobserved heterogeneities across sponsors, we further consider models that control not only for the time period fixed effects, but also for the sponsor fixed effects. It could be possible that pension plans of some firms perform better because these firms have better expertise in pension asset management or better access to skilled external money managers, or because they devote more resources to assist employees with retirement money investment. Having the sponsor fixed effects in the model would allow us to remove the effects of such heterogeneities on plan performance. This is our preferred specification for the cross-sectional analysis, because it balances between controlling for unobservable fixed effects and preserving observations for model estimation.

Our last set of models controls for sponsor by time period (denoted by sponsor $\otimes$ time period) fixed effects. This specification is the strictest. It maximizes performance comparability by comparing only between plans observed over the same time period and sponsored by the same employer. One disadvantage of this specification is that it leads to a substantially smaller sample.

3.1.2. Results

Table 3 presents the cross-sectional regression results. The dependent variable is Alpha estimated using two Vanguard index funds in Panel A, Sharpe ratio in Panel B, and geometric mean return in Panel C. We control for time period fixed effects in the first three columns, sponsor and time period fixed effects in the next three columns, and sponsor $\otimes$ time period fixed effects in the last three columns. In all specifications, standard errors are triple-clustered by sponsor and the start and end years of the measurement period.

In Panel A, the coefficient on the DC dummy is significantly positive in all model specifications. This suggests that when performance is measured by alpha, DC plans with a size close to the cross-sectional mean (i.e., with Nsize close to zero) outperform DB plans of a similar size. The outperformance is statistically significant at the 1% level, and is economically large in magnitude, ranging from 32 basis points in Model (3) to 86 basis points in Models (7) and (8). The point estimate of the coefficient increases progressively as we control for more fixed effects. Controlling for asset allocation has little effect on the magnitude of the outperformance, but accounting for administrative expenses does reduce it significantly. For example, the coefficient drops from 0.60 in Model (2) to 0.32 in Model (3) after we add the expense ratio and its interaction with the DC dummy as controls. This suggests that for plans with a size close to the cross-sectional mean, about one half of the underperformance of DB plans relative to DC plans can be explained by administrative expenses. A comparison of the coefficients on Nsize and Nsize*DC suggests that other things equal, DC plans outperform size-matched DB plans in most size ranges.[18] This is consistent with what we find in Table 3 with size-sorted portfolios.

The coefficient on Nsize represents the impact of size on the alpha of DB plans. This coefficient is significantly positive in all specifications, confirming the existence of economies of scale in DB plans. The coefficient on Nsize*DC captures the difference between the size effects in DC and DB plans. While this coefficient is insignificantly different from zero in the first four models, it is significantly negative in the remaining five models, in which more fixed effects and plan characteristics are controlled for. This is consistent with a weaker degree of economies of scale in DC plans. Take our preferred specification, Model (5), as an example. The estimated coefficient on Nsize is 0.201, with a t-stat of 5.87. This suggests that a one standard deviation increase in the logarithm of the initial DB plan size from the cross-sectional mean is associated with an increase of alpha by 20 basis point per year (ignoring the second order effect due to the nonlinearity), which is about 9% of the standard deviation of the alpha across DB plans. However, the coefficient on the interaction term Nsize*DC is -0.125, with a t-stat of -2.61. This implies that for DC plans, the same increase in the initial plan size is only associated with an increase of alpha by 8 basis points per year. Interestingly, there is non-linearity in the size-performance relation, as the coefficient on NsizeSQ is significantly negative in all models except the last three. This suggests that after the plan size increases to a certain level, diseconomies of scale will kick in.

Another notable result from the table is that administrative expenses have a strong negative effect on pension plan performance, especially for DB plans. The coefficient on *Expense* ranges from -0.56 to -0.67, suggesting that a one-percentage-point increase in expense ratio reduces the alpha of a DB plan by about 60 basis points. The negative effect of expenses on alpha is somewhat smaller for DC plans, but the difference is only statistically significant without

[18] Table Model (5) as an example, the coefficient estimates suggest that even if the plan size is three standard deviation above the mean (Nsize=3), DC plans still outperform DB plans by 35 basis points per year (=0.726+(0.201-0.125)*3-0.201*3).

controlling for the sponsor fixed effects. This suggests that more expensive administrative services do not increase gross asset returns enough to offset the extra costs, a result that echoes many similar findings in the mutual fund literature (for example, Carhart (1997)).

When performance is measured by the Sharpe ratio (Panel B) or the geometric mean return (Panel C), the relative performance of the average size DC and DB plans is sensitive to the model specification. In particular, it is sensitive to whether we control for administrative expenses, which have a more negative effect on the performance of DB plans. For example, before controlling for expenses, the Sharpe ratio of an average size DB plan tends to be higher than the Sharpe ratio of an average size DC plan (Columns (4)-(5) and (7)-(8)). However, their positions switch once we control for expenses (Columns (3), (6), (9)). Nevertheless, both panels consistently demonstrate a positive size effect on plan performance that is significantly stronger for DB plans, which implies that DB plans outperform DC plans when the plan size is large, and vice versa when the plan size small. Both panels also show a strong concavity in the size-performance relation.

To better illustrate the differential size effects in DB and DC plan performance, we plot the estimated relation between the normalized size and performance in Figure 3, using the results from our preferred specification, Model (5), in each panel of Table 3. Panels (a), (b), (c) shows, respectively, the predicted alpha, Sharpe ratio, and geometric mean return as a function of normalized plan size, together with the 95% confidence intervals. As one can see, all the three performance measures increase as the size increases, and the slope is steeper for DB plans. Relative to a size-matched DB plan, the alpha of a DC plan is about 35-100 basis points higher over the plotted size range, and the gap is biggest on the lower end of the size distribution. For the Sharpe ratio and geometric mean return, DB plans underperform DC plans significantly when the size is below the average, but they perform better on the high end of the size distribution. All the three graphs show that DC plans have a clear comparative advantage when the plan size is small.

To summarize, consistent with the results from the size-sorted portfolios, the cross-sectional regressions at the plan level shows a positive size effect on pension plan performance, which is stronger for DB plans than for DC plans. In terms of the benchmark-adjusted return, DB plans underperform size-matched DC plans in most size ranges, and the underperformance is only partly explained by administrative costs. In terms of the Sharpe ratio and the geometric mean return, small DB plans underperform and large DB plans outperform their size-matched

DC counterparts.

3.2. Size and Administrative Expenses

Table 3 has shown a strong negative relation between plan size and the expense ratio, especially for DB plans. We now investigate the determinants of the expense ratio using panel regressions. Specifically, we consider the following model specification:

$$\begin{aligned} Expense_{i,j,t} &= a + b_1 * DC_{i,j} + b_2 * Nsize_{i,j,t-1} + b_3 * DC_i * Nsize_{i,j,t-1} \\ &\quad + b_4 * NsizeSQ_{i,j,t-1} + b_5 * Controls_{i,j,t-1} + Fixed\ Effects + e_{i,j,t}, \end{aligned} \tag{4}$$

where the explanatory variables are similar to those in Equation (3), except that they are now measured at an annual frequency. In the baseline model, we control only for year fixed effects, but we also consider models with both sponsor and year fixed effects, as well as models with sponsor⊗year fixed effects. The standard errors are clustered by both year and sponsor in all specifications.

Table 4 shows the results for six different models. Consistent with what is shown in Table 3, the coefficient on the DC dummies is significantly negative in all specifications. The point estimates are highly consistent across the models, suggesting a cost advantage of about 52 to 57 basis points of a DC plan relative to a DB plan when both have a size close to the cross-sectional mean. If we ignore the quantitatively small effect of nonlinearity, the estimated coefficients on Nsize imply that a one-standard deviation increase in log asset size from the mean value leads to a reduction in the expense ratio by 18 to 22 basis points for a DB plan. This effect is reduced by about one-third when it comes to a DC plan. The nonlinear effect is also statistically significant, suggesting a diminished size effect in expense ratio as the plan grows bigger and bigger. Among the control variables, allocations to safe assets, mutual funds or investment trust are associated with lower expenses, while plan age is associated with higher expenses. It is possible that older plans are managed by more senior and more entrenched managers and staff, which leads to a higher cost.

Panel (d) of Figure 3 visualizes the relation between plan size and expense ratio, based on the estimated result of Model (4). It shows that over the relevant size range, the DB plan expense ratio is about 30-70 basis points higher than the expense ratio of a size-matched DC plan. It also shows that the DB plan expense ratio declines faster as the size increases.

3.3. Size and Termination Probability

The strong economies of scale in both net performance and expenses imply that small plans may face a higher probability of being terminated. We now test whether this indeed the case. When a plan is terminated, all assets under the plan must be distributed to the participants and beneficiaries or legally transferred to the control of another plan (in the case of mergers/consolidations). By examining the factors driving plan termination, we can gain direct insights into the economic forces behind the great shift from the DB to DC plans observed in the past four decades.

As with the expense analysis, we run panel regressions using annual observations. We estimate the plan termination probability using linear probability models. This allows us to easily accommodate various fixed effects, from the year fixed effects, sponsor and year fixed effects, to the sponsor $\otimes$ year fixed effects.[19] Specifically, we consider the following model specification:

$$\begin{aligned} Termination_{i,j,t} \;&=\; a + b_1 * DC_{i,j} + b_2 * Nsize_{i,j,t-1} + b_3 * DC_i * Nsize_{i,j,t-1} \\ &\quad + b_4 * NsizeSQ_{i,j,t-1} + b_5 * Controls_{i,j,t-1} + \textit{Fixed Effects} + e_{i,j,t}, \end{aligned} \tag{5}$$

where $\text{Termination}_{i,j,t}$ is a dummy equal to 1 if plan i sponsored by firm j is terminated at the end of year t (recall that we record a termination before the end of year $t+1$ also in year t because we only keep regular plan years coinciding with calendar years). Among the control variables are the lagged expense ratio, the average plan return in the three most recent years, as well as their interactions with the DC dummy. This allows us to see how performance and administrative expenses are related to plan termination beyond what is implied by their correlations with plan size.

Table 5 reports the results for six alternative models. The coefficient on the lagged normalized plan size, Nsize, is negative at the 1% significance level in all specifications, confirming that small DB plans are more likely to be terminated. However, the coefficient on the interaction term, Nsize*DC, is significantly positive, indicating a significantly weaker predictive power of plan size for DC plan termination. The coefficient on NsizeSQ is insignificantly different from

[19]The estimation of marginal effects is problematic for a nonlinear model with sponsor fixed effects, because these fixed effects, which are needed for computing marginal effects, cannot be consistently estimated due to the small number of plans for each sponsor (the incidental parameters problem).

zero in four out of the six models, suggesting that the nonlinearity in the size-termination probability relation is relatively weak.

The coefficient on the mean return in the most recent three years, Ret3y, is significantly positive, while the coefficient on Ret3y*DC is significantly negative. This suggests that DB plans tend to perform well prior to the termination, which is somewhat surprising and inconsistent with findings in other contexts. For example, Deuskar et al. (2013) find that hedge funds are more likely to be terminated after poor performance. However, it can be explained by the timing strategy of the sponsor. A sponsor is generally not allowed to terminate an underfunded DB plan, i.e., when the asset value of a plan is lower than the present value of liabilities. A rise in asset value makes a plan more likely to meet the legal conditions for a termination. Also, by law the excess assets above the liabilities cannot be reverted to the sponsor until a plan is terminated. Therefore, the sponsor has stronger incentives to terminate a plan when the surplus is large, which also means a higher termination probability after good performance.

The coefficient on Log(Age) is significantly negative in Model (2). In contrast, it is significantly positive in Model (4) and (6), in which the fixed-effects of sponsors are controlled for. This is potentially because younger firms, which tend to have younger pension plans, are generally less stable and thus are more likely to terminate their plans. However, for a given sponsor, older plans have a higher probability of being terminated and replaced by new plans.

The coefficient on Expense is significantly positive in Model (2), suggesting that other things equal, DB plans with higher administrative expenses are more likely to be terminated. This coefficient becomes insignificant after we control for sponsor or sponsor $\otimes$ time period fixed effects; however, the coefficient on Expense*DC is then strongly positive. These results suggest that high expenses indeed increase the likelihood of plan termination to some degree.

To summarize, our results in this section show that small DB plans have the highest administrative expenses and the worst investment performance even after accounting for their high expenses. Not surprisingly, they are also most likely to be terminated. Due to cost inefficiency and poor investment performance, such plans may have difficulty in maintaining an adequate funding ratio and become a big financial burden for the plan sponsor. Therefore, they tend to be replaced by DC plans. Our results thus suggest that the inefficiency of the DB structure for small plans may be an important contributing factor to the overall decline of DB plans relative to DC plans.

4. Size and the Choice of Pension Plan Structure

We now analyze how size affects the sponsor's choice between the DB and DC structures when a pension plans is created. Based on our findings of high expenses and low investment performance of small DB plans, we expect that new plans that are relatively small are more likely to adopt the DC structure. Using pension plans created during our sample period, we test this prediction by estimating binary choice models.

Because new plans may not immediately meet the Schedule H filing threshold (100 plan participants) and our sample selection criterion (minimum $1 million asset value in year 2018 dollars), there are generally some time lags between a plan's inception and its entry into our sample.[20] Also, because our sample consists of regular filings covering a full calendar year, even a large plan that meets those thresholds does not enter our sample in its inception year unless it is created at the beginning of the year. To ensure that the first plan size we observe is a good indicator of the plan size at the inception, we consider three different samples for our tests. The first one consists of plans that enter our sample within one year since inception (i.e., in the inception year or the year after). The second and third samples consist of plans that enter our sample within three and five years since inception, respectively. The further delay we allow, the large is the sample, but the noisier is the observed plan size as measure of the initial size. We use the normalized size (by contemporaneous cross-sectional mean and standard deviation across all plans) at the beginning of the first observed plan year and its square as the main predictive variables for the choice of the plan form, and control for the age at which a plan enters our sample, as well as the fixed effects of the inception year.[21] We estimate both a linear probability model and a logit model for each sample.

Table 6 presents the results of our binary choice models. These results are quite consistent across samples and model specifications, both qualitatively and quantitatively. The coefficient on Nsize is strongly negative, suggesting that smaller plans are much more likely to adopt the DC structure, consistent with our conjecture. The point estimates of the coefficient on Nsize in the linear probability models show that for a new plan with an initial size (measured at age zero) close to the cross-sectional average (i.e., Nsize close to 0), a one standard deviation

[20] The median lag is 2 years for DB plans and 6 years for DC plans.

