Measuring Fiduciary and Investor Losses in 401(k) Plans

Abstract: This is the first comprehensive academic study of 401(k) plan fees and the first study to measure the relative costs of limited investment menus, fund- and plan-level fees, and aggregate misallocation of investments. Expressing these costs in terms of reduced returns allows us to compare the relative magnitude of costs attributable to plan fiduciaries, which we term fiduciary losses and losses attributable to mistakes that investors make in choosing how to allocate among menu offerings, which we term investor losses. Using a sample of plans that offer publicly listed mutual funds as investment options, we show that investor losses exceed fiduciary losses. Taken together, these losses consume about 17.8% of the optimal risk premium. The majority of losses come from fund and plan level expenses. Large plans have lower fiduciary losses than small plans, but there is substantial variation in plan quality independent of plan size. Plan menu design affects investor losses and the fees investors pay, and advisor compensation is related to menu design. We measure plausible proxies for quality of service and find that plan costs are inversely correlated with these proxies, suggesting that higher costs may not buy better services.

KEYWORDS: 401(k) plans; portfolio choice; retirement; investing; law and economics

Quinn Curtis
University of Virginia
580 Massie Road
Charlottesville, VA 22903
quinn.curtis@virginia.edu

Ian Ayres
Yale Law School
127 Wall Street
New Haven, CT 06511
ian.ayres@yale.edu

Investors in participant-directed 401(k) plans incur losses both from decisions made by the plan fiduciaries and the investors' own suboptimal choices. Fiduciaries, for example, select the menu of investments over which plan participants are permitted to choose. This limitation imposes costs in two ways: it may limit the ability of investors to select an optimally diversified investment portfolio, and it may force investors to choose from among funds that have higher fees than other funds in the marketplace. Investors also pay fees at the plan level to cover the administrative costs associated with the plan. Each of these costs is attributable to choices made by the plan sponsor, which has a fiduciary duty to act with prudence in making decisions regarding the plan menu.[1] Suboptimal investor choice also creates losses. For example, previous studies have shown that investors in 401(k) plans exhibit a number of behaviors in asset allocation that tend to increase risk and reduce return. Provided that the plan menu meets certain requirements,[2] the plan sponsor is not responsible as a fiduciary for losses that results from participants' own investing decisions. Because losses due to menu limitations and investor portfolio decisions have divergent legal and policy consequences, it is natural to ask how these losses are distributed and whether one type of loss predominates.

This study uses a large proprietary data set of 401(k) plan data, including information on plan menus and plan-level portfolio allocations, to measure the relative costs to aggregate plan portfolios of menu limitations, fees in excess of index fund fees, and investor mistakes. Using this data, we construct a sample of plans that offer only publicly listed mutual funds, allowing us to draw fee and return information from commercial databases. We construct a series of optimal portfolios based on expected risk and return, taking account of the effect of costs on returns. Using these portfolios, we are able to express the utility loss

[1] 29 U.S.C. § 1104(a)(1).
[2] These requirements include the inclusion of sufficiently diverse investment alternatives, and the opportunity for plan participants to adjust their portfolio with reasonable frequency. 29 C.F.R. § 2550.404c–1

associated with menu limitations, fees, and investor allocation mistakes as losses relative to the risk premium on a benchmark portfolio of index funds.

We find that if fees are disregarded, on average, investors in 401(k) plans choose from investment menus that are quite efficient in the sense of providing investors with the capacity to sufficiently diversify. We estimate that losses from menu restrictions comprise less than one percent of the optimal risk-premium. In addition to these costs due to restricted diversification opportunities, investors incur fees both at the plan and fund level. The combination of excess plan expenses, fund fees in excess of index fund fees, and diversification limitations from menu restrictions account for a loss of 5.7% of the optimal risk-premium. While we observe only aggregate plan portfolios and not investor-level allocations, the loss associated with investor choice, conditional on the offered menus, accounts for an additional 12.1% reduction in the risk-premium. Importantly, 43% of investor loss is due to fees investors incur in deviating from an optimal portfolio. Taken together, these costs consume 17.8% of the potential excess return that investors might have earned if they invested optimally without menu restrictions and paid fees consistent with low cost index funds.

Losses are particularly high in small plans, which have both higher costs and lower quality menus. In the smallest fifth of plans, losses due to fiduciary decisions are more substantial than losses caused by investor mistakes. Even among plans in the largest quintile, 80 basis points separates fees in the plan at the 90^{th} percentile of fiduciary loss from the plan at the 10^{th} percentile. Our results suggest that investors incur unnecessary losses due to fiduciaries' decisions to include a preponderance of costly funds in plan menus. Plans that include a significant proportion of index funds show lower fiduciary losses.

In addition to costs directly imposed on investors through fiduciary choices, we find evidence that menu construction choices made by plan fiduciaries predictably exacerbate investor mistakes with regard to both diversification and excessive fees. Some plans have optimal portfolios that more closely align with investors' tendency to allocate investments using the 1/N heuristic of Benartzi & Thaler (2001) and aggregate portfolios in these plans have better expected performance. Investors in plans that include a low proportion of index funds have lower expected performance. Moreover, some of the losses attributable to investor mistakes result from a failure to optimize fees rather than failing to optimally diversify. More than 44% of losses due to investor mistakes are attributable to choosing investment options with excessive fees (relative to other funds in the offered menu). If losses due to excess plan-level costs, fund fees, and investor allocation to high-fee funds are aggregated, then fee-related losses are larger, on average, than aggregate diversification losses.

This study has important implications for policy concerning participant-directed retirement plans. Employer sponsors of 401(k) plans have fiduciary duties of prudence and loyalty to plan participants. Courts have been clear that these duties extend to the construction of the investment menu. Plaintiffs have won substantial settlements by alleging that investment menus included only options that were too costly. Menus that are insufficiently diversified can also give rise to liability for the plan sponsor. But under ERISA, plan sponsors can escape liability for participants' investing decisions so long as investors are given a set of diversified investment options that permit them to tailor risk to their specific circumstances and disclosure requirements are met. The law therefore creates a dichotomy between the two types of plan problems: insufficiently diversified menus and excessive fees can give rise to liability for employers, but mistakes by adequately-informed investors choosing from a menu of quality options constructed with prudence and loyalty generally do not.

This dichotomy makes understanding the relative losses attributable to fiduciaries and to investors important. If 401(k) menus are highly efficient and fees are low, then improving investor outcomes becomes entirely a function of improving decision making by investors. Such efforts might include financial education and high-quality default portfolio allocations. If losses attributable to menu construction are negligible, then efforts to increase the scope of fiduciary duties would be misguided. Such a finding might also suggest that much of ERISA litigation relating to menu quality is frivolous and socially costly. Conversely, if fiduciary losses are widespread and substantial, then strengthening the enforcement of fiduciary duties and broadening their application, as the Department of Labor has attempted,[3] might yield improved outcomes for investors. In fact, the results of this study suggest that improving fiduciary decision-making may prove a more tractable solution than educating millions of investors, particularly in light of fiduciaries' duty of prudence. We find evidence that a substantial majority of funds could reduce total losses by (i) offering additional lower-fee index funds and (ii) not offering funds with high fees.

We test several proxies for quality of service including participation rate, employee contributions, and investor misallocation. We find no evidence that more expensive plans are better along these dimensions. Rather, we find a statistically significant negative relationship between costs and these variables.

The rest of this paper proceeds as follows: Section one reviews the prior literature. Section two describes the dataset and addresses potential selection issues. Section three describes the methodology for measuring losses. Section four presents results. Section five concludes.

1. Relevant Prior Literature

This paper advances three strands of the 401(k) literature. First, this study provides important new information about the structure of plan fees, a topic which, outside of industry surveys (Investment Company Institute, 2011), has not

[3] The Department of Labor has proposed and expansion of the parties that may be considered plan fiduciaries in a rule released October 22, 2010 and subsequently withdrawn under objections from the financial services industry.

been the subject of direct investigation.[4] Second, we contribute to the literature that evaluates the adequacy of plan menus, Elton, et al. (2006); Angus, et al. (2007); Tang, et al. (2010); and Brown & Harlow (2012), by measuring diversification issues with and without fees. Finally, we contribute to the extensive literature on the structure of 401(k) menus by examining the impact of fees and menu limitations in the cross section of plans.

Prior work on the quality of options 401(k) menus has produced conflicting results. Using similar methodology to this study, Tang, et al. (2010) found, with regard to Vanguard-managed plans, that losses due to limited 401(k) menus were small and that the vast majority of menus were of high quality. Elton, et al. (2006) found that only about half the plans in their sample provided sufficiently diversified options relative to a benchmark portfolio. Angus, et al. (2007) evaluated menus in academic retirement plans and found that investors in TIAA-CREFF plans were likely to have significantly lower end-of-period wealth than other investors as a result of menu limitations.

These existing studies differ from this study in their sample construction. The Angus, et al. study is limited to academic plans from a specific, atypical service provider. It is therefore difficult to draw broad conclusions about retirement plans from their results. Elton, et al., used survey data from Moody's Investor Services to construct a sample of 680 plans. This sample is similar in construction to our own, but is smaller and relies on survey data rather than public filings. The Elton, et al. data, from 2001, is also now somewhat out of date. The Tang, et al. study is the largest by sample size with 1003 plans, but these plans are drawn from a dataset of Vanguard-managed retirement plans. As one of the largest and lowest cost service providers, Vanguard may be associated with plans

[4] Pool, Sialm, & Stefanescu, (2012) offer evidence that plan service providers may favor their own funds: a finding with indirect relevance to fees, since it suggests that service providers may extract rents from plans.

of particularly higher quality than the industry average. Vanguard would also be unlikely to manage the worst plans.

Work in the menu-quality literature has varied in its attention to fees. Elton et al., use an estimation method that accounts for fund-level costs, and these costs partially account for the inefficiency of many 401(k) plans in their sample. Tang, et al. estimate returns using a zero-alpha factor model that does not account for the impact of fees on performance. They note, however, that the fees of funds in their Vanguard sample are quite low. No existing study of plan efficiency has included plan-level costs as a factor. This is a significant omission because plan service providers sometimes derive part of their compensation for plan administration from fund fees. Plan-level and fund-level fees should both be understood as part of the total cost of investing in a 401(k) plan.

A more extensive literature has examined the effects of menu structure in 401(k) plans.[5] These studies have documented that investors are subject to a number of behavioral biases that reduce their returns and increase risk. For example, investors tend to follow a naïve diversification strategy, dividing assets equally among funds, regardless of the make-up of the investment menu. (Benartzi & Thaler, 2001), For this project it is the broad conclusion of this literature that is relevant: Investors in 401(k) plans have a documented tendency to make suboptimal allocation decisions, contingent on the limited menu from which they are able to choose.

