Do People Understand the Benefit of Diversification?

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**Abstract**

Diversification—investing in imperfectly correlated assets—reduces expected volatility without sacrificing expected returns. While the expected return from a diversified portfolio is just the weighted average mean of its constituent parts, the expected variance is less than the weighted average variance of its constituent parts. We demonstrate that very few people have correct statistical intuitions about the effects of diversification. Many people, especially those low in financial literacy, believe diversification *increases* the volatility of a portfolio because they conflate the predictability of individual assets with the aggregate predictability of the portfolio. Additionally, most people, but especially those high in financial literacy, believe diversification increases the expected return of a portfolio. These errors lead people to construct investment portfolios that mismatch investors' risk preferences. The fact that people do not understand the benefit of diversification may partially explain why investors are poorly diversified, despite valuing risk reduction.

*Keywords*: diversification, financial decision making, investing, numerical cognition

## Do People Understand the Benefit of Diversification?

When choosing between investments, people face a tradeoff between risk and return. The safer an asset, the less profit an investor should expect. Diversification—investing in many imperfectly correlated assets—allows investors to escape this tradeoff. It reduces their exposure to risk without sacrificing expected returns (Markowitz 1952, Sharpe 1964). Some assets in a diversified portfolio will perform better than expected and others will perform worse, but the value of the portfolio will be less volatile as these unpredictable deviations will tend to offset. Because people value risk reduction (Bernoulli 1738/1954, Holt and Laury 2005), it is puzzling that so many people are undiversified (Campbell 2006, Goetzmann and Kumar 2008). For example, a typical individual investor holds a portfolio with only four stocks (Barber and Odean 2001).

While several explanations have been proposed to account for improper diversification (e.g., special preferences: Benartzi 2001, Cooper and Kaplanis 1994, Huberman 2001; transaction costs: Brennan 1975, Merton 1987, Nieuwerburgh and Veldkamp 2010; heuristics: Benartzi and Thaler 2001), we explore a more fundamental question: Do investors understand the benefit provided by diversification?

Understanding how diversification affects portfolio performance requires understanding the distributional properties of a sum of random variables. This may be straightforward for statisticians, but most people have poor statistical intuitions (Lipkus et al. 2001, Paulos 1988). Moreover, people may lack the financial literacy required to apply this knowledge correctly (Hilgert et al. 2003, Lusardi and Mitchell 2007). Initial evidence connecting improper diversification to understanding comes from studies showing that increased diversification correlates with cognitive ability (Grinblatt et al. 2011) and financial literacy (Guiso and Japelli 2009).

We demonstrate two pervasive errors in people's beliefs about diversification. First, many people believe that diversification increases, rather than decreases, the volatility of a portfolio. This error is particularly common among people low in financial literacy, and appears to result from a judgment of

representativeness (Kahneman and Tversky 1972, 1973): Because diversification involves investing in many unpredictable assets (vs. only a few), it feels like it should increase the aggregate unpredictability of the portfolio. This is analogous to conflating the properties of the outcome with the properties of the generating mechanism.

Second, many people incorrectly believe that diversification increases the mean performance of a portfolio. This error is most common among those high in financial literacy and seems to result from a misunderstanding of financial advice: People, especially those with some financial literacy, may know that diversification is a good investment strategy but associate this with an increase in the mean, rather than a decrease in volatility. This is consistent with previous work suggesting that people have poor intuitions about dispersion, but find it relative easy to think about the central tendency of a distribution (Goldstein and Taleb 2007, Obrecht et al. 2007, Peterson and Beach 1967).

While these beliefs may be justified for strategically constructed portfolios (i.e., you can create a diversified portfolio that has a higher expected return and/or more volatility), we provide evidence that the beliefs we identify are not rational expectations based on inferences about portfolio composition but are instead resultant from a systematic misunderstanding of how diversification influences portfolio performance.

In Studies 1A–1F we examine participants forecasts for diversified and undiversified portfolios. We show that most people in our experimental sample express at least one of the two incorrect beliefs we describe above. Studies 2A and 2B show negative downstream consequences of these incorrect beliefs on portfolio construction. Study 3 examines the underlying psychological processes by manipulating what participants think about before forecasting the performance of a portfolio.

For all studies, target sample size was determined in advance. We had no prior estimate of effect size, so following Nelson (2014) we targeted a sample size in our first study that seemed reasonably large and adjusted the target sample size in later studies based on cost considerations and participant availability. In Studies 1A (100%), 1C (50%), and 3 (100%) we collected additional data (sample size

increase reported in parentheses) after the initial target was reached. All manipulations, data exclusions, and measured variables are reported. No studies are excluded for failed results.

## Studies 1A–1E: Distribution Builder Studies

We conducted a series of studies where participants made forecasts for a diversified portfolio (stocks from ten different companies) and an undiversified portfolio (stock from a single company) using a graphical, "balls-in-bins" tool (Delavande and Rohwedder 2008, Goldstein et al. 2008, Goldstein and Rothschild 2014, Sharpe et al. 2000). After making forecasts for both portfolios, we collected a measure of financial literacy (Fernandes et al. 2014).

We conducted five experiments that share the same critical features and yield similar results. These studies are presented here in aggregate for brevity. Table 1 shows the results by individual study (including Study 1F, which we present separately). Descriptions of the portfolios used in the studies are available in Appendix A. We compare the forecasts for both portfolios in terms of expected volatility and expected return. We further look to see if perceived differences between the forecasts of the two portfolios vary based on each participant's financial literacy.

**Method**

**Participants**. In total, 1,825 unique participants made forecasts for the diversified and undiversified portfolios. One hundred seventy-six participants were undergraduate business students at a large public university and participated for course credit. The remainder (1,649) were recruited through Amazon Mechanical Turk (AMT) and participated for monetary compensation (targeted to be $6/hour for these and all other AMT studies). Due to technological issues, 182 of the 1,825 unique participants (identified by their AMT worker IDs) completed multiple studies. We do not remove these participants, but control for this overlap in the analysis we report. If we instead remove these participants, the results are almost identical. We restrict the presented analysis to participants who correctly passed an attention

check question directly related to the dependent measure (identifying the order in which they evaluated

the portfolios) and who scored better than chance on the financial literacy measure (better than 4 out of

13)[1]. Neither of these choices has a substantive effect on the significance of the results we report in these

or future studies (in which we use the same exclusion criteria), but allow more accurate estimation of

model parameters and effect sizes. Results without data exclusions for all studies are provided in

Appendix B. After the exclusions, we are left with 1,500 unique participants.


        **Distribution builder**. We measure participants' beliefs about future portfolio performance using

a tool we call a distribution builder (see Appendix C for example; note that Sharpe and colleagues (1999)

use the same term for a different, but related tool). The distribution builder requires participants to assign

100 "balls" to different uniformly spaced "bins" representing possible portfolio values after one year.