[21] We have also tried controlling for the interactions of various plan age dummies with normalized size. None of these interaction terms has a coefficient that is statistically significant. Thus, for parsimony we do not include them in our models.

increase in normalized plan size leads to a decline of seven percentage points in the probability of adopting a DC structure (ignoring the second-order effect). This is an economically large effect, suggesting that plan size is a crucial determinant of the pension plan type. For the logit models, we report in the last row of the table the estimated marginal effects of Nsize (measured at Nsize=0) on the probability of adopting the DC structure. These estimates are very similar to the estimates from the linear probability model, also rounded to -0.07 in all three samples.

The coefficients on all the age dummies except D(Age=1) are significantly positive, reflecting a significantly longer lag for DC plans to enter our sample after their inceptions relative to DB plans. This suggests that many DC plans are relatively small and do not meet the filing and sample selection thresholds initially. The coefficient on the dummy for age 1 is insignificant, suggesting that there is no difference whether a fund enters our sample in the inception year or in the year after. This is because funds in these two groups are essentially the same. The one-year lag for the second group is simply because their filings in the inception year do not cover an entire calendar year, and are therefore not included in our sample.

Combined with our findings of stronger economies of scale in DB plans, the results from the binomial choice models further confirm the comparative disadvantage of the DB organizational form for small plans.

5. The Role of Plan Sponsors

Our analysis so far focuses on the characteristics of individual plans. However, it is also interesting to see how plan performance, termination probability, and the choice of plan structure are affected by the characteristics of plan sponsors. To answer these questions, we merge our pension plan database with the Compustat North America database, which contains corporate accounting and market information. Using the Employer Identification Number (EIN), we are able to match about 8,000 sponsors to the Compustat database, each on average with 15 annual observations.

5.1. Sponsor Characteristics and Plan Performance

Since large pension plans tend to be sponsored by large firms, one may wonder whether the significant size effects we document in plan performance and expenses are driven by the size of pension sponsors or the size of pension plans. Our regression analysis based on models with sponsor fixed effects or sponsor $\otimes$ time period fixed effects suggests that the results are not driven by the characteristics of plan sponsors. Nevertheless, it is of interest to disentangle the size effect of the plan and the size effect of the sponsor.

We focus on pension plans with at least five years of data. We use the logarithm of the sales (measured in million of year 2018 dollars) in the first year of pension performance measurement period as the measure of sponsor size. This information is available for about 9,000 plans, among which about one quarter are DB plans.[22] We extend our baseline model in Table 3 by including the sponsor size and its interaction with the DC dummy in the model. Since the majority of sponsors have only one pension plan, our estimation relies heavily on heterogeneity across sponsors. Therefore, we consider only the models without the sponsor fixed effects in these cross-sectional regressions. To examine whether pension plans sponsored by financial firms perform differently from those sponsored by non-financial firms, potentially due to better financial knowledge or better connections to fund managers, we create a sponsor type dummy based on the historical SIC code to indicate whether a sponsor is a financial firm and include it in our regression models.

The results are reported in Table 7. Compared to the results in the first three columns of each panel in Table 3, the relation between plan size and performance remains strongly positive, but the magnitudes of the estimated coefficients on Nsize is slightly smaller. The sponsor size is also positively related to plan performance, although the relation is somewhat weaker for DC plans. This is consistent with more efficient management of pension plans sponsored by larger firms, potentially because large firms have stronger financial expertise or better access to skilled money managers, or because they are able to negotiate better asset management contracts with outside managers. Taken together, these results suggest that the size effect we document in the previous sections can only be partially explained by the sponsor size.

Interestingly, the financial industry dummy is positively related to the risk-adjusted performance (alpha and Sharpe ratio) of DB plans, suggesting that financial firms may manage their DB portfolios more efficiently than other firms. Furthermore, DC plans sponsored by financial firms outperform DC plans sponsored by non-financial firms in terms of the geometric mean return and the Sharpe ratio. These results suggest that greater financial expertise at the company or employee level improves pension plan performance. In contemporaneous studies, Andonov and Mao (2019) find that 401(k) plans sponsored by financial firms hiring independent trustees

[22]The results are very similar if we measure the sponsor size by book asset value or market capitalization.

have better investment menus than those sponsored by non-financial firms or financial firms not hiring independent trustees. Yadav (2020) examines the investment behavior of mutual fund family employees in their 401(k) plans and finds that the employee fund flows predict fund performance up to two years. Our results are consistent with these findings.

5.2. Sponsor Characteristics and Plan Termination

To examine how sponsor characteristics affect plan termination decision, we extend our baseline model (5) to include a few variables related to the status and financial situation of the sponsor, including SponsorSize, defined as the logarithm of annual sales (measured in million of year 2018 dollars); Profitability, which is measured by the operating income before depreciation over total assets, winsorized at the 1st and 99th percentiles and averaged over the three most recent years (from $t-2$ to t); Leverage, which is measured by the sum of short-term and long-term debt over total assets, also winsorized at the 1st and 99th percentiles and averaged over three years.

Panel B of Table 7 report the results for the extended models. The first two models control for the year fixed effects, the last two control for both the year and the industry fixed effects, where industry is defined by the three-digit SIC code. While the effects of the plan-level variables remain largely the same as in Table 5, the extended models reveal several interesting sponsor-level determinants of the plan termination event. In all the four models, the termination probability of DB plans is significantly positively related to the leverage ratio and negatively related to the profitability of the sponsor. This result provides new evidence that DB plan sponsors facing financial pressures from low profitability or high leverage are more likely to terminate pension plans to save financial costs, which collaborates the finding of Rauh et al. (2019). In contrast, the termination probability of DC plans is not significantly related to either of these variables, suggesting that DC plans are more insulated from the sponsor's financial status. Furthermore, the sponsor size is positively related to the termination probabilities of both DB and DC plans, potentially because large sponsors tend to have a larger number of plans, which leads to more plan mergers and replacements.

5.3. Sponsor Characteristics and the Choice of Plan Structure

To examine how sponsor characteristics affect the choice between DB and DC structures, we extend the linear probability models in Table 6 by adding SponsorSize, Profitability, Leverage observed in the plan inception year, as explanatory variables. These variables are measured in the same way as in Panel B. In addition to the inception year fixed effects, we also consider models with industry fixed effects, where industry is defined by the three-digit SIC code.

The results for the extended models are shown in Panel C of Table Table 7. Sponsor size emerges as an important determinant of the choice of plan structure. The coefficient on sponsor size is significantly negative in all the six models, with t-stats ranging from 3.72 to 5.96. This suggests that holding constant the plan size, small sponsors have a preference for the DC structure. Because smaller firms are more likely to be financially constrained, they have an incentive to preserve their debt capacity by avoiding the implicit leverage embedded in DB plan liabilities.

Although the samples available for the estimation of the extended models are substantially smaller, the negative relation between plan size and the probability that a new plan adopts the DC form remains to be highly significant. Column (6) shows that even after controlling for both the sponsor size and the industry fixed effects, a one standard deviation increase of the initial plan size (from the mean value) is still associated with a 4.0 percentage point decrease in this probability. This demonstrates the robustness of the influence of plan size to both sample selection and model specification.

To summarize, the results in this section suggest that our baseline results are largely unaffected after we control for the characteristics of sponsors. However, sponsor characteristics do have additional explanatory power for plan performance, termination rate, and the choice between the DC and DB structures. Holding plan size constant, a larger sponsor size is associated with better plan performance, especially for DB plans; and small sponsors are more likely to choose the DC structure for their new plans, potentially because of their aversion to implicit leverage embedded in DB plan liabilities. Furthermore, the sponsor's low profitability and high leverage are associated with a higher termination probability of DB plans, but they are unrelated to the termination probability of DC plans.

6. Robustness and Further Analysis

The results in the previous sections highlight the inefficiency of the DB structure for small plans. Whether this inefficiency is a contributing factor to the rise of DC plans' popularity over time depends on whether there is a shift in the distribution of pension plans toward smaller sizes. If changes in economic structures lead to more prevalence of small plans, then the inefficiency of the DB structure for such plans will give the DC structure an advantage. In this section, we present time series evidence to show that there is indeed such a shift, and that this shift is closely related to the rise of DC plans. We also conduct a series of robustness checks for our main results.

6.1. The Evolution of the Median Plan Size and the Rise of DC plans

Our comprehensive sample of pension plans allows us to analyze the evolution of the U.S. private pension system directly. While the median inflation-adjusted plan size in our sample increases from \$6.7 million to \$10.8 million, recording an annual growth rate of 1.7%, an economically more meaningful measure of plan size is the size relative to the asset markets in which they invest. Therefore, we use the median plan size scaled by the total market value of the U.S. stock and bond markets to gauge the evolution of pension plan size distribution. We obtain the annual data on the total U.S. stock market capitalization of domestic listed companies from the website of the World Bank, and obtain the total U.S. bond market value data from the website of the Securities Industry and Financial Markets Association (SIFMA). We calculate the ratio of the median year-end pension asset value to the sum of the stock and bond market values. We denote this index by Msize1. As an alternative, we scale the median pension size by the size of the U.S. stock market capitalization only and denote it by Msize2. For convenience, both measures are normalized to 100 for 1990.

Figure 4 plots the time series of these two size indexes against the time series of the percentage of DC plans in the total number in our sample. Both size indexes show a strong downward trend, especially during the 1990s. The index Msize1 drops from 100 in 1990 to 39 in 2018, suggesting a 61% shrinkage of the median plan size relative to the size of the stock and bond markets. Relative to the stock markets alone, the shrinkage is even more pronounced, amounting to 78%. In contrast, the percentage of DC plans in the total number of plans increases from 60% to 92% over the same period, and the increase is also rapidest during the 1990. This supports the idea that as more and more smaller pension plans are created, which are predominately of the DC structure, the median plan size drops and the DC percentage rises.

To further examine the extent to which the rise of DC plans can be attributed to the evolution of plan size, we run univariate regressions of the DC percentage on the two scaled median plan size indexes, both in levels and in first-order differences. Table 8 reports the results. The regressions in levels show that the scaled median plan size Msize1 (Msize2) alone explains 93% (81%) of the variation in the level of DC percentage over time, and the regressions in differences show that changes in Msize1 (Msize2) alone can explain 47% (73%) of the variation in the change of DC percentage over time.

Obviously both the plan size distribution and the proportions of DB and DC plans in the pension system are endogenously determined by the choices of plan sponsors/employees and the employment structure of the economy. Our interpretation of the strong univariate relation between them is that the downward trend of the scaled plan size reflects a shift in employment mix from large manufacturing firms to small and young firms in service and high-tech industries, as documented by Gustman and Steinmeier (1992), Ippolito (1995).[23] As shown by the results in the previous sections, the DC organizational form has strong comparative advantages relative to the DB form for small plans. Therefore, when the relatively small and young firms in those industries set up their pension plans, a natural choice is the DC structure. Even those with established DB plans may be tempted to convert them into DC plans for lower costs and higher asset management efficiency, especially if their plans cannot keep up with the expansion of the asset markets. Therefore, our findings suggest that the size-dependent relative efficiency of the DB vs. DC organizational form in asset management plays an important role in the great shift toward DC plans.

6.2. Robustness Checks

We conduct a series of robustness tests to further confirm our main result, namely a stronger size effect in performance for DB plans than for DC plans. We first conduct Fama-MacBeth

[23] According to the U.S. Bureau of Labor Statistics, while the total number of nonfarm workers increases from 91 million in 1980 to 150 million in 2018, the total number of workers in the manufacturing industries drops from 19 million to 13 million over the same period.

regressions using annual raw returns. We then consider two alternative formulas for annual return calculation. Finally, we consider three alternative models for the alpha estimation.

6.2.1. Fama-MacBeth Regressions

In our baseline analysis, we use the pension plan as the unit of observation, and compute a performance measure for each plan using its annual return observations over the entire sample period. The advantage of this approach is that plan performance is benchmark- or risk-adjusted, but it has two disadvantages. One is that the plan size is fixed at the beginning of the performance measurement period. Another is that plans with fewer than a certain number (five in baseline case) of observations have to be excluded. As a robustness check, we now perform Fama-MacBeth regressions using annual raw returns as the performance measure. While this measure is not benchmark- or risk-adjusted, it overcomes the two drawbacks of our baseline approach mentioned above.[24]

Specifically, each year we run cross-sectional regressions of plan returns on the normalized plan size and other plan characteristics measured at the beginning of the year. We then use the time series of the coefficients estimated from these regressions to compute the point estimate and t-statistic of each coefficient. We account for autocorrelation in the coefficient estimates using the Newey-West correction (with three lags). Table 9 reports results from four models. The last two models control for sponsor fixed effect, while the first two do not. The results are very similar to what we obtain using the Sharpe ratio and the geometric mean returns as the performance measures. There is a positive size effect in the performance of both DB and DC plans, and the effect is stronger for DB plans. Both the size effect itself and its difference between DB and DC plans can only be partially explained by plan expenses. While the coefficient on the DC dummy is statistically insignificant, the stronger economies of scale in DB plans imply that the DC plans perform better when plan size is small.

6.2.2. Alternative Return Measures

Our baseline raw return formula, Equation (1), assumes that contributions, distributions, and transfers occur in the middle of the year. Alternatively, one may assume that they occur

[24] Compared to the standard panel regressions, the Fama-MacBeth approach has two important advantages. First, it avoids the inflation of the t-statistics due to cross-correlations of plan returns in a given year. Second, it allows us to control for the sponsor fixed effects without suffering from the regression-to-the-mean problem discussed at the beginning of Section 3.

at the end of the year, which leads to the following return formula:

$$R_{i,t}^{A1} = \frac{\text{Net Assets}_{i,t} - \text{Net Assets}_{i,t-1} - \text{Contribution}_{i,t} + \text{Distribution}_{i,t} + \text{Net Transfer}_{i,t}}{\text{Net Assets}_{i,t-1}}. \tag{6}$$

Instead of calculating returns using net asset values, one can also compute return based on the income and expense statement reported in Schedule H of Form 5500 as follows:

$$R_{i,t}^{A2} = \frac{\text{Investment Earnings}_{i,t} - \text{Interest Expenses}_{i,t} - \text{Administrative Expenses}_{i,t}}{\text{Total Assets}_{i,t-1}}, \tag{7}$$

where Investment Earnings include interest and dividend incomes, rents, realized and unrealized capital gains.[25]

Using these two alternative return measures, we recalculate the alpha, Sharpe ratio, and geometric mean return of each pension plan, and repeat our cross-sectional analysis of the size-performance relation described in Section 3.1. For simplicity, we only report the results for the regressions with both time period and sponsor fixed effects in Table A.2 in Internet Appendix. In Panel (A), returns are calculated using Equation (6), while in Panel B they are calculated using Equation (7). These results are similar to those reported in Table 3. There is a significantly positive size effect in performance under all three measures, with or without controlling for plan expenses. Furthermore, this size effect is stronger in DB plans than in DC plans. For pension plans with an initial size close to the cross-sectional mean (i.e., Nsize close to zero), DC plans outperform DB plans by about 80 basis points in alpha. After controlling for expenses, the outperformance is still statistically significant at around 50 basis points. The outperformance of the average size DC plans relative to DB plans is also significant when performance is measured by geometric mean returns or Sharpe ratio. However, the outperformance according to these measures can be explained away by administrative expenses. These results show the robustness of our baseline results to the method used for return calculations.[26]

[25]This is similar to the pension fund investment return calculated in Rauh (2009), except that it is net of expenses.