This project extends the existing literature by measuring the relative magnitude of menu limitations, fees, plan-level expenses, and investor mistakes within a single framework. We compute these losses over a sample of funds substantially larger and less subject to selection issues than existing studies. Taking advantage of these loss measures and large sample, we explore the cross-

[5]This literature include Benartzi & Thaler (2001); Agnew, Balduzzi, & Sunden, (2003); Choi, Laibson, Madrian, & Metrick, (2002); Elton, Gruber, & Blake, (2007); (Carroll, Choi, Laibson, Madrian, & Metrick, 2009; Sialm, Starks, & Zhang, 2012; Sialm & Starks, 2012).

sectional determinants of plan quality, most notably plan size. We are also able to partially control for industry effects, and we are the first study to look at the effect of fees on proxies for quality of service, such as participation rate and asset allocations. Our results provide the clearest and most comprehensive picture to date of the relative importance in plan performance of fiduciary decisions and investor decisions.

2. Data, Sample Construction, and Selection Issues

The data used in this study come from a proprietary database of 401(k) plans constructed by Brightscope, Inc. Brightscope collects data from a number of public sources, most notably the Department of Labor's Form 5500, and the data set includes information about plan administration and expenses, the menu of investment options offered by the plan, and balance of plan funds invested in each option. The Brightscope data include filings as far back as 2006 in a non-panel dataset. We use data from plans with a plan year ending on December 31, 2009, the most recent date with a significant number of plan filings.[6] Brightscope has gathered data for 12,475 plans for that date.

One of the primary contributions of this study is to identify the effect of investment management fees on plan quality. Many large 401(k) sponsors, about 70% of plans in the Brightscope database, negotiate management arrangements with financial advisors so that assets of the plan are managed through collective trusts or separate accounts rather than true mutual funds. While these alternative investment vehicles often hold portfolios identical to some publicly available mutual fund, the fee agreements for these accounts are undisclosed. Other plans hold shares of public mutual funds subject to additional service fees through a wrap fee agreement. The expenses associated with the investment options available in such plans cannot be measured from publicly available information.

[6] There are 222 plans with end dates more recent that December 31, 2009 and 12,475 plans with the December 31, 2009 end date. We exclude the former set of plans for simplicity.

Separate accounts generally have lower fees than the corresponding funds, while wrap agreements would produce higher fees.

Fees for plans that exclusively utilize publicly listed mutual funds for their risky investment options can be calculated using mutual fund expense ratios from the fund prospectuses. Since this study is concerned with the impact of the cost of 401(k) investment options, we restrict our sample to plans that offer publicly-traded mutual funds as their sole risky investment options, and eliminated plans that offer collective trusts or separate accounts, often with wrap fee agreements.[7] Potential selection issues related to this restriction are addressed below.

There are three other asset classes in the remaining sample of plans that require discussion. The first is company stock. Plans for publicly traded companies frequently offer company stock as an investment option. We hand match the Brightscope data to the CRSP database to draw information on stock return and variance. We exclude plans that include company stock if we could not identify a unique match or if returns data was not available for the dates needed for our estimations.[8] A second asset class that raises issues is brokerage windows. These are discretionary brokerage accounts held inside a 401(k) plan, but generally making available a vastly greater number of investment options for an additional wrap fee. Investors who elect to place some of their account balance in the brokerage option are not restricted by the plan menu. Our data includes information about total allocations to these accounts, but no details of individual investor choices. Since investors must explicitly opt into the brokerage option and the allocation to the option is a small fraction of total assets, we include plans offering these options in our sample, but disregard the brokerage

[7] Elton, et al. (2006) also limit their analysis to plans that offer menus of mutual funds.
[8] 9.5% of plans not using separate accounts offered company stock. Average asset allocation to company stock in such plans is 14%. Our match rate on company stock was 75%.

options for our analysis.[9] Finally, 58.3% of plans in our sample offered Guaranteed Investment Contracts with fixed returns. Since these are not risky assets we exclude them from our analysis, but include the plans that offer them.

These restrictions leave 3,534 plans out of 12,475 plans in the Brightscope database with an end date of December 31, 2009.[10] Plans in our sample include 28.7% of plans in the unrestricted database, and 17.0% of total assets. Is this remaining sample of plans representative? The selection issue is one that existing studies have not explicitly addressed. The choice to offer mutual funds, as opposed to separate accounts or collective trusts may introduce questions of selection that could raise issues about the external validity of our results. One key issue is the size of plans in the sample. It is well-known that the total cost of 401(k) plans is related to the size of the plans. If our sample differs markedly from the universe of plans by size, this would suggest caution in extending our findings to plans not represented in our sample. This concern is compounded by the significant difference in average size between our sample plans, which average \$35.4 million, and the all plans in the Brightscope database, which average \$69.7 million in size. This difference in means can be attributed to the relative absence of extremely large plans from our sample, as illustrated in Figure 1.

Figure 1 sorts plans into bins by percentile of plan size then shows the density of plans in our sample relative to the total number of plans in the Brightscope database in each bin. A perfectly random sample would produce a level density distribution. Our sample underrepresents plans in the below the 20th and above the 80th percentile and oversamples plans in between. Very large plans are likely to use separate accounts with privately negotiated fee agreements. Very

[9] Three hundred and thirty nine plans in our sample of 3,552 plans offer this option, and the average allocation is 11%. Tang et al. (2010) also include plans with brokerage windows and similarly exclude investments inside the window from analysis.

[10] Of the excluded plans, 71% were excluded from our sample because managed trusts or separate accounts. Ninety-two plans were excluded because we could not match their company stock.

small plans may be more likely to use mutual funds subject to wrap agreements that increase fees. In either case, fee information is not available and the plan is excluded from our sample. Since the largest plans are orders of magnitude larger than the average plan the fact that such plans are underrepresented is sufficient to account for the substantial difference in means.

Of course, size is not the sole criteria that might generate selection effects. Other, unobservable differences between sample and non-sample plans may pose a challenge to the external validity of our conclusions. One basis for comparison is the 2009 Defined Contribution/401k Fee Study by Deloitte and the Investment Company Institute (ICI 2009). This survey-based study of 130 plans was not restricted to mutual fund-only plans. The study used a measure of "All-in Fee" to measure total plan cost. The "All-in Fee" is comparable to the sum of our measures of fee loss, plan expense loss, and fee allocation loss.[11] ICI (2009) found a mean All-in Fee of 0.93%. The comparable measure for our sample is 1.07%, about 14 basis points higher. It is not possible to determine from the summary statistics reported in ICI (2009) whether this difference reflects a difference in the size of sampled plans or a selection effect of our restriction to mutual fund plans conditional on size. Selection issues aside, our sample represents a non-trivial segment of the market in its own right, and, given the dearth of data on the impact of plan design on plan performance, these results provide important new information about the cost and performance of plans.

We match Brightscope data with CRSP mutual fund data by ticker symbol. CRSP provides the monthly return data used to compute the return and variance for each fund. Data on fund fees is taken from Morningstar.

3. Methodology

[11] See section 3.2, *infra*.

The goal of this study is to identify the relative impact of menu limitations, investment costs and plan fees, and investor mistakes on investor welfare. To measure the quality of 401(k) plan menus and participant choices we draw on the work of Calvet, Campbell, & Sodini, (2007) and Tang, et al., (2010). The central measure of financial performance in this framework is the expected Sharpe ratio, computed using a factor model as described below. We compute the expected Sharpe ratio of five different portfolios, and use the differences in these Sharpe ratios to derive a return-equivalent loss associated with the difference between them. The five portfolios are:

1) The observed aggregate allocation of investor funds in the plan.
2) The portfolio with the highest attainable Sharpe ratio, given plan menu, including mutual fund fees and plan-level fees.
3) The portfolio with the highest attainable Sharpe ratio, given plan menu, including mutual fund fees, but excluding plan-level fees.[12]
4) The portfolio with the highest attainable Sharpe ratio, given the plan menu, but excluding all fees and expenses.
5) The portfolio with the highest attainable Sharpe ratio formed directly on a three factor model (described in next section).

We use the differences in expected performance for these portfolios to express the impact of fees, menu limitations, and investor choices as a change in expected returns at a selected variance.

3.1 Measuring Fund Expected Performance

We begin by implementing a factor model that can be used estimate the moments of return for each fund. Since 401(k) plans include funds other than

[12] Since plan fees are constant across allocations, the effectively shift the efficient frontier downward relative to portfolio 2, which includes no plan-level fees. Given a constant risk free rate this downward shift results in a riskier optimal portfolio, so the weights of portfolio 2 and 3 may be different.

domestic equity funds, we use a model that includes factors reflecting systematic risks in non-equity markets. The model is as follows:

$$R_{it} - r_f = \beta_i^1 * (r_{mkt,t} - r_f) + \beta_i^2 * (r_{bond,t} - r_f) + \beta_i^3 * (r_{intl,t} - r_f) + \varepsilon$$

Here R_{it} is the return of ith mutual fund for the month *t*. In the model, r_{mkt} is the return on the Russell 3000, r_{bond} is the return on the Barclay's US Aggregade Bond index, and r_{intl} is the return on the MSCI EAFE international equity index. This model is similar to Tang, et al. (2010). We estimate the model for all mutual funds using data between 1/2002 and 12/2009. If mutual funds are missing more than 3 years of data during this period those funds, and their associated plans, are excluded from the sample. The risk free rate, r_f, is taken from 3-month treasuries. Many 401(k) plans include savings account-type assets, such as guaranteed investment contracts, that may be thought of as risk free. Since our goals is to facilitate comparison of investment menus across plans, it is essential that a single risk free rate be used as a benchmark, otherwise plans with a very poor risk free asset may produce a higher Sharpe ratio. By using a common risk free rate across plans, we ensure that the Sharpe ratio is an informative cross sectional measure of the quality of the risky assets available in each plan's portfolio.

We estimate the mean excess return of the factors, $\hat{\mu}$, and the variance covariance matrix of the factors, $\hat{\Sigma}$. The absolute levels of fiduciary and investors loss are sensitive to choice of estimating window for the factor moments.[13] One option, used in Tang, et al. (2010), would be to estimate the factor moments over the same window as the fund betas. However, we find that the portfolio weights suggested by the factor moments over the period of 2002 to 2009 are historically anomalous. The Sharpe ratio optimal portfolio during that time would have shorted domestic equities and put more than 90% of the portfolio into bonds. Estimating plan quality using these weights produces very large menu losses,

[13] See the discussion of robustness of details of how we address this sensitivity with respect to the relative and cross-sectional results.

since very few plans include funds that negatively correlate with domestic equities. While it is fair to question whether current plan menus are well-attuned to challenging market conditions,[14] we believe a more conservative choice of factor loadings for our purposes is one that reflects conventional advice about portfolio allocation, and therefore reflect the likely approach of plan fiduciaries in constructing plans. Canner, Mankiw, & Weil (1997) review brokerage advice regarding asset allocation and find that brokerages recommend ratios of bonds to stocks of 0.25 to 1.5. We estimate factor moments over the window 1980 to 2000, which yields factor moments with an optimal portfolio where the ratio of bonds to equities is 1.2, on the conservative side of the Canner, et al. range.