Participants assign balls to the different bins by clicking "+" or "-" buttons that add or subtract balls

accordingly (all bins start empty). Participants are told to assign balls to bins based on how likely they

think each portfolio value is and that they should assign the most balls to the bin for the portfolio value

they think is most likely. They are also told that ratios matter: If they assign 20 balls to one portfolio

value and 10 balls to another, it means they think the first portfolio value is twice as likely as the second.

Once participants assign all 100 balls to the different outcomes, they can "submit" their distribution. In

effect, the distribution builder yields a histogram of each participant's subjective beliefs about the future

value of the stock portfolio.

        Prior research has suggested this type of tool can effectively elicit probabilistic beliefs (Goldstein

and Rothschild 2014). Consistent with this, participants seem to understand and use the distribution

builder competently after a brief training tutorial. Participants tend to express well-behaved, bell-shaped

distributions, and we find consistent results across all studies.

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[1] Of 2,030 responses, 210 failed the attention check, 131 scored below chance on financial literacy, and 47 did both. The chance cutoff for financial literacy was 1.82 SD below mean performance, while a perfect score was only 1.43 SD above.

**Procedure**. After consenting to participate, we gave participants a tutorial on how to use the distribution builder. Before moving on to the critical measures, participants were required to demonstrate an understanding of the distribution builder tool by passing a simple test in which they translated a text-based description of a distribution to a graphical representation.

Participants then used the distribution builder tool to evaluate different stock portfolios. They evaluated portfolios one at a time in random order. For each portfolio, participants were given information about the composition and value of the portfolio and then asked what they thought the value of that portfolio would be in exactly one year. In each study, one portfolio consisted of stocks from ten different companies and the other consisted of stock from a single company. Although we did not use the words "diversified" or "undiversified" in the descriptions we gave to participants, we will use those terms to describe the portfolios in our analysis. The initial value of both portfolios was held constant in each study (see Table 1).

After participants made forecasts for all of the portfolios, we administered a simple attention check where we asked participants to recall the order in which they evaluated the portfolios. Following this, participants completed a 13-item financial literacy measure (Fernandes et al. 2014). We also collected a numeracy measure in two studies, which correlated highly with financial literacy ($r = .51$) and yields similar conclusions if used in the analysis instead of financial literacy.

**Results**

**Analysis strategy for distribution builder responses**. Each response to the distribution builder task consisted of 100 balls assigned to the various bins. For the analysis, bins were arbitrarily valued from 1 to $N_{bins}$ and balls assigned to a bin were given the corresponding value of the bin (e.g., a ball assigned to the lowest bin would be given the value of 1). The values of all 100 balls were converted into a vector representing a numerical distribution of the participant's response. For example, if a participant put seven balls in the first bin, the vector would contain seven "1"s. To allow for better interpretation of the results

(and comparisons across studies), we then linearly transformed these values to correspond to percent changes from the initial portfolio values.

We computed distributional statistics on each of the vectors with mean (which represents the average expected value of the portfolio) and standard deviation (which represents the expected volatility of the portfolio) being of primary interest. These computed distributional statistics serve as the dependent variables in the following analyses. As a test of robustness, we also computed other distributional statistics including medians, implied confidence intervals, and counts of balls in the most extreme bins.

**Model specification**. We perform the following mixed-effect, within-subject regressions with the *lme4* package for R (Bates et al. 2014) augmented with the *lmerTest* package to estimate the significance of effects (Kuznetsova et al. 2014). We treat portfolio type (effect coded: +.5 = diversified, -.5 = undiversified), financial literacy (mean centered), and their interaction as fixed factors. We treat participants and studies as random factors (random intercepts). To appropriately account for variance due to interactions including random factors (Judd et al. 2012), we add random slopes to the model (portfolio for participants; portfolio, financial literacy, and their interaction for studies).

Table 1.
Parameters and Results from Studies 1A–1F.

| Study Parameters | Study 1A | Study 1B | Study 1C | Study 1D | Study 1E | Study 1F |
|---|---|---|---|---|---|---|
| *N* [1] | 300 | 176 | 359 | 796 | 399 | 400 |
| *N* (after exclusions) [2] | 266 | 125 | 224 | 696 | 331 | 348 |
| Population | AMT | Univ. Lab | AMT | AMT | AMT | AMT |
| Number of Portfolios [3] | 2 | 2 | 3 | 2 | 2 | 2 |
| Initial Value of Portfolios | 15,000 | 350 | 350 | 3,500 | 3,500 | 3,500 |
| Number of Balls | 100 | 100 | 100 | 100 | 100 | 100 |
| Number of Bins | 10 | 10 | 11 | 11 | 11 | 11 |
| Nature of Bins [4] | Range | Range | Point | Point | Point | Point |
| Bin Size / Separation [5] | 1,000 | 25 | 25 | 250 | 250 | 250 |
| **Measures** | | | | | | |
| Financial Literacy [6] | 9.10 (2.09) | 9.30 (2.06) | 9.93 (2.19) | 9.63 (2.17) | 9.53 (2.33) | 9.63 (2.32) |
| Numeracy [7] | 5.41 (2.04) | 4.43 (1.84) | -- | -- | -- | -- |
| **Results** [8] | | | | | | |
| Volatility: $\beta_{Portfolio}$ | .15% | .00% | .27% | .00% | -.31% * | .14% |
| $\beta_{FinLit}$ | -.37% *** | -.39% ** | -.09% | -.33% *** | -.32% *** | -.23% ** |
| $\beta_{Interaction}$ | -.36% *** | -.17% | -.19% * | -.15% ** | -.26% *** | -.06% |
| Returns: $\beta_{Portfolio}$ | 1.08% ** | .69% | 1.58% *** | 1.46% *** | 1.77% *** | 2.62% *** |
| $\beta_{FinLit}$ | -0.23% | .00% | -.70% *** | -.19% | -.19% | -.52% *** |
| $\beta_{Interaction}$ | .52% ** | .39% | .37% | .13% | .22% | -.05% |

*Notes*:
1. For studies conducted on AMT, we only count responses we could match with AMT worker IDs. Across the five studies, there were six participants who were paid on AMT, but could not be linked to a response.
2. We exclude participants who failed to correctly recall the order in which they evaluated the portfolios and those who scored worse than chance on the financial literacy measure (4 or less).
3. Study 1C featured a control condition in which participants evaluated a second single-stock portfolio that was matched with the diversified portfolio on number of shares. The average response to this condition was in between the other two conditions for both volatility and expected returns, perhaps because the language used for this condition did not sufficiently differentiate it from the diversified condition.
4. For the "point" bins, participants were told to round their "guesses" to the nearest point.
5. Bins were centered on the initial value of the portfolio and extreme bins were unbounded (e.g., "less than $250").
6. Measured with 13-item scale from Fernandes et al. 2014. Sample mean with SD in brackets.
7. Measured with 8-item scale from Fernandes et al. 2014. Sample mean with SD in brackets.
8. From regression model with portfolio (diversified = .5, undiversified = -.5), financial literacy (mean centered for each study), their interaction, and random intercepts for participant. Volatility is operationalized as the standard deviation of the elicited distribution. Returns are operationalized as the mean of the elicited distribution. Statistical significance indicators: *** $p < .01$, ** $p < .05$, * $p < .10$.