[26]The results for models with time period fixed effects or sponsor $\otimes$ time period fixed effects are also very similar to those reported in Table 3.

6.2.3. Alternative Alpha Estimations

Our baseline alpha estimation uses the Vanguard 500 Stock Market Index Fund and the Vanguard Total Market Bond Index Fund as the benchmark. For robustness checks, we also consider three alternative benchmarks. First, we extend the baseline model by adding the Vanguard Extended Market Index Fund and the Vanguard Balance Index Fund to the benchmark portfolio, as described in Section 1.3. Second, to account for exposure to international markets, we augment our baseline alpha estimation model (Equation 2) by adding an equal-weighted portfolio of three oldest Vanguard international equity index funds to the benchmark. These are Vanguard European Stock Index Fund (ticker VEURX), Vanguard Pacific Stock Index Fund (ticker VPACX) and Vanguard Emerging Market Stock Index Fund (ticker VEIEX). We combine these three funds into one to reduce the loss of degrees of freedom in the beta estimation.[27] Third, we augment the widely-used Fama and French (1992) three-factor model and use it for the alpha estimation. While the Fama-French factors do not include trading and management costs, and thus do not represent an investment opportunity directly available to investors, they are useful for cross-sectional analysis. Because the model considers only risk factors in equity markets, we augment it by adding the excess return of the Vanguard Total Market Index Fund as an additional factor.

Due to the need to estimate three or four betas, we require a plan to have at least 10 annual return observations to be included in this analysis. We report the cross-sectional regression results from models with both time and sponsor fixed effects based on these three alternative alpha estimation approaches in Table A.3 in Internet Appendix. They look very similar to the corresponding results in Table 3.[28] Specifically, the benchmark-adjusted returns of DC plans are significantly higher than those of their size-matched DB counterparts for most size ranges, and the performance difference is only partially explained by administrative expenses. Furthermore, there are strong economies of scale in both DB and DC plans, and the economies of scale are generally stronger for DB plans than for DC plans. These results demonstrate the robustness of our baseline results to the alpha estimation approach.

To summarize, the results in this section show that the rise of DC plans in the private

[27] The European Fund and the Pacific Fund were incepted in June 1990, so for the first 6 months of 1990, we use two actively managed Vanguard international equity funds, i.e., the Vanguard International Growth Fund and the Vanguard International Growth Fund, as their substitutes. The Emerging Market Fund was incepted in May 1994, so it enters the portfolio in June 1994.

[28] This is also the case for models with time period fixed effects or sponsor $\otimes$ time period fixed effects.

pension sector is closely related to the downward shift of the median plan size relative to the asset markets, and that the size effect in pension plan performance we document is robust to an alternative testing strategy using the Fama-MacBeth regressions, alternative return measures, and alternative benchmarks for the alpha estimation.

7. Conclusion

Using a comprehensive and bias-free sample of U.S. private pension plans constructed from IRS Form 5500 filings from 1990 to 2018, we document significant economies of scale in pension plan investment performance and administrative expenses, and show that they are significantly more pronounced for DB plans than for DC plans. Furthermore, holding plan size constant, a large sponsor size is also associated with better plan performance, especially for the DB type. The strong economies of scale suggest that consolidation of pension plans, especially of the DB type, may be efficiency-improving. This is consistent with the recent trend of consolidation in the pension sector observed in both the U.S. and Europe.

The majority of plans of both types underperform their benchmark formed by Vanguard index funds. To the extent that these index funds are liquid investment opportunities readily available to both institutional and retail investors, the underperformance suggests a welfare loss due to inefficient pension asset management. Although the unconditional means of raw and benchmark-adjusted returns are higher for DB plans, our regression analysis shows that small DC plans compare favorably with size-matched DB plans, irrespective of whether performance is measured by raw returns, risk-adjusted returns, or benchmark-adjusted returns (alphas). These results have important implications for pension plan sponsors, and suggest that the optimal choice of the pension structure depends crucially on plan size. The performance comparison is most favorable to DC plans when returns are benchmark-adjusted, in which case DC plans outperform size-matched DB plans in most size ranges. Overall, our results suggest that investment performance of individually managed DC plans is in general not worse than the performance of institutionally managed DB plans, despite many widely-held concerns about the limited financial knowledge of typical plan participants. Although DC plans have their own agency issues, it is possible that they are outweighed by agency issues in DB plans.

Consistent with the stronger economies of scale for DB plan management, we find small DB plans face the highest probability of being terminated, and small new plans are much more likely to adopt the DC structure than large ones. Holding constant the plan size, small sponsors are more likely to choose the DC structure. Due to their cost inefficiency and poor investment performance, sponsors of small DB plans have to contribute more to employee retirement plans than sponsors of small DC plans to achieve the same level of employee satisfaction, which implies a bigger financial burden for the shareholders. No surprisingly, they have a preference for the DC structure. Combined with the evidence of a downward trend in the scaled plan size distribution, our findings suggest that the relative inefficiency of the DB structure for small plans may be a contributing factor to the shift from DB to DC plans in recent decades.

While our findings of economies of scale in the private pension asset management are robust and strong, our results do not necessarily generalize to other asset management spaces, such as the public pension and mutual fund sectors. The differential size effects we find in DB and DC plans suggest that the degree of returns to scale in asset management is a function of the organizational form, which further cautions against a simple generalization. Moreover, public pension funds and mutual funds are generally much bigger than the private pension funds in our sample. The concave size-performance relation we find suggests that diseconomies of scale will eventually kick in when the fund size grows to a certain level. Furthermore, assets of pension plans, DB or DC, are usually split among many outside fund managers. This suggests that our findings of economies of scale may be more relevant to the asset allocation stage than to the full process of asset management.

References

Andonov, A., Bauer, R., Cremers, M., 2012. Can large pension funds beat the market? Asset allocation, market timing, security selection, and the limits of liquidity. Unpublished working paper. University of Amsterdam.

Andonov, A., Mao, M.Q., 2019. Financial sophistication and conflicts of interest: Evidence from 401(k) investment menus. Unpublished working paper. University of Amsterdam.

Benartzi, S., Thaler, R.H., 2007. Heuristics and biases in retirement savings behavior. Journal of Economic Perspectives 21, 81–104.

Bergstresser, D., Desai, M., Rauh, J., 2006. Earnings manipulation, pension assumptions, and managerial investment decisions. Quarterly Journal of Economics 121, 157–195.

Berk, J.B., van Binsbergen, J.H., 2015. Measuring skill in the mutual fund industry. Journal of Financial Economics 118, 1–20.

Berk, J.B., Green, R.C., 2004. Mutual fund flows and performance in rational markets. Journal of Political Economy 112, 1269–1295.

Blake, D., Rossi, A.G., Timmermann, A., Tonks, I., Wermers, R., 2013. Decentralized investment management: Evidence from the pension fund industry. Journal of finance 68, 1133–1178.

Calvet, L.E., Campbell, J.Y., Sodini, P., 2007. Down or out: Assessing the welfare costs of household investment mistakes. Journal of Political Economy 115, 707–747.

Carhart, M.M., 1997. On persistence in mutual fund performance. Journal of Finance 52, 57–82.

Chalmers, J., Reuter, J., 2020. Is conflicted investment advice better than no advice? Journal of Financial Economics forthcoming.

Chen, J., Hong, H., Huang, M., Kubik, J.D., 2004. Does fund size erode mutual fund performance? The role of liquidity and organization. American Economic Review 94, 1276–1302.

Christopherson, J.A., Ferson, W.E., Glassman, D.A., 1998. Conditioning Manager Alphas on Economic Information: Another Look at the Persistence of Performance. Review of Financial Studies 11, 111–142.

Clark, R.L., McDermed, A.A., 1990. The choice of pension plans in a changing regulatory environment. The AEI Press, Washington DC.

Coggin, T.D., Fabozzi, F.J., Rahman, S., 1993. The investment performance of U.S. equity pension fund managers: An empirical investigation. Journal of finance 48, 1039–1055.

Cohen, L., Schmidt, B., 2009. Attracting flows by attracting big clients. Journal of finance 64, 2125–2151.

Del Guercio, D., Tkac, P.A., 2002. The determinants of the flow of funds of managed portfolios: Mutual funds vs. pension funds. Journal of Financial and Quantitative Analysis 37, 523–557.

Deuskar, P., Wang, Z.J., Wu, Y., Nguyen, Q.H., 2013. The dynamics of hedge fund fees. Unpublished working paper. Indian School of Business.

Dutch Central Bank, 2017. Dnbulletin: Pension fund consolidation continues–general pension funds are gaining market share. Https://www.dnb.nl/en/news/news-and-archive/dnbulletin-2017/dnb362426.jsp.

Dyck, I.J.A., Pomorski, L., 2012. Is bigger better? Size and performance in pension plan management. Unpublished working paper. University of Toronto.

Fama, E.F., French, K.R., 1992. The cross-section of expected stock returns. Journal of finance 47, 427–465.

Goyal, A., Wahal, S., 2008. The selection and termination of investment management firms by plan sponsors. Journal of finance 63, 1805–1847.

Gustman, A.L., Steinmeier, T.L., 1992. The stampede toward defined contribution pension plans: Fact or fiction? Industrial Relations: A Journal of Economy and Society 31, 361–369.

Huberman, G., Jiang, W., 2006. Offering versus choice in 401(k) plans: Equity exposure and number of funds. Journal of finance 61, 763–801.

Ippolito, R.A., 1995. Toward explaining the growth of defined contribution plans. Industrial Relations 34(1), 1–19.

Ippolito, R.A., Turner, J.A., 1987. Turnover, fees and pension plan performance. Financial Analysts Journal 43, 16–26.

Lakonishok, J., Shleifer, A., Vishny, R.W., 1992. The structure and performance of the money management industry. Brookings Papers on Economic Activity: Microeconomics , 339–391.

Li, C.W., Yao, T., Ying, J., 2020. Should corporate pensions invest in risky assets? A risk-sharing perspective. Unpublished working paper. University of Iowa.

Lusardi, A., Mitchell, O.S., 2014. The economic importance of financial literacy: Theory and Evidence. Journal of Economic Literature 52, 5–44.

McLemore, P., 2019. Do mutual funds have decreasing returns to scale? Evidence from fund mergers. Journal of Financial and Quantitative Analysis 54, 1683–1711.

Meulbroek, L., 2005. Company stock in pension plans: How costly is it? Journal of Law and Economics 48, 443–474.

Munnell, A.H., Aubry, J.P., Crawford, C.V., 2015. Investment returns: Defined benefit vs. defined contribution plans. Center for Retirement Research at Boston College Issue in Brief 15-21, 1–14.

Munnell, A.H., Soto, M., Libby, J., Prinzivalli, J., 2006. Investment returns: Defined benefit vs. 401(k) plans. Center for Retirement Research at Boston College Issue in Brief 52, 1–9.

Pastor, L., Stambaugh, R.F., Taylor, L.A., 2015. Scale and skill in active management. Journal of Financial Economics 116, 23–45.

Petersen, M.A., 1992. Pension reversions and worker-stockholder wealth transfers. Quarterly Journal of Economics 107, 1033–1056.

Pool, V.K., Sialm, C., Stefanescu, I., 2016. It pays to set the menu: Mutual fund investment options in 401(k) plans. Journal of Finance 71, 1779–1812.

Pool, V.K., Sialm, C., Stefanescu, I., 2020. Mutual fund revenue sharing in 401(k) plans. Unpulished working paper. Vanderbilt University.

Poterba, J.M., Venti, S.F., Wise, D.A., 2004. The transition to personal accounts and increasing retirement wealth: Macro- and microevidence, In Perspectives on the Economics of Aging, edited by David A. Wise, University of Chicago Press.

Rauh, J.D., 2009. Risk shifting versus risk management: Investment policy in corporate pension plans. Review of Financial Studies 22, 2687–2733.

Rauh, J.D., Stefanescu, I., Zeldes, S.P., 2019. Cost shifting and the freezing of corporate pension plans. Unpublished working paper. Stanford University.

Reuter, J., Zitzewitz, E., 2015. How much does size erode mutual fund performance? A regression discontinuity approach. Unpublished working paper. Boston College.

Samwick, A.A., Skinner, J., 2004. How will 401(k) pension plans affect retirement income? American Economic Review 94, 329–343.

Sialm, C., Starks, L.T., Zhang, H., 2015. Defined contribution pension plans: Sticky or discerning money? Journal of Finance 70, 805–838.

Tang, N., Mitchell Olivia S., O.S., Mottola, G.R., Utkus, S.P., 2010. The efficiency of sponsor and participant portfolio choices in 401(k) plans. Journal of Public Economics 94, 1073–1085.

U.S. Department of Labor, 2020. Private pension plan bulletin historical tables and graphs 1975-2018. Https://www.dol.gov/agencies/ebsa/researchers/statistics/retirement-bulletins/private-pension-plan.

Wu, Y., Wermers, R., Zechner, J., 2016. Managerial rents vs. shareholder value in delegated portfolio management: The case of closed-end funds. Review of Financial Studies 29, 3428–3470.

Yadav, P., 2020. Is mutual fund family retirement money smart? Unpublished working paper. Drexel University.

Yan, X., 2008. Liquidity, investment style, and the relation between fund size and fund performance. Journal of Financial and Quantitative Analysis 43, 741–768.

Zhu, M., 2018. Informative fund size, managerial skill, and investor rationality. Journal of Financial Economics 130, 114 – 134.