The model provides estimated betas for every fund in each plan, $\widehat{\beta_\iota^1}, \widehat{\beta_\iota^2}, \widehat{\beta_\iota^3}$. The model also provides a variance-covariance matrix of idiosyncratic risk, $\hat{\Sigma}_{idio}$, computed as the variance-covariance matrix of the residuals,. For each plan we define $\hat{\beta} = \begin{bmatrix} \widehat{b_1} \\ \dots \\ \widehat{b_\iota} \end{bmatrix}$, where *i* indexes funds in the plan and $\widehat{b_\iota} = (\widehat{\beta_\iota^1}, \widehat{\beta_\iota^2}, \widehat{\beta_\iota^3})$. Let $\phi_i$be the management fee for each fund in the plan as of 2009. We compute three sets of expected returns. The vector of pre-fee expected excess returns on each fund in the plan is:

$$\hat{\mu}_p = \hat{\beta}\hat{\mu}$$

The vector of after-fee expected excess returns is computed as

$$\hat{\mu}'_p = \hat{\beta}\hat{\mu} - \hat{\phi}$$

where $\hat{\phi}$ is the vector of fees for the funds in the plan menu.[15] Expected returns after fund-level fees and plan-level expenses is

[14] The future of equities has been a subject of recent public discussion. PIMCO's Bill Gross has argued that the conventional weight given to equities is no longer appropriate(Gross, 2012) while Malkiel (2012) has defended the traditional approach to allocation.

[15] While 401(k) plan menus often include shares that carry loads, these loads are generally waived, and so we exclude them from the calculation.

$$\hat{\mu}'_p = \hat{\beta}\hat{\mu} - \hat{\phi} - \rho\hat{1}$$

Where ρ is the scalar value of plan-level expenses and $\hat{1}$ is a vector of ones.

The inclusion of fees in the returns computation is a notable difference from Calvet, et al. (2007) and Tang, et al. (2010). Since the fund management fees are constant, they do not affect the variance-covariance matrix, given by

$$\hat{\Sigma}_p = \hat{\beta}\hat{\Sigma}\widehat{\beta'} + \hat{\Sigma}_{idio}$$

For a given portfolio over plan options, w, we are now equipped to compute the Sharpe ratio of the plan portfolio:

$$\widehat{SR}(w) = \frac{\hat{\mu}_p}{\sqrt{w'\hat{\Sigma}_p w}}$$

The post-fee and post-fee and expense Sharpe ratios are computed using equivalent methodology.

To compute the optimal pre-fee portfolio, w_p, for each plan, we use an optimization package to find the no-short-sale portfolio that maximizes $\frac{\hat{\mu}_p}{\sqrt{w'\hat{\Sigma}_p w}}$ where the sum of the portfolio weights is one. Similarly, to find the post-fee portfolio, w_f, we solve the same maximization problem using post-fee returns. Finally, the actual expected Sharpe ratio is computed using the observed balances for each fund in the plan, w_a.

Note that the optimization problem is solved separately for the pre- and post-fee returns. This means that the optimum portfolio weights change to underweight high-cost funds. This is in contrast to simply deducting fees from the pre-fee optimum portfolio weights. Repeating the optimization will lead to a lower cost of fees, since weights can shift to reduce the impact of expensive funds.

Using this procedure, we compute the Sharpe ratios for the five portfolios listed above: global optimum formed directly on the factors, pre-fee optimum, post-fee optimum, post-fee and expense optimum, and actual plan portfolio.

Figure 2 illustrates the mean-variance spaces of the portfolios. The upper curve is the mean-variance frontier of portfolios formed directly on the three factors. The tangency line to this frontier gives the Sharpe ratio of the globally optimum portfolio. The second curve is the pre-fee mean variance frontier for portfolios formed over a given plan with the associated tangency line. The lower curve is the mean-variance frontier of the post-fee portfolios. Below the post-fee mean-variance frontier is the point corresponding to the mean and variance of the observed portfolio.

3.2 Measuring Plan Losses

To provide a simple framework for comparing losses from different sources, we use the Sharpe ratios of these portfolios to render all losses as *return-equivalent losses.* That is, given the difference between the Sharpe ratios of two portfolios, we compute the corresponding difference in returns for a fixed level of portfolio risk. In particular, we use the average expected standard deviation of returns of observed portfolios held by plan participants, $\overline{\sigma_a}$ (which in Table Table 2 is estimated to be 11.8%), as our benchmark risk measure. To determine the return-equivalent loss between two portfolios w_a and w_b we compute:

$$SR(w_a) * \overline{\sigma_a} - SR(w_b) * \overline{\sigma_a}$$

This difference is the change in returns to portfolio *b* that would be required to give it the same Sharpe ratio as portfolio *a*, given that both portfolios are leveraged to have the same risk, $\overline{\sigma_a}$.

Figure 2 illustrates our approach. The mean returns for each portfolio, leveraged to standard deviation $\overline{\sigma_a}$ (11.8%) are denoted by μ_g, μ_p, μ_f, μ_e and μ_a, for the global optimum, pre-fee menu optimum, post-fee menu optimum, and actual portfolios, respectively. Since each portfolio has, by construction, the same variance, the differences in these returns provide a means of comparing the losses due to the limitations of investing through a 401(k) plan.

The difference between the global optimum portfolio, μ_g, and the pre-fee optimum portfolio, μ_p, provides a measure of the costs of being limited to a specified menu of funds. We term this *menu diversification loss*. This loss occurs when menus do not provide investors with sufficient options to diversify. Because a limited set of funds cannot span the space of factor loadings as completely as a more generous menu, investors making optimal choices over a limited set of funds will do worse than the global optimum. Even an extensive menu of funds may produce a low optimum Sharpe ratio if the funds are highly correlated, or if they are missing exposure to an important systematic risk factor. The global optimum Sharpe ratio is computed by optimizing directly on factor-loadings, and is therefore not a directly investible portfolio. Nonetheless, a number of plans in the sample achieve this optimum, up to rounding error, on a pre-fee basis. It therefore provides a reasonable pre-fee benchmark for plan menus.

To measure the losses due to mutual fund expenses, we compute the difference between the pre-fee and post-fee optimum portfolio and deduct the fees associated with an optimized portfolio of low cost index funds.[16] The difference between the pre- and post-fee optimums reflect the impact of mutual fund fees, while deducting the fees of a low-cost portfolio reflects the reality that fund expenses will not be zero. We term the return-equivalent loss associated with the difference between these two portfolios *menu excess fee loss.* "Excess" in this context is not intended to connote "excessive" fees, but simply to indicate that fees are expressed the amount by which fee losses exceed those associated with a very low cost portfolio. Since some plans offer options with lower fees than the benchmark portfolio of retail index funds, fee loss for some plans is negative. The effect of fees on obtainable Sharpe ratio captures both the direct cost of fees and the distortive effect of fees on investment decisions. For example, if a fund carries low weight in the pre-fee portfolio, then its fees should have slight effect

[16] The benchmark portfolio consists of retail shares of 28Vanguard index funds offered during the sample period. Since these funds are available to individuals, they provide a reasonable cost benchmark of basic fund operational costs for even very small plans.

on the post-fee optimum. Conversely, if a fund is heavily weighted, relatively modest fees may have a substantial effect on the pre-and post-fee optimum Sharpe ratios.

We also compute the loss due to administrative expenses, *excess plan expense loss*. This is the difference between the return on the post-fee optimal portfolio, μ_f, and the return on the optimal portfolio, μ_e, which accounts for both fund and plan level fees, less a very low cost administrative fee of 8 basis points.[17] Again, "excess" in this measure indicates only that the measure is expressed as a difference, not that fees over 8 basis points are excessive. Plan level fees are those itemized expenses reported on the Form 5500 that are not associated with specific investment choices. They include investment plan management, book-keeping and administrative fees.

Finally, we term the difference between the adjusted returns on the optimum post-fund fee and post plan-level expense portfolio, μ_e, and the actual portfolio, μ_a, *investor loss*. This difference reflects losses from the failure of plan investors, in aggregate, to optimize their portfolios within the limitations of the menu. This loss can be further decomposed into fee mistakes and allocation mistakes. Since the optimal portfolio accounts for fees, any additional fees incurred by investors are incurred in deviating from the optimal strategy and over-allocating funds toward menu offerings with higher fees. We term any fees incurred by investors over the fees on the optimal post-fee and post-expense portfolio *investor excess fee loss*. Note that this quantity can be negative if investors pay lower fees than in the optimal portfolio. For example, investors

[17] The majority of plans report that they pay no plan-level expenses. Service providers for these plans are compensated from mutual fund expenses. Since compensation paid from fund fees is not currently disclosed, it is absent from our data. A very-low cost service provider, Employee Fiduciary LLP, reports that it charges $30 per employee plus 0.08% of plan assets for administrative services for small plans. Vanguard offers services to plans under $20 million through its small-business program. While pricing information is not publicly available, Vanguard estimates that a $5 million dollar plan would feature an all-in fee of about 32 basis points, including fund fees, which corresponds well with Employee Fiduciary's 8 basis point administration-only fee.

might over-allocate to a money-market fund resulting in a portfolio with lower fees than the optimal portfolio, but also lower returns. The balance of investors' loss arises from mistakes investors make in factor allocation, which we term *investor diversification loss.* Diversification loss results if investors expected return (net of their excess fee loss) is lowered by allocating plan funds in ways that reduce the expected Sharpe ratio as measured by the factor model.

We do not observe individual portfolios, and so investor mistakes that, in aggregate, cancel out are not captured by our measure. For example, we cannot distinguish two investors each holding a single fund from two investors holding identical portfolios of two funds. This makes our measure of investor loss less precise than our measure of fiduciary loss, but nevertheless useful, particularly in cross-sectional regressions.[18] Given the aggregate nature of our data, these estimates provide a lower bound on the costs of investor mistakes. Despite this limitation, the aggregate allocation is useful for our primary purpose, which is to evaluate the quality of *plans.* For example, if young investors over-concentrate in stocks and older investors over-concentrate in bonds, then our aggregate measure may overestimate the welfare of plan participants, but so long as this pattern holds across firms then useful comparisons between aggregate portfolios can still be made. Moreover, because our primary interest is to evaluate plans, the aggregate quality of the portfolio is helpful in identifying patterns related to menu design and fund fees. For example, we find that allocations to high-cost funds are a major component of investor loss. While these losses may be heterogeneous across investors, the total losses at the plan level are nevertheless an important measure of plan quality.

[18] We also do not observe individual savings outside the plan which need not (and in many cases should not) mimic the 401k portion of a savings portfolio. Shoven & Sialm, 2004; Bergstresser & Poterba, 2004. But evidence from the Survey of Consumer Finance suggests that for many individuals the non-401k savings is not sufficient to substantially change our conclusions. Bergstresser & Poterba, 2004.

4. Results

Part 4.1 presents summary statistics for the sample, for the optimal and observed portfolios, and for the measured investor and fiduciary losses. Part 4.2 presents cross-sectional regressions that investigate the determinants of investor and fiduciary loss. Part 4.3 examines the impact of menu design on investor loss.

