Financial Knowledge and 401(k) Investment Performance

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Abstract

Using a unique new dataset linking administrative data on investment performance and financial knowledge, we examine whether investors who are more financially knowledgeable earn more on their retirement plan investments, compared to their less sophisticated counterparts. We find that risk-adjusted annual expected returns are 130 basis points higher for the most financially knowledgeable employees, and those scoring higher on our Financial Knowledge Index have slightly more volatile portfolios while they do no better diversifying their portfolios than their peers. Overall, financial knowledge does appear to help people invest more profitably; this may provide a rationale for efforts to enhance financial knowledge in the population at large.

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Numerous studies show that more financially knowledgeable people accumulate more retirement wealth.[1] Several explanations have been offered for this finding, including the fact that more financially sophisticated people are more likely to plan and save for the future (Berhman et al. 2012; Lusardi and Mitchell 2007, 2008, 2009, 2011a andb). Also, they also are more aware of, and manager better, the fees and charges associated with financial products (Hastings and Mitchell 2011, Choi et al. 2010). Moreover, more sophisticated people are more likely to invest in stocks (van Rooij, Lusardi and Alessie (2011) and Yoong (2011)) But, as yet, little is known about whether more financially knowledgeable people also earn higher returns on their retirement saving. This paper contributes to the literature by showing that financial knowledge enables defined contribution (DC) plan investors to earn higher risk-adjusted expected returns compared to their less-sophisticated counterparts.

This is an important topic since, with the spread of 401(k) plans, which are the most common form of DC plans in the U.S., plan participants are increasingly required to take on responsibility for managing their individual retirement accounts.[2] In the 1980's, for instance, only 40 percent of U.S. private-sector retirement contributions went to DC pensions; two decades later, 90 percent of contributions are flowing to DC retirement accounts (see Poterba et al., forthcoming). If financial knowledge can be shown to enable people to better allocate resources over their lifetimes in a world of individual responsibility, this could motivate private (and perhaps public) efforts to enhance financial knowledge for the larger population. The ability

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[1] For a recent review of the literature see Lusardi and Mitchell (2014); early work on the topic includes the influential paper by Bernheim et al. (2001).

[2] Potential changes in other employer-provided retirement benefits (e.g., health saving accounts and health reimbursement accounts) are also likely to enhance the importance of individually-managed retirement saving. These accounts also may require employees to contribute to and manage individual saving accounts.

to invest wisely and earn better returns will therefore be increasingly critical for national retirement wellbeing in an aging world.[3]

In what follows, we use a novel dataset which links a unique administrative dataset on retirement plan investment performance with a survey which permits us to measure and evaluate employees' financial knowledge. Our results show that more financially knowledgeable investors earn substantially better risk-adjusted investment returns. Specifically, expected risk-adjusted annual returns are 130 basis points higher for the most financially literate investors, as compared to the financially unsophisticated. This advantage could have important implications over a lifetime of saving for retirement, and it might help account for large differences in retirement wealth in the population.

Prior Research

In our recent review of the economic impact of financial literacy on retirement planning and saving (Lusardi and Mitchell 2014), we described numerous studies suggesting that people with better understanding of economic and finance fundamentals also have higher wealth.

A potential explanation for this observation might be that financially knowledgeable individuals earn higher returns. While there is some suggestive evidence supportive of this hypothesis, confirming it empirically has been difficult since, to our knowledge, researchers have not had access to datasets reporting both financial knowledge questions and detailed administrative data on investment holdings and returns. Some authors have shown that better-

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[3] While investors might be able to substitute financial advice instead of enhancing their own financial literacy, recent evidence (Bricker et al. 2012; EBRI 2013) indicates that fewer than one-third of Americans consults financial advisors, lawyers, or accountants for investment help. Of those, only a quarter followed the advice. Moreover, Calcagno and Monticone (2011) argue that non-independent advisors do not offset clients' low levels of financial knowledge, and Collins (2012) concludes that financial advice is a complement to, rather than a substitute for, financial knowledge. Clark et al. (2014) report most people (62%) get their investment advice from family and relatives. Kim et al. (2013) explore the tradeoff between hiring a financial adviser and investing in on-the-job human capital.

educated households hold more stock than their less-educated counterparts (Haliassos and Bertaut 1995; Calvet et al. 2007; 2009a, b; 2014), but that research did not measure any specific effect of respondent financial knowledge. Bodnaruk and Simonov (2012) examined the portfolios of private mutual fund managers and concluded that financial experts did not make better investment decisions than their less savvy counterparts. That study also lacked a direct measure of investor financial knowledge. In related work, Grinblatt et al. (2013) explored the links between cognitive functioning (IQ), business education, and investment performance in a Finnish dataset. They reported that higher-IQ investors were less likely to pay high mutual fund fees, and business education also played an important role. Christelis et al. (2010) and Jappelli and Padula (2013a, b) noted that cognitive ability, proxied by math scores in school, was associated with more stock market participation. Yet Lusardi et al. (2010) showed that, while cognitive ability is positively associated with financial knowledge, it is not the sole determinant. In other words, there remains substantial heterogeneity in financial literacy even after controlling for cognition.