Table 1: **Summary statistics**

We extract annual observations of private sector single-employer pension plans with at least $1 million assets at the beginning of the year from the IRS Form 5500 filings. Our sample covers a total of 166,235 plans from 1990 to 2018. All asset values are expressed in year 2018 dollars (converted using the GDP deflator). Panel A shows year by year the total numbers of DB plans and DC plans, the total assets in these two types of plans (in billion of dollars), as well as the numbers employers sponsoring only DB plans, employers sponsoring only DC plans, and employers sponsoring both. Panel B shows summary statistics for the full sample of plan-year observations. The variable Assets is the total assets in a plan (in million of dollars). Age is the number of years since the plan inception. Ret is the raw return in a given year. Expense is the ratio of total administrative expenses divided by the average of the total assets at the beginning and end of the year. SafeAssets, Equity, MutualFund, Trust, and Other are fractions of plans assets invested in safe securities, stocks, mutual funds, investment trusts, and all other assets, respectively. Panel C shows the cross-sectional distribution of variables estimated plan by plan, using 96,170 plans with at least five years of return data. Beta_equity and Beta_bond are estimated by regressing excess plan returns on the excess returns of the Vanguard 500 Stock Market Index Fund and the Vanguard Total Bond Market Index Fund. Alpha2 is the estimated intercept term from this regression. Mret is the geometric mean return over the sample period. SR is the Sharpe ratio. Nyear is the total number of years for which a plan has return data available.

Panel A. Aggregate statistics over time

	N_DB	N_DC	Assets_DB	Assets_DC	Sponsor_DB	Sponsor_DC	Sponsor_Both
1990	10,371	15,388	933	579	4,344	10,009	3,176
1991	9,046	17,337	816	648	3,887	11,783	3,195
1992	8,805	19,266	874	735	3,646	13,316	3,343
1993	8,142	18,050	1,004	808	2,969	12,456	3,179
1994	9,876	22,803	1,127	879	3,481	15,948	3,853
1995	9,621	24,512	1,309	1,088	3,295	17,440	3,914
1996	9,464	27,220	1,392	1,246	3,149	19,783	3,979
1997	9,179	29,562	1,556	1,522	2,949	21,975	3,981
1998	8,869	32,311	1,656	1,750	2,813	24,590	3,907
1999	6,054	21,682	1,279	1,447	2,512	17,304	2,194
2000	7,233	31,213	1,474	1,704	2,635	24,943	3,041
2001	7,225	34,598	1,342	1,650	2,579	28,125	3,102
2002	7,161	36,207	1,210	1,595	2,445	29,694	3,203
2003	7,039	37,052	1,507	1,881	2,286	30,646	3,308
2004	6,949	39,252	1,586	2,084	2,220	32,828	3,355
2005	6,982	40,794	1,667	2,213	2,181	34,391	3,421
2006	6,880	42,527	1,782	2,454	2,104	36,189	3,406
2007	6,794	44,306	1,848	2,603	2,064	37,964	3,402
2008	6,468	44,029	1,370	1,883	1,989	37,956	3,238
2009	6,272	47,399	1,598	2,565	1,659	40,137	3,432
2010	6,147	48,789	1,761	2,915	1,584	41,531	3,435
2011	5,991	50,780	1,733	2,888	1,479	43,536	3,479
2012	5,912	50,727	1,892	3,194	1,461	43,572	3,449
2013	5,677	51,801	1,947	3,752	1,369	44,796	3,371
2014	5,599	53,208	2,043	3,985	1,328	46,296	3,347
2015	5,409	53,966	1,897	3,941	1,282	47,246	3,244
2016	5,192	54,669	1,907	4,202	1,220	48,141	3,115
2017	4,963	55,786	2,073	4,810	1,169	49,494	2,977
2018	4,673	56,924	1,809	4,469	1,112	50,875	2,801

Panel B. Summary statistics at the plan-year level

	mean	sd	min	p25	p50	p75	max
DB plans							
Assets	206.54	1352.71	1.00	6.06	17.42	63.90	80,576.49
Age	30.17	16.98	0.00	17.00	29.00	42.00	114.00
Ret(%)	7.28	10.81	-32.47	1.11	7.85	13.73	35.50
Expense(%)	0.69	0.68	0.00	0.13	0.54	1.00	2.59
SafeAssets	0.15	0.25	0.00	0.00	0.01	0.20	0.98
Equity	0.11	0.21	0.00	0.00	0.00	0.11	0.99
MutualFund	0.17	0.32	0.00	0.00	0.00	0.15	1.00
Trust	0.46	0.45	0.00	0.00	0.34	0.98	1.00
Other	0.10	0.17	-0.00	0.00	0.03	0.13	0.92
DC plans							
Assets	55.27	474.16	1.00	3.24	7.35	19.51	60,304.85
Age	17.45	11.67	0.00	9.00	15.00	23.00	102.00
Ret(%)	6.40	12.41	-32.47	-0.49	7.87	14.00	35.50
Expense(%)	0.24	0.38	0.00	0.01	0.07	0.33	2.59
SafeAssets	0.11	0.19	0.00	0.00	0.02	0.15	0.98
Equity	0.06	0.19	0.00	0.00	0.00	0.00	0.99
MutualFund	0.51	0.40	0.00	0.00	0.67	0.89	1.00
Trust	0.25	0.35	0.00	0.00	0.03	0.46	1.00
Other	0.06	0.13	-0.00	0.01	0.03	0.06	0.92

Panel C. Summary statistics at the plan level

	mean	sd	min	p25	p50	p75	max
DB plans							
Beta_equity	0.49	0.21	-0.13	0.38	0.52	0.62	1.16
Beta_bond	0.30	0.52	-2.11	0.02	0.30	0.59	2.07
Mret (%)	7.12	3.29	-8.83	5.07	6.73	8.97	22.16
Alpha2(%)	-0.80	2.24	-10.51	-2.02	-0.85	0.35	10.71
SR	0.42	0.27	-0.25	0.25	0.38	0.56	1.41
Nyear	13.46	7.38	5.00	7.00	11.00	19.00	29.00
DC plans							
Beta_equity	0.65	0.21	-0.13	0.55	0.68	0.79	1.18
Beta_bond	0.01	0.53	-2.12	-0.23	0.08	0.30	2.06
Mret (%)	5.83	3.40	-23.78	4.06	5.63	7.38	35.50
Alpha2(%)	-0.98	2.40	-10.55	-2.43	-1.17	0.16	10.85
SR	0.42	0.32	-0.25	0.21	0.34	0.62	1.41
Nyear	11.65	5.99	5.00	7.00	10.00	15.00	29.00

Table 2: **Size-sorted pension portfolios**

This table shows the alphas and other characteristics of the size-sorted DB and DC portfolios. Based on the asset value at the beginning of each year, both DB plans and DC plans are evenly sorted into 10 portfolios at an ascending order. The annual return of each portfolio is the value-weighted (by the beginning-of-year assets) average across plans. Panel A shows the alphas of size-sorted DB and DC portfolios estimated from two alternative models. Alpha2 is estimated by regressing excess portfolio returns on excess returns of the Vanguard S&P 500 Index Fund and the Vanguard Total Bond Fund. Alpha4 is estimated by including two additional index funds in the benchmark portfolio: the Vanguard Extended Market Index Fund and the Vanguard Balance Index Fund. The third section of the panel shows the alphas for the portfolio that longs a DB portfolio and shorts a DC portfolio in the same size decile. Panel B shows other characteristics of the size-sorted pension portfolio. The variable Assets is the time-series mean of the average asset size of each portfolio. Mean return and Sharpe ratio are the geometric mean and Sharp ratio calculated using the value-weighted returns of each portfolio; Expense ratio is the time-series average of the asset-weighted expense ratios; Termination rate is the time series average of the annual termination rate. The last columns of each panel show the differences between portfolios 10 and 1, together with t-statistics in parentheses when available. (For the alphas, geometric mean return, and Sharpe ratio, the last column is calculated using the zero-investment portfolio of longing portfolio (10) and shorting portfolio (1).) Statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

Panel A. Alphas of the size-sorted plan portfolios

Portfolio	1	2	3	4	5	6	7	8	9	10	(10)-(1)
DB plans (average number of plans per group = 717)											
Alpha2	-1.515**	-1.002*	-0.804	-0.869	-0.841	-0.746	-0.771	-0.676	-0.606	0.364	1.879***
	(-2.62)	(-1.75)	(-1.34)	(-1.47)	(-1.44)	(-1.25)	(-1.34)	(-1.13)	(-1.03)	(0.47)	(3.44)
Alpha4	-1.182***	-0.679*	-0.459	-0.516	-0.504	-0.407	-0.443	-0.353	-0.329	0.609	1.791***
	(-3.12)	(-1.75)	(-1.13)	(-1.31)	(-1.28)	(-1.02)	(-1.15)	(-0.87)	(-0.75)	(0.94)	(3.16)
DC plans (average number of plans per group = 3801)											
Alpha2	-0.862	-0.759	-0.592	-0.490	-0.417	-0.283	-0.213	-0.156	-0.041	-0.094	0.768*
	(-1.03)	(-0.90)	(-0.72)	(-0.59)	(-0.52)	(-0.36)	(-0.28)	(-0.21)	(-0.06)	(-0.15)	(1.75)
Alpha4	-0.374	-0.256	-0.086	0.015	0.077	0.202	0.253	0.291	0.372	0.208	0.582
	(-0.68)	(-0.48)	(-0.16)	(0.03)	(0.15)	(0.41)	(0.51)	(0.61)	(0.79)	(0.41)	(1.48)
DB−DC											
Alpha2	-0.653*	-0.242	-0.212	-0.379	-0.424	-0.463	-0.558	-0.520	-0.566	0.458	1.111
	(-1.78)	(-0.66)	(-0.62)	(-1.19)	(-1.27)	(-1.44)	(-1.68)	(-1.57)	(-1.48)	(0.72)	(1.58)
Alpha4	-0.808**	-0.423	-0.374	-0.531*	-0.581*	-0.609**	-0.696**	-0.644*	-0.701*	0.401	1.209*
	(-2.53)	(-1.40)	(-1.26)	(-2.03)	(-2.06)	(-2.13)	(-2.29)	(-2.02)	(-1.90)	(0.60)	(1.74)

Panel B. Other characteristics of the size-sorted pension plan portfolios

Portfolio	1	2	3	4	5	6	7	8	9	10	(10)-(1)
DB plans											
Assets ($ million)	2.38	4.82	7.71	11.79	17.81	27.69	45.44	80.02	173.92	1883.79	
Mean return	5.19	5.85	6.07	6.17	6.41	6.58	6.66	6.89	7.09	7.93	2.88
Sharpe ratio	0.28	0.35	0.37	0.37	0.39	0.40	0.41	0.42	0.44	0.51	1.00
Expense ratio	1.04	0.88	0.79	0.74	0.68	0.66	0.62	0.55	0.52	0.29	-0.74 (-46.03)
Termination rate	4.59	4.05	3.87	3.52	3.37	3.13	3.02	2.79	2.56	2.03	-2.56 (-9.49)
DC plans											
Assets ($ million)	1.38	2.20	3.18	4.42	6.06	8.38	12.07	18.89	36.88	422.45	
Mean return	5.59	5.75	5.94	6.05	6.16	6.29	6.45	6.53	6.74	7.20	1.58
Sharpe ratio	0.27	0.29	0.30	0.31	0.32	0.34	0.35	0.36	0.38	0.42	0.74
Expense ratio	0.43	0.37	0.32	0.29	0.26	0.23	0.20	0.17	0.14	0.08	-0.35(-25.71)
Termination rate	2.30	2.20	2.29	2.21	2.27	2.20	2.25	2.20	2.18	2.02	-0.29 (-2.13)

Table 3: **The size effect in pension performance: DB vs. DC**

This table shows the differential impacts of pension plan size on the performance of DB and DC plans estimated from cross-sectional regressions. The performance is measured by alpha in Panel A, Sharpe ratio in Panel B, geometric mean return in Panel C, all measured at the plan level over the sample period. The alpha is estimated by regression the excess plan returns on excess returns of Vanguard 500 Index Fund and Vanguard Total Bond Market Index Fund. Observations are weighted by the number of years over which the performance is measured, and a minimum of five annual return observations is required for a plan to be included. DC is a dummy variable equal to 1 for a DC plan, and 0 for a DB plan. Nsize is the logarithm of a plan's total assets at the beginning of the performance measurement period normalized as standard deviations from the contemporaneous cross-sectional mean. Log(1+Age) is the logarithm of one plus the number of years since the plan inception, measured in the first plan year. SafeAssets, Equity, MutualFund, and Trust are fractions of assets in safe securities, individual stocks, mutual funds, and investment trusts at the beginning of the first plan year. Expense is the expense ratio measured for the first plan year. In the first three columns, we control for the time period (defined by the beginning and ending years of the performance measurement period) fixed effects. In Columns (4) to (6), we control for both the time period and the sponsor fixed effects. In the last three columns, we control for the sponsor ⊗ time period fixed effects. Standard errors are triple-clustered by sponsor and the start and end years of the measurement period, and t-statistics are reported in parentheses. Statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

Panel A. Alpha

	(1) Alpha	(2) Alpha	(3) Alpha	(4) Alpha	(5) Alpha	(6) Alpha	(7) Alpha	(8) Alpha	(9) Alpha
DC	0.668***	0.600***	0.321***	0.730***	0.726***	0.429***	0.861***	0.859***	0.498***
	(12.56)	(9.73)	(4.68)	(12.82)	(11.97)	(5.56)	(17.66)	(19.79)	(5.00)
Nsize	0.259***	0.281***	0.186***	0.208***	0.201***	0.113***	0.240***	0.254***	0.121**
	(10.84)	(8.30)	(7.14)	(7.98)	(5.87)	(4.32)	(3.96)	(3.77)	(2.25)
Nsize*DC	0.047	0.013	0.060	-0.064	-0.125**	-0.076*	-0.150**	-0.198***	-0.136***
	(0.85)	(0.25)	(1.36)	(-1.19)	(-2.61)	(-1.90)	(-2.48)	(-4.18)	(-3.56)
NsizeSQ	-0.043***	-0.041***	-0.033***	-0.034***	-0.029**	-0.021*	-0.027	-0.030	-0.016
	(-17.89)	(-8.75)	(-6.90)	(-3.62)	(-2.68)	(-2.04)	(-1.41)	(-1.58)	(-1.14)
Expense			-0.560***			-0.586***			-0.670***
			(-13.43)			(-16.36)			(-8.65)
Expense*DC			0.096**			0.121			0.247
			(2.55)			(1.51)			(1.13)
Log(1+Age)		-0.058**	-0.056***		-0.049**	-0.043**		-0.052**	-0.043*
		(-2.73)	(-3.13)		(-2.47)	(-2.18)		(-2.24)	(-1.95)
SafeAssets		0.526***	0.517***		0.463***	0.452***		0.439***	0.392***
		(6.90)	(6.53)		(3.90)	(3.69)		(5.21)	(4.76)
Equity		0.701	0.802		1.001*	1.073*		0.845	0.903
		(1.24)	(1.44)		(1.80)	(1.94)		(1.32)	(1.45)
MutualFund		0.075	0.032		-0.356*	-0.389*		-0.649***	-0.729***
		(0.51)	(0.22)		(-1.79)	(-1.98)		(-8.85)	(-9.86)
Trust		-0.047	-0.019		-0.145**	-0.127*		-0.195**	-0.223***
		(-0.53)	(-0.20)		(-2.15)	(-1.90)		(-2.74)	(-3.30)
Constant	-1.237***	-1.224***	-0.856***	-0.895***	-0.897***	-0.527***	-0.881***	-0.755***	-0.305
	(-26.27)	(-12.74)	(-8.19)	(-21.60)	(-8.95)	(-5.94)	(-75.84)	(-4.41)	(-1.49)
Observations	94248	94248	93563	30587	30587	30314	7733	7733	7676
R^2	0.242	0.250	0.265	0.546	0.556	0.563	0.661	0.670	0.678
Time period FE	Yes	Yes	Yes	Yes	Yes	Yes	Subsumed	Subsumed	Subsumed
Sponsor FE	No	No	No	Yes	Yes	Yes	Subsumed	Subsumed	Subsumed
Sponsor⊗Time period FE	No	No	No	No	No	No	Yes	Yes	Yes