4.1 Summary Statistics for Plans, Optimal Portfolios, and Plan Losses

Table 1 presents the summary statistics for plans in our sample. Of note is that the vast majority of plans offer funds in the U.S. equities, bonds, and international equities categories. Index funds are somewhat less common, but are offered by a majority of plans.

Figure 3 is a histogram of the number of investment options offered by each plan showing the distribution of offerings centered on a mean of number of about 23 funds.

Table presents the summary statistics for the pre- and post-fee optimum portfolios and the observed portfolios. All values in this table are annualized. The mean expected standard deviation of observed portfolios, $\overline{\sigma_a}$, is about 11.8%. This is the level of risk used as a baseline to compute the return-equivalent losses. This risk is relatively modest by the standard of US equities, but reflects that most plans include bond and other lower risk asset classes. The expected return on observed plans is 7.2%, which is quite high given the level of risk. This high expected return reflects the relatively favorable market conditions for the window over which factor moments are estimated. The optimal portfolio allocates 44% to domestic equities, 55% to bonds and 1% to international equities, and has an expected return of 4.8% and only 6% standard deviation. The optimal portfolio is lower risk than most observed portfolios since it weights the bond factor more heavily.[19]

Table 2 presents the return-equivalent losses for sample plans. Because the return-equivalent losses are scaled to the 11.8% average risk of observed 401(k) portfolios and measured relative to an optimum factor portfolio, the most natural interpretation of the results is as a percentage of the excess return on the optimum portfolio at this selected risk level. About 17.8% of the optimum excess return is lost to the combination of fiduciary and investor losses. Fiduciary losses are smaller than investor losses on average, comprising 50 basis points, or 32.1% of total loss, compared to 106 basis points for investor losses. Fiduciary losses decompose into menu losses, fund fee losses, and plan expense losses. On average, fiduciary losses are mostly due to fund fees, with menu losses accounting for less than a percent of the optimal risk premium and less than a basis point of real return at the average risk level. Figure 4 shows the distribution of the components of loss and shows that menu losses and plan expenses losses are more dispersed than fund fee losses.

Overall, we find that just 3.8% of total losses come from fiduciaries offering menus that unavoidably expose investors to higher fees or limited diversification opportunities. Our measure of fiduciary loss understates however the proportion of total loss that might be attributed to poor fiduciary menu construction. As we emphasize below, fiduciaries that offer menus that

---

[19] The global optimum portfolio has 54.5% allocated to stock and 44.3% allocated to bonds. The optimal pre-fee menu portfolio had substantially less exposure to equity then the optimal post-fee menu portfolio -- as indicated by the substantially lower standard deviation in Table 3. Optimization gave less weight to equity in the pre-fee estimation because the risk-adjusted equity premium of bonds relative to stock is higher on a pre-fee basis than on a post fee basis.

predictably lead to poorer investor choices are a cause of some investor loss. For example, a fiduciary including in a menu a high fee fund that no reasonable investor should hold can predictably lead to unnecessary investor losses.

Table 4 also distinguishes the relative magnitude excess fees and diversification losses without regard to fiduciary/investor attribution (which are labeled in the table as "Total Excess Fee Loss" and "Total Diversification Loss"). We find that excess fee losses are an important component of total losses and account for on average 85 basis points and 54.5% of total plan losses. The total impact of excess fees, on average, exceeds the total losses attributable to diversification problems.

More insight into the relative significance of investor and fiduciary losses is provided in Table 3, Panel A, which breaks out the percentage of plans with larger investor or fiduciary losses by plan size quintile. As discussed below, smaller plans tend to have larger fiduciary loss. While 81.8% have higher investor losses, nearly a third of the smallest plans have investor losses that exceed fiduciary losses. Conversely, fiduciary losses are the predominating factor in less than 5% of the largest plans. Panel B disaggregates losses somewhat differently. Rather than assign losses to investors or fiduciaries, Panel B compares the total loss due to excess fees on the observed portfolio relative to the total loss due to insufficient diversification (regardless of whether these losses were caused by menu restrictions or investor choice). In this alternative disaggregation, the total effect of fees exceeds the allocation issues for most plans. The effect is particularly strong in the smallest plans.

4.2 The Cross Section of Return-Equivalent Loss

Do investors in plans with higher expected optimum Sharpe ratios hold better aggregate portfolios than other investors? This is not inevitably the case. Since the optimal portfolio can always assign zero-weight to a fund on the menu, adding funds to a menu can only increase the optimum Sharpe ratio of a plan. Our methodology therefore rewards menus with wider arrays of investment options. But limited menus may limit bad decisions as well as good ones. While limited investment menus restrict obtainable optimums, such restrictions might be justified if they prevent real investors from making mistakes that wipe out much of their portfolio. When investors are cognitively constrained, menus might at times be improved more by subtraction than by addition. Since our data is limited to aggregate, plan-level portfolio data, we cannot observe the worst outcomes for investors in different plans. We can nevertheless address the threshold question of whether increasing the Sharpe ratio of the optimum portfolio leads to better expected Sharpe ratios in observed portfolios.

Table 4 presents the results of a regression of plans' total loss relative to the optimum portfolio on fiduciary loss and components of fiduciary loss. The results confirm that higher fiduciary loss is associated with worse observed aggregate portfolios. The coefficient on fiduciary loss suggests that investors benefit from lower fiduciary losses on an almost dollar-for-dollar basis, with 97% of the fiduciary loss being passed through to investors. These regressions confirm that the Sharpe ratio of the average observed portfolio is increasing in the Sharpe ratio of the optimal portfolio. Put simply, improving investor options leads to improved aggregate portfolios. Table 4 confirms the normative force of our quality measure by showing that investors hold portfolios with better expected Sharpe ratios in higher-quality plans. Model 2 breaks out the components of fiduciary loss. As might be expected, menu losses have a less than one-to-one relationship with investor losses, since some of the benefit of improved menus is dissipated by investors' mistakes. Nonetheless, the result is strong, with 93% of menu losses impacting the aggregate portfolio. Mutual fund fee losses have an even stronger effect on investor welfare, with a nearly one-to-one relationship. This suggests that investors are less prone to fee mistakes than allocation mistakes, a suggestion borne out by the summary statistics for the two types of investor losses in Table 2.

The coefficient on plan-level expense loss requires some explanation, as the loss to investors exceeds the direct impact of the fees. The likely explanation is that investors do not adjust their portfolio risk-loading to account for the effect of plan-level fees. Since plan-level expenses have the effect of shifting the mean-variance frontier downward, the optimal portfolio in the presence of these costs has higher mean and variance than without them. To the extent investors fail to adjust accordingly, their portfolios will fall short of the post-fee optimum, and this will result in increased expense losses.[20] The omission of the investor loss measure would bias the effect of plan level expenses upward. Since the goal of the Table 4 regressions is to measure the effect of fiduciary losses on total loss, including the indirect effect through investor decision-making, this effect is intentionally included.

It is well understood that larger 401(k) plans have lower fees than smaller plans. This is often credited to the economies of scale and bargaining power associated with large plans. Table 5 presents regressions of elements of plan loss on two measures of plan size: the log of total plan size and the log of the number of participants. Plans may be large either because they include many participants or because the participants have large average balances. While having a substantial pool of assets under management ought to lead to lower per-dollar administrative costs through economies of scale, plans with many participants may have high cost despite their size if there are per-participant costs that scale with the number of accounts.

In addition to the size variables, Table 5 accounts for two other elements that might be associated with plan costs. First, it includes a control for the share of total contributions to the plan in the prior plan year that came from the employer. This is a proxy for the generosity of the employer match, as used by

[20] Unreported regressions of Investor Loss on Plan-Level Expenses Loss shows that expenses are in fact associated with higher investor loss. We also find that Plan-Level Expenses Loss is not associated with a higher risk observed portfolio. These results support this explanation.

Papke (1995). Employers that offer generous matching may be more diligent in contracting for services or choosing low cost funds. Second, Panel B of Table 5 includes dummies for seven industry groupings. There is a strong liklihood that the quality of 401(k) plans varies across industry groups. While our data does not include industry codings, we use word matching in company names to identify plans that are associated with particular industries. For example, plans including the words "hospital," "clinic," or "health" can be coded under the healthcare industry grouping. Since not all company names include an industry key word, only 826 of the firms can be coded for industry. The structure of the industry groupings is included in the appendix.

For the main variable of interest, total plan size, results confirm that it is an important predictor of fiduciary and total loss, with the total impact of size being both statistically and economically significant. Doubling the assets in a plan is associated with a decrease of 26 basis points in fiduciary loss. Interestingly, investor loss is also lower in large plans though this effect is economically small, with a doubling of plan size associated with only four basis points of loss and is not robust to the inclusion of industry dummies.

As might be expected, increasing the number of plan participants while holding the asset base constant increases the fiduciary loss. This reflects that servicing additional investors increases the cost of administering a plan. For each measure of loss, the number of plan participants is associated with a significant increase the loss at a high level of statistical significance, though the economic impact of increasing participants is lower than the economic impact of reducing assets.

Of some interest is that employee contribution share, the proxy for employer matching, is associated with lower investor loss. While it is difficult to draw causal conclusions from this cross-sectional regression, this effect is robust to the inclusion industry controls as well as the menu quality controls described in the next subsection. The result is consistent with the possibility that employers with generous matching policies may provide other services, such as investor education, that enhance participant allocations.

Panel B of Table 5 includes control dummies for each industry classification. Industry differences in plan quality have not previously been an object of study, and so the table reports, rather than suppresses, the coefficients on industry dummies, with healthcare, the largest industry group in the sample, ommitted as the base case. The general results are consistent with the non-industry controlled Panel A, except that investor loss is no longer statistically signifiant, in addition to being economically small. Of some interest is that industry differences in fiuciary loss, menu loss, and excess expense loss are significant only for the manufacturing and construction category, which has costs significantly higher than healthcare.

As measured by total loss, investors in large plans do better, with a doubling of plan size associated with a 28 basis point decrease in total loss. While economies of scale can justify a price differential between large and small plans Figure 5 shows a wide dispersion of costs at every level of plan size, suggesting that the market for 401(k) services may not be fully competitive. Being a participant in a large plan is not a guarantee of low fee losses. Twenty percent of plans in the largest decile of total assets have fees losses that exceed the median for all plans.

4.3 Menu Design

While fiduciary losses are the most direct source of costs to investors, other costs arise from the construction of the plan menu. One of the central lessons of behavioral economics is that the design of a menu can influence choices over that menu. This section investigates aspects of plan menu design and shows that plan menus are subject to design issues that reduce investor welfare.