A separate group of researchers has examined this topic by drawing on surveys of financial literacy but without detailed information on peoples' actual investment holdings. For instance van Rooj et al. (2011) used self-reported data on stocks and mutual funds by Dutch households, and they found a positive correlation between financial knowledge and stock market participation. Similarly, Yoong (2011) used a US survey with a battery of financial knowledge questions and again reported that the more financially knowledgeable were more likely to say they held stocks and mutual funds (controlling for other factors). Nevertheless, neither study had the administrative information to link fund holdings, investment performance, and financial knowledge.

In addition to asking whether more knowledgeable individuals earn higher investment returns on their portfolios, it is also important to ascertain whether this might be due to better diversification patterns. For instance von Gaudecker (2011) showed that more knowledgeable respondents reported holding better diversified funds in the Netherlands, though again his analysis relied on self-reported portfolios rather than what are likely to be more accurate administrative records.

A different explanation for the observed positive relationship between financial knowledge and wealth is that, in the retail market at least, sophisticated investors might pay lower fees on their investments, thereby enhancing their net returns. Lab experiments by Choi et al. (2010) found that people who deemed themselves more financially knowledgeable did elect lower-fee investment options than their counterparts. Indeed those authors concluded (p. 1408): "mistakes driven by financial illiteracy are the primary source of the demand for high-fee index funds." In a Chilean field experiment, Hastings et al. (2011) used a financial literacy module to examine whether less financially knowledgeable respondents were differentially sensitive to how pension plan fee information was framed. They reported that the less financially knowledgeable were more sensitive to this framing, and that financial knowledge scores and education were sufficiently uncorrelated to effectively test their separate impacts. Yet that study did not assess how financial knowledge affected respondents' pension plan *investment performance*. In related work, financial literacy has been found to affect return on simple assets such as saving accounts: for instance, Deuflhard et al. (2013) linked saving account returns earned by Dutch survey respondents to a set of financial literacy questions and to information on bank interest rates. Their study concluded that financial knowledge was associated with higher returns on saving accounts; interestingly, some of this impact appeared to be attributable to peoples' willingness to

use self-managed online banking. Nevertheless, their database did not contain information on any more sophisticated investments. [4]

In sum, previous financial literacy studies have not had access to high-quality administrative data on sophisticated investments nor linked outcomes to detailed information on investors' financial knowledge levels. In what follows, we use a new dataset to explore whether financial knowledge is associated with investment behavior and investment performance.

Data and Methods

We investigate the link between financial knowledge and investment performance using a unique new dataset from a large financial institution (hereafter, the institution) employing over 20,000 individuals across the U.S. This institution offers to its employees a defined contribution retirement plan with a fund menu including stock and bond index choices, target date funds, lifestyle funds (conservative, moderate, aggressive), international and emerging market funds, and a real estate fund.

The institution provided us with administrative records on each employee's contribution rates and investment allocations across the fund menu, which then we link to fund returns data as detailed below. Accordingly, we have information on which of the funds offered by the plan sponsor each participant had selected. Using this linkage and 10 years of historical net returns for the investment menu, we computed each participant's equity allocation and own portfolio performance metrics as of 2013. Moreover, in cooperation with the employee benefits office of the institution, we fielded an internet survey on financial knowledge via email in October of 2013. Under confidentiality conditions, these responses were linked to the administrative records

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[4] It is unclear whether that evidence is particularly informative about U.S. 401(k) participants, most of whom hold a mix of stocks and bonds in their portfolios.

on respondents' investment allocations immediately prior to the survey, along with their personal characteristics (including sex, age, marital status, job tenure, salary, and 401(k) plan balances). In what follows we describe our data and methodology.

A. Measuring Financial Knowledge

With our input, the employee benefits office designed and fielded an online survey on the financial knowledge levels of approximately 22,000 employees. Some 16% of these individuals responded to the invitation to take the survey, a response rate similar to other voluntary and non-incentivized surveys.[5] Our respondent sample differs from the nonparticipating sample in some unsurprising ways: for instance, Table 1 shows those who responded to the survey contributed 1.7 percentage points more of their pretax salary; additionally, they had significantly higher plan balances, held about two percentage points more equity, were about five years older, and had worked for the institution about four years longer than their non-responsive counterparts. To the extent that employees who participated in our survey were probably more financially sophisticated than nonparticipants, the effects we report below are likely to underestimate the results that would be obtained from a survey covering all employees.

Table 1 here

We measure respondent financial knowledge using five questions to the online survey (correct answers are provided in bold):

- **Interest Rate:** Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow? ***More than $110****, Exactly $110, Less than $110, DK, RF*
- **Inflation:** Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account? *More than today, Exactly the same , **Less than today**, DK, RF*

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[5] This response rate is in line with what is found in many other online, nonmandatory, and nonincentivized surveys (c.f., Clark et al. (2014); Constant Contact http://support2.constantcontact.com/articles/FAQ/2344; Benchmark http://www.benchmarkemail.com/help-FAQ/answer/what-is-a-typical-survey-response-rate; Surveygizmo, http://www.surveygizmo.com/survey-blog/survey-response-rates/).