Panel B. Sharpe ratio

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	SR	SR	SR	SR	SR	SR	SR	SR	SR
DC	0.005	0.002	-0.026**	0.014***	0.015***	-0.014*	0.021***	0.019***	-0.019**
	(0.68)	(0.26)	(-2.35)	(2.86)	(2.94)	(-2.03)	(11.62)	(4.95)	(-2.29)
Nsize	0.043***	0.044***	0.035***	0.034***	0.035***	0.027***	0.041***	0.042***	0.029***
	(10.67)	(7.79)	(7.94)	(16.09)	(8.59)	(8.50)	(14.84)	(9.06)	(9.04)
Nsize*DC	-0.013**	-0.014**	-0.009*	-0.022***	-0.024***	-0.019***	-0.027***	-0.027***	-0.021***
	(-2.07)	(-2.37)	(-1.90)	(-4.44)	(-5.45)	(-5.51)	(-5.95)	(-7.05)	(-7.98)
NsizeSQ	-0.005***	-0.005***	-0.004***	-0.003***	-0.003***	-0.002***	-0.003***	-0.003***	-0.002***
	(-5.08)	(-3.97)	(-3.41)	(-8.04)	(-4.36)	(-3.40)	(-3.88)	(-3.45)	(-3.15)
Expense			-0.053***			-0.053***			-0.067***
			(-9.26)			(-14.75)			(-13.92)
Expense*DC			0.017***			0.023***			0.032**
			(3.45)			(2.83)			(2.14)
Log(1+Age)		-0.003	-0.003		-0.001	-0.001		-0.002	-0.001
		(-1.12)	(-1.25)		(-0.87)	(-0.73)		(-0.88)	(-0.56)
SafeAssets		0.035***	0.034***		0.047***	0.046***		0.049***	0.044***
		(9.71)	(7.96)		(5.30)	(5.24)		(3.96)	(3.50)
Equity		0.021	0.030		0.017	0.026		0.009	0.017
		(0.57)	(0.82)		(0.38)	(0.56)		(0.16)	(0.30)
MutualFund		0.021***	0.018**		-0.004	-0.005		-0.001	-0.009
		(3.16)	(2.65)		(-0.36)	(-0.47)		(-0.03)	(-0.57)
Trust		0.011	0.014*		0.014	0.017		0.012	0.009
		(1.67)	(1.98)		(1.16)	(1.33)		(0.48)	(0.38)
Constant	0.397***	0.388***	0.421***	0.391***	0.377***	0.408***	0.411***	0.402***	0.444***
	(62.53)	(31.21)	(26.91)	(115.48)	(27.69)	(26.67)	(244.55)	(15.80)	(16.03)
Observations	92903	92903	92243	30018	30018	29769	7553	7553	7500
R^2	0.594	0.595	0.593	0.730	0.731	0.731	0.810	0.811	0.812
Time period FE	Yes	Yes	Yes	Yes	Yes	Yes	Subsumed	Subsumed	Subsumed
Sponsor FE	No	No	No	Yes	Yes	Yes	Subsumed	Subsumed	Subsumed
Sponsor⊗Time period FE	No	No	No	No	No	No	Yes	Yes	Yes

Panel C. Geometric mean return

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Mret	Mret	Mret	Mret	Mret	Mret	Mret	Mret	Mret
DC	0.123	0.033	-0.234	0.288*	0.251	-0.014	0.294*	0.220	-0.089
	(0.61)	(0.19)	(-1.13)	(1.80)	(1.67)	(-0.09)	(1.89)	(1.33)	(-0.52)
Nsize	0.582***	0.540***	0.455***	0.433***	0.392***	0.319***	0.436***	0.428***	0.307***
	(10.91)	(8.69)	(8.66)	(19.80)	(13.18)	(12.42)	(28.21)	(9.78)	(8.72)
Nsize*DC	-0.234***	-0.210***	-0.164***	-0.272***	-0.267***	-0.222***	-0.248***	-0.268***	-0.216***
	(-3.79)	(-3.73)	(-3.37)	(-5.41)	(-6.77)	(-6.93)	(-7.13)	(-7.70)	(-7.15)
NsizeSQ	-0.065***	-0.068***	-0.062***	-0.049***	-0.042***	-0.036***	-0.028**	-0.028*	-0.015
	(-15.70)	(-12.95)	(-12.91)	(-5.32)	(-7.62)	(-5.81)	(-2.17)	(-1.94)	(-1.21)
Expense			-0.520***			-0.480***			-0.618***
			(-11.69)			(-14.94)			(-12.78)
Expense*DC			0.130**			0.200**			0.101
			(2.37)			(2.27)			(0.68)
Log(Age)		-0.101***	-0.095***		-0.053**	-0.048**		-0.069**	-0.059**
		(-8.42)	(-8.06)		(-2.38)	(-2.15)		(-2.75)	(-2.35)
SafeAssets		-0.193*	-0.185		0.069	0.066		0.018	-0.025
		(-1.75)	(-1.67)		(0.67)	(0.65)		(0.18)	(-0.22)
Equity		1.274**	1.344**		1.188*	1.242*		1.346*	1.401**
		(2.58)	(2.76)		(1.72)	(1.78)		(2.06)	(2.18)
MutualFund		0.826***	0.786***		0.442***	0.418***		0.776***	0.670***
		(7.76)	(7.44)		(3.85)	(3.52)		(5.25)	(4.70)
Trust		0.547***	0.567***		0.518***	0.537***		0.440***	0.412***
		(6.05)	(6.21)		(4.32)	(4.32)		(3.38)	(3.19)
Constant	6.037***	5.853***	6.177***	6.430***	6.154***	6.454***	6.792***	6.555***	6.969***
	(36.19)	(39.76)	(36.02)	(72.20)	(33.32)	(36.73)	(77.25)	(27.53)	(31.24)
Observations	96170	96170	95459	32168	32168	31855	7954	7954	7895
R^2	0.457	0.467	0.473	0.663	0.666	0.669	0.794	0.797	0.801
Time period FE	Yes	Yes	Yes	Yes	Yes	Yes	Subsumed	Subsumed	Subsumed
Sponsor FE	No	No	No	Yes	Yes	Yes	Subsumed	Subsumed	Subsumed
Sponsor⊗Time period FE	No	No	No	No	No	No	Yes	Yes	Yes

Table 4: **Size and expense ratio: DB vs. DC plans**

This table shows the pension plan expense ratio as a function of plan size and other plan characteristics estimated using the panel data of annual observations. Nsize is the logarithm of a plan's total assets under management at the beginning of each year normalized as standard deviations from the contemporaneous cross-sectional mean. NsizeSQ is the square of Nsize. DC is a dummy variable equal to 1 for a DC plan, and 0 for a DB plan. Log(1+Age) is the logarithm of one plus the number of years since the plan inception. Safe, Equity, MutualFund, and Trust are fractions of assets in safe securities, individual stocks, mutual funds, and investment trusts at the beginning of the year. In the first two columns, we control for the year fixed effects. In Columns (3) and (4), we control for both the sponsor and year fixed effects. In the last two columns, we control for the sponsor ⊗ year fixed effects. Standard errors clustered by year and sponsor, and t-statistics are reported in parentheses. Statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

	(1) Expense	(2) Expense	(3) Expense	(4) Expense	(5) Expense	(6) Expense
DC	-0.549***	-0.518***	-0.567***	-0.526***	-0.562***	-0.517***
	(-50.39)	(-40.21)	(-63.44)	(-58.36)	(-59.55)	(-56.24)
Nsize	-0.207***	-0.215***	-0.181***	-0.192***	-0.189***	-0.200***
	(-40.75)	(-41.75)	(-33.99)	(-35.70)	(-29.45)	(-30.47)
Nsize*DC	0.080***	0.081***	0.089***	0.084***	0.087***	0.083***
	(18.53)	(18.80)	(18.84)	(18.29)	(19.03)	(18.91)
NsizeSQ	0.027***	0.027***	0.018***	0.019***	0.020***	0.021***
	(22.72)	(24.04)	(13.41)	(14.37)	(13.70)	(14.41)
Log(1+Age)		0.020***		0.035***		0.037***
		(5.14)		(11.70)		(9.21)
SafeAssets		-0.116***		-0.007		-0.099***
		(-4.01)		(-0.57)		(-4.24)
Equity		0.051*		0.105***		-0.036
		(1.91)		(5.81)		(-1.36)
MutualFund		-0.144***		-0.070***		-0.165***
		(-9.13)		(-8.78)		(-9.01)
Trust		-0.075***		-0.020		-0.089***
		(-3.98)		(-1.55)		(-4.22)
Constant	0.757***	0.773***	0.782***	0.679***	0.741***	0.713***
	(81.62)	(23.92)	(100.24)	(45.16)	(101.48)	(35.04)
Observations	1300830	1300800	1285785	1285768	385493	385478
R^2	0.191	0.199	0.577	0.580	0.689	0.692
Year FE	Yes	Yes	Yes	Yes	Subsumed	Subsumed
Sponsor FE	No	No	Yes	Yes	Subsumed	Subsumed
Sponsor⊗Year FE	No	No	No	No	Yes	Yes

Table 5: **Size and termination probability: DB vs. DC plans**

This table shows the relation between plan termination probability and plan size estimated from linear probability models using the panel data of annual observations. Nsize is the logarithm of a plan's total assets under management at the beginning of each year normalized as standard deviations from the contemporaneous cross-sectional mean. NsizeSQ is the square of Nsize. DC is a dummy variable equal to 1 for a DC plan, and 0 for a DB plan. Ret3y is the average return in the three most recent plan years. Log(1+Age) is the logarithm of one plus the number of years since the plan inception. Safe, Equity, MutualFund, and Trust are fractions of assets in safe securities, individual stocks, mutual funds, and investment trusts at the beginning of the year. Expense is the administrative expense ratio in the prior year. In the first two columns, we control for the year fixed effects. In Columns (3) and (4), we control for both the year and the sponsor fixed effects. In the last two columns, we control for the sponsor ⊗ year fixed effects. Standard errors are clustered by year and sponsor, and t-statistics are reported in parentheses. Statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

	(1) Termination	(2) Termination	(3) Termination	(4) Termination	(5) Termination	(6) Termination
DC	-0.015***	-0.004	-0.013***	0.009***	-0.006***	0.012***
	(-11.75)	(-1.26)	(-6.70)	(2.96)	(-4.69)	(3.20)
Nsize	-0.007***	-0.008***	-0.017***	-0.029***	-0.018***	-0.023***
	(-9.40)	(-7.63)	(-18.22)	(-21.53)	(-17.06)	(-16.84)
Nsize*DC	0.006***	0.007***	0.005***	0.003***	0.002***	0.002***
	(9.16)	(8.06)	(5.81)	(3.43)	(3.79)	(3.44)
NsizeSQ	-0.000	0.000	-0.004***	-0.000	-0.001**	0.000
	(-0.77)	(1.19)	(-8.66)	(-1.18)	(-2.08)	(1.19)
Ret3y		0.003***		0.003***		0.003***
		(5.48)		(5.18)		(4.98)
Ret3y*DC		-0.001***		-0.001***		-0.002***
		(-4.10)		(-3.66)		(-4.47)
Expense		0.004***		0.000		0.000
		(2.83)		(0.22)		(0.19)
Expense*DC		-0.001		0.005***		0.004
		(-0.45)		(3.81)		(1.47)
Log(1+Age)		-0.004***		0.020***		0.007***
		(-4.74)		(16.56)		(6.19)
SafeAssets		0.014***		0.023***		0.015***
		(5.27)		(7.28)		(3.37)
Equity		-0.007**		-0.005		-0.001
		(-2.37)		(-1.55)		(-0.30)
MutualFund		0.001		-0.005**		-0.009**
		(0.46)		(-2.22)		(-2.53)
Trust		0.008***		-0.001		-0.004
		(3.87)		(-0.49)		(-1.10)
Constant	0.037***	0.018***	0.037***	-0.057***	0.046***	-0.002
	(32.74)	(3.78)	(21.63)	(-10.09)	(39.04)	(-0.29)
Observations	1310151	911535	1295183	899884	390917	252636
R^2	0.003	0.006	0.154	0.173	0.517	0.541
Year FE	Yes	Yes	Yes	Yes	Subsumed	Subsumed
Sponsor FE	No	No	Yes	Yes	Subsumed	Subsumed
Sponsor ⊗ Year FE	No	No	No	No	Yes	Yes

Table 6: **Size and the choice between DB and DC plans**

This table shows the cross-sectional determinants of the choice of between the DC and DB plan forms by new pension plans, estimated using plans entering our sample within one, three, and five years since inception, respectively. The dependent variable DC is a dummy variable equal to 1 if a plan is of the DC type, and 0 otherwise. Nsize is the logarithm of a plan's first observed beginning-of-year total asset value normalized as standard deviations from the contemporaneous cross-sectional mean. NsizeSQ is Nsize squared. Age is the year in which the plan size is measured minus the inception year. The base case is Age=0. Columns (1) to (3) show the results from the linear probability models, while columns (4) to (6) present the result from the logit models. All models are estimated with inception year fixed effects. The last row reports the marginal effect of plan size at Nsize=0 for the logit models. Standard errors are clustered by sponsor and inception year, and t-statistics are reported in parentheses. Statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