Investors are subject to behavioral biases in their allocation of portfolio assets. This includes the 1/N heuristic of Benartzi & Thaler (2001) who show that investors tend naively to diversify by allocating funds equally to each option in a 401(k) plan. A corollary of this finding is that the inclusion of poor choices in an investment menu will leave investors worse off, even if they are free to pick other funds. To investigate the impact of low-quality menu choices on investor welfare, we construct two measures of menu quality. The first measure is the distance in N-space between the optimal portfolio and the 1/N portfolio. Let $w_N = (\frac{1}{N}, \frac{1}{N}, \dots \frac{1}{N})$, the equal-weight portfolio of all funds in a plan. Then we define the *equal weight distance* as

$$\|w^* \; - w_N\|$$

Where w^* is the post-fee optimal portfolio for the plan. This distance which ranges between 0 and 1 is a measure of difference between the optimal portfolio and an equally-weighted portfolio, suggested by the 1/N heuristic. The average and standard deviation of equal weight distance in our data are 0.66 and 0.10, respectively. Since investors tend to the equally weighted portfolio, plans that are robust to this tendency should produce lower investor losses, and this measure is designed to capture this effect.

Table 7 presents the results of regressions of investor loss on this measure of menu quality, as well as the percentage of index funds offered and a variety of control variables, including the plan controls described above, with and without industry dummies. The results suggest that choices made by the fiduciary in structuring the menu can substantially affect the losses from investor choices over the menu. Menus with a high equal weight distance incur substantially higher losses. Menus that include more index funds also show substantially lower investor choice loss, even after controlling for plan size. This is likely a result of index funds' relatively low fees, combined with investors' tendency to choose all available menu options. Across all models, investor choice loss is increasing in the number of options. Since investors may hold expensive funds that the optimal portfolio avoids plans with large menus of high-cost funds are associated with worse expected performance for investors.

The results presented in Table 7 imply that the impact of fiduciary decisions on investor welfare is not limited to direct fiduciary losses. Fiduciary decisions also have a predictable impact on investor choices. Menus that are robust to the 1/N heuristic, that is, have a low equal weight distance, are associated with better outcomes for investors than menus that require more careful portfolio selection.

How does the compensation of service providers affect the structure of menus? Fiduciaries are responsible for the design of plan menus, but the choice of investment options is heavily influenced by the plan service providers.[21] One concern of policy makers has been that service providers have a conflict of interest. Since service provider compensation comes, in part, through the fees of funds on the menu, service providers may encourage fiduciaries to include menu choices that are profitable for the provider, but not beneficial to plan participants. This conflict of interest may be reduced if service providers are paid a percentage of plan assets rather than indirectly through the fees of the funds included in the plan menu.

Do investors in plans that compensate their fiduciary directly feature better menus than plans that record no plan-level expenses, but compensate advisors indirectly through fund fees? Our data includes the expenses paid for investment management by each plan for those plans that record such an expense. About 13% of plans in the sample record such a cost. Table 7 reports the results of regressions of measures of menu quality from Table 7, as well as direct measures of loss, on direct investment management compensation, the employer contribution share, and plan size controls, with and without industry dummies.

[21] Service provider input into plan design may be particularly problematic in light of the 404(c) liability standard and revenue sharing. If plan administrators are held not to be liable for investor mistakes, but those mistakes predictably induce investors to opt for supra-optimal fees which increase the revenue of service providers who, in turn, consult on menu design, then investors may be insufficiently protected against poor menu design.

The results show that plans that report direct service provider compensation, and do not rely exclusively on revenue sharing, tend to offer more index funds and smaller menus. Interestingly, plans with higher employer contribution percentages tend score well on a variety of measures; having a higher percentage of index funds, lower fund fees, and lower equal weight distance. Equal weight distance is marginally related to direct investment management fees, with higher fees actually increasing the equal weight distance, but this is not robust in the industry-dummy controlled Panel B regressions. Fee loss and fund fee loss is lower as well, while total loss is higher. This likely reflects that, while some plans that rely on direct compensation receive benefits in plan structure and fees that offset those direct costs, other plans may be high-fee across the board, attenuating the average effect of direct compensation. Nevertheless, the measurable impact of direct advisor compensation on menu design provides some empirical support for concerns about conflicts of interest related to revenue sharing.

4.4 Plan Services

Service providers to 401(k) plans differ in the types of services that they provide. Since these services are difficult to observe, some heterogeneity in plan costs could be explained by unobserved differences in plan services. To the extent these services lead investors to end their careers with more available funds for retirement, by inducing higher savings rates, for example, they may be beneficial in leaving plan participants better situated for retirement even if they are a drag on annual returns. In order to address this possibility, Table 9 explores plan outcomes that might be related to quality of service by regressing proxies for quality of service on total excess expense. The regressions include measures of plan participation rate, 2009 contributions to the plan per active account, and investor allocation loss to capture the effect of investor education.

Control variables are designed to capture the overall quality of the plan and generosity of the employer in order to isolate the effect of costs from overall plan quality. Regressions are presented with and without dummy variables for industry, constructed as described above. Regressions are also presented with total excess expense, menu loss, and both the expense and menu loss independent variables. While the effect of expenses is the main variable of interest in these regressions, low-quality menus are likely to be correlated with poor plan outcomes and so is an important control. Other controls include the fraction of total plan contributions coming from the employer, a measure of employer generosity likely to be correlated with overall plan quality, and log of total net assets in the plan.

Panel A presents regressions of participation rate on these independent variables. Participation rate is the percentage of employees contributing to accounts as a percentage of all eligible employees, as in Papke (1995). A full-service plan offering more personalized interactions and investor education might benefit employees by inducing more of them to participate. This would directly benefit the marginal participant who would otherwise be less prepared for retirement, and could benefit infra-marginal participants by increasing assets under management which may reduce the overall cost of the plan.

Since participation rate is bounded by 0 and 1, we estimate generalized linear models with robust standard errors. Across all specifications, participation rate is negatively correlated with the costs of the plan. A single standard deviation increase in plan expenses is associated with a statistically significant 2.6% reduction in plan participation. The results are robust for the industry-controlled subsample. Other independent variables have the expected sign. Menu loss is negatively correlated with participation, but not statistically significant when cost is included. Employer contribution is associated with an increase in participation. The size control is particularly important, because size is associated with lower fees and all else equal a plan that has had historically more participants will have more assets.

It is difficult to make a causal claim from the relationship between fees and participation rate. While we have controlled for plausible measures of plan quality, omitted measures of plan attractiveness may drive participation. That is, low cost plans may be better than high cost plans along some unobservable non-cost dimension, and therefore attract more participants. But the correlation we demonstrate is important in light of the 401(k) industry's obverse claim that costly services garner benefits for participants. Our data cast doubt on that relationship.

Panel B presents similar regressions using employee contributions. The dependent variable is the average employee contribution per active account. This is a measurement, holding participation constant, of how much each participant contributes. The regressions evaluate the claim that employees receiving better services may contribute more to their accounts. The control variables are changed slightly to use employer contribution per participant rather than employer contribution as a share of total contributions, since the dependent variable appears in the denominator of the latter. Across all specifications, total excess expense is associated with a reduction in contributions. A one standard deviation change in fiduciary loss is associated with 7.1% decrease in contributions. Once again, these results must be interpreted with caution, but the findings cast doubt on the claim the high cost plans provide services that attract participants' dollars.

A final test of the services hypothesis is provided in Panel C in which pre-fee diversification losses are the dependent variable. Diversification losses measure the cost of diversification problems before fees are taken into account, so they are not directly affected by the inclusion of high-cost funds in the menu. If costly services include investment advice that emphasizes diversification, then this measure might be lower in more costly plans. The regressions show, however, that diversification losses are higher in plans with high costs. Interestingly, they are lower in plans with significant employer contributions, though this result does not hold in the industry-controlled subsample.

Taken together, these results cast substantial doubt on the argument that high costs are offset by services that benefit employees. While we cannot rule out unobservable hedonic benefits to participants, the measures we choose plausibly capture concrete benefits to participants that might arise from superior services. In each case, the measures are strongly negatively correlated with increased expenses.

4.5 Robustness

Following Tang (2010) and Calvet, Campbell, & Sodini (2007), we estimate returns using a factor model with no alpha. To the extent actively managed funds produce persistent positive alpha, this model may overstate the costs of holding such funds. Gil-Bazo & Ruiz-Verdú (2009) investigate the relationship between mutual fund fees and alpha in domestic equity funds. They find that pre-fee alpha is, on average, negative, and that high-fee funds have lower pre-fee alpha. Both results suggest that, in aggregate, high-cost funds disfavored by our portfolio optimization methodology are likely to be poor choices.[22]

To investigate the potential impact of alpha on our results, we re-estimate the expected returns model including alpha. Since Elton, Gruber and Blake (2006) document abnormally high historical performance for funds included in 401(k) plans and show that these returns do not persist, we estimate alpha for each fund in 2010 and 2011, so that the alphas represent returns actually available to investors. Our estimation procedure is analogous to Carhart (1997) [23], with the significant caveat that, unlike the literature on mutual fund performance persistence, we cannot limit our sample of domestic equity funds. These alpha estimates are subject to two caveats. First, the limited factor model applied to funds other than domestic equity funds is likely to overstate alpha to the extent

[22] There is not unanimity in the empirical estimates of prevalence of alpha in mutual funds. See, e.g., Wermers, 2000 and Barras, Scaillet, & Wermers, (2010).
[23] These regressions are run by re-estimating the factor model for the years 2010 and 2011, so as to capture returns actually available to investors. The alphas from these regressions are then used, along with the betas estimated as in section 4 to compute the expected returns of each fund.

that our factor model fails to capture, for example, systematic risk associated with factors not included in the factor model. Second, we are unable to adjust for manager luck as in Barras, Scaillet, & Wermers, (2010). Both effects result in higher alphas.

Using these estimates of fund-level alphas, we then recompute optimal portfolios and re-run our cross-sectional regressions. We find that our regression results are generally robust to the inclusion of alphas, so estimated, but with a few exceptions. One exception is the relationship between investor loss and the percentage of index funds included in the plan menu in model 3 of Table 8, which reverses sign in the alternative regression.[24] This occurs because the optimal portfolio will heavily weight any fund in the portfolio where the estimated alpha exceeds the fees, any weight given to other funds will be measured as investor loss relative to this optimum. Given the limits of our alpha estimates, the sensitivity of some results to alpha is not unduly concerning.

Finally, we test an alternative factor model to estimate the portfolio returns, rerunning all tests using the Carhart (1997) four-factor model to estimate fund betas in lieu of the three factor model outlined in section 3 above. We then estimate optimal portfolios using predicted returns using the four-factor betas and recompute all results. The results are robust to this alternative specification of the factor model.

5. Conclusion

Our findings indicate that costs associated with plan investment options should be a crucial consideration in designing policies to guide plan fiduciaries. Fiduciary losses are a source of considerable costs to plan investors, particularly those in smaller plans, and investors cannot avoid these costs except by investing outside the plan. While, on average, fiduciary losses are smaller than investor losses, fiduciary losses exceed investor losses in small plans. Moreover, a

[24] Other, less important results that are sensitive to alpha include Menu Diversification Loss and Total Investor loss in Table 6, models 4, 5, and 6 in Table 8.

comparison to retail index funds suggests that many plans are inefficient in the fees they offer. Reducing fiduciary losses could be a productive point of focus for policy makers: investors benefit nearly dollar-for-dollar from reduced losses.

Our results also point to menu redesign as a potential source of plan improvement. While the law tends to attribute allocation mistakes to investors, menus that include poor choices or few index funds show higher investor losses. While adding index fund options would benefit most plans, eliminating poor choices would also be a powerful palliative, and our regressions suggesting elimination of poor funds might be a more effective strategy than adding good ones. If fiduciaries adapt their menus to accommodate well-understood investor behavioral biases, investor outcomes may be improved.

Appendix

Industry codings were determined from company names using the following keywords.

Industry Code	Count	Key Words
Health	202	medical health clinic healthcare hospital orthopedic physicians eye dental cardiovascular diagnostic cardiology hematology surgical surgeons cardiology
Finance	139	bank credit financial mutual capital consulting
Industrial and Construction	182	industries manufacturing construction steel paper lumber industrial equipment machine machinery mechanical metal contractors builders
Technology	145	technologies engineering network electronics software data networks electric computer engineers
Research	95	pharmaceuticals laboratories research
Hospitality	49	foods hotel distributors
Union	67	union local
Uncoded	2,704	

Works Cited

Agnew, J., Balduzzi, P., & Sunden, A. (2003). Portfolio choice and trading in a large 401 (k) plan. *American Economic Review*, 193–215.

Angus, J., Brown, W. O., Smith, J. K., & Smith, R. (2007). What's in Your 403(b)? Academic Retirement Plans and the Costs of Underdiversification. *Financial Management*, *36*(2), 1–38.

Barras, L., Scaillet, O., & Wermers, R. (2010). False Discoveries in Mutual Fund Performance: Measuring Luck in Estimated Alphas. *The Journal of Finance*, *65*(1), 179–216. doi:10.1111/j.1540-6261.2009.01527.x

Benartzi, S., & Thaler, R. H. (2001). Naive Diversification Strategies in Defined Contribution Saving Plans. *The American Economic Review*, *91*(1), 79–98.

Bergstresser, D., & Poterba, J. (2004). Asset allocation and asset location: Household evidence from the Survey of Consumer Finances. *Journal of Public Economics*, *88*(9), 1893–1915.

Bill Gross: We're Witnessing the Death of Equities - MarketBeat - WSJ. (n.d.). Retrieved August 15, 2012, from http://blogs.wsj.com/marketbeat/2012/07/31/bill-gross-were-witnessing-the-death-of-equities/

Brown, K. C., & Harlow, W. V. (2012). How good are the investment options provided by defined contribution plan sponsors? *International Journal of Portfolio Analysis and Management*, *1*(1), 3–31.

Burt Malkiel: Even Amid the Current Turmoil, Stocks Still Beat Bonds - WSJ.com. (n.d.). Retrieved August 15, 2012, from http://online.wsj.com/article/SB100008723963904441847045775857527861 29144.html

Calvet, L. E., Campbell, J. Y., & Sodini, P. (2007). Down or Out: Assessing the Welfare Costs of Household Investment Mistakes. *The Journal of Political Economy*, *115*(5), 707–747.

Canner, N., Mankiw, N. G., & Weil, D. N. (1997). An Asset Allocation Puzzle. *American Economic Review*, *87*(1), 181–91.

Carhart, M. M. (1997). On persistence in mutual fund performance. *Journal of Finance*, *52*(1), 57–82.

Carroll, G. D., Choi, J. J., Laibson, D., Madrian, B. C., & Metrick, A. (2009). Optimal defaults and active decisions. *The Quarterly Journal of Economics*, *124*(4), 1639–1674.

Choi, J. J., Laibson, D., Madrian, B. C., & Metrick, A. (2002). Defined contribution pensions: Plan rules, participant choices, and the path of least resistance. In *Tax Policy and the Economy, Volume 16* (pp. 67–114). MIT Press. Retrieved from http://www.nber.org/chapters/c10863.pdf

Elton, E. J., Gruber, M. J., & Blake, C. R. (2007). Participant reaction and the performance of funds offered by 401 (k) plans. *Journal of Financial Intermediation*, *16*(2), 249–271.

Gil-Bazo, J., & Ruiz-Verdú, P. (2009). The Relation between Price and Performance in the Mutual Fund Industry. *The Journal of Finance*, *64*(5), 2153–2183.

Investment Company Institute. (2011). *Inside the Structure of Defined Contribution/401(k) Plan Fees,*. Retrieved from http://www.ici.org/pressroom/news/11_news_deloitte_401k

Papke, L.E., 1995. Participation in and Contributions to 401 (k) Pension Plans: Evidence from Plan Data. *Journal of Human Resources*, pp.311–325.

Pool, V. K., Sialm, C., & Stefanescu, I. (2012). *It Pays to Set the Menu: Mutual Fund Investment Options in 401 (k) Plans*. Working Paper. Retrieved from http://www.fma.org/Napa/2013/Papers/PSS_main_Napa.pdf

Shoven, J. B., & Sialm, C. (2004). Asset location in tax-deferred and conventional savings accounts. *Journal of Public Economics*, *88*(1), 23–38.

Sialm, C., & Starks, L. (2012). Mutual fund tax clienteles. *The Journal of Finance*, *67*(4), 1397–1422.

Sialm, C., Starks, L., & Zhang, H. (2012). Defined contribution pension plans: sticky or discerning money? Working Paper. Retrieved from http://www.rsm.nl/fileadmin/home/Department_of_Finance__VG5_/PAM 2013/Final_Papers/Defined_Contribution_Clemens_Sialm.pdf

Tang, N., Mitchell, 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*(11–12), 1073–1085.

Figure 1: Density Histogram of In-Sample Plans Relative to All Brightscope Plans

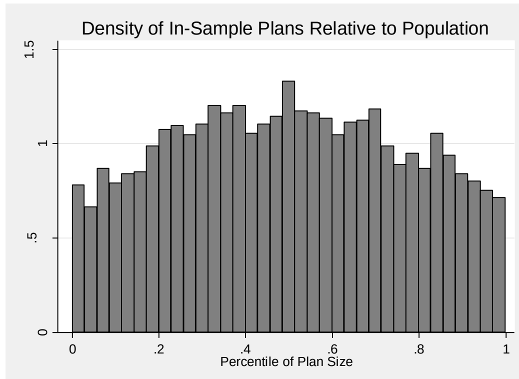


Figure 2: Mean-Variance Diagram of Return-Loss Decomposition

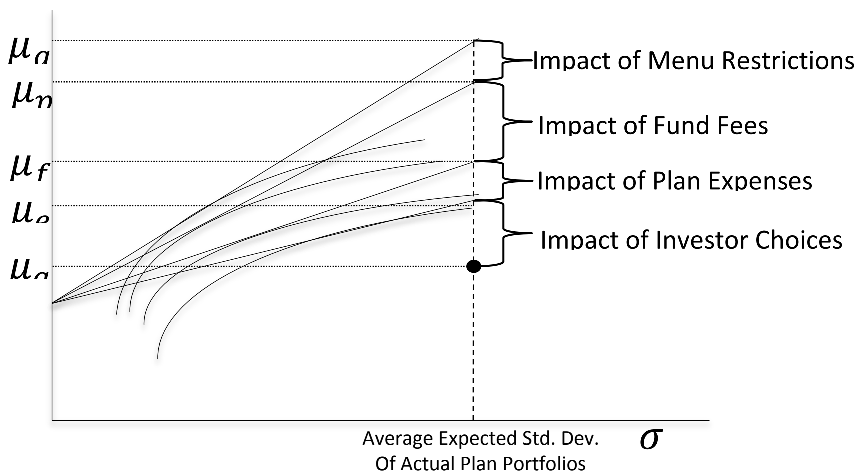


Figure 3: Histogram of Number of Investment Options

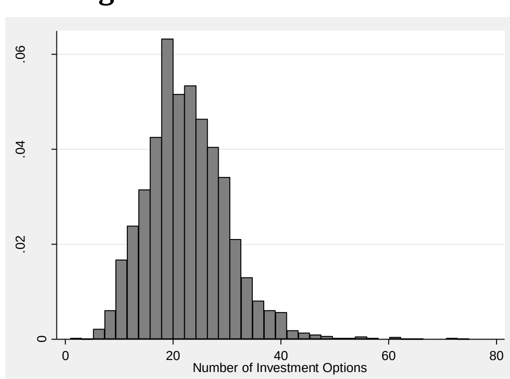
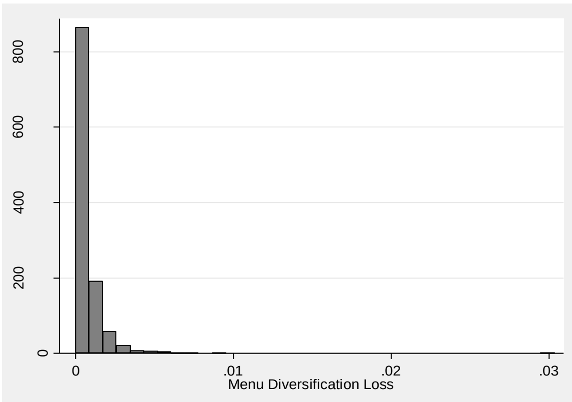
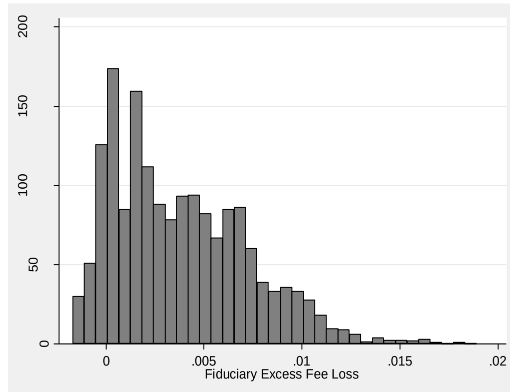


Figure 4: Density Histograms of Return-Equivalent Loss

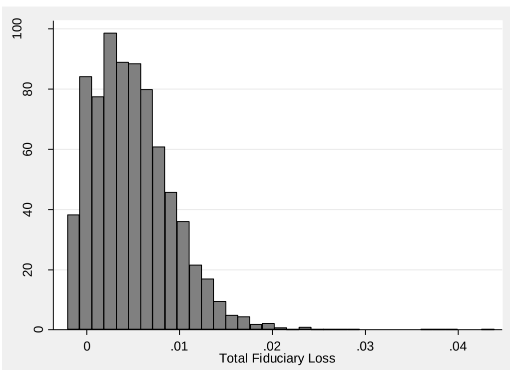
4.A Loss Due to Menu Limitations



4.B Loss Due to Mutual Fund Fees



4.C Total Fiduciary Loss



4.D Loss Due to Investor Portfolio Choice

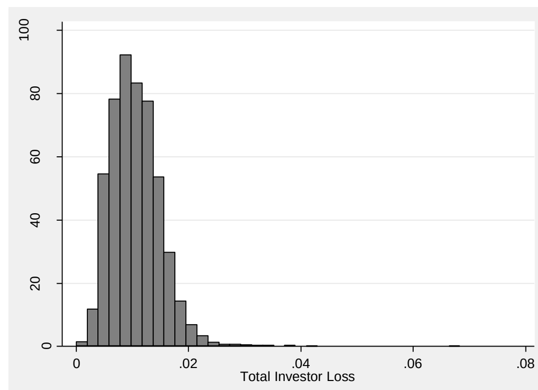


Figure 5: Scatterplot of Fiduciary Loss and Plan Size

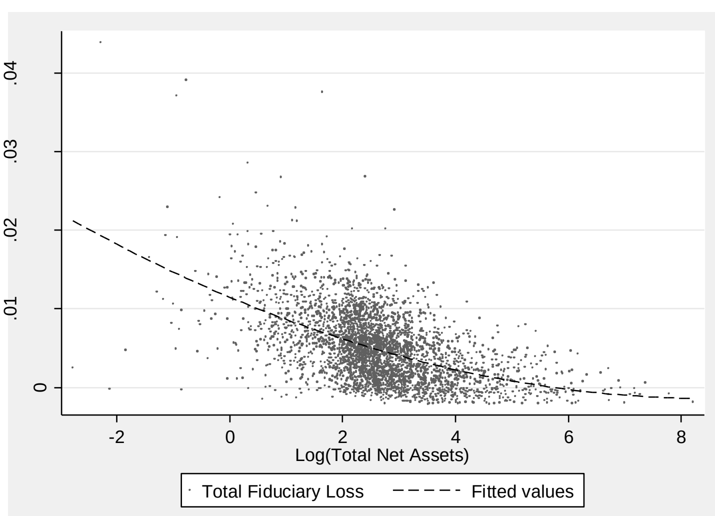


Table 1: Plan Summary Statistics

This table presents summary statistics for the plans included in the sample. Total Plan Assets is the sum of balances of all investment options. Number of Options is the number of mutual fund options as well as GIC, brokerage window, and company stock options. The table also summarizes the percentage of plan offering at least one instance of each broad category of investment type. We use the Morningstar asset class designation to derive the broad investment classes. Plans with only retirees may be reported as having zero active participants.

N = 3534	**Mean**	**Median**	**Std. Dev.**	**Min**	**Max**
Total Plan Assets ($ millions)	33.68	12.98	114.3	.06	3,662.5
Number of Active Participants	927.0	927	4,724.0	0	221,558
Number of Investment Options	22.7	22	7.7	1	75
Percent of Plans Offering Options					
Asset Classes					
Equity Funds	99.9%				
Bond Funds	99.3%				
Balanced Funds	94.1%				
International Equity	99.2%				
Index Funds	79.3%				
Company Stock	5.2%				
Brokerage Windows	9.5%				

Table 2: Portfolio Summary Statistics

We compute three portfolios which provide the baseline for our computation of return-equivalent losses. The Global Optimum is 0.7354. The Pre-Fee Menu Optimum Portfolio is the portfolios with the highest Sharpe ratio computed over the expected mean and variance of the investment options as determined by the factor model without accounting for investment costs. The Post-Fee Menu Optimum Portfolio is the maximum Sharpe ratio portfolio computed over the investment options after deducting fees from expected returns. This optimization is computed independently so that the optimization minimizes the impact of fees. The Observed Portfolios is the aggregate portfolio of the plan with return and Sharpe ratio computed after the deduction of fees.

	N=3,534	**mean**	**sd**	**min**	**p5**	**p95**	**max**
Sharpe Ratio							
	Pre-Fee Optimum	0.7303	0.0085	0.4812	0.7166	0.7354	0.7354
	Post-Fee Optimum	0.6690	0.0370	0.3431	0.6047	0.7169	0.7278
	Observed Portfolio	0.5908	0.0470	0.1073	0.5179	0.6705	0.7096
Return							
	Pre-Fee Menu Optimum, μ_p	0.0483	0.0250	0.0005	0.0024	0.0735	0.1707
	Post-Fee Menu Optimum, μ_f	0.0748	0.0142	0.0390	0.0619	0.0947	0.3013
	Observed Portfolio, μ_a	0.0722	0.0111	0.0049	0.0538	0.0881	0.1827
Standard Dev							
	Pre-Fee Optimum	0.0644	0.0331	0.0006	0.0033	0.0977	0.2171
	Post-Fee Optimum	0.1085	0.0211	0.0563	0.0878	0.1444	0.3759
	Observed Portfolio	0.1183	0.0153	0.0209	0.0924	0.1388	0.2960

Table 2: Return-Equivalent Losses

Return equivalent losses are computed as the difference, at the mean level of expected risk on all observed portfolios, between the returns on the benchmark portfolios as determined by their expected Sharpe ratios. All returns are reported as ratios, so that 0.01 is equal to one percent. For menu losses, the benchmarks are the global optimum factor portfolio and the Pre-Fee Optimum. Fund Fee Loss is determined by the Pre-Fee Optimum and Post-Fee Optimum. Plan Expense Loss is directly calculated as total itemized plan expenses (other than fund fees), divided by plan net assets, less 8 basis points of baseline plan expenses. Total Expense Loss is the sum of Fund Fee Loss and Plan Expense Loss. Total Fiduciary Loss is the sum of Menu Loss and Total Expense Loss. Investor Loss is the difference between the Post-Fee Optimum and Observed Portfolio returns. Total Loss is the sum of Total Fiduciary Loss and Investor Loss. The estimates for excess fee loss assume basline fund fees of 21 basis points and the estimates for excess plan expense loss assume competitive plan expenses of 8 basis points. N= 3,534

			% of Total	Mean	Std. Dev.	Min	5th Pctle	95th Pctle	Max
Fiduciary Loss		Menu Diversification Loss	3.8%	0.0006	0.0010	0.0000	0.0000	0.0022	0.0303
Fiduciary Loss	Total Excess Expense	Excess Fee Loss	24.4%	0.0038	0.0035	-0.0017	-0.0005	0.0101	0.0189
Fiduciary Loss	Total Excess Expense	Excess Plan Expense Loss	3.2%	0.0005	0.0023	-0.0008	-0.0008	0.0048	0.0315
Fiduciary Loss	Total Excess Expense		27.6%	0.0043	0.0040	-0.0025	-0.0008	0.0112	0.0392
Fiduciary Loss			32.1%	0.0050	0.0044	-0.0021	-0.0007	0.0126	0.0438
Investor Loss		Diversification Loss	41.7%	0.0065	0.0037	-0.0022	0.0017	0.0127	0.0666
Investor Loss		Excess Fee Loss	31.4%	0.0049	0.0025	-0.0036	0.0012	0.0086	0.0282
Investor Loss			67.9%	0.0106	0.0045	0.0000	0.0045	0.0179	0.0684
Total Excess Fee (and Expense) Loss			54.5%	0.0085	0.0040	-0.0003	0.0025	0.0144	0.0535
Total Diversification Loss			45.5%	0.0071	0.0039	-0.0015	0.0019	0.0134	0.0672
Total Loss			100.0%	0.0156	0.0062	0.0001	0.0054	0.0250	0.0721

Table 3 Losses by Plan Net Assets

Panel A. Investor and Fiduciary Losses

	Investor Losses Predominate	Fiduciary Losses Predominate
All Plans	81.8%	18.2%
Size Quintile		
1	62.8%	37.2%
2	77.1%	22.9%
3	85.0%	15.0%
4	89.2%	10.8%
5	95.2%	4.8%
N=3,534		

Panel B. Allocation and Fee Losses

	Total Diversification Loss Predominates	Total Excess Fee (and Expense) Loss Predominates
All Plans	25.3%	74.7%
Size Quintile		
1	18.6%	81.4%
2	19.4%	80.6%
3	27.7%	72.3%
4	24.2%	75.8%
5	36.8%	63.2%
N=3,534		

Table 4: Regression of Total Loss on Components of Fiduciary Loss

This table presents regressions of Total Loss on Fiduciary Loss and components of Fiduciary Loss. Since these components are mechanically related to Total Loss, which is the sum of Fiduciary Loss and Investor Loss, the purpose of the regressions is to determine how the coefficients compare to 1. The table therefore presents standard deviations in parentheses and the stars indicate the likelihood that the coefficients are different than 1. Standard deviations in parentheses. * $p < 0.10$, ** $p < 0.01$, *** $p < 0.001$

	(1) Total Loss	(2) Total Loss
Total Fiduciary Loss	0.970	
	(0.0233)	
Menu Loss		0.926
		(0.122)
Fiduciary Fee Loss		0.920**
		(0.0266)
Plan-Level Expense Loss		1.121**
		(0.0468)
Constant	0.0107***	0.0109***
	(0.000134)	(0.000131)
Observations	3534	3534
R^2	0.474	0.478

Table 5: Plan Total Assets and Plan Losses

The regressions in this table investigate the relationship between plan size, plan balances, and loss variables of interest. The loss variables of interest are all measured on a return-equivalent basis. The column headers list the dependent variable for each regression. Employee contribution share is the proportion of total contributions to the plan made by the employer. Panel B includes industry dummies coded as described in the appendix.

Panel A. No Industry Controls

	(1) Fiduciary Loss	(2) Menu Diversification Loss	(3) Total Excess Expense	(4) Investor Loss	(5) Total Loss
Log(Total Net Assets)	-0.00261***	-0.000229***	-0.00239***	-0.000216**	-0.00283***
	(-22.13)	(-10.44)	(-21.51)	(-2.07)	(-17.34)
Empl. Contribution Share	-0.0000700	-0.000172	0.000102	-0.00148***	-0.00155***
	(-0.18)	(-1.63)	(0.29)	(-3.47)	(-2.66)
Log(Plan Participants)	0.000970***	0.0000868***	0.000883***	0.000195**	0.00116***
	(9.98)	(4.34)	(9.65)	(2.20)	(8.71)
Constant	0.00619***	0.000757***	0.00544***	0.0104***	0.0166***
	(15.74)	(7.05)	(15.09)	(24.02)	(29.29)
Observations	3534	3534	3534	3534	3534
R^2	0.296	0.046	0.292	0.007	0.181

t statistics in parentheses
* $p < 0.10$, ** $p < 0.01$, *** $p < 0.001$

Panel B. Including Industry Controls

	(1) Total Fiduciary Loss	(2) Menu Diversification Loss	(3) Total Excess Expense	(4) Total Investor Loss	(5) Total Loss
Log(Total Net Assets)	-0.00256***	-0.000306***	-0.00225***	-0.000210	-0.00277***
	(-9.14)	(-5.04)	(-8.46)	(-1.07)	(-7.66)
Empl. Contribution Share	0.000411	-0.000157	0.000568	-0.00162**	-0.00121
	(0.56)	(-0.67)	(0.88)	(-2.08)	(-1.24)
Log(Plan Participants)	0.00104***	0.000143***	0.000900***	0.000162	0.00120***
	(4.69)	(3.11)	(4.21)	(0.88)	(4.20)
Finance Indicator	0.000377	0.000280	0.0000966	0.000830*	0.00121*
	(0.78)	(0.97)	(0.27)	(1.84)	(1.81)
Manuf./Const. Indicator	0.00122***	0.000212*	0.00101***	-0.000503	0.000716
	(3.16)	(1.70)	(2.93)	(-1.25)	(1.33)
Technology Indicator	0.000636	0.000324	0.000311	0.00176***	0.00240***
	(1.24)	(1.08)	(0.82)	(3.60)	(3.49)
Research Indicator	-0.000330	0.000132	-0.000462	0.00112*	0.000794
	(-0.61)	(0.93)	(-0.96)	(1.69)	(0.92)
Hospitality Indicator	0.000943	0.000187	0.000756	-0.000622	0.000322
	(1.55)	(1.10)	(1.30)	(-1.17)	(0.41)
Union Plan Indicator	0.000182	-0.000123	0.000305	-0.000530	-0.000348
	(0.39)	(-1.23)	(0.70)	(-0.88)	(-0.54)
Constant	0.00497***	0.000473**	0.00449***	0.0102***	0.0152***
	(5.29)	(2.22)	(5.07)	(10.38)	(11.93)
Observations	826	826	826	826	826
R^2	0.241	0.044	0.239	0.048	0.165

t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.0$

Table 6: Investor Loss and Menu Quality

Regressions in this table measure the effect of menu design on investor losses with and without size controls. The first measure, 1/N portfolio distance, is the distance in N-space between the equally weighted portfolio and the optimal portfolio. This distance captures the effect of the interaction of menu design and the 1/N heuristic on plan losses. Employee contribution share is the proportion of total contributions to the plan made by the employer. Models 1 through 4 include the entire sample, while models 5 through 8 include the subsample of plans that could be successfully coded for industry. t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

	All Plans				Industry Coded Subsample			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Equal Weight Distance	0.00849*** (11.61)	0.00812*** (11.10)			0.00854*** (6.55)	0.00823*** (6.30)		
Percent of Index Funds			-0.00472*** (-5.52)	-0.00377*** (-4.33)			-0.00378* (-2.35)	-0.00332* (-2.04)
Number of Investment Options	0.000172*** (18.54)	0.000178*** (19.02)	0.000176*** (18.73)	0.000182*** (19.16)	0.000153*** (8.43)	0.000159*** (8.63)	0.000160*** (8.58)	0.000166*** (8.76)
Log(Total Net Assets)		-0.000395*** (-4.60)		-0.000385*** (-4.37)		-0.000200 (-1.33)		-0.000205 (-1.32)
Empl. Contribution Share		-0.00107** (-2.67)		-0.00115** (-2.84)		-0.00176* (-2.40)		-0.00195** (-2.60)
Log(Plan Participants)		0.000207* (2.45)		0.000218* (2.53)		-4.96e-08 (-0.68)		-5.01e-08 (-0.67)
Constant	0.00127* (2.53)	0.00146* (2.28)	0.00698*** (29.05)	0.00680*** (14.30)	0.000922 (0.98)	0.00223* (2.16)	0.00660*** (11.93)	0.00774*** (11.79)
Industry Dummies	No	No	No	No	Yes	Yes	Yes	Yes
Observations	3534	3519	3534	3519	830	827	830	827
R^2	0.127	0.135	0.101	0.110	0.168	0.178	0.130	0.142

Table 7: Direct Investment Management Fees and Menu Quality

This table presents regressions of measures of menu quality and fee losses on the percentage of plan assets paid for investment advisory services. Percent Index Funds is the fraction of funds in the menu that are classified as index funds by Morningstar. Equal Weight Distance is the vector norm of the equally distributed 1/N portfolio and the optimal portfolio. All are estimated as OLS regressions with robust standard errors. Panel A presents regressions for the full sample, while Panel B presents regressions including industry dummies. Employee contribution share is the proportion of total contributions to the plan made by the employer.

Panel A. No Industry Controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Percent of Index Funds	Number of Investment Options	Equal Weight Distance	Fee Loss	Investor Excess Fee Loss	Total Fund-fee Loss	Total Loss
Direct Investment Management Fees	0.0203***	-1.073***	0.00809*	-0.000873***	0.000511***	-0.000362**	0.00137***
	(4.90)	(-2.83)	(1.66)	(-5.58)	(4.18)	(-2.51)	(4.90)
Log(Total Net Assets)	0.0153***	1.245***	-0.00524***	-0.00142***	0.0000804	-0.00134***	-0.00283***
	(9.15)	(8.13)	(-2.67)	(-22.43)	(1.62)	(-22.97)	(-24.92)
Empl. Contribution Share	0.0226***	-1.177	-0.0235**	-0.000581*	-0.000301	-0.000882***	-0.00171***
	(2.87)	(-1.63)	(-2.54)	(-1.95)	(-1.29)	(-3.22)	(-3.19)
Log(Plan Participants)	-0.00725***	-0.259*	0.00434**	0.000282***	0.000115**	0.000398***	0.00115***
	(-4.36)	(-1.70)	(2.22)	(4.49)	(2.34)	(6.86)	(10.21)
Constant	0.0749***	21.41***	0.632***	0.00618***	0.00405***	0.0102***	0.0165***
	(9.14)	(28.54)	(65.73)	(19.97)	(16.72)	(35.88)	(29.75)
Observations	3519	3519	3519	3519	3519	3519	3519
R^2	0.040	0.027	0.006	0.184	0.012	0.175	0.186

t statistics in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel B. Including Industry Controls

	(1) Percent of Index Funds	(2) Number of Investment Options	(3) Equal Weight Distance	(4) Fee Loss	(5) Investor Excess Fee Loss	(6) Total Fund-fee Loss	(7) Total Loss
Direct Investment Management Fees	0.0238**	-1.774**	0.0178	-0.000812**	0.000127	-0.000685**	0.00128**
	(2.48)	(-2.14)	(1.52)	(-2.29)	(0.48)	(-2.18)	(2.12)
Log(Total Net Assets)	0.0145***	1.388***	-0.00747	-0.00135***	0.000000172	-0.00135***	-0.00275***
	(3.51)	(3.89)	(-1.48)	(-8.80)	(0.00)	(-9.94)	(-10.51)
Empl. Contribution Share	-0.00610	0.775	-0.0182	-0.0000869	-0.000969**	-0.00106*	-0.00133
	(-0.36)	(0.53)	(-0.89)	(-0.14)	(-2.09)	(-1.92)	(-1.25)
Log(Plan Participants)	-0.00540	-0.403	0.00462	0.000324**	0.000110	0.000434***	0.00115***
	(-1.31)	(-1.13)	(0.92)	(2.13)	(0.97)	(3.22)	(4.44)
Constant	0.0841***	21.81***	0.639***	0.00551***	0.00464***	0.00935***	0.0155***
	(3.84)	(11.55)	(23.95)	(6.81)	(7.70)	(13.04)	(11.25)
Observations	826	826	826	826	826	826	826
R^2	0.041	0.073	0.017	0.140	0.024	0.167	0.166

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Proxies for Quality of Plan Services

This table presents, in three panels regressions of three proxies for plan services on plan cost and control variables. The proxies are the participation rate, employee contributions per account, and diversification loss on a pre-expense basis. Panel A shows the participation rate and uses GLM regressions since the dependent variable is bounded at zero and one. The other panels present regressions using OLS with robust standard errors. In each panel, models 1 through 3 include the entire sample, while models 4 through 6 includes the subsample of plans that could be successfully coded for industry.

Panel A. Participation Rate GLM Regressions

	Full Sample			Industry Coded Subsample		
	(1)	(2)	(3)	(4)	(5)	(6)
Total Excess Expense	-38.49***		-36.89***	-42.31***		-41.95***
	(-6.67)		(-6.24)	(-3.85)		(-3.76)
Menu Loss		-53.95*	-33.56		-18.21	-6.897
		(-1.93)	(-1.45)		(-0.65)	(-0.29)
Employer Contribution Pct	2.061***	2.063***	2.053***	2.440***	2.453***	2.437***
	(17.57)	(17.45)	(17.49)	(8.56)	(8.65)	(8.58)
Log(Total Net Assets)	0.208***	0.272***	0.204***	0.167***	0.238***	0.166***
	(8.34)	(12.25)	(8.19)	(3.19)	(5.07)	(3.16)
Constant	0.358***	0.0509	0.383***	0.369*	-0.000940	0.375*
	(4.34)	(0.78)	(4.58)	(1.87)	(-0.01)	(1.91)
Industry Dummies	No	No	No	Yes	Yes	Yes
Observations	3511	3511	3511	823	823	823

Panel B. Employee Contributions Per Active Account and Plan Expenses

	Full Sample			Industry Coded Subsample		
	(1)	(2)	(3)	(4)	(5)	(6)
Total Excess Expense	-38046.4***		-40400.7***	-66513.0***		-71717.6***
	(-3.28)		(-3.43)	(-3.95)		(-4.23)
Menu Loss		23435.5	47076.0		66817.5	93241.5**
		(0.59)	(1.17)		(1.53)	(2.14)
Employer Contribution Per Participant	0.250***	0.252***	0.251***	0.202***	0.204***	0.202***
	(11.95)	(12.01)	(11.97)	(6.85)	(6.86)	(6.86)
Log(Total Net Assets)	1508.0***	1602.2***	1513.1***	1245.8***	1411.3***	1263.6***
	(25.66)	(30.25)	(25.68)	(13.18)	(15.87)	(13.34)
Log(Plan Participants)	-1573.0***	-1607.1***	-1574.9***	-1196.6***	-1260.9***	-1205.4***
	(-30.08)	(-31.17)	(-30.10)	(-13.65)	(-14.42)	(-13.77)
Industry Dummies	No	No	No	Yes	Yes	Yes
Observations	3511	3511	3511	821	821	821
R^2	0.384	0.382	0.384	0.551	0.543	0.553

Panel C. Diversification Losses and Plan Expenses

	Full Sample			Industry Coded Subsample		
	(1)	(2)	(3)	(4)	(5)	(6)
Total Excess Expense	0.176***		0.184***	0.200***		0.206***
	(9.90)		(10.18)	(5.77)		(5.87)
Menu Loss		-0.0333	-0.151**		-0.0184	-0.102
		(-0.53)	(-2.38)		(-0.20)	(-1.11)
Empl. Contribution Pct	-0.00117***	-0.00129***	-0.00120***	-0.000467	-0.000596	-0.000501
	(-3.40)	(-3.68)	(-3.49)	(-0.73)	(-0.91)	(-0.78)
Log(Total Net Assets)	0.0000708	-0.000253***	0.0000591	0.000145	-0.000183	0.000134
	(1.09)	(-4.35)	(0.91)	(1.10)	(-1.49)	(1.02)
Constant	0.00582***	0.00749***	0.00591***	0.00475***	0.00653***	0.00483***
	(24.59)	(40.28)	(24.66)	(8.78)	(13.85)	(8.86)
Industry Dummies	No	No	No	Yes	Yes	Yes
Observations	3523	3523	3523	766	766	766
R^2	0.038	0.011	0.040	0.073	0.035	0.074