**Analysis of expected volatility**. The interaction between financial literacy and portfolio type on expected volatility was negative ($\beta_{\text{Interaction}}$ = -.21, 95% CI = [-.29, -.13], $t$ = -4.93 p < .001). People low in financial literacy (incorrectly) expected diversification would increase portfolio volatility (at -1SD: $M_{\text{Diversified}}$ = 15.05% vs. $M_{\text{Undiversified}}$ = 14.59%; $t$ = 3.47, $p$ = .014)[2]. At mean financial literacy, there was no difference between the volatility expected for the diversified and undiversified portfolios ($M_{\text{Diversified}}$ = 14.14% vs. $M_{\text{Undiversified}}$ = 14.14%; $\beta_{\text{Portfolio}}$ = .00, 95% CI = [-.63, .63], t = .00, $p$ > .99). Those high in financial literacy (correctly) expected diversification would decrease portfolio volatility (at +1SD on financial literacy: $M_{\text{Diversified}}$ = 13.24% vs. $M_{\text{Undiversified}}$ = 13.70%; $t$ = -3.47, $p$ = .017). This relationship is shown in the left panel of Figure 1. Similar results are obtained using other measures of volatility: width of implied 75% confidence intervals ($\beta_{\text{Portfolio}}$ = .12, 95% CI = [-.61, .85], $t$ = .32, $p$ = .75; $\beta_{\text{Interaction}}$ = -.86, 95% CI = [-1.58, -.13], $t$ = -3.36, $p$ = .030), width of implied 50% confidence intervals ($\beta_{\text{Portfolio}}$ = .34, 95% CI = [-.24, .92], $t$ = 1.15, $p$ = .25; $\beta_{\text{Interaction}}$ = -.48, 95% CI = [-.75, -.22], $t$ = -3.60, $p$ < .001), and the number of balls placed in the most extreme bins ($\beta_{\text{Portfolio}}$ = .53, 95% CI = [-.57, 1.63], $t$ = 2.06, $p$ = .17; $\beta_{\text{Interaction}}$ = -.27, 95% CI = [-.50, -.05], $t$ = -2.38, $p$ = .017).

Overall, 51% of participants believed that the diversified portfolio would be more volatile than the undiversified portfolio. Equal variance is a conservative benchmark: If the hypothetical stocks in the diversified portfolio had equal variance and had an average correlation of .5, you should expect the standard deviation of the diversified portfolio to be approximately 3/4ths that of the undiversified portfolio[3]. Using this benchmark, 90% of participants failed to appreciate the magnitude by which diversification reduces volatility.

**Analysis of expected returns**. At mean financial literacy, people expected the diversified portfolio to yield higher returns than the undiversified portfolio ($M_{\text{Diversified}}$ = 6.46% vs. $M_{\text{Undiversified}}$ = 5.04%; $\beta_{\text{Portfolio}}$ = 1.42, 95% CI = [1.05, 1.78], $t$ = 7.63, $p$ < .001). People high in financial literacy were

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[2] Expected means and significance calculated from mixed-model using procedure outlined by Spiller et al. (2013).
[3] For reference, Google and Facebook have a historical correlation of approximately .33.

even more likely to hold the belief that diversified portfolios yield higher returns ($\beta_{\text{Interaction}}$ = .27, 95% CI

= [.10, .43], $t$ = 3.13, $p$ = .002; at +1SD: $M_{\text{Diversified}}$ = 6.25% vs. $M_{\text{Undiversified}}$ = 4.25%, $t$ = 7.61, $p$ < .001; at -

1SD: $M_{\text{Diversified}}$ = 6.67% vs. $M_{\text{Undiversified}}$ = 5.83%, $t$ = 3.18, $p$ = .001). This relationship is shown in the

right panel of Figure 1. Similar results are obtained using the median of the elicited distributions ($\beta_{\text{Portfolio}}$

= 2.17, 95% CI = [.14, 4.20], $t$ = 2.86, $p$ = .041; $\beta_{\text{Interaction}}$ = .43, 95% CI = [-.20, 1.07], $t$ = 2.03, $p$ = .13).

Across all five studies, 59% of participants indicated a belief that the diversified portfolio would have a

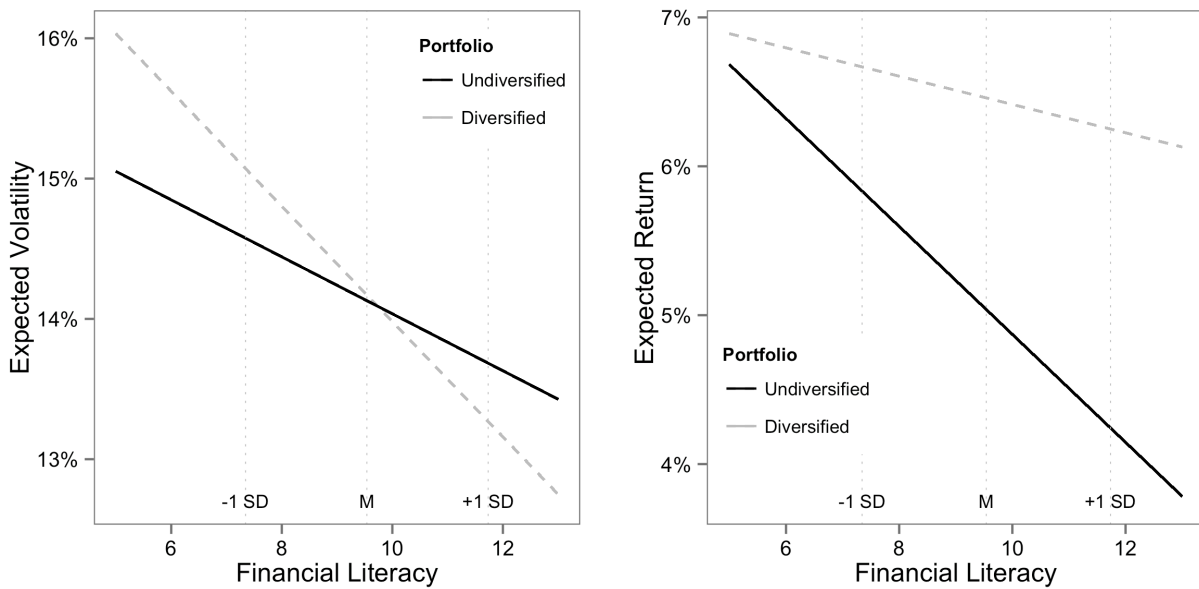higher (mean) return than the undiversified portfolio.



Fig. 1.
Average expected portfolio volatility and return from Studies 1A–1E. Volatility is operationalized as the standard deviation of the forecast distribution and return as the mean of the forecast distribution.

## Study 1F: Real Stocks

A diversified portfolio could, in principle, have higher returns or higher volatility than an

undiversified portfolio if the assets in the two portfolios are systematically different. Consider, for

instance, and undiversified portfolio invested entirely in a money market fund versus a portfolio invested

half in the a money market fund and half in the stock market. The latter will be riskier with higher return,

despite being more diversified. Thus, believing the diversified portfolio will have higher returns/higher

volatility could be justified if participants make inferences about how the stocks in each portfolio are selected.

This explanation is inconsistent with Study 1E where we told participants that the stocks in both portfolios are randomly selected (see Appendix) and still observed a bias towards expecting higher returns from a diversified portfolio ($M_{diversified} = 5.78\%$ vs. $M_{undiversified} = 4.00\%$; $\beta_{Portfolio} = 1.77$, 95% CI = [1.05, 2.49], $t = 4.82$, $p < .001$).[4] In Study 1F, we provide more evidence against this explanation by using real, explicitly specified stocks in each portfolio. Thus, participants' beliefs about portfolio composition cannot explain perceived differences in expected returns between the two portfolios.

**Method**

Four hundred participants were recruited from AMT. The same exclusion criteria from Studies 1A–1E were used, yielding 348 responses. The procedure was the same as in Studies 1A–1E. Participants made forecasts for two portfolios in random order using the distribution builder. The critical difference in this study is that the portfolios contained stocks from real companies. The diversified portfolio featured five companies, with equal investment in each. We selected companies that are well known and have similar historical volatility: Amazon, Bank of America, Apple, Starbucks, and Ford Motor Company. The undiversified portfolio contained only one of these companies, randomly selected for each participant.

**Results**

As in the previous studies, participants believed that the diversified portfolio would perform better than the average of the individual portfolios ($M_{diversified} = 9.11\%$ vs. $M_{undiversified} = 6.49\%$; mixed-effects regression coded as in previous studies: $\beta_{Portfolio} = 2.62$, 95% CI = [1.64, 3.59], $t = 5.29$, $p < .001$). The diversified portfolio was expected to outperform all but one of the component stocks ($M_{Apple} =$

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[4] After the forecasting task, we asked participants how the stocks in the portfolios were selected and provided five plausible choices (e.g., picked by a financial advisor) plus an option to indicate they did not remember. Fifty-nine percent of participants correctly remembered the stocks were picked randomly and the observed bias was slightly stronger in this subset ($M_{diversified} = 7.83\%$ vs. $M_{undiversified} = 5.36\%$, $t = 5.03$, $p < .001$).

9.70%, $M_{\text{Amazon}} = 7.66\%$, $M_{\text{Starbucks}} = 6.25\%^*$, $M_{\text{Ford}} = 4.62\%^*$, and $M_{\text{BoA}} = 4.34\%^*$; asterisks denote a

significant difference from the diversified portfolio at $p < .05$). For additional results, see Table 1.

### Studies 1A–1F Discussion

Across the six studies, we found two consistent effects. First, participants with low financial

literacy believed that portfolios containing more stocks would be more volatile than portfolios containing

fewer stocks. Second, most people, but especially those high in financial literacy, believed diversified

portfolios would yield higher returns than undiversified portfolios. These two biases are inconsistent with

both rational explanations and measurement noise. Instead, they seem to be systematic biases in how

people think about diversification.

We find consistent evidence for these beliefs in survey data (see Appendix D). For example,

when asked about the effect of "adding an uncorrelated asset to a portfolio, which has the same risk and

return of that portfolio," 26% of participant said it would increase the average return from the portfolio,

26% said it would increase the volatility of the portfolio, and only 38% said it would reduce the volatility

of the portfolio. Similarly, many people gave a positively biased estimate for the return from a portfolio

of two stocks with know returns (Question 5) and even more people overestimated the volatility of

portfolio composed of two stocks with known volatility (Question 7).

### Study 2A: Portfolio Construction with Real Stocks

Studies 2A and 2B test whether the incorrect beliefs documented in the previous studies have negative

downstream consequences. Participants were asked to construct stock portfolios for two investors with

different risk preferences: One was younger and more risk seeking, the other was older and more risk

averse. If, as our previous results suggest, people low in financial literacy believe diversification increases

volatility and returns, they should—incorrectly—create a more diversified portfolio for the younger

investor who wants high returns and can tolerate volatility. Because people high in financial literacy

believe diversification decreases volatility and increases returns, no clear prediction emerges: Less

volatility favors giving the older investor a more diversified portfolio, but higher returns favors giving the

younger investor a more diversified portfolio. Note that we do not make a normative claim about whether

the older or younger invest *should* get a more diversified portfolio, we simply deduce predictions based

on the beliefs expressed in Studies 1A–1F.

**Method**

  **Participants**. We recruited 184 participants through AMT (target recruitment was 200, but the

survey was closed after a long period of inactivity). Ten of these participants scored below chance on the

financial literacy measure and, as in previous studies, are excluded from the reported analysis.

  **Procedure**. The study asked participants to take the role of financial advisor and help two

investors with different investment goals construct stock portfolios. One of the investors was younger and

risk seeking. Her investment goal was high returns. The other investor was older and risk averse. Her

investment goal was stability, even if it meant lower returns (see Appendix E for investor profiles).

  Participants helped the investors in random order. They first learned about one of the investors

(either the younger or older investor), seeing a picture and a short profile about her investment goals.

They then constructed a portfolio for this investor by selecting to invest in any number of companies from

an available assortment. The companies were the 30 biggest American companies in 2013 according to

Financial Times based on market capitalization (see Appendix F for companies). They could select as few

or as many of the companies as they wished and were told the investment would be divided equally

amongst the companies selected. They then did the same task for the second investor. Finally, they

completed the 13-item financial literacy scale used in Studies 1A–1F.

**Results**

As our dependent measure, we created a difference score for each participant by subtracting the number of companies they chose for the younger (risk-seeking) investor from the number of companies they chose for the older (risk-averse) investor. Both were log-transformed to improve normality. Significant results are also obtained if we use non-parametric tests without this transformation. Higher scores on this measure indicate that participants gave the older investor a more diversified portfolio in terms of number of companies.

We conducted a regression with the difference score as the dependent variable and financial literacy (mean centered) as the predictor. The intercept from the regression model was negative ($\beta_0 = -.064$, 95% CI = [-.131, .003], $t(172) = -1.88$, $p = .062$), meaning the average participant in our study put *fewer* companies in the older investor's portfolio ($M_{Older} = 5.74$ vs. $M_{Younger} = 6.12$)[5]. Further, the coefficient for financial literacy was positive ($\beta_{FinLit} = .044$, 95% CI = [.014, .074], $t(172) = 2.87$, $p = .005$) indicating that those low in financial literacy were significantly more likely to give the older investor fewer stocks (at -1 SD on financial literacy: $M_{Older} = 4.74$ vs. $M_{Younger} = 5.58$, $t(172) = -2.87$, $p = .001$). This relationship is illustrated in Figure 2.

**Study 2B: Portfolio Construction with Hypothetical Stock Funds**

A virtue of Study 2A is the use of real stocks, however this introduces a possible alternative explanation for the results. While participants chose fewer stocks for the older investor, those stocks may have been historically less risky than those chosen for the younger investor. In Study 2B, we instead had participants choose from eight hypothetical stocks funds—all of which were created to be equally risky. This rules out the possibility that giving the older investor fewer stocks actually decreases risk.

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[5] Reported means are exponentiated means of logged number of stocks.
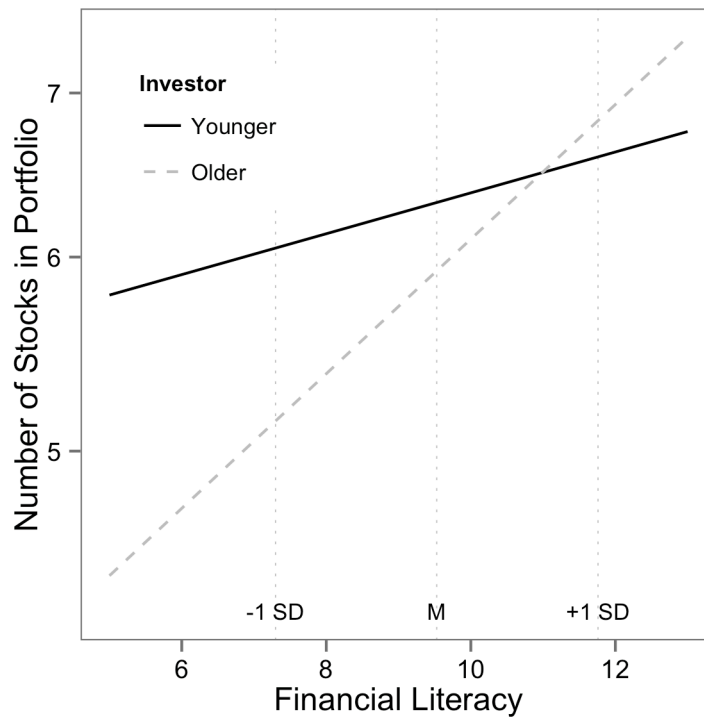
Fig. 2.
Number of stocks given to each investor in Study 2A.


**Method**

One hundred ninety-two undergraduate business students at a large public university participated for course credit. Sixteen participants scored below chance on the financial literacy measure and are excluded from the analysis (as in previous studies). As in Study 2A, we asked participants to take the role of financial advisor and help two different investors (same profiles as previous study) construct stock portfolios to meet their investment goals. We used the same procedure as in Study 2A, with two exceptions. First, instead of constructing the portfolios with stocks from real companies, we had participants construct the portfolios out of eight hypothetical stock funds, which we said were the only funds offered by the investor's brokerage firm. We generated five years of "historical" returns (1,250 trading days) for each of the eight funds using identical parameters. Participants could view the historical returns for each portfolio by hovering their mouse pointer over the funds name (names were given to

funds based on the NATO phonetic alphabet; e.g., "Fund Bravo"). An example stimulus is shown in Appendix G.

The second difference between this study and Study 2A was that participants were not limited dividing the investment equally across selected assets. Participants were told to allocate whatever percent they wished to each stock fund (using a constant sum allocation method). If they did not want to invest in a particular fund, they could allocate 0% to it. Following the portfolio construction tasks (and a block of unrelated studies) participants completed the same 13-item financial literacy scale used in previous studies.

## Results

**Number of stock funds**. As a first level of analysis, we looked again at the number of assets assigned to each investor's portfolio. As in Study 2A, we created a difference score for each participant by subtracting the number of stock funds they chose for the younger (risk-seeking) investor from the number of stock funds they chose for the older (risk-averse) investor (both were log-transformed to improve normality; significant results are also obtained if we use non-parametric tests without this transformation). A regression with this difference score as the dependent measure and financial literacy (mean centered) yielded a non-significant intercept ($\beta_0$ = -.005, 95% CI = [-.080, .070], $t(174)$ = -.13, $p$ = .90) but, once again, revealed a positive effect of financial literacy ($\beta_{FinLit}$ = .063, 95% CI = [.026, .099], $t(174)$ = 3.37, $p$ = .001): Participants low in financial literacy gave the older investor fewer stock funds (at -1 SD on financial literacy: $M_{Older}$ = 4.38 vs. $M_{Younger}$ = 5.00, $t(174)$ = -2.48, $p$ = .014) and there was no difference at mean financial literacy ($M_{Older}$ = 4.52 vs. $M_{Younger}$ = 4.54). The average number of stock funds chosen for each investor at different levels of financial literacy is shown in Figure 3.

**Deviation from optimal allocation**. Participants were not limited to an equal allocation, so we can also examine how their portfolio deviates from an optimal allocation. Because all of the stock funds are uncorrelated and have equal variance and expected returns, the optimal allocation is to assign 12.5%

of the investor's wealth to each fund. For each participant, we calculated the sum of the squared

deviations from this optimal allocation for both the older and younger investor's portfolios. This is

analogous to a diversification measure suggested by Blume and Friend (1975). A regression with

financial literacy (mean centered) as the predictor variable and the difference in portfolio deviation

between the older and younger investor's portfolios as the dependent variable yields a non-significant

intercept ($\beta_0$ = 48, 95% CI = [-257, 353], $t(174)$ = .31, $p$ = .76) and a negative coefficient for financial

literacy ($\beta_{\text{FinLit}}$ = -234, 95% CI = [-383, -84], $t(174)$ = -3.08, $p$ = .002). As in the analysis based on number

of stock funds, this indicates that people low in financial literacy tended to give the older investor a less

diversified portfolio than they gave to the younger investor (at -1 SD on financial literacy: $M_{\text{Older}}$ = 3169

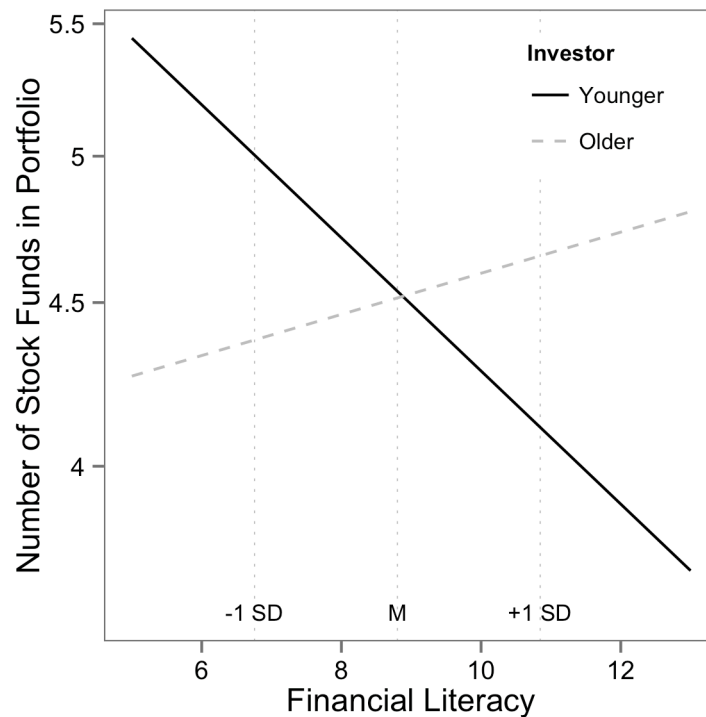vs. $M_{\text{Younger}}$ = 2623, $t(174)$ = 2.40, $p$ = .017).

Fig. 3.
Number of stock funds given to each investor in Study 2B.

**Study 3: Process Evidence**

In Study 3 we provide preliminary evidence for two cognitive processes that may underlie the effects observed in previous studies. First, we examine whether the belief that diversified portfolios are more volatile stems from a tendency to conflate the uncertainty associated with a portfolio with the combined uncertainty associated with the assets it contains. Because a more diversified portfolio contains a greater number of risky assets—each of which being difficult to forecast independently—the whole portfolio may feel more unpredictable and thus more volatile. We examine this proposed mechanism by manipulating the degree to which participants focus on individual assets within a portfolio before forecasting the portfolio's future value. We predict that first elaborating on the individual assets will make the portfolio's overall performance seem harder to predict and thus the portfolio will be perceived as more volatile.

Second, we examine whether the belief that diversified portfolios will yield higher returns stems from a superficial understanding of financial advice. Most people have learned that diversification is good, but may extrapolate from this knowledge that diversification leads to increased returns rather than decreased volatility. Participants likely know that increasing diversification entails a beneficial change in the distribution of expected returns, but mistakenly represent this as an effect on the first moment (the mean) instead of the second (the variance). We examine this proposed mechanism by manipulating the degree to which participants focus specifically on the level of diversification of the portfolio. We predict that focusing participants on the fact that a portfolio is well diversified will increase their expectations for portfolio return. Note that we did not measure financial literacy in Study 3, as we did not have predictions for how it would interact with the manipulations.

**Method**

Six hundred participants were recruited through AMT. The study consisted of two tasks. First, as baseline measures, we asked participants to give us their opinion on the stock market in general. They

were asked whether they expected money invested in the stock market to increase or decrease over the next year (-5 = decrease substantially, 0 = no change, +5 = increase substantially). They were also asked how predictable they thought the value of money invested in the stock market would be in one year (0 = completely unpredictable, 9 = very predictable). These two measures were designed to tap into the same constructs we measured in Studies 1A– 1F with the distribution builder: The first was designed to map onto expectations of mean returns and the second was designed to map onto expectations of volatility.

We then asked participants to give us their opinion on a stock portfolio we created containing shares of Facebook, PetSmart, Dow Chemicals, and Whole Foods (investments in each company were roughly equal; see Appendix H for exact portfolio stimuli). These companies were selected because they are well known and have low historical intercorrelations. All participants saw and evaluated the same target portfolio on the same two scales as they did for the stock market in general.

After seeing the portfolio, participants were randomly assigned to one of three conditions. Participants in the control condition evaluated the target portfolio immediately after seeing it. Participants in the "stock-focus condition" were asked to "take a moment to think about each of the individual stocks … and how they will perform over the next year." These participants were then asked to type a few thoughts about each stock. Then they evaluated the portfolio on the two dependent measures. Participants in the "diversification-focus condition" were told that the portfolio was "well-diversified" and to "think for a moment about what this means." These participants were then asked to type a few thoughts about diversification. Then they evaluated the portfolio on the two dependent measures (see Appendix I for manipulation wording).

**Results**

For each participant, we took responses for the target portfolio and subtracted responses for the stock market in general to help control for within-participant differences in general beliefs about the stock market. These difference scores serve as the dependent variables in our analysis.

**Analysis of predictability**. Supporting our hypothesis, participants in the stock-focus condition—those who first considered the performance of the individual stocks—believed the target portfolio was less predictable ($M_{\text{stock-focus}}$ = .37, 95% CI = [.20, .54]) compared to the other two conditions ($M_{\text{diversification-focus}}$ = .70, 95% CI = [.53, .86] and $M_{\text{control}}$ = .59, 95% CI = [.40, .78]; $t(598) = 2.35$, $p = .019$). It is also worth noting that only 17% of participants thought the stock market in general was more predictable than the target portfolio ($M_{\text{all participants}}$ = .56, 95% CI = [.46, .66], $t(599) = 10.77$, $p < .001$). This is surprising—and an insight into our hypothesis—as the stock market in general is the most diversified portfolio and thus should be easiest to predict.

**Analysis of expected returns**. Supporting our hypothesis, participants in the diversification-focus condition had the highest expectations for the future value of the portfolio relative to the market ($M_{\text{diversification-focus}}$ = .39, 95% CI = [.17, .61] vs. $M_{\text{stock-focus}}$ = .17, 95% CI = [-.08, .42] and $M_{\text{control}}$ = .03, 95% CI = [-.20, .27]; $t(598) = 2.07$, $p = .039$).

## General Discussion

The logic behind diversification is not an intuitively easy concept. In our experiments, we find two prevalent errors: First, people low in financial literacy tend to believe that diversification increases volatility. Second, most people, but especially those high in financial literacy, tend to believe that diversification will increase a portfolio's return. These errors can lead to perverse downstream consequences. In Studies 2A and 2B we show that participants low in financial literacy create less diversified portfolios for an older, risk-averse investor compared to a younger, risk-tolerant investor. Ironically, this means that risk aversion combined with a misunderstanding of diversification can lead to increased exposure to risk.

The errors appear to stem from separate psychological processes as they dissociate in a predictable manner based on financial literacy. Study 3 provides more evidence for these processes by

showing that participants who focus on individual stocks give higher estimates of portfolio volatility, but participants who focus on what it means to be well-diversified give higher estimates of portfolio returns.

The findings may provide novel insight into prior research on diversification. Benartzi (2001) found that 83.7% of Morningstar.com subscribers believed that the stock of their own employing firm was less likely to lose half of its value than the overall stock market, an effect he attributed to familiarity. Our studies suggest that a more general misunderstanding of the relationship between diversification and volatility may contribute to this result. Our results also provide a potential explanation for the correlation between financial literacy and diversification in the market (Guiso and Jappelli 2008). Finally, Goetzmann and Kumar (2008) found that personal retirement accounts tend to be *less* diversified than non-retirement accounts. In other words, people seem to be taking on more risk with the money they plan to live on during retirement. While this may seem surprising, it is consistent with our studies: If people think that diversification leads to less predictability, they may choose to invest their retirement wealth in a small number of assets.

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### Appendix A: Portfolio Descriptions from Studies 1A–1F

**Study 1A**

*Undiversified*. Imagine **you just invested $15,000** in the stock market. You invested all of your $15,000 in **a single company** with sound fundamentals. Using the tool below, please indicate your expectations for the value of your portfolio **in exactly one year**.

*Diversified*. Imagine **you just invested $15,000**in the stock market. You divided your $15,000 investment evenly **between ten different companies** with sound fundamentals. Using the tool below, please indicate your expectations for the value of your portfolio **in exactly one year**.

**Study 1B**

*Undiversified*. Imagine you just purchased one share of stock in a well known company with sound fundamentals. The **share is currently valued at $350**, so the total value of your portfolio is currently **$350**. Using the tool below, please indicate your expectations for the value of your portfolio **in exactly one year**.

*Diversified*. Imagine you just purchased one share of stock in each of ten different well known companies with sound fundamentals. The **average value of each share is $35**, so the total value of your portfolio is currently **$350**. Using the tool below, please indicate your expectations for the value of your portfolio **in exactly one year**.

**Study 1C**

*Undiversified*. Imagine you just purchased **one share** of stock in a well known company with sound fundamentals. The share is currently valued at **$350**. What do you think the value of this stock will be after one year? Using the tool below, please guess what the stock's value will be in one year. You must make 100 guesses (each ball represents a guess). Please round your guesses to the closest value provided.

*Diversified*. Imagine you just purchased **one share** of stock **in each of ten** well known companies with sound fundamentals. The average share in your portfolio is currently valued at **$35**, so the total value of the portfolio is **$350**. What do you think the value of this portfolio will be after one year? Using the tool below, please guess what the portfolio's value will be in one year. You must make 100 guesses (each ball represents a guess). Please round your guesses to the closest value provided.

*Undiversified (Control)*. Imagine you just purchased **ten shares** of stock in a well known company with sound fundamentals. The shares are currently valued at **$35**, so the total value of the portfolio is **$350**. What do you think the value of this portfolio will be after one year? Using the tool below, please guess what the portfolio's value will be in one year. You must make 100 guesses (each ball represents a guess). Please round your guesses to the closest value provided.

**Study 1D**

*Undiversified*. Imagine you just purchased stock from **one company** (the company is well known and has sound fundamentals). The current value of your shares is **$3500**. Using the tool below, please guess what this portfolio's value will be in one year. You must make 100 guesses (each ball represents a guess). Please round your guesses to the closest value provided.

*Diversified*. Imagine you just purchased stock from **ten *different* companies** (the companies are well known and have sound fundamentals). The current value of your shares is **$3500**. Using the tool below, please guess what this portfolio's value will be in one year. You must make 100 guesses (each ball represents a guess). Please round your guesses to the closest value provided.

**Study 1E**

*Undiversified*. Imagine a stock portfolio consisting of **one company** *randomly selected* from the Financial Times Global 500 (list of the most valuable companies in the world. The current value of your shares is **$3500**. Using the tool below, please guess what this portfolio's value will be in one year. You must make 100 guesses (each ball represents a guess). Please round your guesses to the closest value provided.

*Diversified*. Imagine a stock portfolio consisting of **ten *different* company** *randomly selected* from the Financial Times Global 500 (list of the most valuable companies in the world. The current value of your shares is **$3500**. Using the tool below, please guess what this portfolio's value will be in one year. You must make 100 guesses (each ball represents a guess). Please round your guesses to the closest value provided.

**Study 1F**

*Undiversified*. Imagine you just purchased stock from **[one of the five companies from the diversified condition, selected randomly]**. The current value of your shares is **$3500**. Using the tool below, please guess what this portfolio's value will be in one year. You must make 100 guesses (each ball represents a guess). Please round your guesses to the closest value provided.

*Diversified*. Imagine you just purchased stock from **five different companies: Amazon, Bank of America, Apple, Starbucks, and Ford Motor Company** (equal investment in each company). The current value of your shares is $3500. Using the tool below, please guess what this portfolio's value will be in one year. You must make 100 guesses (each ball represents a guess). Please round your guesses to the closest value provided.

**Appendix B: Study Results without Data Exclusions**

Table S1.
Results from Studies 1A–1F without data exclusions.

|  | Study 1A | Study 1B | Study 1C | Study 1D | Study 1E | Studies 1A–1E | Study 1F |
|---|---|---|---|---|---|---|---|
| $N$ | 300 | 176 | 359 | 796 | 399 | 1825 | 400 |
| Volatility: |  |  |  |  |  |  |  |
| $\beta_{Portfolio}$ | .15% | -.05% | .50%** | .02% | -.36%** | .05% | .15% |
| $\beta_{FinLit}$ | -.14%* | -.28%** | -.15%* | -.30%*** | -.28%*** | -.24%*** | -.30% |
| $\beta_{Interaction}$ | -.20%** | -.12% | -.10% | -.08%* | -.04% | -.09%*** | -.03% |
| Returns: |  |  |  |  |  |  |  |
| $\beta_{Portfolio}$ | .99%** | .40% | 1.47%*** | 1.09%*** | 1.42%*** | 1.15%*** | 2.47%*** |
| $\beta_{FinLit}$ | -.15% | .36%* | -.40%*** | -.10% | -.08% | -.08% | -.12% |
| $\beta_{Interaction}$ | .30%* | .55%** | .24% | .26%*** | .25%** | .28%*** | .02% |

*Notes*: Study details and variable coding are provided in Table 1 and main text. Significance indicators: *** $p < .01$, ** $p < .05$, * $p < .10$.

Table S2.
Results from Studies 2A and 2B without data exclusions.

|  | Study 2A | Study 2B |
|---|---|---|
| $N$ | 184 | 192 |
| Difference (logged number of stocks): |  |  |
| $\beta_0$ | -.062* | -.022 |
| $\beta_{FinLit}$ | .030** | .055*** |
| Difference (squared deviation from optimal portfolio): |  |  |
| $\beta_0$ | -- | 75 |
| $\beta_{FinLit}$ | -- | -169*** |

*Notes*: Significance indicators: *** $p < .01$, ** $p < .05$, * $p < .10$.

**Appendix C: Example of Distribution Builder**

Imagine you just purchased **one share** of stock **in each of ten** well known companies with sound fundamentals. The average share in your portfolio is currently valued at **$35**, so the total value of the portfolio is **$350**. What do you think the value of this portfolio will be after one year?

Using the tool below, please guess what the portfolio's value will be in one year. You must make 100 guesses (each ball represents a guess). Please round your guesses to the closest value provided.

| | |
|---|---|
| $225 | |
| $250 | |
| $275 | o |
| $300 | ooo |
| $325 | oooooooooo |
| $350 | ooooooooooooooo |
| $375 | oooooooooooooooooooooooo |
| $400 | oooooooooooooooo |
| $425 | oooooooooooooo |
| $450 | ooooooo |
| $475 | ooo |

You have 8 ball(s) left to assign

Submit Response

Fig. S1.
Example of Distribution Builder from Study 1C.

**Appendix D: Survey Results (*N* = 237, undergraduate business students)**

Percent of respondents giving each answer shown in bold. Correct answer indicated by an asterisk. Questions were presented in randomized order.

1. Compared to a less diversified portfolio, a more diversified portfolio:
    a. Will have higher average expected returns **(34%)**
    b. Will have lower chance of below average returns **(44%)**
    *c. Will have a smaller range of returns **(15%)**
    d. Will have lower average returns **(6%)**

2. Adding an uncorrelated asset to a portfolio, which has the same risk and return as that portfolio, will:
    a. Decrease diversification **(11%)**
    b. Increase average returns **(14%)**
    c. Decrease average returns **(6%)**
    *d. Increase diversification **(69%)**

3. Adding an uncorrelated asset to a portfolio, which has the same risk and return as that portfolio, will:
    *a. Decrease the volatility of the portfolio **(38%)**
    b. Increase the average returns of the portfolio **(26%)**
    c. Decrease the average returns of the portfolio **(11%)**
    d. Increase the volatility of the portfolio **(26%)**

4. A portfolio consists of 50/50 stock funds Alpha and Beta. If the portfolio is down 2%, and alpha has a return of zero, that means beta's return must be:
    a. Cannot know **(6%)**
    b. Down 2% **(65%)**
    *c. Down 4% **(27%)**
    d. Down 6% **(1%)**

5. A portfolio consists of 50/50 stock funds alpha and beta. If the return from alpha is 3% and the return from beta is 9%, what is the return from the portfolio?
    a. less than 6% **(6%)**
    *b. exactly 6% **(58%)**
    c. greater than 6% **(30%)**
    d. cannot know **(6%)**

6. A portfolio invests equally (50/50) in two funds, alpha and beta. The typical return from alpha ranges from 2% to 4% and the typical return from beta ranges from 6% to 8%. The typical range of returns from this portfolio is:
    *a. Less than 2% **(3%)**
    b. Exactly 2% **(22%)**
    c. Greater than 2% **(72%)**
    d. Cannot know **(3%)**

7. A portfolio invests equally (50/50) in two funds, alpha and beta. The return from alpha fluctuates by about 5% year to year and the return from beta also fluctuates by about 5% year to year. They don't move perfectly in tandem however, i.e. are not perfectly correlated. What is the typical year-to-year fluctuation for the portfolio?

     *a. Less than 5% **(8%)**

     b. Exactly 5% **(46%)**

     c. Greater than 5% **(32%)**

     d. Cannot know **(12%)**

**Appendix E: Investor Profiles from Studies 2A and 2B**

**Younger Investor Profile**

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[Picture of Younger Woman]

**Name**: Janelle Thompson

**Age**: 27

**Investment Goals**: Janelle has been working at her job for 5 years. She has saved up some money and wants to invest it in a portfolio of stocks that will yield a high return. Janelle is willing to tolerate unpredictability and volatility from her investments. She just wants her investments to make money!

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**Older Investor Profile**

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[Picture of Older Woman]

**Name**: Doris Westward

**Age**: 63

**Investment Goals**: Doris is about to retire and wants predictability from her investments. After retirement, Doris plans to withdraw some money from her portfolio each year for living expenses. She doesn't need her portfolio to make a lot of money, she just wants a stable source of income in retirement.

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**Appendix F: Companies Available in Study 2A**

Apple, Google, Amazon, Microsoft, Oracle, Verizon, Cisco, Qualcomm, Comcast, Intel, Pfizer, Philip Morris, CitiGroup, IBM, Merck, Berkshire Hathaway, Wells Fargo, Exxon, Chevron, AT&T, Bank of America, JP Morgan Chase, Home Depot, Walt Disney, PepsiCo, Walmart, Procter and Gamble, General Electric, Johnson and Johnson, and Coca-Cola.
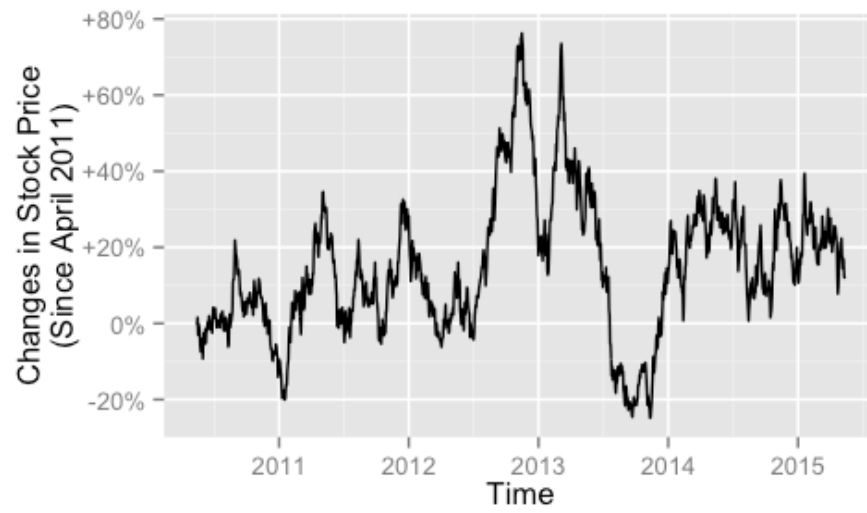
**Appendix G: Sample Stimulus for Study 2B**



Fig. S2.
Sample stimulus from Study 2B.

**Appendix H: Target Portfolio for Study 3**

| | Name | Symbol | Last price | Shares | Mkt value |
|---|---|---|---|---|---|
| ☐ | Facebook Inc | FB | 75.18 | 10.00 | 751.80 |
| ☐ | PetSmart, Inc. | PETM | 81.46 | 10.00 | 814.65 |
| ☐ | Dow Chemical Co | DOW | 44.79 | 20.00 | 895.80 |
| ☐ | Whole Foods Market, Inc. | WFM | 51.46 | 20.00 | 1,029.20 |
| | Cash - Deposit / Withdraw | | | | |
| | Portfolio value: | | | | $3,491.45 |

Fig. S3.
Target Portfolio Stimulus used in Study 3.

## Appendix I: Manipulation Wording for Study 3

**Stock-Focus Condition**

Please take a moment to think about each of **each of the individual stocks** in this investor's portfolio and how they will perform over the next year. In the spaces below, please write a few thoughts about your expectations for each of the stocks.

**Diversification-Focus Condition**

According to conventional measures, this is a **well-diversified** portfolio. Please think for a moment about what this means. In the space below, write a couple of sentences expressing your thoughts.