	Linear Probability Models			Logit Models		
	(1)	(2)	(3)	(4)	(5)	(6)
	DC	DC	DC	DC	DC	DC
Nsize	-0.070***	-0.070***	-0.068***	-0.711***	-0.778***	-0.823***
	(-13.81)	(-15.17)	(-16.68)	(-16.04)	(-21.04)	(-24.00)
NsizeSQ	-0.012***	-0.015***	-0.016***	0.032	0.045**	0.058***
	(-4.74)	(-7.60)	(-8.59)	(1.52)	(2.41)	(3.24)
D(Age=1)	0.015	0.018	0.018	0.147	0.158	0.151
	(1.18)	(1.25)	(1.20)	(1.26)	(1.27)	(1.19)
D(Age=2)		0.038**	0.038**		0.457***	0.420***
		(2.33)	(2.26)		(2.95)	(2.69)
D(Age=3)		0.050***	0.050***		0.766***	0.714***
		(3.12)	(2.99)		(4.52)	(4.15)
D(Age=4)			0.060***			1.024***
			(3.72)			(6.68)
D(Age=5)			0.062***			1.064***
			(3.62)			(5.81)
Constant	0.869***	0.866***	0.867***	1.366***	1.379***	1.283***
	(62.00)	(52.70)	(49.96)	(12.14)	(10.77)	(9.41)
Observations	15099	32179	46105	15099	32179	46105
R^2	0.072	0.076	0.079			
Pseudo R^2				0.092	0.111	0.128
Inception Year FE	Yes	Yes	Yes	Yes	Yes	Yes
$\frac{\partial P(DC=1)}{\partial Nsize}\|_{Nsize=0}$				-0.072	-0.068	-0.065

Table 7: **The role of plan sponsors**

This table shows the effects of sponsor characteristics on pension plan performance, termination rate, and the choice between the DB and DC structures. Panel A extends the baseline models in Table 3 for plan performance; Panel B extends the baseline models in Table 5 for plan termination; Panel C extends the linear probability models in Table 6 for the pension structure choice. Panels B and C include models with or without the industry fixed effects. Ret3y is the average return in the three most recent regular plan years. SponsorSize is the logarithm of the annual sales of the plan sponsor. Profitability is operating income before depreciation over total assets, winsorized at the 1st and 99th percentiles and averaged over three years (from $t-2$ to t). Leverage is the sum of short-term and long-term debt over total assets, also winsorized at the 1st and 99th percentiles and averaged over three years. Finance is a dummy variable equal to 1 if the sponsor is a financial firm and 0 otherwise. These variables are measured in the first year of the performance measurement period in Panel A, on an annual base in Panel B, and in the plan inception year in Panel C. All the other variables are defined and measured in the same way as in the baseline tables. Standard errors are clustered by sponsor and by the start and end years of the measurement period in Panel A, by year and sponsor in Panel B, and by inception year and sponsor in Panel C. T-statistics are reported in parentheses. Statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

Panel A. Sponsor characteristics and plan performance

	(1) Alpha	(2) Alpha	(3) Alpha	(4) SR	(5) SR	(6) SR	(7) Mret	(8) Mret	(9) Mret
DC	1.264***	1.240***	0.924***	0.023	0.015	-0.019	0.565*	0.400	0.042
	(6.36)	(7.72)	(7.54)	(1.02)	(0.75)	(-1.20)	(1.84)	(1.22)	(0.12)
Nsize	0.215***	0.224***	0.163***	0.030***	0.032***	0.026***	0.352***	0.349***	0.281***
	(5.42)	(5.33)	(3.93)	(10.09)	(8.67)	(6.54)	(10.42)	(8.69)	(8.50)
Nsize*DC	-0.055	-0.050	-0.002	-0.018***	-0.016***	-0.012**	-0.160***	-0.137**	-0.085
	(-0.95)	(-0.88)	(-0.04)	(-4.15)	(-3.47)	(-2.35)	(-3.29)	(-2.50)	(-1.53)
NsizeSQ	-0.030**	-0.029**	-0.026**	-0.002	-0.002	-0.002	-0.038**	-0.037**	-0.033**
	(-2.36)	(-2.27)	(-2.24)	(-1.29)	(-1.29)	(-1.20)	(-2.68)	(-2.51)	(-2.39)
SponsorSize	0.109**	0.109***	0.101***	0.010***	0.008***	0.007***	0.145**	0.116**	0.106***
	(2.74)	(2.95)	(3.25)	(3.13)	(3.17)	(3.60)	(2.57)	(2.75)	(3.05)
SponsorSize*DC	-0.077*	-0.071*	-0.066**	-0.004	-0.002	-0.001	-0.093*	-0.054	-0.048
	(-1.92)	(-1.92)	(-2.18)	(-0.97)	(-0.45)	(-0.39)	(-1.73)	(-1.27)	(-1.29)
Finance	0.271*	0.273*	0.261*	0.018	0.026**	0.026**	-0.015	0.136	0.123
	(1.80)	(1.82)	(1.84)	(1.67)	(2.18)	(2.22)	(-0.11)	(0.82)	(0.75)
Finance*DC	-0.181	-0.104	-0.110	-0.000	0.007	0.006	0.761***	0.727**	0.720**
	(-1.06)	(-0.58)	(-0.64)	(-0.03)	(0.52)	(0.52)	(2.91)	(2.62)	(2.64)
Expense			-0.442***			-0.044***			-0.489***
			(-9.67)			(-9.31)			(-6.62)
Expense*DC			0.115			0.022***			0.143**
			(0.92)			(5.05)			(2.16)
Log(Age)		0.036	0.028		0.005*	0.004		0.073**	0.064**
		(1.19)	(1.02)		(1.72)	(1.37)		(2.18)	(2.09)
SafeAssets		0.380	0.351		0.022	0.020		-0.204	-0.235
		(1.58)	(1.47)		(1.11)	(0.99)		(-1.04)	(-1.18)
Equity		-0.485	-0.507		-0.100***	-0.101***		-0.476	-0.502
		(-0.87)	(-0.92)		(-2.94)	(-3.02)		(-0.92)	(-0.97)
MutualFund		0.021	-0.086		0.001	-0.008		0.630***	0.516**
		(0.11)	(-0.47)		(0.14)	(-0.84)		(2.95)	(2.60)
Trust		-0.026	-0.090		0.002	-0.003		0.337**	0.267**
		(-0.23)	(-0.78)		(0.27)	(-0.44)		(2.77)	(2.36)
Constant	-1.655***	-1.749***	-1.285***	0.303***	0.308***	0.353***	5.640***	5.447***	5.961***
	(-8.18)	(-9.36)	(-8.79)	(17.33)	(20.95)	(21.70)	(25.26)	(25.36)	(30.60)
Observations	8752	8752	8744	8644	8644	8636	8965	8965	8957
R^2	0.167	0.171	0.177	0.487	0.497	0.501	0.443	0.450	0.454
Time period FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. Sponsor characteristics and plan termination

	(1) Termination	(2) Termination	(3) Termination	(4) Termination
DC	-0.004	0.016	-0.004	0.016*
	(-0.44)	(1.70)	(-0.39)	(1.72)
Nsize	-0.016***	-0.021***	-0.018***	-0.022***
	(-8.77)	(-9.80)	(-9.49)	(-11.00)
Nsize*DC	0.004**	0.005**	0.003	0.004*
	(2.08)	(2.27)	(1.52)	(1.86)
NsizeSQ	-0.001**	0.000	-0.001**	0.000
	(-2.40)	(1.65)	(-2.72)	(1.20)
SponsorSize	0.012***	0.010***	0.013***	0.011***
	(6.76)	(6.88)	(7.36)	(8.28)
SponsorSize*DC	-0.001	-0.001	-0.001	-0.001
	(-0.66)	(-0.83)	(-0.43)	(-0.59)
Profitability	-0.065***	-0.052**	-0.057**	-0.059**
	(-2.89)	(-2.29)	(-2.63)	(-2.50)
Profitability*DC	0.039*	0.028	0.032	0.031
	(1.76)	(1.25)	(1.48)	(1.36)
Leverage	0.021***	0.024***	0.020***	0.021***
	(3.14)	(4.09)	(2.95)	(4.38)
Leverage*DC	-0.019**	-0.019***	-0.016**	-0.016***
	(-2.69)	(-3.74)	(-2.37)	(-3.95)
Ret3y		0.003***		0.003***
		(5.44)		(5.35)
Ret3y*DC		-0.002***		-0.002***
		(-4.40)		(-4.37)
Expense		-0.004		-0.004
		(-1.10)		(-1.04)
Expense*DC		0.004		0.005
		(1.01)		(1.33)
Log(1+Age)		0.005***		0.005***
		(5.57)		(6.00)
SafeAssets		0.009		0.006
		(1.29)		(0.85)
Equity		0.023***		0.021***
		(3.83)		(3.25)
MutualFund		0.006		0.004
		(1.29)		(0.82)
Trust		0.017***		0.013**
		(3.49)		(2.65)
Constant	-0.037***	-0.077***	-0.046***	-0.082***
	(-3.62)	(-6.47)	(-4.45)	(-7.47)
Observations	115379	82211	115378	82208
R^2	0.022	0.026	0.029	0.034
Year FE	Yes	Yes	Yes	Yes
Industry FE	No	No	Yes	Yes

Panel C. Sponsor characteristics and the choice of plan structure

	(1) DC	(2) DC	(3) DC	(4) DC	(5) DC	(6) DC
Nsize	-0.050***	-0.056***	-0.053***	-0.026*	-0.038***	-0.040***
	(-3.55)	(-5.71)	(-5.59)	(-1.76)	(-4.17)	(-4.66)
NsizeSQ	-0.005	-0.008	-0.009*	-0.005	-0.007	-0.008
	(-0.82)	(-1.67)	(-2.04)	(-0.59)	(-1.44)	(-1.61)
SponsorSize	-0.042***	-0.036***	-0.034***	-0.035***	-0.029***	-0.027***
	(-5.50)	(-5.46)	(-5.96)	(-3.72)	(-4.13)	(-5.01)
Profitability	-0.005	0.007	0.009	0.032	0.019	0.019
	(-0.15)	(0.35)	(0.51)	(1.28)	(1.10)	(1.18)
Leverage	-0.041	-0.027	-0.020	-0.026	-0.006	-0.007
	(-1.14)	(-0.97)	(-0.83)	(-0.64)	(-0.27)	(-0.32)
D(Age=1)	0.099*	0.097*	0.098*	0.057	0.064	0.078
	(1.90)	(1.81)	(1.83)	(0.89)	(1.10)	(1.39)
D(Age=2)		0.083*	0.086*		0.070	0.086
		(1.72)	(1.77)		(1.31)	(1.64)
D(Age=3)		0.086*	0.090*		0.075	0.087*
		(1.80)	(1.88)		(1.41)	(1.71)
D(Age=4)			0.096*			0.085
			(2.02)			(1.57)
D(Age=5)			0.118**			0.107*
			(2.17)			(1.91)
Constant	1.045***	1.008***	0.993***	1.012***	0.973***	0.952***
	(18.01)	(21.04)	(20.00)	(12.77)	(15.54)	(15.82)
Observations	1217	2106	2521	1170	2065	2491
R^2	0.134	0.153	0.158	0.296	0.273	0.275
Inception Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	No	No	No	Yes	Yes	Yes

Table 8: **Scaled median plan size and DC plan percentage**

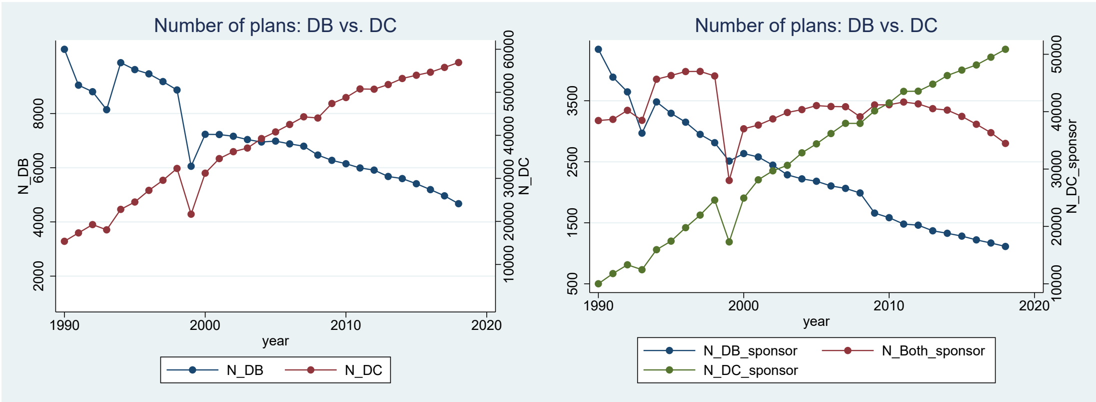
This table shows the time series regression results on the relation between the number of DC plans as a percentage of all plans in our sample (DC %) and the scaled median plan size. Msize1 is the median pension plan asset value at the end of each year scaled by the sum of the total U.S. stock market capitalization of domestic listed companies and total U.S. bond market value. Msize2 is the median pension plan asset value at the end of each year scaled by the total U.S. stock market capitalization of domestic companies. Both variables are normalized to 100 for the year 1990. ΔDC%, ΔMsize1, ΔMsize2 are first-order differences of each corresponding variable. Standard errors are Newey-West corrected for autocorrelation (with three lags), and t-statistics are reported in parentheses. Statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

	(1) DC%	(2) DC%	(3) ΔDC%	(4) ΔDC%
Msize1	-0.477***			
	(-16.18)			
Msize2		-0.448***		
		(-10.90)		
ΔMsize1			-0.214**	
			(-2.71)	
ΔMsize2				-0.204***
				(-5.14)
Constant	107.733***	101.158***	0.702***	0.646***
	(45.48)	(35.77)	(4.63)	(3.76)
Observations	29	29	28	28
R^2	0.929	0.812	0.468	0.725