- **Risk:** Is this statement True or False? Buying a single company's stock usually provides a safer return than a stock mutual fund. *True, **False**, DK, RF*
- **Tax Offset:** Assume you were in the 25 percent tax bracket (you pay $0.25 in tax for each dollar earned) and you contributed $100 pretax to an employer's 401(k) plan. Your take-home pay (what's in your paycheck after all taxes and other payments are taken out) will then: *Decline by $100, **Decline by $75, Decline** by $50, Remain the same, DK*
- **Match:** Assume that an employer matched employee contributions dollar for dollar. If the employee contributed $100 to the 401(k) plan, his account balance in the plan including his contribution would: *Increase by $50, Increase by $100, **Increase by $200**, Remain the same , DK*

The first question measures peoples' ability to do a simple interest rate calculation; the second tests peoples' understanding of inflation; and the third is a joint test of knowledge about "stocks" and "stock mutual funds" as well as risk diversification, since the correct response requires the respondent to know both what a stock is and that a mutual fund is comprised of many stocks. The first three questions were developed by Lusardi and Mitchell (2008; 2011a) and have been used in many other national surveys in the United States including the National Longitudinal Survey of Youth, the American Life Panel (Lusardi, Mitchell and Curto, 2010, and Lusardi and Mitchell, 2009), and the US National Financial Capability Study (Lusardi, 2011). They have also been fielded in 12 other countries as well (Lusardi and Mitchell, 2011c, 2014). The last two questions were used in surveys fielded in large firms by Clark, Maki and Morrill (2014).

Our prior research showed that very few Americans can answer all of the first three questions correctly (with similar results in other countries), and not many more know the correct answers to a majority of them. By contrast, this workforce was substantially more financially knowledgeable (as measured by the first three queries) than the general population, an unsurprising result given that the group consists of financial sector employees (Table 2). Specifically, 76 percent of the respondents got the Interest Rate question correct, 92 percent the Inflation question, and 88 percent knew the right answer to the Risk question. This can be

compared to 75 percent, 61 percent, and 48 percent correct response rates to the interest, inflation, and risk diversification questions in the nationally representative 2012 National Financial Capability Study (FINRA Investor Education Foundation, 2012) which is also an online survey, as was ours.[6]

Table 2 here

The final two financial knowledge questions, developed by Clark, Maki, and Morrill (2014), proved to be more difficult, even for such a relatively sophisticated group. This is understandable since the queries required respondents to understand how employer and employee contributions influence pension accumulations, taking into account the tax implications of worker pre-tax contributions. In the Tax Offset question, the employee had to understand that the tax-deferred aspect of own contributions reduced the net cost of payments into the plan. Here only 45 percent of respondents answered correctly. The Match question required the employee to know that a dollar-for-dollar match meant that $100 of own contributions would generate an equal employer contribution; moreover employer match dollars are not taxed when contributed to the plan. This last question was easier to answer for this population, and 78 percent scored correctly.

As is conventional, we sum the correct answers to these questions to produce a Financial Knowledge Index for each person. The Index values range from 0 to 5, with a mean of 3.7 and a standard deviation of 1.2. One-third answered all five questions correctly, and just under two percent (46 respondents) got all three questions wrong.

B. Investment Metrics

This institution offered 16 funds in its 401(k) plan portfolio, including a government securities fund, a TIPS fund, and several bond funds, along with a several equity funds and a REIT Index Fund.

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[6] A report on the 2012 data is available at
http://www.usfinancialcapability.org/downloads/NFCS_2012_Report_Natl_Findings.pdf

Descriptive statistics regarding fund returns (net of expenses, measured over a 10-year period to September 2013) and asset allocation patterns (measured as of October 2013) appear in Table 3.[7] The first three columns on fund returns, show that, over this period (and not surprisingly), bond funds generally earned returns below those of the equity and REIT funds, and they also experienced lower volatility.

The next four columns report the share of assets held by survey participants who responded to the knowledge questions, as well as sorted by their Index score. Interestingly, the least knowledgeable were substantially less likely to hold the equity index, international equity and small company equity funds. Conversely, when they did invest in stock, they were more likely to invest in the conservative asset allocation fund; overall they were much more likely to be holding bonds than not.

Table 3 here

To further compare participant investment behavior and performance in the defined contribution plan, we use four measures found in the literature. The first is the *fraction of equity* in participants' retirement portfolios,[8] computed from retirement plan assets as of October 2013. While financial sophistication need not imply that all participants will hold more equity, it is likely that more knowledgeable individuals will more invest in equities compared to their less-knowledgeable counterparts.

For our second measure, we compute each participant's *risk-adjusted excess returns,* defined as $r_j^e = \sum_{k=1}^{N} \omega_k r_k$. Here ω_k refers to the portfolio weight of the kth fund in the jth participant's pension account, and r_k is the excess return of the kth benchmark over Treasury

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[7] Fund return correlations are provided in Appendix Table 1.
[8] The equity allocation refers to the fraction of contributions directed to US equity funds, international equity funds, and a percentage of balance/lifecycle funds. The equity percentage for balanced/target date funds is calculated based on each fund's investment policy which varies from fund to fund.

bills in a given month.[9] We hypothesize that the more financially sophisticated are likely to earn higher excess returns.

Third, we compute the standard deviation of these excess returns to determine whether those with more financial knowledge can expect relatively more or less volatile excess return streams. Our fourth performance measure is the participant's *portfolio idiosyncratic risk share,* computed using the variance-covariance matrix of all assets $\hat{\Sigma}$ decomposed into its systematic and idiosyncratic components:

$$\hat{\Sigma}_j = \omega'_{j,k}\hat{\Sigma}\omega_{j,k} = \omega'_{j,k}(\hat{\Sigma}^{sys} + \hat{D}^{idio})\omega_{j,k} = \hat{\Sigma}_j^{sys} + \hat{\Sigma}_j^{idio}$$

where $\hat{D}$ is the diagonal matrix with diagonal elements computed as the square of $\hat{\varepsilon}_n$.

Our final measure reflects how much of the participant's portfolio variance is attributable to nonsystematic or non-market factors. The idiosyncratic risk share is then the ratio of the participant's idiosyncratic portfolio risk to his total portfolio variance, $NSR/TV_{j,t} = \hat{\Sigma}_j^{idio}/\hat{\Sigma}_j$.

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[9] To compute this, we regress $r_{i,t}$, the excess returns of the *i*th fund over Treasury bills by month, on the excess monthly returns on the assets held in fund *i* ($r_{i,t} = \alpha_i + \sum \beta'_j R_t^j + \varepsilon_{i,t}$). Following Calvet, Campbell, and Sodini (2007) and Tang et al. (2010), we use a three-factor asset pricing model with US equities (the value-weighted CRSP portfolio), US bonds (the Lehman Brothers Aggregate Bond Index or LBA) and international equities (the Morgan Stanley Capital International Europe, Australia, and Far East (MSCI-EAFE) Index). The time period used to estimate these returns includes covers January 2003 through September 2013. Here α is the Jensen's alpha from regression on the *i*th benchmark index, and the βs refer to the risk loadings.β_1, β_2 and β_3; $\varepsilon_{i,t}$ is the error term. Estimation produces the risk loading matrix $\hat{B} = (\hat{b}_1,...,\hat{b}_n)'$, where $\hat{b}_n$ is the estimated loading vector of fund *n*, which can be written as $\hat{b}_n = (\hat{\beta}_1^n, \hat{\beta}_2^n, \hat{\beta}_3^n)'$. Using the averages of the factor vector $\overline{R}_f = (\overline{R}_{CRSPRF,t}, \overline{R}_{LBARF,t}, \overline{R}_{MSCIRF,t})$ and the variance-covariance matrix $\hat{\Sigma}_f$ of factors, we compute the *risk-adjusted excess return* R_n^e of fund *i*. For the *j*th participant, his *excess risk-adjusted return* is then the weighted average return of his factor exposures over the period, or $r_j^e = \sum_{k=1}^N \omega_{k,t} r_k$, where $\omega_{k,t}$ refers to the portfolio weight he gives to the *k*th fund in month *t*.

We anticipate that the more financially knowledgeable are likely to have lower relative levels of nonsystematic risk.[10]

All four attributes of investors' performance are summarized in Table 4. Panel A reports investment patterns for those who did not take the survey, alongside those who did. In addition, the panel displays investment measures by Financial Knowledge Index for those for whom we have them. First, we note that nonparticipants held slightly less of their portfolios in equity than those who responded to the survey; accordingly, their risk-adjusted returns, standard deviations, and nonsystematic risk were slightly lower.[11] Second, looking across the Financial Knowledge Index groupings, those who scored lowest on the Index were also less likely to hold stocks: the least informed held about 49% of their retirement assets in equity, whereas the most informed held 66%. Turning to annualized risk adjusted expected returns, standard deviations, and nonsystematic risk levels, Rows 2-4, we see only small differences between survey respondents and non-respondents. Yet on the right side of Panel A, expected risk-adjusted returns appear somewhat lower for the least knowledgeable, compared to the most knowledgeable. We examine shortly whether this tabular difference persists after controlling on other factors.

Table 4 here

Row 2 of Table 4 confirms that the most knowledgeable respondents earned 130 basis points higher risk-adjusted excess returns annually, as compared to the least knowledgeable counterparts (9.5%-8.2%=1.3%, a difference significant at the 1% level). This is a substantial difference, enhancing the retirement nest egg of the most knowledgeable by 25% over a 30-year

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[10] The three last measures are similar to those used in Tang et al. (2010).
[11] Appendix Table 2 compares performance metrics for those who did versus did not respond to the survey. Controlling on other measurable factors, our results indicate that respondents were more likely to hold equity, earn higher risk-adjusted returns, have somewhat higher portfolio volatility, and higher nonsystematic risk.

worklife.[12] This confirms the surmise of Calvet et al. (2007) who contended that higher expected returns are positively correlated with variables associated with financial sophistication (e.g. family size, financial wealth); nevertheless, that study lacked direct measures of financial knowledge as we have here.

Turning to Row 3, top scorers on the Index appear to hold a somewhat more volatile portfolio than their least knowledgeable peers, with one-fifth higher annualized standard deviation of risk-adjusted expected returns (11.8% versus 9.2%, significant at the 1% level). Row 4 indicates that the least knowledgeable participants had less idiosyncratic risk than their better informed counterparts. In other words, more financially knowledgeable participants hold more equity and would earn higher risk-adjusted returns, though their portfolios reflect more nonsystematic risk. Panel B of Table 4 displays the number of funds held by survey participants arrayed by financial knowledge, where we see a slight upward slope as financial knowledge rises. The least savvy hold 3.97 funds on average, whereas the most savvy hold slightly more, at 4.13 funds (however this difference is not statistically significant).

Multivariate Analysis

In order to test whether these findings are robust to a range of controls, we estimate a series of multivariate regression models of the following form:

$$PORTFOLIO_i = \alpha \, FinancialKnowledgeIndex_i + \beta X_i + \varepsilon_i \qquad .$$

Here $PORTFOLIO_i$ refers to each of four investment outcomes of interest for each participant i, namely portfolio equity share, annualized excess return, standard deviation, and idiosyncratic risk. The coefficient of most interest for our purposes is the term α associated with the Financial

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[12] Comparing, for instance, a base return of 2% annually versus a 3.3% yearly return (see http://illuminations.nctm.org/Activity.aspx?id=3568)

Knowledge Index. In each case, the first model includes the Index and Index-squared term (to test for nonlinear effects); the second model differentiates the three knowledge groups (least knowledgeable Index = 0, 1; a middle group with Index = 2, 3; and the most knowledgeable Index = 4, 5) with the reference category being the least knowledgeable. We also control on participant attributes including age, sex, whether married, salary ($100K), plan balance ($100K), and years of tenure at the institution.[13]

Results appear in Table 5, where the first two rows indicate the estimated impact of greater financial knowledge along with a squared term on our measures of interest. Rows 3-4 in the second column of each panel provide the estimated impacts of higher Index scores relative to the reference low knowledge reference category. In each case, participant controls available in our dataset are also included. In particular, to help control for differences across groups, we include controls for salary and pension wealth.

Table5 here

Our first conclusion is that, ceteris paribus, more financially knowledgeable people hold more equity in their portfolios, and hence they can expect higher risk-adjusted returns. These effects are statistically significant and nonlinear: that is, the most knowledgeable hold 11.5% more stock than their least knowledgeable counterparts and they can anticipate earning around 10 percent or one hundred basis points more (coefficient on the High Financial Literacy Index of 0.975 versus a mean of 9.142). In other words, the most financially sophisticated earn higher risk-adjusted excess returns. Since we control on respondents' 401(k) balances, it is remarkable that there remains a positive and statistically significant association between excess returns and the financial index after netting out past investment success

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[13] The models also control for region-specific fixed effects and missing data dummies. We do not have information on respondent education, but income and plan balances are reasonable proxies. We also lack risk aversion measures in this dataset, though in other datasets including the American Life Panel, we find that the correlation between financial literacy and risk aversion is only 0.05 (Brown et al. 2013).

A second finding is that the portfolios of the more financially knowledgeable are more volatile, particularly for the most knowledgeable, and this finding is robust to the two alternative functional forms explored here. Thus the portfolio of the highest scoring group has a 1.8 percentage point higher standard deviation in risk-adjusted returns, relative to the lowest scoring one (16% on a base mean of 11%). And the last panel shows that, though the most financially knowledgeable have higher expected returns, their portfolios exhibit 1 percentage point more idiosyncratic portfolio risk as a fraction of total portfolio variance, $NSR/TV_{i,t}$ (or 18% on a base mean of 5.63). In other words, the most financially sophisticated hold more equity and can expect to earn about one percentage point higher risk-adjusted returns compared to the least financially sophisticated,[14] but they diversify portfolios marginally less well than their less-knowledgeable peers.

It is worth recalling that those who responded to the financial knowledge survey at this institution were somewhat better off, had higher plan balances, and contributed more of their salaries to their retirement accounts, compared to their non-respondent counterparts. That is, while we have little direct evidence on the levels of nonrespondents' financial knowledge, it is reasonable to surmise that employees who responded to the survey were likely more financially sophisticated than those who did not. Accordingly, it is quite likely that the financial knowledge impacts we report here are lower bound estimates of the links between knowledge and investment performance in the larger population.

Conclusions and Discussion

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[14] Since we also include the respondents' 401(k) balance as a control variable in the regressions, this weakens the concern about reverse causality between returns and financial knowledge. That is, the fact that there remains a positive and statistically significant association between excess returns and the financial index *after netting out past investment success* points to the fact that knowledge drives returns, rather than vice versa.

Prior studies have not had been able to establish a firm connection between investment performance and financial knowledge. This paper remedies that gap using high-quality administrative data on sophisticated investments and a purpose-built survey on the financial knowledge levels of participants in a 401(k) plan. We show that more financially knowledgeable employees are also significantly more likely to hold stocks in their 401(k) plan portfolios. They can also anticipate significantly higher expected excess returns, which over a 30-year working career could build a retirement fund 25% larger than that of their less-knowledgeable peers. Their investment portfolios are also somewhat more volatile, exposing them to slightly more idiosyncratic risk.

These results are important in view of the growing role that 401(k) plans play in Americans' retirement security, and they confirm the key role of financial knowledge in the modern workplace. The fact that more knowledgeable investors can expect to earn more in their 401(k) retirement plans is also supportive of models that posit differences in financial sophistication as a driver of wealth inequality (e.g., Lusardi et al. 2013).

Our estimates of the positive association between financial knowledge and investment returns may be understated. As noted above, survey respondents at this institution were likely to be better informed than non-respondents, implying that a stronger and more positive relationship between knowledge and returns is likely to hold in the workforce as a whole. Additionally, this institution provided relatively few pension investment choices, many of which were index funds. Where more complex investment menus are available, it can be surmised that the measured effect of financial knowledge would be even larger.

It would be premature to offer policy recommendations, since additional research will be needed to evaluate whether the improvements in investment performance found here are sufficiently powerful to motivate efforts to spur greater provision of financial knowledge.

Additionally, both costs and benefits of such financial knowledge provision would need to be considered. Nevertheless the significantly higher risk-adjusted annual expected returns of 130 basis points for the best versus the least knowledgeable confirm that financial literacy can contribute to better earnings in 401(k) retirement plans.

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Table 1. Comparison of Observables for Survey Participants and Nonparticipants
This Table summarizes key variables for 401(k) plan participants who responded to the Financial Knowledge questions in the survey, as well as for those who did not take the survey. All data are taken from the institution's administrative records, and refer to active employees (i.e., not retired, vested terminated, or deceased).

Variable	Participants	Nonparticipants	Diff. (Nonpart.- Part.)	T-test for signif.
% Salary Contribution Pretax	9.65	7.98	-1.67	***
Total balance ($100k)	2.47	1.52	-0.96	***
% Balance in equity	59.30	57.17	-2.13	***
% Contribution in equity	61.35	58.99	-2.35	***
Age	48.66	43.65	-5.02	***
Male	0.57	0.56	-0.01	
Married	0.70	0.63	-0.07	***
Married missing	0.00	0.00	0.00	*
Salary ($100k)	1.10	1.03	-0.07	***
Tenure (years)	14.15	10.25	-3.90	***
N	2,763	13,547		

Note: *** Significant at the 0.01 level; ** Significant at the 0.05 level; * Significant at the 0.10 level.

Table 2. Results of Financial Knowledge Assessment
This Table summarizes responses to the five-item Financial Knowledge questions (see text) by survey respondents. Correct answers are bolded. N=2,763.

Panel A. Responses by Question

Financial Knowledge Questions:	Mean	*SD*
Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow? **More than $110,** *Exactly $110, Less than $110, DK, RF*	0.76	*0.42*
Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account? *More than today, Exactly the same ,* **Less than today,** *DK, RF*	0.92	*0.27*
True or False? Buying a single company's stock usually provides a safer return than a stock mutual fund. *True,* **False, DK,** *RF*	0.88	*0.33*
Assume you were in the 25% tax bracket (you pay $0.25 in tax for each dollar earned) and you contributed $100 pretax to an employer's 401(k) plan. Your take-home pay (what's in your paycheck after all taxes and other payments are taken out) will then: *Decline by $100,* **Decline by $75,** *Decline by $50, Remain the same, DK*	0.45	*0.50*
Assume that an employer matched employee contributions dollar for dollar. If the employee contributed $100 to the 401(k) plan, his account balance in the plan including his contribution would: *Increase by $50, Increase by $100,* **Increase by $200,** *Remain the same ,*	0.78	*0.42*
Financial Knowledge Index (# of questions answered correctly)	3.79	*1.19*

Panel B. Distribution of Financial Knowledge Index

Fin. Knowledge Index	Freq.	Percent
0	46	1.66
1	90	3.26
2	255	9.23
3	532	19.25
4	920	33.3
5	920	33.3
Total	2,763	100.0

Table 3. Fund Returns and Participant Assets by Fund

This Table summarizes monthly mean returns and standard deviations by fund, along with annualized mean returns. It also reports asset allocation patterns for participants who responded to the Financial Knowledge survey; these were contributors to their 401(k) plans who had a Financial Knowledge Index derived from summing correct answers in Table 2.

	Fund Returns			Asset Allocation Patterns			
				Full Survey	FinLit Index=0,1	FinLit Index=2,3	FinLit Index=4,5
Fund	*Monthly mean return*	*Sd. Dev.*	*Annualized mean return*	*%*	*%*	*%*	*%*
Government Securities Fund	0.002	0.004	0.027	4.5%	6.3%	5.8%	4.1%
TIPS Index Fund	0.005	0.019	0.057	2.2%	0.9%	1.9%	2.3%
Interest Income fund	0.004	0.001	0.053	0.0%	0.0%	0.0%	0.0%
Bond Index Fund	0.004	0.010	0.048	2.6%	2.3%	2.3%	2.7%
2014 Select Maturity Bond Fund	0.002	0.002	0.019	5.9%	7.0%	7.3%	5.4%
2016 Select Maturity Bond Fund	0.004	0.006	0.048	5.9%	9.7%	8.2%	5.2%
2018 Select Maturity Bond Fund	0.006	0.012	0.074	6.1%	9.5%	7.7%	5.5%
2020 Select Maturity Bond Fund	0.007	0.017	0.086	1.1%	2.3%	1.5%	1.0%
Equity Index Fund	0.008	0.044	0.107	27.5%	19.8%	23.6%	28.8%
International Equity Fund	0.009	0.060	0.111	6.0%	3.8%	4.7%	6.4%
Emerging Markets Equity Fund	0.014	0.068	0.177	0.8%	0.2%	0.3%	1.0%
Small Company Equity Fund	0.010	0.054	0.127	7.5%	4.4%	5.5%	8.1%
Conservative Asset Allocation Fund	0.005	0.014	0.064	7.5%	11.5%	8.9%	6.9%
Moderate Asset Allocation Fund	0.007	0.025	0.085	12.5%	11.9%	14.1%	12.1%
Aggressive Asset Allocation Fund	0.008	0.038	0.102	7.0%	8.1%	6.4%	7.1%
REIT Index Fund	0.012	0.073	0.149	2.8%	2.2%	1.6%	3.2%

Table 4. Descriptive Statistics on Pension Investment Performance Metrics (%)

This Table reports the average fraction of retirement assets held in equity, annualized risk-adjusted excess returns, annualized standard deviations, and idiosyncratic risk shares (see text). Survey nonparticipants refer to those employees who contributed to their 401(k) plan but did not respond to the survey. Survey participants were contributors to their 401(k) plans and had a Financial Knowledge Index derived from summing correct answers in Table 2.

Panel A: Investment Performance of Survey Nonparticipants and Survey Participants (Overall and by Financial Knowledge Index bins)

	Survey Nonparticipants		Survey Participants		Low Fin. Literacy Index (0-1)		Medium Fin. Literacy Index (2-3)		High Fin. Literacy Index (4-5)	
	Mean	*Sd*	*Mean*	*Sd*	*Mean*	*Sd*	*Mean*	*Sd*	*Mean*	*Sd*
Equity Allocation	59.0	29.5	61.4	29.7	48.8	31.8	52.7	30.0	66.0	28.2
Annualized excess returns*	8.9	2.3	9.1	2.3	8.2	2.4	8.4	2.2	9.5	2.3
Annualized st.dev.	10.6	4.4	11.0	4.5	9.2	4.5	9.7	4.3	11.8	4.4
NSR/TV**	5.2	7.3	5.6	7.4	4.9	6.8	4.8	6.7	6.1	7.7
N	13,547		2,763		136		787		1,840	

Notes: *Excess risk-adjusted return; ** NSR/TV = Nonsystematic Risk/Total Portfolio Variance estimated from 3-factor CAPM model (see text).

Panel B. Funds Held by Financial Literacy Index (Survey Participants Only)

	# Funds Held	
	Mean	*Sd.*
Average Overall	4.11	*2.77*
Low Fin. Literacy Index (0-1)	3.97	*2.88*
Mid Fin. Literacy Index (2-3)	4.10	*2.86*
High Fin. Literacy index (4-5)	4.13	*2.72*

Table 5. Multivariate Models of Portfolio Outcomes and Financial Knowledge

This Table reports linear regression estimates of factors associated with the average fraction of retirement assets held in equity, annualized risk-adjusted excess returns, annualized standard deviations, and idiosyncratic risk shares. Sample consists of contributors to their 401(k) plans who had a Financial Knowledge Index derived from summing correct answers in Table 2. N=2.763. All models also control for region-specific fixed effects and missing data dummies. (For descriptive statistics on all variables see Appendix Table 3.)

	Equity allocation		Risk-Adjusted Returns		Std. Deviation		NSR/TV	
	1	2	3	4	5	6	7	8
Financial Knowledge Index	0.092		-0.102		-0.191		-0.891 *	
	[2.077]		[0.159]		[0.302]		[0.471]	
Financial Knowledge Index**2	0.596 *		0.071 ***		0.132 ***		0.236 ***	
	[0.310]		[0.024]		[0.046]		[0.074]	
Mid Fin. Literacy Index (2-3)		2.506		0.178		0.293		-0.164
		[2.781]		[0.216]		[0.406]		[0.625]
High Fin. Literacy index (4-5)		11.522 ***		0.975 ***		1.773 ***		1.062 *
		[2.729]		[0.214]		[0.402]		[0.620]
Age	-0.625 ***	-0.627 ***	-0.047 ***	-0.047 ***	-0.092 ***	-0.093 ***	0.005	0.003
	[0.059]	[0.059]	[0.005]	[0.005]	[0.009]	[0.009]	[0.016]	[0.016]
Male	3.826 ***	4.027 ***	0.372 ***	0.397 ***	0.738 ***	0.784 ***	0.953 ***	1.055 ***
	[1.103]	[1.103]	[0.087]	[0.087]	[0.167]	[0.167]	[0.285]	[0.285]
Marital status	2.086 *	2.089 *	0.142	0.143	0.252	0.252	0.196	0.199
	[1.202]	[1.204]	[0.094]	[0.095]	[0.181]	[0.181]	[0.313]	[0.314]
Salary ($100k)	2.544	2.916 *	0.126	0.172	0.295	0.380	-0.314	-0.131
	[1.615]	[1.619]	[0.132]	[0.133]	[0.248]	[0.250]	[0.419]	[0.422]
Total balance ($100k)	1.840 ***	1.881 ***	0.120 ***	0.125 ***	0.236 ***	0.244 ***	-0.171 **	-0.158 *
	[0.312]	[0.312]	[0.026]	[0.026]	[0.050]	[0.050]	[0.086]	[0.086]
Tenure	-0.546 ***	-0.558 ***	-0.034 ***	-0.035 ***	-0.067 ***	-0.069 ***	0.005	0.001
	[0.070]	[0.070]	[0.005]	[0.005]	[0.010]	[0.010]	[0.017]	[0.017]
R-square	0.159	0.157	0.148	0.143	0.150	0.145	0.026	0.020
Mean of dep var	61.347		9.142		11.037		5.629	
St.dev of dep var	29.656		2.339		4.485		7.363	

Notes: * Significant at 0.10 level, ** Significant at 0.05 level, *** Significant at 0.01 level. Regional controls also included.

Appendix Table 1. Correlation of Fund Returns

This Table reports simple correlations between fund net returns from 2003 to 2013.

Fund Type	Govt Securities Fund	TIPS Index Fund	Interest Income Fund	Bond Index Fund	2014 Sel. Mat. Bond Fund	2016 Sel. Mat. Bond Fund	2018 Sel. Mat. Bond Fund	2020 Sel. Mat. Bond Fund	Equity Index Fund	Int'l Equity Fund	Em. Mkts Equity Fund	Small Co. Equity Fund	Conserv. Asset Alloc. Fund	Mod. Asset Alloc. Fund	Aggr. Asset Alloc. Fund	REIT Index Fund
Govt Securities Fund	1.00															
TIPS Index Fund	0.55	1.00														
Interest Income fund	0.20	0.02	1.00													
Bond Index Fund	0.71	0.79	0.02	1.00												
2014 Select Maturity Bond Fund	0.59	0.68	0.02	0.80	1.00											
2016 Select Maturity Bond Fund	0.70	0.79	0.02	0.97	0.91	1.00										
2018 Select Maturity Bond Fund	0.70	0.79	0.03	0.99	0.85	0.99										
2020 Select Maturity Bond Fund	0.70	0.79	0.02	1.00	0.82	0.98	1.00	1.00								
Equity Index Fund	-0.22	0.15	-0.05	0.02	0.15	0.06	0.04	0.02	1.00							
International Equity Fund	-0.10	0.20	0.05	0.12	0.22	0.14	0.13	0.11	0.91	1.00						
Emerging Markets Equity Fund	-0.10	0.26	0.11	0.12	0.25	0.16	0.14	0.12	0.81	0.87	1.00					
Small Company Equity Fund	-0.25	0.07	-0.04	-0.06	0.08	-0.02	-0.04	-0.06	0.94	0.83	0.75	1.00				
Conservative Asset Allocation Fund	0.32	0.70	0.02	0.68	0.63	0.68	0.69	0.68	0.72	0.76	0.71	0.63	1.00			
Moderate Asset Allocation Fund	-0.04	0.35	0.01	0.27	0.33	0.29	0.28	0.26	0.95	0.94	0.87	0.88	0.88	1.00		
Aggressive Asset Allocation Fund	-0.15	0.21	0.00	0.10	0.20	0.13	0.12	0.10	0.98	0.96	0.88	0.92	0.79	0.98	1.00	
REIT Index Fund	-0.03	0.25	0.00	0.20	0.27	0.22	0.21	0.20	0.77	0.73	0.60	0.78	0.68	0.78	0.77	1.00

Appendix Table 2. Portfolio Performance Measures for Respondents to Financial Literacy Survey versus Nonrespondents

This Table reports coefficient estimates from a multivariate linear regression model of each of the four dependent variables on an indicator of whether the pension plan contributor answered the survey on Financial Knowledge, along with other controls. N=16,310

	Equity allocation	Returns	Std deviation (σ)	NSR/TV
Answered Fin.Lit. Survey	3.887 ***	0.323 ***	0.548 ***	0.324 **
	[0.603]	[0.048]	[0.091]	[0.160]
Age	-0.542 ***	-0.038 ***	-0.074 ***	0.031 ***
	[0.025]	[0.002]	[0.004]	[0.007]
Male	4.674 ***	0.415 ***	0.835 ***	0.807 ***
	[0.447]	[0.035]	[0.067]	[0.115]
Marital status	2.230 ***	0.167 ***	0.342 ***	0.090
	[0.484]	[0.038]	[0.072]	[0.126]
Salary ($100k)	10.094 ***	0.733 ***	1.403 ***	0.689 ***
	[0.629]	[0.050]	[0.094]	[0.164]
Total balance ($100k)	1.783 ***	0.123 ***	0.230 ***	-0.146 ***
	[0.176]	[0.013]	[0.026]	[0.038]
Tenure	-0.576 ***	-0.038 ***	-0.067 ***	-0.007
	[0.035]	[0.003]	[0.005]	[0.008]
R-square	0.115	0.095	0.094	0.010
Mean of dep var	59.392	8.950	10.708	5.267
St.dev of dep var	29.553	2.323	4.398	7.338

Notes: * Significant at 0.10 level, ** Significant at 0.05 level, *** Significant at 0.01 level. Regional controls also included.

Appendix Table 3. Descriptive Statistics for Variables in Table 5

This Table reports descriptive statistics for dependent and explanatory variables used in models reported in Table 5.

	Mean	Sd. Dev.	Min	Median	Max
Equity Allocation	61.35	29.66	0.00	65.00	100.00
Annualized returns	9.14	2.34	2.21	9.35	17.61
Annualized st.dev.	11.04	4.49	1.26	11.16	25.08
NSR/TV*	5.63	7.36	0.08	2.50	54.13
Financial Knowledge Index	3.79	1.19	0	4	5
Financial Knowledge Index**2	15.79	7.83	0	16	25
Low Fin. Literacy Index (0-1)	0.05	0.22	0	0	1
Low Fin. Literacy Index (2-3)	0.28	0.45	0	0	1
High Fin. Literacy index (4-5)	0.67	0.47	0	1	1
Age	48.66	10.34	21	50	78
Male	0.57	0.50	0	1	1
Marital status	0.70	0.46	0	1	1
Salary ($100k)	1.10	0.51	0.29	1.02	4.24
Total balance ($100k)	2.47	2.89	0	1.42	30.85
Tenure	14.15	11.46	0	12	46