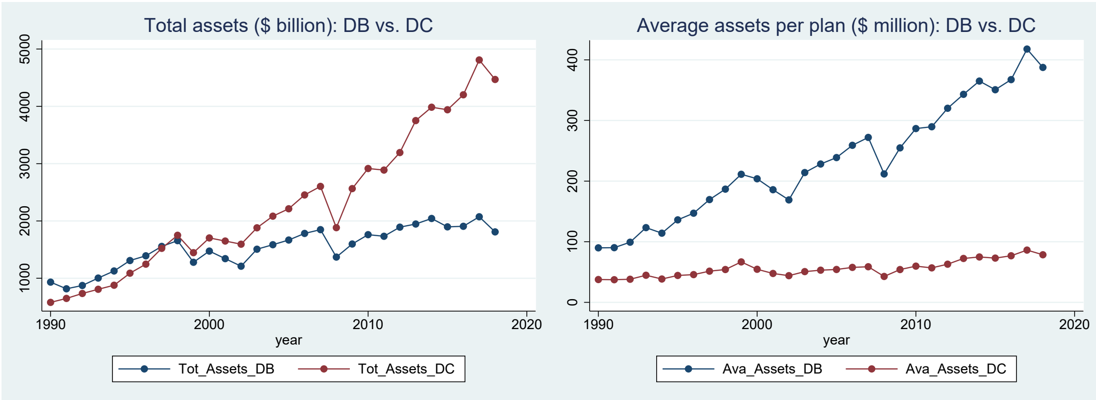
Table 9: **Size and performance: Fama-MacBeth Regressiosn using annual returns**

This table shows the Fama-MacBeth regression results using annual raw returns as the dependent variable. DC is a dummy variable equal to 1 for a DC plan, and 0 for a DB plan. Nsize is the logarithm of a plan's total assets under management at the beginning of each year normalized as standard deviations from the contemporaneous cross-sectional mean. NsizeSQ is the square of Nsize. Log(1+Age) is the logarithm of one plus the number of years since the plan inception. Safe, Equity, MutualFund, and Trust are fractions of assets in safe securities, individual stocks, mutual funds, and investment trusts at the beginning of the year. Expense is the administrative expense ratio in the prior year. The last two models control for the sponsor fixed effects, while the first two models do not. Standard errors are Newey-West corrected for autocorrelations (with 3 lags) and t-statistics are reported in parentheses. Statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

	(1) Ret	(2) Ret	(3) Ret	(4) Ret
DC	0.273	-0.285	0.433	-0.003
	(0.80)	(-0.75)	(1.55)	(-0.01)
Nsize	0.717***	0.579***	0.616***	0.442***
	(9.38)	(6.67)	(8.56)	(5.20)
Nsize*DC	-0.269***	-0.156*	-0.285***	-0.214***
	(-3.79)	(-2.01)	(-6.31)	(-4.36)
NsizeSQ	-0.067***	-0.058***	-0.056***	-0.029**
	(-6.90)	(-5.53)	(-6.37)	(-2.50)
Expense		-0.929***		-0.823***
		(-11.11)		(-8.18)
Expense*DC		0.211		-0.039
		(1.56)		(-0.23)
Log(1+Age)	-0.103*	-0.085*	-0.096***	-0.046
	(-1.90)	(-1.76)	(-3.10)	(-1.45)
SafeAssets	-0.015	-0.258	0.173	-0.265
	(-0.02)	(-0.35)	(0.27)	(-0.38)
Equity	3.231***	3.476***	3.487***	3.496***
	(3.73)	(4.12)	(3.32)	(3.53)
MutualFund	2.093***	2.151***	2.076***	1.907***
	(3.98)	(4.29)	(3.20)	(3.00)
Trust	1.629***	1.620***	1.770***	1.555***
	(3.61)	(3.69)	(3.19)	(2.82)
Constant	5.469***	6.288***	5.391***	6.221***
	(3.39)	(3.84)	(3.70)	(4.14)
Observations	1145481	1000917	333949	294523
Sponsor FE	No	No	Yes	Yes

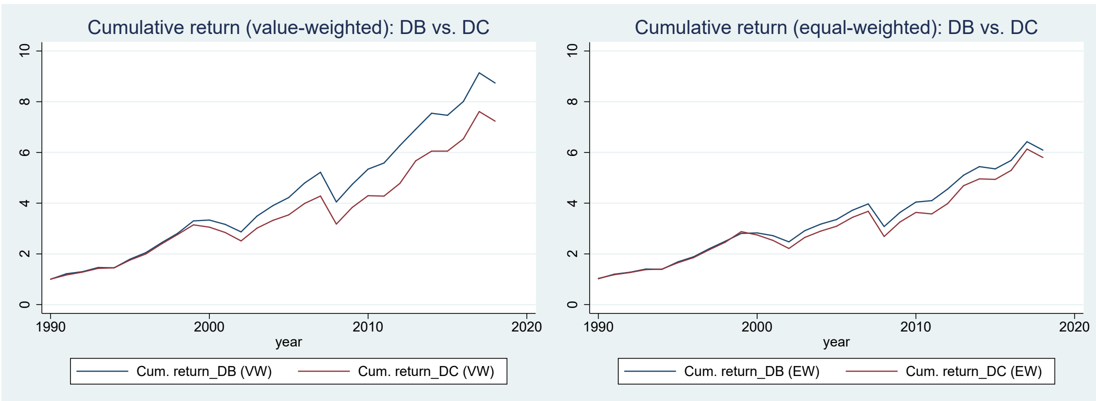


(a) (b)



(c) (d)

Figure 1: **The evolution of the U.S. corporate pension system.** This figure shows the evolution of the U.S. corporate pension system from 1990 to 2018, including the total numbers of DB vs. DC plans (Panel (a)); the numbers of sponsors of DB plans, DC plans, and both plans (Panel (b)); the total and the average asset sizes of both types of plans (Panel (c) and (d)). The asset values are converted into year 2018 dollars using the GDP deflator.



(a) (b)

Figure 2: **The cumulative returns of pension plans: DB vs. DC.** Panel (a) shows the cumulative value-weighted (by asset value at the beginning of each year) returns of DB and DC portfolios. Panel (b) shows the cumulative return of equal-weighted DB and DC plans.

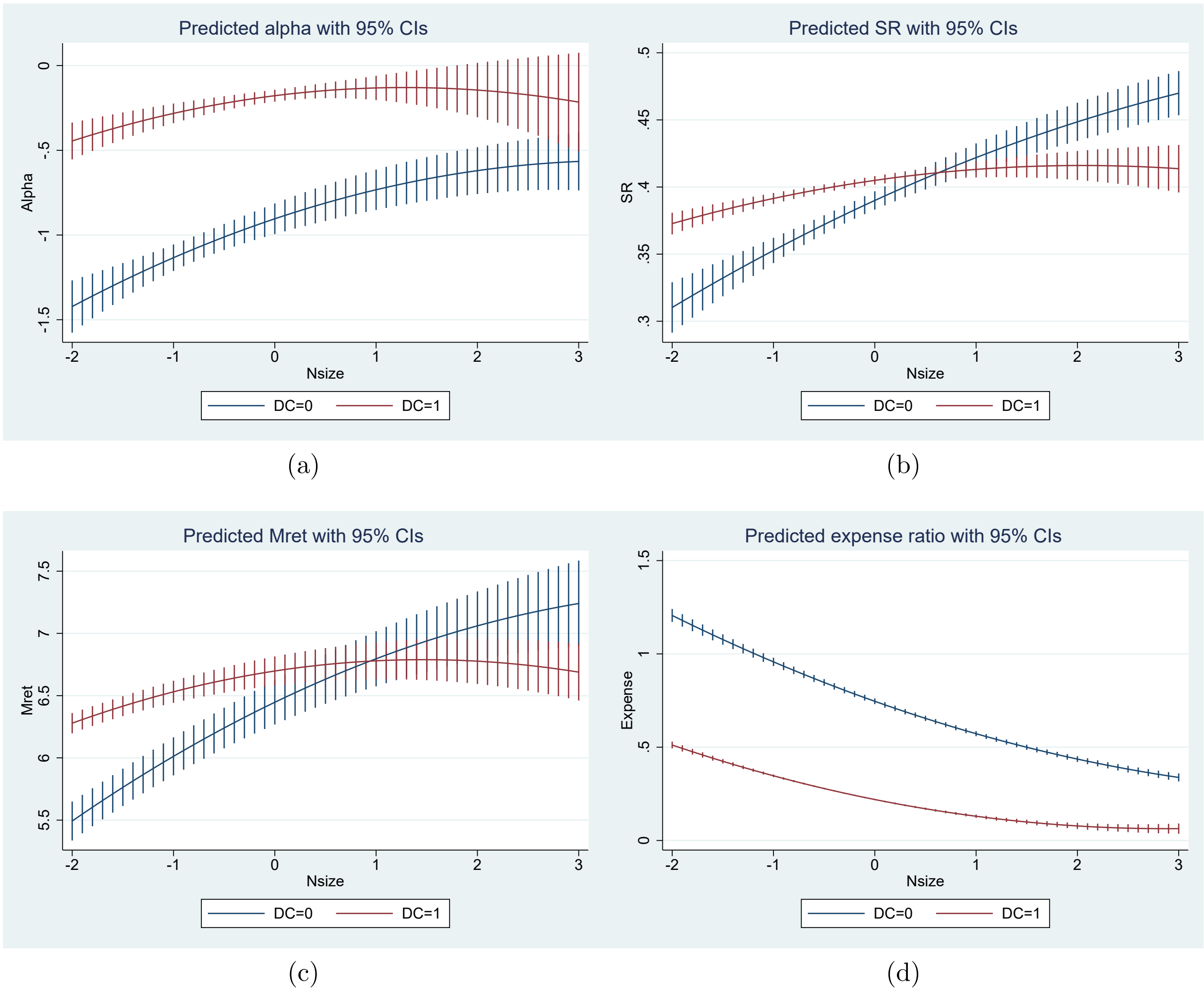


Figure 3: **The estimated relations between performance, expenses, and plan size.** The first three panels show the fitted cross-sectional relations between the alpha (Panel (a)), Sharpe ratio (Panel (b)), geometric mean return (Panel (c)) and the normalized initial plan size for both DB and DC plans, based on estimated results in Column (5) of each panel in Table 3. Panel (d) shows the fitted relation between the plan expense ratio and the normalized plan size, based on the estimated coefficients in Column (4) of Table 4. Each panel also shows the 95% confidence interval of the predicted values of the outcome variable.

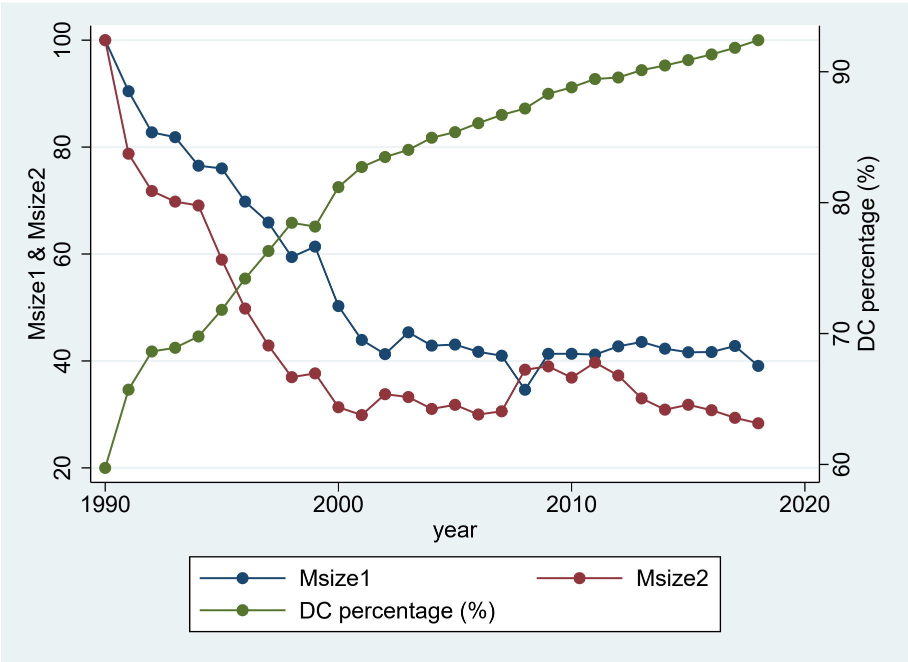


Figure 4: **The scaled median plan size and the percentage of DC plans.** The right Y-axis shows the percentage of DC plans in the total number of plans in our sample (DC%) and the left Y-axis shows two alternative measures of scaled median pension plan size. Msize1 is the median pension plan asset value at the end of each year scaled by the sum of the total U.S. stock market capitalization of domestic listed companies and total U.S. bond market value. Msize2 is the median pension plan asset value at the end of each year scaled by the total U.S. stock market capitalization of domestic companies. Both variables are normalized to 100 for the year 1990.

A. Internet Appendix

This internet appendix presents additional results from our portfolio analysis and results from two sets of robustness tests. Table A.1 shows alphas and other characteristics of size-sorted DB and DC portfolios formed using the largest 10 percent of DB and DC plans. Table A.2 shows the size effect in the performance of DB and DC plans estimated from cross-sectional regressions when annual fund returns are calculated using two alternative formulas: Equations (6) and (7). Table A.3 shows the cross-sectional regression results when alpha is estimated using three alternative models.

Table A.1: **Size-sorted pension portfolios formed using the largest DB and DC plans**

This table shows alphas and other characteristics of the size-sorted DB and DC portfolios formed using the largest 10 percent of DB and DC plans. Based on the asset value at the beginning of each year, both DB and DC plans in the top 10% of their size distributions are evenly sorted into 10 portfolios at an ascending order. The annual return of each portfolio is the value-weighted (by the beginning-of-year assets) average across plans. Panel A shows the alphas of size-sorted DB and DC portfolios estimated from two alternative models. Alpha2 is estimated by regressing excess portfolio returns on excess returns of the Vanguard S&P 500 Index Fund and the Vanguard Total Bond Fund. Alpha4 is estimated by including two additional index funds in the benchmark portfolio: the Vanguard Extended Market Index Fund and the Vanguard Balance Index Fund. The third section of the panel shows the alphas for the portfolio that longs a DB portfolio and shorts a DC portfolio in the same size decile. Panel B shows other characteristics of the size-sorted pension portfolio. The variable Assets is the time-series mean of the average asset size of each portfolio. Mean return and Sharpe ratio are the geometric mean and Sharp ratio calculated using the value-weighted returns of each portfolio; Expense ratio is the time-series average of the asset-weighted expense ratios; Termination rate is the time series average of the annual termination rate. The last columns of each panel show the differences between portfolios 10 and 1, together with t-statistics in parentheses when available. (For the alphas, geometric mean return, and Sharpe ratio, the last column is calculated using the zero-investment portfolio of longing portfolio (10) and shorting portfolio (1).) Statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

Panel A. Alphas of the size-sorted portfolios

Portfolio	1	2	3	4	5	6	7	8	9	10	(10)-(1)
DB plans (average number of plans per group = 72)											
Alpha2	-0.594	-0.117	-0.424	-0.405	-0.505	-0.080	-0.178	-0.208	0.356	0.730	1.324***
	(-0.91)	(-0.17)	(-0.68)	(-0.60)	(-0.78)	(-0.12)	(-0.24)	(-0.30)	(0.45)	(0.87)	(3.23)
Alpha4	-0.240	0.153	-0.128	-0.128	-0.206	0.187	0.101	0.052	0.632	0.953	1.194***
	(-0.49)	(0.30)	(-0.26)	(-0.24)	(-0.41)	(0.35)	(0.18)	(0.10)	(0.95)	(1.30)	(2.98)
DC plans (average number of plans per group = 380)											
Alpha2	0.068	0.084	0.131	0.160	-0.014	0.143	0.109	-0.194	0.039	-0.168	-0.236
	(0.10)	(0.12)	(0.19)	(0.22)	(-0.02)	(0.21)	(0.15)	(-0.27)	(0.06)	(-0.26)	(-0.73)
Alpha4	0.411	0.478	0.509	0.579	0.370	0.531	0.482	0.128	0.329	0.108	-0.303
	(0.79)	(1.04)	(1.07)	(1.16)	(0.79)	(1.04)	(0.96)	(0.25)	(0.65)	(0.20)	(-1.01)
DB−DC											
Alpha2	-0.662	-0.202	-0.556	-0.564	-0.491	-0.224	-0.287	-0.014	0.317	0.898	1.560***
	(-1.36)	(-0.46)	(-1.23)	(-1.08)	(-1.01)	(-0.41)	(-0.49)	(-0.03)	(0.52)	(1.19)	(2.88)
Alpha4	-0.651	-0.325	-0.637	-0.707	-0.576	-0.344	-0.381	-0.076	0.304	0.846	1.497***
	(-1.28)	(-0.73)	(-1.38)	(-1.32)	(-1.14)	(-0.61)	(-0.63)	(-0.14)	(0.47)	(1.08)	(2.94)

Panel B. Other characteristics of the size-sorted portfolios

Portfolio	1	2	3	4	5	6	7	8	9	10	(10)-(1)
DB plans											
Assets ($ million)	307.72	360.15	428.18	518.32	649.06	861.79	1181.66	1719.05	2829.57	10,063.40	
Mean return	7.15	7.65	7.41	7.21	7.39	7.60	7.55	7.51	7.94	8.19	1.02
Sharpe ratio	0.44	0.48	0.46	0.45	0.46	0.48	0.47	0.46	0.51	0.53	0.60
Expense ratio	0.48	0.47	0.45	0.41	0.37	0.40	0.36	0.31	0.31	0.24	-0.23 (-10.80)
Termination rate	2.24	2.84	1.98	2.11	2.35	2.48	1.54	2.24	1.18	1.29	-0.95 (-2.77)
DC plans											
Assets ($ million)	61.50	70.43	82.18	97.83	119.48	151.95	203.85	299.68	531.14	2609.44	
Mean return	6.90	6.91	7.01	6.95	6.99	7.12	7.14	7.03	7.34	7.25	0.41
Sharpe ratio	0.40	0.40	0.41	0.40	0.40	0.42	0.42	0.40	0.43	0.42	0.26
Expense ratio	0.11	0.11	0.11	0.10	0.10	0.09	0.08	0.07	0.07	0.07	-0.04 (-7.36)
Termination rate	2.18	2.24	2.11	2.31	2.24	2.18	1.88	1.87	1.73	1.42	-0.76 (-3.17)

Table A.2: **Plan size and performance: alternative return measures**

This table shows the size effect in the performance of DB and DC plans estimated from the cross-sectional regressions using returns calculated from Equation (6) (Panel A) or (7) (Panel B) instead of Equation (1). The performance is measured by alpha (calculated using the Vanguard 500 Index Fund and the Vanguard Total Market Index Funds as the benchmark), geometric mean return, or Sharpe ratio. Observations are weighted by the number of years over which the performance is measured, and a minimum of five annual return observations is required for each plan. DC is a dummy variable which is 1 for a DC plan, and 0 for a DB plan. Nsize is the logarithm of a plan's total assets at the beginning of the performance measurement period normalized as standard deviations from the contemporaneous cross-sectional mean. Log(1+Age) is the logarithm of one plus the number of years since the plan inception measured in the first plan year. SafeAssets, Equity, MutualFund, and Trust are fractions of assets in safe securities, individual stocks, mutual funds, and investment trusts at the beginning of the first plan year. Expense is the expense ratio measured for the first plan year. We control for both the time period (defined by the start and end years of the performance measurement period) and sponsor fixed effects. Standard errors are triple-clustered by sponsor and by the start and end years of the measurement period, and t-statistics are reported in parentheses. Statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

Panel A. Performance based on returns calculated using Equation (6)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Alpha	Alpha	Alpha	SR	SR	SR	Mret	Mret	Mret
DC	0.831***	0.807***	0.513***	0.022***	0.021***	-0.008	0.455***	0.363***	0.108
	(11.57)	(16.16)	(8.71)	(4.06)	(4.80)	(-1.34)	(3.56)	(2.86)	(0.82)
Nsize	0.149***	0.158***	0.071***	0.025***	0.028***	0.020***	0.280***	0.272***	0.200***
	(5.11)	(6.57)	(3.69)	(14.43)	(8.53)	(8.35)	(9.33)	(10.52)	(8.13)
Nsize*DC	-0.090	-0.148**	-0.099**	-0.025***	-0.026***	-0.021***	-0.303***	-0.294***	-0.251***
	(-1.44)	(-2.80)	(-2.23)	(-3.92)	(-4.87)	(-4.94)	(-4.90)	(-6.15)	(-6.08)
NsizeSQ	-0.026**	-0.022**	-0.014	-0.001***	-0.001***	-0.000	-0.021	-0.018*	-0.011
	(-2.54)	(-2.61)	(-1.60)	(-3.28)	(-3.11)	(-0.86)	(-1.43)	(-2.00)	(-1.15)
Expense			-0.582***			-0.054***			-0.480***
			(-17.42)			(-13.31)			(-15.61)
Expense*DC			0.117			0.022**			0.144**
			(1.57)			(2.44)			(2.07)
Log(Age)		-0.082***	-0.075***		-0.005*	-0.005*		-0.130***	-0.126***
		(-3.55)	(-3.10)		(-1.97)	(-1.93)		(-6.50)	(-6.07)
SafeAssets		0.553***	0.539***		0.046***	0.047***		0.073	0.070
		(4.09)	(3.93)		(4.88)	(4.86)		(0.79)	(0.76)
Equity		0.925	0.996*		0.009	0.018		1.146	1.205
		(1.63)	(1.76)		(0.20)	(0.40)		(1.64)	(1.70)
MutualFund		-0.350	-0.383*		-0.010	-0.011		0.431***	0.403***
		(-1.60)	(-1.77)		(-1.06)	(-1.14)		(3.61)	(3.33)
Trust		-0.115	-0.098		0.010	0.013		0.484***	0.503***
		(-1.06)	(-0.93)		(0.87)	(1.07)		(3.77)	(3.82)
Constant	-0.956***	-0.888***	-0.520***	0.388***	0.388***	0.419***	6.362***	6.321***	6.624***
	(-16.98)	(-7.15)	(-4.33)	(94.46)	(26.78)	(25.09)	(102.15)	(32.44)	(36.37)
Observations	30573	30573	30279	29975	29975	29741	32141	32141	31828
R^2	0.553	0.562	0.570	0.727	0.728	0.728	0.664	0.667	0.670
Time period FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sponsor FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. Performance based on returns calculated using Equation (7)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Alpha	Alpha	Alpha	SR	SR	SR	Mret	Mret	Mret
DC	0.821***	0.814***	0.508***	0.025***	0.026***	-0.002	0.453**	0.418***	0.156
	(15.53)	(18.24)	(8.50)	(5.50)	(4.91)	(-0.28)	(2.76)	(2.95)	(1.08)
Nsize	0.130***	0.142***	0.050**	0.026***	0.027***	0.019***	0.243***	0.230***	0.155***
	(5.59)	(6.89)	(2.77)	(11.50)	(9.11)	(8.29)	(11.03)	(8.49)	(6.18)
Nsize*DC	-0.113*	-0.154***	-0.103**	-0.027***	-0.027***	-0.022***	-0.362***	-0.325***	-0.279***
	(-1.74)	(-2.85)	(-2.30)	(-4.15)	(-4.88)	(-4.91)	(-4.90)	(-5.64)	(-5.42)
NsizeSQ	-0.025***	-0.023***	-0.013*	-0.002***	-0.002***	-0.001**	-0.013*	-0.013**	-0.006
	(-3.34)	(-3.15)	(-1.94)	(-4.70)	(-4.58)	(-2.65)	(-1.85)	(-2.50)	(-1.09)
Expense			-0.597***			-0.053***			-0.478***
			(-13.29)			(-14.27)			(-17.38)
Expense*DC			0.135*			0.019**			0.195***
			(1.86)			(2.73)			(3.48)
Log(Age)		-0.046**	-0.038**		-0.001	-0.000		-0.015	-0.008
		(-2.70)	(-2.26)		(-0.26)	(-0.01)		(-0.79)	(-0.41)
SafeAssets		0.500***	0.497***		0.041***	0.041***		0.026	0.021
		(6.23)	(6.19)		(4.79)	(4.82)		(0.27)	(0.22)
Equity		0.415	0.499		-0.010	-0.003		0.276	0.328
		(0.80)	(0.96)		(-0.24)	(-0.07)		(0.46)	(0.54)
MutualFund		-0.295	-0.328*		0.005	0.003		0.620***	0.600***
		(-1.61)	(-1.79)		(0.48)	(0.27)		(4.84)	(4.61)
Trust		-0.098	-0.078		0.024*	0.025**		0.519***	0.533***
		(-1.04)	(-0.84)		(1.94)	(2.11)		(3.91)	(3.97)
Constant	-1.087***	-1.056***	-0.691***	0.367***	0.351***	0.384***	6.101***	5.839***	6.131***
	(-26.86)	(-11.65)	(-6.83)	(121.55)	(22.64)	(21.65)	(66.94)	(28.66)	(31.78)
Observations	30668	30668	30668	30012	30012	30012	32141	32141	32141
R^2	0.550	0.554	0.562	0.720	0.721	0.725	0.666	0.667	0.670
Time period FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sponsor FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table A.3: **Plan size and performance: alternative alpha estimations**

This table shows the size effect in the performance of DB and DC plans estimated from the cross-sectional regressions using plans with at least ten years of return observations. In the first three columns, alpha is estimated using four Vanguard index funds (Vanguard 500 Index Fund, Vanguard Total Bond Market Index Fund, Vanguard Extended Market Index Fund, and Vanguard Balance Index Fund) as the benchmark. In the middle three columns, alpha is estimated using the Vanguard 500 Index Fund, Vanguard Total Bond Market Index Fund, and an equally-weighted portfolio of three Vanguard international index funds as the benchmark. In the last three columns, alpha is estimated using the Fama and French (1992) three-factor model augmented by the excess return of Vanguard Total Bond Market Index Fund. Observations are weighted by the number of years over which the performance is measured, and a minimum of ten annual return observations is required for each plan. DC is a dummy variable which is 1 if a plan is DC, and 0 otherwise. Nsize is the logarithm of a plan's total assets at the beginning of the performance measurement period normalized as standard deviations from the contemporaneous cross-sectional mean. Log(1+Age) is the logarithm of one plus the number of years since the plan inception measured in the first plan year. SafeAssets, Equity, MutualFund, and Trust are fractions of assets in safe securities, individual stocks, mutual funds, and investment trusts at the beginning of the first plan year. Expense is the expense ratio measured for the first plan year. We control for both the sponsor and time period fixed effects. Standard errors are triple-clustered by sponsor and by the start and end years of the measurement period, and t-statistics are reported in parentheses. Statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

	Alternative Benchmark I			Alternative Benchmark II			Alternative Benchmark III		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Alpha	Alpha	Alpha	Alpha	Alpha	Alpha	Alpha	Alpha	Alpha
DC	0.715***	0.732***	0.510***	0.709***	0.698***	0.455***	0.687***	0.692***	0.465***
	(14.48)	(13.49)	(9.72)	(14.38)	(11.43)	(7.08)	(30.79)	(21.48)	(12.42)
Nsize	0.184***	0.190***	0.125***	0.142***	0.140***	0.073***	0.192***	0.196***	0.132***
	(7.73)	(6.13)	(4.52)	(7.34)	(5.68)	(3.32)	(5.84)	(6.12)	(5.05)
Nsize*DC	-0.059	-0.110***	-0.075**	-0.007	-0.046*	-0.008	-0.067	-0.109**	-0.073
	(-1.57)	(-3.30)	(-2.45)	(-0.30)	(-1.85)	(-0.39)	(-1.30)	(-2.29)	(-1.73)
NsizeSQ	-0.025**	-0.023*	-0.016	-0.018	-0.015	-0.009	-0.022*	-0.020	-0.014
	(-2.38)	(-1.96)	(-1.43)	(-1.48)	(-1.20)	(-0.72)	(-1.79)	(-1.56)	(-1.16)
Expense			-0.457***			-0.476***			-0.465***
			(-22.00)			(-32.25)			(-26.52)
Expense*DC			0.095			0.173***			0.120
			(1.36)			(3.11)			(1.53)
Log(1+Age)		-0.007	-0.002		-0.032	-0.025		-0.041	-0.034
		(-0.42)	(-0.09)		(-1.36)	(-1.11)		(-1.37)	(-1.15)
SafeAssets		0.562***	0.549***		0.454***	0.447***		0.488***	0.477***
		(5.91)	(5.51)		(4.95)	(4.80)		(3.71)	(3.50)
Equity		0.304	0.378		0.631**	0.718**		0.574	0.649*
		(1.06)	(1.30)		(2.35)	(2.60)		(1.71)	(1.91)
MutualFund		-0.328**	-0.351**		-0.100	-0.127		-0.274	-0.298*
		(-2.42)	(-2.66)		(-1.15)	(-1.46)		(-1.73)	(-1.88)
Trust		-0.157***	-0.148***		-0.005	0.008		-0.027	-0.016
		(-3.35)	(-3.45)		(-0.11)	(0.19)		(-0.42)	(-0.25)
Constant	-0.482***	-0.537***	-0.265***	-0.918***	-1.003***	-0.726***	-1.247***	-1.283***	-1.011***
	(-13.57)	(-7.55)	(-3.74)	(-21.76)	(-11.90)	(-8.56)	(-78.85)	(-11.80)	(-9.75)
Observations	15075	15075	14970	15012	15012	14909	15030	15030	14925
R^2	0.593	0.600	0.608	0.567	0.573	0.581	0.597	0.604	0.611
Time period FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sponsor FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes