Easy, Breezy, Risky:
Why Investors with Low Financial Literacy Prefer Correlated Assets

12/05/2018

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*Corresponding Author. The first author gratefully acknowledges financial support from the Social Sciences and Humanities Research Council of Canada (SSHRC), and from the PH&N Centre for Financial Research.
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ABSTRACT

Why do people fail to diversify risk in their investment portfolio? We study how lay investors (investors with low financial literacy) invest in financial assets whose past or expected returns are provided. Although assets with uncorrelated returns provide investors with an opportunity to reduce portfolio risk (i.e., reduce portfolio fluctuations), we find that lay investors instead prefer investing in assets with positively correlated returns, which results in a much riskier investment than intended. This happens because lay investors rely on a lay perception of portfolio risk based on processing fluency: assets with correlated (versus uncorrelated) returns are processed more fluently, and thus erroneously perceived as less risky. We find that lay investors succeed in forming a diversified portfolio with uncorrelated assets when aggregate portfolio returns are provided, or when—paradoxically—they are encouraged to take more risk.

Keywords: perceived risk, lay perception, processing fluency, diversification, financial decision-making, financial literacy
With the development of employee saving plans and privatized retirement saving schemes, people with scant knowledge of finance routinely make risky decisions with a potentially dramatic impact on their future wealth. In particular, as defined contribution pension plans are replacing defined benefit plans in many countries, more workers become responsible for allocating their savings among investment products (Lusardi, 2009). Likewise, the booming FinTech industry has made it easier than ever for lay investors to buy and sell assets on their personal computer or their smartphones (Mackenzie, 2015). Choosing an optimal asset allocation is generally difficult, but there is one universally endorsed principle in portfolio management: diversification, which reduces fluctuations without sacrificing gain. For a given level of return, the overall risk (or volatility) of a portfolio can be reduced by investing in assets with uncorrelated or negatively correlated returns, since the poor performance of one asset can be offset by the good performance of another (Markowitz, 1952). Yet, investors tend to hold under-diversified portfolios (Campbell, 2006), and are largely invested in positively correlated assets such as domestic assets (Baxter & Jermann, 1997; French & Poterba, 1991), familiar assets (Huberman, 2001), or their own company’s stocks (Benartzi, 2001).

Why would anybody avoid uncorrelated or negatively correlated assets and pass up a “free” opportunity to reduce their investment risk? While past research attributes such behavior to familiarity heuristic and home bias (Baxter & Jermann, 1997; French & Poterba, 1991; Huberman, 2001), we uncover a more fundamental psychological explanation. In five studies, we show that investing in positively correlated assets may be a deliberate choice made by people with low financial literacy (referred to as lay investors), because they rely on a lay perception of portfolio risk: while experts evaluate portfolio risk based on its volatility, lay investors’ perception of portfolio risk is influenced by how fluently they process information about asset
covariance. Assets with highly correlated returns—i.e., returns that “move together” over time—are processed more fluently, and thus perceived as less risky. In five multi-method studies (relying on qualitative, psychometric, and experimental approaches), we show that lay investors significantly prefer investing in assets with positively (vs. negatively) correlated returns, due to such fluency-based perception of risk. Because of this misleading lay risk perception, encouraging lay investors to take risk—ironically—makes them invest in diversified, lower-risk portfolios made of negatively correlated assets. Providing aggregate portfolio returns (which makes portfolio fluctuations more salient) also helps lay investors better diversify.

We seek to contribute to research on lay financial diversification by drawing on psychology research on lay risk perception (Slovic, 1987). Previous studies explaining inefficient diversification have focused on investors’ tendencies to neglect covariance (Hedesstrom, Svedsater, & Garling, 2006) and to invest evenly across all financial assets on the menu (Benartzi & Thaler, 2001; Morrin, Inman, Broniarczyk, Nenkov, & Reuter, 2012). Our findings contrast with this research: lay investors do not ignore covariance information so much as use it incorrectly, and rely on a lay risk perception that drastically differs from expert risk perception.

**DIVERSIFICATION HEURISTICS AND COVARIANCE NEGLECT**

A successful financial diversification largely relies on understanding the link between asset covariance and portfolio risk: investors should select assets not merely on their individual merits, but also on how their prices vary relative to each other (Markowitz, 1952). Indeed, for a given return, portfolio risk (or volatility) can be minimized by selecting assets with uncorrelated or negatively correlated returns.
Yet behavioral research suggests that individual investors largely neglect this prescription. For instance, when selecting assets sequentially, some investors exhibit narrow framing (Dorn & Huberman, 2010) by evaluating and selecting assets one at a time based on each individual asset’s volatility. Presenting assets simultaneously (in a menu) does not seem to solve this problem – investors then tend to apply a naïve diversification strategy called the 1/n heuristic, which consists in investing evenly across all assets on the menu (Benartzi & Thaler, 2001). While investors typically do not invest in every single available asset, they tend to apply a weaker form of the 1/n heuristic whereby their allocation decision depends on how a menu of assets is partitioned (Fox, Ratner, & Lieb, 2005; Morrin et al., 2012). If the menu is mostly composed of correlated assets, the portfolio will be as well, resulting in poor diversification (Karlsson, Massa, & Simonov, 2007).

Such lack of diversification skill has been explained by “covariance neglect” (Gubaydullina & Spiwoks, 2015; Hedesstrom et al., 2006; Kroll, Levy, & Rapoport, 1988). In several studies by Hedesstrom et al. (2006), undergraduate students were shown the past returns of several funds; overall, participants made investment decisions that largely ignored covariance information, that is, they didn’t take into account whether assets’ past returns were positively or negatively correlated. Nonetheless, we believe that past research on covariance neglect has overlooked the way in which information on covariance between assets may affect risk perceptions across investors with low versus high financial literacy. As explained below, we propose that lay investors do not ignore covariance information so much as use it incorrectly when estimating the riskiness of a portfolio.

**COVARIANCE INFORMATION, LAY RISK PERCEPTION, AND DIVERSIFICATION**
A wealth of research has shown that the perception of financial risk differs greatly between lay and expert investors. Risk simply means different things to different people, depending on their level of expertise (Gooding, 1975; Slovic, 1987; Slovic, Fischhoff, & Lichtenstein, 1985).

Experts think of risk as an objective, quantitative, and measurable construct. In the case of financial diversification, the risk of a portfolio is measured by the volatility (i.e., the fluctuations) of its returns; expert investors know that a portfolio is less volatile, and thus less risky, when its components have uncorrelated or negatively correlated returns. Lay investors may do well at evaluating the volatility (and thus the risk) of an individual asset (Hedesstrom et al., 2006), but evaluating the risk of a portfolio is a more challenging task because it requires knowing the objective relation between asset covariance and portfolio volatility. Since lay investors do not have this knowledge, how does covariance information (presented in the form of past or expected returns) impact “lay” portfolio risk perception? While prior research has not addressed this focal question, research in other financial contexts has identified some key drivers of lay risk perception.

Lay people make highly subjective and feelings-based assessments of financial risk: risk is associated with feelings of fear, dread, anxiety, stress, and discomfort (Loewenstein, Weber, Hsee, & Welch, 2001; Slovic & Peters, 2006). Hence, events that feel familiar, well-known, simple, easy to control, to track, to manage, or to predict are typically judged less risky (Slovic, 1987; Slovic et al., 1985). These common drivers of lay risk perception (e.g., familiarity, simplicity, predictability) have one important common denominator, particularly relevant for our research: processing fluency. Past studies have established a solid link between how easy a stimulus is processed, and how risky it is perceived (Alter & Oppenheimer, 2009; Alter,
Oppenheimer, Epley, & Eyre, 2007). For instance, stimuli (including financial assets) whose name or description is easy to process—to read, to pronounce, to understand, to remember, or to recognize—are judged less risky (Alter & Oppenheimer, 2006; Mitchell & Greatorex, 1988; Novemsky, Dhar, Schwarz, & Simonson, 2007; Song & Schwarz, 2009; E. U. Weber, Siebenmorgen, & Weber, 2005). Likewise, financial asset classes (e.g., bonds, stocks, gold) reported to be “easy to understand” are perceived as less risky (Wang, Keller, & Siegrist, 2011).

In the current research, we propose that assets with returns that “move together” (i.e., positively correlated returns) may appear more consistent and coherent, and therefore be processed more fluently. This is in line with cognitive psychology research that considers fluency and consistency as largely overlapping concepts (Topolinski & Strack, 2009; Winkielman, Huber, Kavanagh, & Schwarz, 2012). Consider for instance Table 1, which displays the past calendar returns of three funds, retrieved from the consumer website of a major North-American bank (TD Bank, 2018). Based on this information, a portfolio consisting of “U.S. Blue Chip Fund” and “Canadian Health Sciences Fund” (with positively correlated returns) is objectively more volatile, thus riskier, than a portfolio consisting of “U.S. Blue Chip Fund” and “Canadian Small-Cap Fund” (with negatively correlated returns). Yet, we hypothesize that lay investors will perceive the latter portfolio as riskier, because the negatively correlated returns feel disfluent (controlling for the individual characteristics of the funds).

***Insert Table 1 here***

We thus hypothesize that:

**H1. Lay investors assess portfolio risk based on the processing fluency of assets’ returns, while expert investors assess portfolio risk based on portfolio volatility.**
Because of this difference between lay and expert risk perception, we predict that lay investors prefer investing in assets with positively correlated returns (which are processed more fluently), while expert investors prefer investing in assets with less correlated or negatively correlated returns (which decrease portfolio volatility):

**H2. Lay (vs. Expert) investors tend to invest in more (vs. less) positively correlated returns.**

Importantly, we propose that lay investors may deliberately invest in an objectively riskier portfolio, because of their misleading lay risk perception. In order to further demonstrate this misleading role of lay risk perception, we further hypothesize that encouraging (vs. discouraging) risk-seeking will ironically improve lay investors’ diversification—they will no longer prefer investing in positively correlated assets:

**H3. Encouraging risk-seeking will improve lay investors’ diversification.**

As stated earlier, lay investors are able to assess the volatility (and thus the risk) of an individual asset based on its returns, but not the volatility of a portfolio of assets. We thus hypothesize that providing investors with the aggregate returns of a portfolio will improve diversification, because the portfolio volatility is directly observable and doesn’t need to be estimated based on the covariance of the portfolio components:

**H4. Providing aggregate portfolio returns will improve lay investors’ diversification**

We ran five multi-method studies. We test our hypothesis that lay investors evaluate portfolio risk based on how fluently they process information about asset covariance (H1) using qualitative (Study 1) and psychometric methods (Study 2). We further test that lay investors prefer non-diversified portfolios, i.e. portfolios with positively correlated returns (H2), based on past returns (Studies 1 through 4) or based on expected returns (Study 5). We also test that
encouraging risk-seeking (Study 3) or providing aggregate portfolio returns (Study 4) improves diversification.

**STUDY 1**

Study 1 adopts a qualitative approach to understand individuals’ diversification decisions across different levels of financial literacy. Participants first decided whether to invest in correlated or uncorrelated assets, then they justified their investment decision in the form of brief, open-ended survey responses. Analyzing open-ended survey responses has been used in management research to provide a rich description of respondent reality at a relatively lower cost than in-depth interviews or focus groups (Sproull, 2002). The responses were analyzed with a thematic coding method (Strauss & Corbin, 1994; R. P. Weber, 1990).

In this and all subsequent studies, we used the panel of online U.S. participants provided by Amazon Mechanical Turk. These participants present a wide diversity in terms of income, education, and professional activity that does not differ fundamentally from the U.S. population (Levay, Freese, & Druckman, 2016; Paolacci, Chandler, & Ipeirotis, 2010), allowing capturing a substantial heterogeneity in financial literacy (we return to this point in the General Discussion.)

**Method**

900 MTurk participants (51.9% female, mean age=32.9) were paid $1 to participate in this study. Responses were collected in two batches (N=400; 500). Participants first read:

*Please imagine that you have invested some of your savings in one mutual fund. You are considering investing in a second fund, and you hesitate between two funds: fund Omega, and fund Epsilon. You want to invest for the long term.*

*Both funds Omega and Epsilon are managed by reputable firms, and in the long run, have yielded equally satisfying returns. There is however one key distinction between these two funds:*
In the past, fund Omega has tended to perform very similarly to the fund you already have: yielding positive returns when your fund also yielded positive returns, and yielding negative returns when your fund also yielded negative returns.

In contrast, fund Epsilon has tended to perform quite differently from the fund you already have: yielding positive returns when your fund yielded negative returns, and yielding negative returns when your fund yielded positive returns.

The names of the funds were counterbalanced across participants. Hence, in the description of the results, we call “non-diversifying fund” the fund whose returns positively correlate with those of the fund already owned (Omega in the scenario above), and “diversifying fund” the fund whose returns are uncorrelated with those of the fund already owned (Epsilon in the scenario).

Then, we asked: “Which fund would you invest in? Please remember that you want to invest for the long term.” Participants chose Omega or Epsilon.

On the next page, participants were shown the scenario again, were reminded of their choice, and were asked: “Please try to explain your choice in a few sentences.” Participants needed to answer using a minimum of 200 characters.

Then, we measured financial literacy with 19 multiple-choice questions presented in random order (see Appendix A). These questions varied across levels of difficulty, and were selected from various sources (Fernandes, Lynch, & Netemeyer, 2014; Lusardi & Mitchell, 2011; Mandell, 2008; Volpe, Kotel, & Chen, 2002). None of the questions addressed financial diversification. Embedded in the financial literacy test was one question designed to verify participants’ attention and seriousness: “Which activity is the riskiest?”; possible answers were “Leaving all your money in a savings account”, “Investing your money in trusted mutual funds”, “Gambling all your money at a casino” (the correct answer), and “I don't know”.

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In the second batch of responses, there were also exploratory close-ended questions placed after the open-ended question. We do not discuss them here (see full survey in Appendix C, and analyses in Appendix D).

**Results.**

*Data Exclusion.* Among the 900 MTurk participants, 87 participants (9.7%) failed the attention check embedded in the financial literacy questionnaire. A large majority of these participants also provided nonsensical open-ended responses (e.g., an unrelated copy-pasted text), indicating that they are likely to be “bots”--automated programs mimicking human behavior--or non-English speaking participants. We excluded these participants from analysis, yielding a total of 813 participants. In all subsequent studies, the exclusion rate was much lower (around 3-4%) due to using the “Turkprime” platform (Litman, Robinson, & Abberbock, 2017), has been shown to improve the data collection quality.

*Fund Choice.* We coded the choice of the diversifying fund as 1, and the choice of the non-diversifying fund as 0. We conducted a logistic regression of this binary variable on the financial literacy score. We found that a higher financial literacy score predicted a higher likelihood to choose the diversifying fund (z=5.44, p<.001).

To better understand fund choices across high and low financial literacy individuals, we proceeded to a quartile analysis (see Figure 1). Among participants in the top quartile of financial literacy (N=185), 62.16% chose the diversifying fund. This proportion was significantly different from chance level, as shown in a two-sided binomial test (p=.001). In contrast, among participants in the bottom quartile of financial literacy (N=230), only 36.95% chose the diversifying fund, also significantly different from chance level (p<.001). The fund choices in the two other quartiles were in-between, as shown in Figure 1.
Thematic coding of open-ended responses. Two trained coders were provided a spreadsheet with all 813 open-ended responses, associated with each respondent’s investment decision. The coders were not aware of our research hypotheses, not informed of participants’ financial literacy level, and not given any pre-established theme. We first instructed the coders to list all reoccurring themes in the responses. The two coders generated their themes list independently. Then, one author of this manuscript met with the two coders, and together they constructed a unique list of reoccurring themes and established a code book. Finally, one of two coders was instructed to code each opened-ended response, based on whether the theme was present. One response could be assigned under more than one theme.

Table 2 provides a list of all the themes that the participants provided to justify their fund choice, associated with the number of participants who evoked each theme, in each quartile of financial literacy.

As shown in Table 2, among participants justifying a decision to invest in the non-diversifying fund, we identified three themes. The first was **simplicity**: correlated assets are simpler to track, monitor, or manage (e.g., #32 “It would be easier to track its performance and use the same strategies I use with my current fund. I like the idea of a fund similar to my own”). The second was **familiarity**: it would be easier to gain knowledge and understand how correlated assets “work” (e.g., #215 “Because it works the same as my current account. I'm familiar with it and feel safe to have another one just like the current one.”). The third was **predictability**: returns of correlated assets are consistent thus easier to predict (e.g., #119 “Because it performs similar to the investment I already have. It makes me feel comfortable and more at ease knowing what to
expect with my investments. It gives me peace of mind because I can plan and expect my returns to be a certain amount.”). We noted much overlap across these three themes, providing initial evidence that they represent an overarching construct related to processing fluency. We also noted that many participants who evoked these themes also explicitly mentioned that their investment decision would be less risky (low risk), especially participants with low financial literacy (e.g., #74 “I am a creature of habit. I am more comfortable investing into something similar. If it is producing the same way as my other fund, I would be more comfortable with that. I am not a person willing to take too many risks.”). Among the 145 participants in the bottom quartile of financial literacy who chose the non-diversifying (correlated) fund, 97 evoked themes related to this “lay” risk perception (i.e., explicitly mentioned low risk and/or themes related to processing fluency).

Additionally, we identified a high profit theme: some participants justified their decision to invest in the non-diversifying fund by saying that owning correlated assets would be more profitable, especially on the short term (e.g. #10 “I chose it because it they are both doing well I can sell them at the same time cash out and make money”). We found this theme especially prevalent among participants in the top quartile of financial literacy (38 out of 70). Importantly, this short-term strategy was inconsistent with the scenario that required making a long-term investment.

Among participants justifying a decision to invest in the diversifying fund, most participants identified the correct (“expert”) reason: uncorrelated assets reduce portfolio volatility, and thus portfolio risk. This was especially prevalent among participants in the top quartile of financial literacy (111 out of 115). However, among the bottom quartile participants who chose the diversifying fund, a majority (56 out of 85) had a close enough intuition (e.g., #467 “I would not
have low points and high points. It would be steady income. One fund would offset the other fund. Like if I had two jobs that pay bi-weekly I would want my checks on opposite weeks”).

**Discussion**

In line with hypotheses 1 and 2, in Study 1, participants with high financial literacy preferred investing in a diversifying fund; most of them explained that uncorrelated assets reduce portfolio volatility, which is the normative (or “expert”) driver of portfolio risk. On the other hand, participants with low financial literacy preferred investing in a non-diversifying fund, erroneously thinking that it would be less risky. We identified three broad themes related to processing fluency and driving this lay risk perception: (1) correlated assets are simpler to track and manage, (2) correlated assets are easy to get familiar with, and (3) correlated performances are easier to predict.

There are limitations to Study 1. First, the scenario endowed participants with a fund, so their decision to invest in a second, identical fund may be explained by a status-quo bias. In the next study, we extend our setting to a situation where investors choose two funds simultaneously. Second, we did not provide numeric information about the funds, and some participants drew inferences about the individual profitability of the funds. We address this limitation in the next study by providing a numeric summary of past returns, and controlling for the individual profitability and volatility of the funds.

**STUDY 2**

Study 2 aims to replicate Study 1 results with simultaneous (in addition to sequential) investment decisions, and to collect process evidence with psychometric methods. We measured
the “lay” themes identified in Study 1 (simplicity, familiarity, and predictability), and tested whether they represent a common, overarching construct (processing fluency). Study 2 also aims to show that lay versus expert investment decisions derive from divergent portfolio risk perceptions: lay risk perception is driven by processing fluency (explaining why correlated assets are judged less risky), while expert risk perception is driven by portfolio volatility (explaining why uncorrelated assets are judged less risky).

Method

395 MTurk participants (60.3% female, mean age=34.7) were paid $1 to participate in this study. In this and all subsequent studies, we used the “TurkPrime” platform. Using this platform allowed not only collecting quality responses, but also ensuring that we did not use any respondent from other studies included in this manuscript. Participants were randomly assigned to one of two experimental conditions: sequential choice and simultaneous choice. Participants first read a scenario. In the “sequential choice” condition, the scenario was very similar to the one presented in Study 1: participants were told that they already owned fund Gamma, and that they could choose to invest in a second fund, either Epsilon (that has reportedly performed very similarly to Gamma in the past) or Sigma (that has reportedly performed quite differently from Gamma in the past). Information about asset covariance was also provided in the form of a table of past returns over 7 years, as shown in Figure 2. The individual variance and the 7-year performance of the funds were identical. The 7-year performance was provided in the table. We created two versions of the table (randomized across participants) to control for any potential effect of the sequence of returns (see Appendix B). For instance, in the first (second) version of the table, the 2016 returns of Gamma and Epsilon were negative (positive) while the 2016 return of Sigma was positive (negative).
In the “simultaneous choice” condition, participants read a similar scenario and were shown
the same table, although they were not told that they already owned Gamma.

In both conditions, participants were reminded that they invested for the long term, and
indicated whether they preferred being invested in Gamma & Epsilon (which we call here the
“non-diversified portfolio”) or in Gamma & Sigma (which we call here the “diversified
portfolio”), on a 5-point scale ranging from -2 (labelled “definitely Gamma & Epsilon”) to +2
(labelled “definitely Gamma & Sigma”) with a middle point 0 (labelled “I’m indifferent”).

Then, we asked a series of questions presented in random order (with the table of past
returns shown to help participants answer the questions).

Risk. We measured risk perception with three items, using wording similar to what Study 1
participants used: “Which portfolio seems riskier?”; “Which portfolio seems safer?”; “and
“Which portfolio seems more dangerous?”. We measured each answer on a 5-point scale ranging
from -2 (labelled “definitely Gamma & Epsilon”) to +2 (labelled “definitely Gamma & Sigma”)
with a middle point 0 (labelled “Both portfolios equally”). The same 5-point scale was used for
all questions listed below.

Volatility (driver of “expert” risk perception). We measured volatility perception with a
single item, using wording that could be understood by all participants: “Which portfolio is
likely to fluctuate more over time (meaning sharply moving up and down)?”.

Fluency (driver of “lay” risk perception). While volatility is an objective, statistic construct
that is measured by a single item, fluency is a more complex and highly context-dependent
construct. We thus measured it with three subscales composed of three items each, measuring the
fluency-related drivers of risk perception uncovered in Study 1. All questions were largely
inspired by the wording of the open-ended responses collected in Study 1. The first 3-item subscale measured simplicity: “Which portfolio would be easier to track?”; “Which portfolio would be more complicated to track?” and “Which portfolio would be more confusing?” The second 3-item subscale measured familiarity—we worded the questions so that they could apply to both sequential and simultaneous investment decisions: “Which portfolio would it be easier to get familiar with?”; “Which portfolio would it be easier to get used to?”; and “Which portfolio would it be easier to get accustomed to?”. The third 3-item subscale measured predictability: “Which portfolio makes you feel more certain about future performances?”; “Which portfolio would have more predictable future performances?”; and “With which portfolio would you know better what to expect about future performances?”.

*Profit and Loss.* We measured perceived long-term profitability (“Which portfolio is more likely to be profitable in the long run?”) and loss (“Which portfolio is more likely to lose money in the long run?”).

Finally, we measured financial literacy with the same 19 questions as in Study 1.

**Results.**

**Data exclusion.** 12 participants (3.0% of the total number of participants) failed the attention check embedded in the financial literacy questionnaire, and were excluded from analysis.

**Scale construction.** The three-item risk perception scale was highly reliable ($\alpha = .93$).

We ran a factor analysis (PCA) of the 9 items measuring the drivers of lay risk perception: simplicity, familiarity, and predictability (3 subscales of 3 items). The first factor had an eigenvalue of 4.50, and the factor loadings of the 9 items ranged between $|.54|$ and $|.86|$. The second factor had a much smaller eigenvalue (1.05), with a maximum factor loading of $|.52|$. We concluded that the scale measuring the drivers of lay risk perception was unidimensional. We
thus created a unique 9-item scale, which was highly reliable ($\alpha = .89$), and which we used for the subsequent analyses. We will refer to this aggregate measure as “fluency perception”, which is the overarching construct for simplicity, familiarity, and predictability.

**Portfolio choice.** We regressed portfolio choice on the mean-centered financial literacy score, a binary variable capturing the effect of the simultaneous vs. sequential decision manipulation (coded -1 for sequential, and +1 for simultaneous), and their interaction. Neither the main effect of the simultaneous vs. sequential decision manipulation, nor the interaction effect between the manipulation and financial literacy significantly impacted investment decision ($p’s>.65$). In contrast, financial literacy significantly predicted investment decisions ($t(379)=8.61, p<.001$). The sequential vs. simultaneous manipulation had no significant impact on any of the collected measures; we thus collapsed the two experimental conditions in the subsequent analyses, and do not discuss them any further.

We then proceeded to quartile analyses (see Figure 3). Consistent with Study 1, participants in the top quartile of financial literacy largely invested in the diversified portfolio, i.e. Gamma-Sigma. The mean answer was .95 (SD=1.12), on the 5-point scale ranging from -2 (Definitely Gamma-Epsilon) to +2 (Definitely Gamma-Sigma). This was significantly different from zero, the indifference point ($t(94)=8.22, p<.001$). Consistent with Study 1, participants in the bottom quartile of financial literacy invested in the non-diversified portfolio, i.e. Gamma Epsilon (M=-.46, SD=1.10; significantly different from zero: $t(90)=-4.00, p<.001$). The results in the other two quartiles were “in-between”.

***Insert Figure 3 here***

**Risk Perception, Volatility and Fluency.** We then proceeded to the analysis of risk perception and its potential drivers: perceived volatility and perceived fluency. Separate
regressions showed that financial literacy significantly predicted risk perception ($t(383)=-7.13, p<.001$) and volatility perception ($t(383)=-5.40, p<.001$), but not fluency perception ($t<1$).

As shown in Figure 3, participants in the top quartile of financial literacy considered the non-diversified portfolio riskier than the diversified one ($M=-.64, SD=.90$; significantly different from zero: $t(94)=-6.94, p<.001$), more volatile ($M=-.67, SD=1.18$; $t(94)=-5.56, p<.001$), but also more fluent ($M=-.38, SD=.64$; $t(94)=-5.76, p<.001$). In fact, all four quartiles found the non-diversified portfolio more “fluent”, although this does not necessarily predict investment decisions, as the following mediation analyses show.

Participants in the bottom quartile of financial literacy erroneously considered the non-diversified portfolio less risky than the diversified one ($M=.37, SD=.89$; significantly different from zero: $t(90)=3.92, p<.001$), and also more “fluent” ($M=-.39, SD=.81$; $t(90)=-4.65, p<.001$). They did not consider a portfolio more volatile than the other ($M=.10, SD=.94$; $t(90)=1.00, p=.32$), consistent with past research suggesting that lay investors ignore the relation between asset covariance and portfolio volatility.

The results in the other two quartiles were consistently “in-between”.

**Mediation Analyses.** In the following analyses, we investigate how volatility perception and fluency perception influence risk perception and portfolio choice across the four quartiles.

We built a structural equation model, with volatility and fluency as independent variables, risk perception as a mediator, and portfolio investment choice as the dependent variable. Hence, two paths (Volatility $\rightarrow$ Risk $\rightarrow$ Investment, and Fluency $\rightarrow$ Risk $\rightarrow$ Investment) were estimated simultaneously. Table 3 displays the coefficients and the 95% confidence intervals of the total effects of the IVs on the DV, the indirect effects (i.e., mediation through risk perception), and the residual direct effects for each of the four quartiles of investment literacy. The 95% confidence
intervals were all obtained with the bootstrapping method (500 replications), which is an estimation option available on STATA for Structural Equation Modeling. The entire outputs are provided in Appendix E.

***Insert Table 3 here***

As shown in Table 3, in the top quartile of financial literacy, perceived fluency did not play any significant role, while perceived volatility played a key role. The perceived lower volatility of the diversified portfolio significantly predicted investment in that portfolio (total effect: $\beta=-.25; 95\% \ CI=[-.47,-.04]$), and this effect was fully mediated by risk perception (indirect effect: $\beta=-.18; 95\% \ CI=[-.29,-.08]$); the residual direct effect was non-significant. In other words, as hypothesized, these expert investors relied on the “expert” driver of risk (volatility), explaining their investment in the diversified portfolio.

In the bottom quartile, perceived volatility did not play any significant role, while perceived fluency played a major role. The perceived fluency of the non-diversified portfolio significantly predicted investment in that portfolio (total effect: $\beta=.57; 95\% \ CI=[.31,.83]$), and this effect was fully mediated by risk perception (indirect effect: $\beta=.39; 95\% \ CI=[.12,.65]$); the residual direct effect was non-significant. In other words, as hypothesized, these lay investors relied on a “lay” driver of risk (fluency), leading them to invest in the non-diversified portfolio.

Role of Profit and Loss Perceptions. Thus far, the analyses showed that differences in risk perception explain why portfolio choices drastically differ across participants with different levels of financial literacy. Arguably, the differences in portfolio choices could also be driven by differences in profit perception or loss perception. However, participants in the bottom quartile of financial literacy did not find any portfolio significantly more profitable than the other ($M=0.00, SD=.86$), although they found the diversified portfolio marginally more prone to loss
Participants in the top quartile found the non-diversified portfolio more profitable ($M=.19$, $SD=.72$; $t(94)=2.57$, $p=.01$) and less prone to loss ($M=-.22$, $SD=.77$; $t(94)=-2.78$, $p=.01$), although these effects were small compared with those of risk perception ($M=-.64$) or volatility perception ($M=-.67$).

To further test these alternative explanations, we estimated a mediation model, with financial literacy as the independent variable, portfolio choice as the dependent variable, and risk perception, profit perception, and loss perception as three potential mediators. Only risk perception was a significant mediator (indirect effect through risk perception: $\beta=.035$, 95% CI=[.019,.051]). The indirect effects through loss perception and profit perception were insignificant (respectively, $\beta=.002$, 95% CI=[-.006,.010]; $\beta=.006$, 95% CI=[-.002,.014]).

**Discussion**

Study 2 replicated the findings of Study 1 with psychometric methods. In line with Hypotheses 1 and 2, lay investors perceived the non-diversified portfolio as less risky, because it was processed more fluently; therefore they diversified poorly. Expert investors perceived the diversified portfolio as less risky, because it was perceived as less volatile; therefore they diversified effectively.

**STUDY 3**

Study 3 aims to provide further experimental evidence that the different diversification strategies of lay and expert investors are driven by divergent perceptions of risk. Rather than measuring risk perception, we manipulated investment goals and encouraged participants to either seek or avoid risk in their investment decision. We hypothesize (H3) that encouraging risk-seeking will have opposite consequences across lay and expert investors: it will effectively
decrease expert investors’ tendency to diversify, while it will ironically *increase* lay investors’ tendency to diversify. Importantly, in the instructions in this study, the term “risk” was always left to participants’ own interpretation.

**Method**

615 MTurk participants (60.2% female, mean age=33.8) were paid $1 to participate in this study. We assigned participants to one of two between-subject conditions, “risk-avoiding” and “risk-seeking”. Participants first read the same “simultaneous choice” scenario as in Study 2, requiring them to choose between a non-diversified portfolio (Gamma & Epsilon, with positively correlated returns), or a diversified portfolio (Gamma & Sigma, with negatively correlated returns).

In addition, in the risk-avoiding condition, the scenario ended with: “This is important: when choosing between "Gamma & Epsilon" and "Gamma & Sigma", you want to make a low-risk investment. You don't care about trying to make huge returns, you only care about making a safe, low-risk investment.” In the risk-seeking condition, the scenario ended with: “This is important: when choosing between "Gamma & Epsilon" and "Gamma & Sigma", you want to make an investment with high returns. You don't care if your investment is risky or unsafe, you only care about making a high-return investment.” Participants made their investment decision on a 5-point scale ranging from -2 (“definitely Gamma & Epsilon”) to +2 ( “definitely Gamma & Sigma”) with a middle point 0 (“I’m indifferent”).

Then, we measured risk, volatility, profit, and loss perception; the results were highly consistent with Study 2, and the risk manipulation did not significantly impact these perceptual measures. For the sake of brevity we provide the analyses in Appendix F.

Finally, we measured financial literacy with the same test as in the previous studies.
Results and Discussion.

Data Exclusion. 19 participants (3.1% of all participants) failed the attention check embedded in the financial literacy questionnaire, and were excluded from analysis.

Portfolio Choice. We regressed portfolio choice on the mean-centered financial literacy score, a binary variable capturing the effect of the manipulation (coded -1 for risk-seeking and +1 for risk-avoiding), and their interaction. We found a significant main effect of financial literacy (t(592)=4.41, \(p<.001\)) and a significant interaction effect (t(592)=3.22, \(p=.001\)). The main effect of the manipulation was not significant (t<1).

We then proceeded to a quartile analysis. As shown on Figure 4, the mean choices in the risk-avoiding condition were very similar to Study 2: participants in the top quartile of financial literacy largely invested in the diversified portfolio (M= .82, SD=1.21; significantly different from zero, t(65)=5.47, \(p<.001\)), and participants in the bottom quartile invested in the non-diversified portfolio (M=-.51, SD=1.16; t(60)=-3.41, \(p=.001\)).

Consistent with Hypothesis 3, encouraging participants to take risk had an opposite effect among participants with different financial literacies. Encouraging risk-seeking significantly decreased top quartile participants’ investment in the diversified portfolio (M=.25, SD=1.27; effect of the risk manipulation: t(131)=2.59, \(p=.01\)), and increased bottom quartile participants’ investment in the diversified portfolio (M=.10, SD=1.21; effect of the risk manipulation: t(127)=-2.92, \(p=.004\)). That is, they ironically made a less risky investment. This shows that lay and expert investment decisions are driven by different perceptions of portfolio risk.

***Insert Figure 4 here***

STUDY 4
Past research suggests that lay investors are able to assess the volatility (and thus the risk) of an individual asset based on its returns, but not the volatility of a portfolio of assets, because it requires them to understand the relation between asset covariance and risk. Our previous studies show that lay investors do not have this knowledge, and instead, they misleadingly rely on how fluently they process assets’ returns. In Study 4, we test whether providing aggregate portfolio returns helps lay investors diversify more effectively (Hypothesis 4). This would suggest that lay investors are potentially sensitive to portfolio volatility, although they need to observe it directly.

In Studies 2 and 3, one of the three possible funds (Gamma) was by default always included in participants’ fund choices. This could potentially have a normative effect ("more common performance is less risky"). In Study 4, we eliminate this potential confound by asking participants to choose among two portfolios, with two distinct funds in each of them.

Also, Study 4 includes a financial incentive: participants were paid a bonus equivalent to a randomly-picked one-year return of their chosen portfolio (where 1% = 1 cent). This feature directly measured participants’ capacity to understand how covariance relates to risk, insofar as choosing the diversified portfolio ensured the payment of a bonus. One limitation of this financial incentive is that it could induce participants to focus on past single years of performance, instead of trying to estimate the best portfolio as a long-term investment. In order to address this limitation, we ran a close replication of Study 4 without any financial incentive; the results were consistent and reported in Appendix H.

**Method**

603 MTurk participants (59.4% female, mean age=33.8) were paid $1 to participate in this study (plus a bonus, as described below). We assigned participants to either a control condition or a “portfolio returns” condition.
In the control condition, participants first read a scenario in which one trusted bank was proposing a portfolio composed of two funds with visibly correlated returns shown in a table (Gamma & Epsilon, which we call here the “non-diversified portfolio”), while another trusted bank was proposing a portfolio composed of two other funds with visibly negatively correlated returns (Omega & Sigma, the “diversified portfolio”). Like in the previous studies, there were two versions of each table to control for the sequence of returns (see Appendix B).

In the “portfolio returns” condition, the scenario was identical, with the exception that we also provided aggregate portfolio returns in the tables. It was thus salient that the diversified portfolio had less volatile returns than the non-diversified portfolio (see Figure 5).

***Insert Figure 5 here***

Next, we explained the financial incentive to participants:

*In order to motivate you to make a choice that you think is best for you, your bonus payment will be determined by your portfolio choice. You will start with a bonus of 10 cents. Then, we will randomly determine one year of returns (it could be 2011, or 2012, or 2013, etc.) and add or subtract the overall return of the chosen portfolio of two funds on that year, where 1% = 1 cent.*

We provided some examples to make sure that the financial incentive was understood (See full script in Appendix C). Then, participants chose either Portfolio Gamma-Epsilon or Portfolio Omega-Sigma.

We measured the risk perception and the volatility perception of the portfolios as manipulation checks. Finally, we measured financial literacy with the same test as in the previous studies.

**Results.**

*Data Exclusion.* 21 participants (3.5% of all participants) failed the attention check and were excluded from analysis.
Manipulation Checks. In the control condition, risk and volatility perceptions were similar to what we found in Study 2. In contrast, in the “portfolio returns” condition, all participants perceived the diversified portfolio as significantly less risky and less volatile (see analyses in Appendix G).

Portfolio Choice. We performed a logistic regression of the portfolio choice (coded 0 for the non-diversified portfolio, and 1 for the diversified portfolio) on mean-centered financial literacy, a binary variable capturing the effect of the manipulation (coded -1 for control and +1 for portfolio returns), and their interaction. We found significant main effects of financial literacy ($z=3.22, p<.001$) and of the manipulation ($z=2.02, p=.04$), as well as a significant interaction effect with a negative sign ($z=-4.31, p<.001$), indicating that the “portfolio returns” manipulation had a stronger effect among participants with low financial literacy, as confirmed below.

We performed a quartile analysis based on financial literacy (see Figure 6). In the control condition, a majority of top quartile participants invested in the diversified portfolio (77.27%; significantly different from chance level based on a two-tailed binomial test, $p<.001$), while a minority of bottom quartile participants invested in the diversified portfolio (38.75%; marginally significantly different from chance level, $p=.06$). Note that the latter test was fully significant when using a one-tailed test, or when using a two-tailed test among participants in the bottom quintile of financial literacy.

Conversely, providing portfolio returns made a majority of bottom quartile participants invest in the diversified portfolio (75.36%; significantly different from chance level, $p<.001$).

Discussion.

As hypothesized (H4), informing lay investors (participants with low financial literacy) of aggregate portfolio returns improved diversification. This shows that lay investors are potentially
influenced by portfolio volatility, although they cannot infer it from the past returns of individual funds. Note that, because of the financial incentive, investing in the non-diversified portfolio was not necessarily suboptimal like it was in the previous studies: risk-seeking participants could have actually preferred this option, which offered approximately a 50% chance to obtain a 26-cent bonus, while choosing the diversified portfolio offered a 100% chance to obtain a 13-cent bonus. Still, when providing clearer information about bonus payment (i.e., when providing portfolio returns), we found that a majority of participants, in all four quartiles of literacy, preferred the safer, diversified portfolio. Hence, bottom quartile participants’ choice of the riskier, non-diversified portfolio in the control condition was a deviation from their risk preference.

**STUDY 5**

Study 5 aims to replicate the effect of financial literacy on diversification decisions (H2) when participants are provided expected returns across hypothetical future scenarios. Further, as demonstrated in the previous studies, lay investors ignore the objective relation between asset covariance and portfolio risk, because this relation is not intuitive. However, in the previous studies, we did not provide any reason why assets covary, which may make it especially difficult to intuit or visualize that investing in negatively correlated assets reduces risk. Thus Study 5 aims to test the generalizability of Hypothesis 2 in situations where individuals are given a concrete, logical reason for why assets co-vary the way they do. In other words, we test whether knowing the underlying causal structure of asset covariance helps lay investors diversify. This is plausible based on findings from prior research (Cosmides & Tooby, 1992) showing that people can more easily solve logical reasoning problems when the abstract rule to test (e.g., “If a person has a 'D’
rating, then his documents must be marked code ’3’”) is reframed as an everyday situation (e.g., “If a person is drinking beer, then he must be over 20 years old”).

Method

408 MTurk participants (68% female, mean age=33.7) were paid $1 to participate in this study. We assigned them to either an “abstract” or a “concrete” scenario condition.

In the abstract condition, participants read the following scenario:

Imagine that you want to invest in two of the following three company stocks: Omega, Gamma, and Epsilon. All companies are profitable, but the expected returns of the stocks depend on the future economic situations. You can expect two kinds of economic situations: Situation A or Situation B. These situations are equally likely to occur in the future.

- If Situation A occurs, then Omega and Gamma are expected to yield +30% positive returns, whereas Epsilon is expected to yield a -10% negative return.
- If Situation B occurs, then Omega and Gamma are expected to yield -10% negative returns, whereas Epsilon is expected to yield a +30% positive return.

In the concrete condition, participants read:

Imagine that you want to invest in two of the following three videogame company stocks: Omega Games, Gamma Games, and Epsilon Games. All companies are profitable, but the expected returns of the stocks depend on the future success of videogame consoles. Omega and Gamma both have an exclusivity deal with the videogame console "GameStation", while Epsilon has an exclusivity deal with the videogame console "GameBox". Usually, only one videogame console is successful and wins the market. You can expect two kinds of situations: GameStation wins the market, or GameBox wins the market. These situations are equally likely to occur in the future.

- If GameStation wins the market, then Omega and Gamma (which produce games for GameStation) are expected to yield +30% positive returns, whereas Epsilon (which does NOT produce games for GameStation) is expected to yield a -10% negative return.
- If GameBox wins the market, then Omega and Gamma (which do NOT produce games for GameBox) are expected to yield -10% negative returns, whereas Epsilon (which produces games for GameBox) is expected to yield a +30% positive return.

In both conditions, we provided a table that summarized this information (see full script in Appendix C). Participants were asked whether they preferred investing in Omega & Gamma (which we call here the “non-diversified portfolio”) or Omega & Epsilon (which we call here the
“diversified portfolio”), on a 5-point scale ranging from -2 (labelled “Strongly prefer Omega & Gamma) to +2 (“Strongly prefer Omega & Epsilon”) with a middle point 0 (“I’m indifferent”).

We measured financial literacy with the same test as in the previous studies.

Like in Study 4, choosing the non-diversified portfolio was not necessarily a mistake—it depends on one’s attitude toward risk. Hence, at the very end of the survey, we measured each participant’s risk tolerance by asking their preference between two options whose risk and payoff were identical to the portfolios. Option A (whose payoff mimicked the non-diversified portfolio) had “50% chance of yielding a +30% return, and 50% chance of yielding a -10% negative return”. Option B (whose payoff mimicked the diversified portfolio) had “100% chance of yielding a +10% return”. Participants answered on a 5-point scale ranging from -2 (labelled “Strongly prefer A”) to +2 (“Strongly prefer B”) with a middle point 0 (“I’m indifferent”).

Results

Data Exclusion. 18 participants (4.4% of all participants) failed the attention check and were excluded from analysis.

Portfolio Choice. We regressed portfolio choice on the mean-centered financial literacy score, a binary variable capturing the effect of the abstract vs. concrete manipulation (coded -1 for abstract, and +1 for concrete), and their interaction. We found a significant main effect of financial literacy (t(386)=4.87, \( p<.001 \)), but neither the main effect of the manipulation nor the interaction effect were statistically significant (respectively, t(386)=−1.28, \( p=.20 \); t(386)=.81, \( p=.42 \)). We therefore collapsed the two experimental conditions (abstract vs. concrete) in the subsequent analyses, and do not discuss them any further.

We then proceeded to quartile analyses (see Figure 7). Consistent with Hypothesis 2 and as shown in Figure 7, participants in the top quartile of financial literacy preferred investing in the
diversified portfolio (M=.54, SD=1.40; significantly different from the midpoint zero: t(77)=3.39, p=.001), while participants in the bottom quartile preferred investing in the non-diversified portfolio (M=-.54, SD=1.29; significantly different from zero: t(110)=-4.41, p<.001).

***Insert Figure 7 here***

**Comparison with Risk Attitude.** As shown in Figure 7, participants in all four quartiles of financial literacy were risk-averse (they preferred the safe option, the one that mimicked the payoff of the diversified portfolio). Participants with high financial literacy were well calibrated and chose a diversified, low-risk portfolio corresponding to their risk tolerance, while participants with low financial literacy chose a non-diversified, high-risk portfolio despite being risk-averse.

**Discussion**

As hypothesized (H2), participants with low financial literacy invested in a non-diversified portfolio based on expected returns, taking more risk than they would seem to want (based on a separate but equivalent measure of risk attitude). Furthermore, providing a concrete, logical reason why assets co-vary did not improve diversification.

**GENERAL DISCUSSION**

We find that lay investors (i.e., those low in financial literacy) perceive portfolio risk differently than expert investors (i.e., those high in financial literacy). Expert investors base their judgments of risk on portfolio *volatility*; they know that portfolios with uncorrelated or negatively correlated assets are less volatile, thus less risky. In contrast, lay investors base their judgments of risk on *fluency*; they process portfolios with positively correlated assets more
fluently (simpler, more familiar, more predictable), and erroneously perceive such non-
diversified portfolios as less risky. Hence, providing covariance information can have perverse
consequences: lay investors will deliberately avoid negatively correlated or uncorrelated assets,
and choose high-risk, high-volatility, non-diversified portfolios due to these portfolios being
processed more fluently. We find this consistent pattern in both sequential and simultaneous
investment allocation tasks, and regardless of whether covariance information is presented with
verbally or numerically described past returns, or expected future returns.

Building on these insights, we identify two interventions that "nudge" lay investors (Thaler
& Sustein, 2003) to choose diversified portfolios. The first intervention is—ironically—to
encourage them to take more risk. Because lay investors perceive negatively correlated assets as
riskier, encouraging risk-seeking results in choosing such assets and forming less volatile, better
diversified portfolios. However, this nudge has the opposite effect on expert investors: because
they base their judgments of risk on volatility, they choose relatively less diversified portfolios
when encouraged to take risk.

The second intervention is to pre-calculate and display aggregate portfolio returns (rather
than only the individual returns of each asset). In this case, it becomes very salient that
diversified portfolios (with negatively correlated assets) are less volatile, increasing their
attractiveness even among lay investors. This intervention complements previous literature on
Myopic Loss Aversion (MLA; Benartzi & Thaler, 1999; Haigh & List, 2005; Looney & Hardin,
2009; Webb & Shu, 2017). Research on MLA has found that aggregating investment returns
over time ("broad bracketing") leads to a preference for investments with a more attractive risk-
return profile, because this aggregation helps investors visualize or understand performance over
time. Similarly, we find that aggregating investment returns across the portfolio also leads to a
preference for a portfolio with a more attractive risk profile. Note however that in the current research, we held investment time horizon and average profitability constant across portfolios, such that the less risky portfolio always provided a more attractive risk-return profile; while research on MLA focuses on situations where a higher return-higher risk investment is more attractive. Future research could vary these factors to see if they moderate our findings.

We tested a possible third intervention: providing concrete, causal reasons why assets co-vary the way they do. This intervention relies on research showing that people can more easily solve logical reasoning problems when an abstract rule is reframed as a concrete one (Cosmides & Tooby, 1992). However, this intervention did not have a significant impact on lay investors’ diversification, suggesting that the relation between asset covariance and risk is particularly difficult to intuit or visualize. Future research could investigate how to make this relation more intuitive to lay investors.

Across all studies, we measured financial literacy with a 19-question test that included a blend of easier and harder questions. We always used the same population, Amazon Mechanical Turk participants, who are fairly representative of the U.S. population in terms of income, education, and professional activity (Levay et al., 2016; Paolacci et al., 2010), hence we could take advantage of heterogeneous, and fairly representative financial literacy.

While we included a study where portfolio choice was financially incentivized, a potential concern is that participants had no extrinsic incentive for the financial literacy test. What if, rather than distinguishing high from low financial literacy, this test is instead a measure of attention or intrinsic motivation? In other words, what if the supposed "low financial literacy" participants are merely random responders? We believe that random responses had a very marginal impact on the results. First, in Studies 2 through 5 (where we used the TurkPrime
platform), only 3 to 4% of participants failed the attention check (a very easy question) embedded in the financial literacy test, and these participants were excluded from analysis. Second, a participant who answered randomly to all 19 questions of the financial literacy test (and somehow managed to pass the attention check) would have, on average, a financial literacy score of 4.55 out of 19, situating her in the bottom quartile of financial literacy (score between 0 and 7). Yet, across all studies, bottom quartile participants preferred investing in correlated assets; the effect was always significantly different from chance level. Again, this suggests that inattentive participants had only a marginal (if any) impact on the results, otherwise we would have failed to find this significant difference from chance level.

We have also examined how well MTurk participants performed on the financial literacy test. Across all studies (N=2763), Mturk participants correctly answered on average more than half of the 19 multiple-choice questions (M=9.64, SD=3.55), which each had 3 to 6 possible choices. As a comparison, we distributed a selection of 7 difficult questions from the test to 710 undergraduate students from a major U.S. Business School (Mean age=19.67; 56% Female); 688 of them passed the same attention check as the one used with the MTurk participants. Among them, there were 211 students in a Finance concentration, and 477 students in a non-Finance concentration (although all of them took at least an Introduction to Finance course). On average, MTurk participants correctly answered 2.25 of these difficult questions (SD=1.43); this was significantly less than the Finance students (M=2.70, SD=1.47; p<.001), but significantly more than the non-Finance students (M=1.64, SD=1.34; p<.001). Therefore, it appears that the overall financial literacy of the MTurk population is reasonable.

In this paper, we have used the terms "lay investor" and "low financial literacy" interchangeably. While these dimensions are undoubtedly correlated, there are lay investors who
are high in financial literacy, and many supposed expert investors who are low in financial literacy. Future research could disentangle the effect of financial literacy from the effect of financial experience.

Our findings make several theoretical contributions. First, we contribute to the literature on "risk as feelings" (Alter & Oppenheimer, 2006; Loewenstein et al., 2001; Slovic & Peters, 2006), demonstrating fluency as an important driver of heuristic perceptions of financial risk, and showing differential reliance of lay (vs expert) investors on this heuristic process. This suggests a novel contributing factor for well-established investment biases, such as the home bias (Cooper & Kaplanis, 1994; Coval & Moskowitz, 1999). For instance, in addition to having familiar names, "home" investments also have correlated returns, which may be more fluently processed by lay investors, further explaining why individuals’ portfolios are over-invested in domestic assets.

Our findings also contribute to the literature on financial diversification, which has two components: “passive diversification” (investing in multiple assets) and “diversification skill” (choosing imperfectly correlated assets) (Goetzmann & Kumar, 2008). Previous research in diversification biases has primarily focused on the former component, passive diversification, finding that lay investors tend to invest evenly across available financial assets (Benartzi & Thaler, 2001) and neglect covariance (Hedesstrom et al., 2006). In contrast, our research focuses on the latter component, diversification skill. We show that lay investors do not neglect covariance; but they use it incorrectly to assess financial risk. Our findings can be reconciled with research on covariance neglect: overall, covariance information does not seem to influence diversification decisions. However, financial literacy strongly moderates this seemingly null
effect, insofar as covariance information has opposite consequences among individuals with low versus high financial literacy.

From a practical perspective, our findings provide solutions to improve financial diversification. For instance, past research has suggested that employers should limit the number of assets offered in a 401(k) investment menu because too much choice may be overwhelming (Iyengar, Huberman, & Jiang, 2004; Morrin et al., 2012). In addition, our results suggest that banks, or employers who offer contribution plans, should propose online tools that allow individuals to observe the aggregate returns of the different assets they wish to invest in. For instance, prospective new assets could be integrated with the existing portfolio to show the aggregate fluctuation. Such features should nudge lay investors to form well-diversified portfolios, while having little effect on expert investors; a “just-in-time” financial education (Fernandes et al., 2014).

Financial illiteracy across individual investors remains widespread, even in such developed financial markets as the United States, Western Europe, and Japan (Van Rooij, Lusardi, & Alessie, 2011). At the same time, as defined contribution pension plans gain popularity among employers and FinTech apps gain popularity among consumers, individuals often find themselves in charge of their own financial security, while simultaneously being confronted with an assortment of sophisticated financial instruments. The need for robust solutions to help people to make better investment decisions has never being greater. Through an improved understanding of the risk perceptions of lay investors, we can build better financial tools to bridge the gap and nudge lay investors to allocate like expert investors.
REFERENCES


Figure 1. Study 1 - Fund choice across financial literacy quartiles
Figure 2. Study 2 – Example of table of past returns

<table>
<thead>
<tr>
<th>Calendar Returns</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>Overall performance (7 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gamma</td>
<td>5.5%</td>
<td>-5.1%</td>
<td>13.8%</td>
<td>-4.6%</td>
<td>13.6%</td>
<td>-1.4%</td>
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<td>+28%</td>
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<tr>
<td>Epsilon</td>
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<td>-4.8%</td>
<td>13.8%</td>
<td>-1.6%</td>
<td>4.9%</td>
<td>+28%</td>
</tr>
<tr>
<td>Sigma</td>
<td>-1.5%</td>
<td>13.9%</td>
<td>-4.8%</td>
<td>13.5%</td>
<td>-4.9%</td>
<td>5.6%</td>
<td>4.9%</td>
<td>+28%</td>
</tr>
</tbody>
</table>
Figure 3. Study 2 – Portfolio choice, and risk, volatility, and fluency perceptions across financial literacy quartiles

Non-diversified portfolio (Gamma-Epsilon)  

Portfolio choice

Diversified portfolio (Gamma-Sigma)  

Financial Literacy:
- Top quartile (N=95)
- 2nd quartile (N=96)
- 3rd quartile (N=101)
- Bottom quartile (N=91)

Portfolio perceived as more fluent (=simple, familiar, predictable)

Portfolio perceived as riskier

Portfolio perceived as more volatile

Portfolio choice

- Top quartile
- 2nd quartile
- 3rd quartile
- Bottom quartile

Non-diversified portfolio (Gamma-Epsilon)  

Portfolio choice

Diversified portfolio (Gamma-Sigma)  

Financial Literacy:
- Top quartile (N=95)
- 2nd quartile (N=96)
- 3rd quartile (N=101)
- Bottom quartile (N=91)

Portfolio perceived as more fluent (=simple, familiar, predictable)

Portfolio perceived as riskier

Portfolio perceived as more volatile

Portfolio choice

- Top quartile
- 2nd quartile
- 3rd quartile
- Bottom quartile

Non-diversified portfolio (Gamma-Epsilon)  

Portfolio choice

Diversified portfolio (Gamma-Sigma)  

Financial Literacy:
- Top quartile (N=95)
- 2nd quartile (N=96)
- 3rd quartile (N=101)
- Bottom quartile (N=91)

Portfolio perceived as more fluent (=simple, familiar, predictable)

Portfolio perceived as riskier

Portfolio perceived as more volatile

Portfolio choice

- Top quartile
- 2nd quartile
- 3rd quartile
- Bottom quartile
Figure 4. Study 3 – Portfolio Choice per Financial Literacy quartile and risk condition

Portfolio Choice

-2 -1.5 -1 -0.5 0 0.5 1 1.5 2

- risk-taking
- risk-avoiding

Financial Literacy:

- Top quartile (N=132)
- 2nd quartile (N=177)
- 3rd quartile (N=159)
- Bottom quartile (N=128)

Non-diversified portfolio
(Gamma-Epsilon)

Diversified portfolio
(Gamma-Sigma)
Figure 5. Study 4 - Examples of tables of past returns in the control condition (top) and “portfolio returns” condition (bottom).

<table>
<thead>
<tr>
<th>Calendar Returns</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
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<th>2017</th>
<th>Overall performance (7 years)</th>
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<td>Gamma</td>
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<td>12%</td>
<td>-9%</td>
<td>16%</td>
<td>+32%</td>
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<tr>
<td>Epsilon</td>
<td>14%</td>
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<td>17%</td>
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<td>-11%</td>
<td>16%</td>
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<tr>
<td>Overall portfolio</td>
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<td>-10%</td>
<td>16%</td>
<td>-10%</td>
<td>16%</td>
<td>+32%</td>
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<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>Overall performance (7 years)</th>
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<tr>
<td>Omega</td>
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<td>Overall portfolio</td>
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<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>16%</td>
<td>+32%</td>
</tr>
</tbody>
</table>
Figure 6. Study 4 – Portfolio Choice per Financial Literacy quartile and information condition
Figure 7. Study 5 – Portfolio Choice and Risk Attitude per Financial Literacy quartile

- Risk Attitude
- Portfolio Choice

Financial Literacy:
- Top quartile (N=78)
- 2nd quartile (N=76)
- 3rd quartile (N=125)
- Bottom quartile (N=111)

Risk Attitude: Risk-Seeking
Portfolio Choice: Non-diversified (Omega-Gamma)

Risk Attitude: Risk-Averse
Portfolio Choice: Diversified (Omega-Epsilon)
Table 1. Example of Table of Past Returns (TD Bank, 2018).

<table>
<thead>
<tr>
<th>Fund</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>TD U.S. Blue Chip Equity Fund</td>
<td>+30.8%</td>
<td>-4.7%</td>
<td>+25.5%</td>
</tr>
<tr>
<td>TD Canadian Health Sciences Fund</td>
<td>+32.8%</td>
<td>-15.2%</td>
<td>+17.3%</td>
</tr>
<tr>
<td>TD Canadian Small-Cap Fund</td>
<td>-7.8%</td>
<td>+18.7%</td>
<td>-1.9%</td>
</tr>
</tbody>
</table>
Table 2. Study 1 – Thematic coding of open-ended responses

<table>
<thead>
<tr>
<th>Reasons for choosing the non-diversifying fund</th>
<th>Total number of participants</th>
<th>Financial literacy:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bottom quartile</td>
<td>Third quartile</td>
</tr>
<tr>
<td>Low risk</td>
<td>61</td>
<td>53</td>
</tr>
<tr>
<td>Choosing this asset is less risky, safer, more stable; it feels &quot;less like a gamble&quot;. Would feel less stressed, less nervous, more confident.</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>Simplicity</td>
<td>58</td>
<td>55</td>
</tr>
<tr>
<td>Assets would be easier to track, monitor, or manage; it would be less confusing and simpler.</td>
<td>27</td>
<td>28</td>
</tr>
<tr>
<td>Predictability</td>
<td>58</td>
<td>55</td>
</tr>
<tr>
<td>Returns are more consistent, thus more predictable and less surprising; easier to plan for the future.</td>
<td>27</td>
<td>28</td>
</tr>
<tr>
<td>Familiarity</td>
<td>27</td>
<td>28</td>
</tr>
<tr>
<td>Assets would become more familiar, easier to gain knowledge and understand how they work.</td>
<td>97</td>
<td>85</td>
</tr>
<tr>
<td>Total &quot;Lay&quot; risk perception</td>
<td>Low risk / simplicity / predictability / familiarity</td>
<td>97</td>
</tr>
<tr>
<td>High profit</td>
<td>56</td>
<td>87</td>
</tr>
<tr>
<td>Choosing this asset would make the overall investment more profitable (making a &quot;double win&quot;), especially if timing the market.</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Indifference</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Other/No reason</td>
<td>26</td>
<td>18</td>
</tr>
<tr>
<td>No clear reason; paraphrase of the scenario; additional assumptions not included in the scenario.</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Reasons for choosing the diversifying fund</td>
<td>Total number of participants</td>
<td>85</td>
</tr>
<tr>
<td>&quot;Expert&quot; risk perception</td>
<td>56</td>
<td>87</td>
</tr>
<tr>
<td>Choosing this asset would reduce portfolio risk/volatility/fluctuations; the profit of one asset would compensate for the loss of the other asset.</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Variety-seeking</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Want something different, for the sake of variety.</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>High risk</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>It would be risky, but willing to take this risk.</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Indifference</td>
<td>3</td>
<td>3</td>
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<tr>
<td>Other/No reason</td>
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<td>13</td>
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<tr>
<td>No clear reason; paraphrase of the scenario; additional assumptions not included in the scenario.</td>
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<td>1</td>
</tr>
<tr>
<td>Financial literacy</td>
<td>Total Effect</td>
<td>Indirect Effect</td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Top quartile (N=95)</td>
<td>β=-.25 [-.47,-.04]*</td>
<td>β=-.18 [-.29,-.08]*</td>
</tr>
<tr>
<td>2nd quartile (N=96)</td>
<td>β=-.10 [-.36,.15]</td>
<td>β=-.11 [-.23,.01]†</td>
</tr>
<tr>
<td>3rd quartile (N=101)</td>
<td>β=.01 [-.25,.25]</td>
<td>β=.03 [-.15,.09]</td>
</tr>
<tr>
<td>Bottom quartile (N=91)</td>
<td>β=.12 [-.14,.39]</td>
<td>β=.07 [-.17,.03]</td>
</tr>
</tbody>
</table>

Note. Coefficients and 95% confidence intervals. Confidence intervals obtained with bootstrapping (500 reps) for all total effects, indirect effects, and residuals direct effects. * indicates significant effects (based on 95% confidence intervals). † indicates marginally significant effects (based on 90% confidence intervals).
Appendix

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APPENDIX A - FINANCIAL LITERACY QUESTIONNAIRE

Correct answers are in italic.

Items 1-7 were the ones used to test the financial literacy of U.S. Business School students (see General Discussion)

Items 1-5 : (Volpe et al., 2002); Item 6: (Mandell, 2008); Item 7: Self-created; Item 8-9: (Lusardi & Mitchell, 2011); Items 10-19: (Fernandes et al., 2014)


(1) A distribution from a mutual fund reduces its net asset value (NAV) by:
- the entire amount of the distribution
- the amount of the distribution less capital gain
- the amount of the distribution less capital inflows
- a distribution does not reduce the NAV
- I don't know

(2) An investment of $1000 compounded annually at an interest rate of 10 % for 10 years will be worth:
- more than $2000 at the end of the 10 years
- less than $2000 at the end of the 10 years
- exactly $2000 at the end of the 10 years
- It cannot be determined using this information
- I don't know

(3) Consider the following companies and their betas. Which stock will underperform the others when the stock market rises by 10%:
- Blue Company Beta = 0.85
- Orange Company Beta = 1.05
- Purple Company Beta = -1.10
- Gold Company Beta = -0.95
- I don't know
(4) A long-term debt-equity ratio that might signal a greater financial leverage risk is:
- 0.09
- 0.6
- 1.5
- 2.4
- 3.3
- I don't know

(5) As interest rates rise, the price of bonds:
- rises
- falls
- stays the same
- it cannot be determined using this information
- I don't know

(6) Which group would have the greatest problem during periods of high inflation that last several years?
- Older, working couples saving for retirement.
- Older people living on fixed retirement income.
- Young couples with no children who both work.
- Young working couples with children.
- I don't know

(7) As interest rates rise, the price of stocks:
- rises
- falls
- stays the same
- it cannot be determined using this information
- I don't know

(8) Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, would you be able to buy:
- more than today with the money in this account
- exactly the same as today with the money in this account
- less than today with the money in this account
- I don't know

(9) Do you think that the following statement is true or false? “Bonds are normally riskier than stocks.”
- True
- False
- I don't know

(10) Considering a long time period (for example 10 or 20 years), which asset described below normally gives the highest return?
- savings accounts
- stocks
- bonds
- I don't know

(11) Normally, which asset described below displays the highest fluctuations over time?
(12) Do you think that the following statement is true or false? “If you were to invest $1,000 in a stock mutual fund, it would be possible to have less than $1,000 when you withdraw your money.”
- True
- False
- I don't know

(13) Do you think that the following statement is true or false? “A stock mutual fund combines the money of many investors to buy a variety of stocks.”
- True
- False
- I don't know

(14) Do you think that the following statement is true or false? “After age 70 1/2, you have to withdraw at least some money from your 401(k) plan or IRA.”
- True
- False
- It depends on the type of IRA and/or 401(k) plan
- I don't know

(15) Do you think that the following statement is true or false? “A 15-year mortgage typically requires higher monthly payments than a 30-year mortgage, but the total interest paid over the life of the loan will be less.”
- True
- False
- I don't know

(16) Suppose you had $100 in a savings account and the interest rate is 20% per year and you never withdraw money or interest payments. After 5 years, how much would you have on this account in total?
- More than $200
- Exactly $200
- Less than $200
- I don't know

(17) Which of the following statements is correct?
- Once one invests in a mutual fund, one cannot withdraw the money in the first year
- Mutual funds can invest in several assets, for example invest in both stocks and bonds
- Mutual funds pay a guaranteed rate of return which depends on their past performance
- None of the above
- I don't know

(18) Which of the following statements is correct? If somebody buys a bond of firm B:
- He owns a part of firm B
- He has lent money to firm B
- He is liable for firm B’s debts
- None of the above
- I don't know

(19) Suppose you owe $3,000 on your credit card. You pay a minimum payment of $30 each month. At an Annual Percentage Rate of 12% (or 1% per month), how many years would it take to eliminate your credit card debt if you made no additional new charges?
(Attention Check) Which activity is the riskiest?

- Leaving all your money in a savings account
- Investing your money in trusted mutual funds
- Gambling all your money at a casino
- I don’t know
### APPENDIX B – TABLES OF PAST RETURNS (STUDIES 2-4)

#### STUDIES 2 & 3

**Sequential Choice Condition (Study 2 only)**

<table>
<thead>
<tr>
<th></th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>Overall performance (7 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Version A</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gamma (fund you already own)</td>
<td>5.5%</td>
<td>5.1%</td>
<td>13.8%</td>
<td>13.6%</td>
<td>13.6%</td>
<td>-1.4%</td>
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<tr>
<td>Epsilon</td>
<td>5.7%</td>
<td>-4.9%</td>
<td>13.9%</td>
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</tr>
<tr>
<td>Sigma</td>
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<td>13.9%</td>
<td>-4.8%</td>
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<td>Gamma (fund you already own)</td>
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**Simultaneous Choice Condition (Studies 2 and 3)**

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<tr>
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## STUDY 4

### Control Condition

#### Calendar Returns

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<th>2013</th>
<th>2014</th>
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<td>+32%</td>
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</table>

### Version A

#### Calendar Returns

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<th>2013</th>
<th>2014</th>
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### Version B

#### Calendar Returns

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### Portfolio Returns Condition

#### Calendar Returns

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### Version A

#### Calendar Returns

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<td>16%</td>
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### Version B

#### Calendar Returns

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### Overall portfolio

<table>
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<td>Sigma</td>
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Replication of Study 4 without financial Incentive (see Appendix H)

Control Condition

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Version A

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<tr>
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Version B

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<tr>
<td>Sigma</td>
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<td>6.8%</td>
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Portfolio Returns Condition

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<th>2014</th>
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<tbody>
<tr>
<td>Gamma</td>
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<tr>
<td>Epsilon</td>
<td>5.6%</td>
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Version A

<table>
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<tbody>
<tr>
<td>Omega</td>
<td>-1.1%</td>
<td>12.4%</td>
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<td>5.2%</td>
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</tr>
<tr>
<td>Sigma</td>
<td>7.4%</td>
<td>-6.2%</td>
<td>6.8%</td>
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<td>-4.3%</td>
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Version B

<table>
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<tr>
<th>Calendar Returns</th>
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<th>2013</th>
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<td>Sigma</td>
<td>7.4%</td>
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<td>6.8%</td>
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<td>-4.3%</td>
<td>3.9%</td>
<td>4.9%</td>
<td>+28%</td>
</tr>
</tbody>
</table>

Overall portfolio 6.5% -3.4% 12.7% -4.3% 12.6% -2.4% 5.1% +28%
APPENDIX C - FULL SURVEYS (STUDIES 1-5)

Each new online page of the survey is preceded by ***

STUDY 1

[Consent form]

***

Thank you for participating in this study. This study is about financial decisions. If you know nothing about finance, don't worry, you can still complete the test and your answers still matter to us!

***

PLEASE TAKE YOUR TIME TO READ THIS SCENARIO, AND ANSWER THE QUESTION BELOW (you will be able to move to the next page in about 1 minute).

Please imagine that you have invested some of your savings in one mutual fund. You are considering investing in a second fund, and you hesitate between two funds: fund Omega, and fund Epsilon. You want to invest for the long term.

Both funds Omega and Epsilon are managed by reputable firms, and in the long run, have yielded equally satisfying returns. There is however one key distinction between these two funds:

- **In the past, fund Omega has tended to perform very similarly to the fund you already have:** yielding positive returns when your fund also yielded positive returns, and yielding negative returns when your fund also yielded negative returns.
- **In contrast, fund Epsilon has tended to perform quite differently from the fund you already have:** yielding positive returns when your fund yielded negative returns, and yielding negative returns when your fund yielded positive returns.

Which fund would you invest in? Please remember that you want to invest for the long term.

☐ Omega
☐ Epsilon

***

[Scenario appears again]

You have chosen the fund [chosen fund]. Please try to explain your choice in a few sentences in the box below.

[Textbox]

***

[Scenario appears again]

[All items below rated on a 5-point scale ranging from “Definitely false” to “Definitely true”]

Please answer the questions below, about fund Omega

Investing in Omega would...

- ...increase the chance that my overall investment loses money in the long run
- ...increase the chance that my overall investment makes money in the long run
- ...increase the fluctuations of my overall investment (meaning moving up and down widely)
- ...increase the chance that my overall investment yields stable returns
- ...make the returns of my overall investment easier to monitor
− ...make the returns of my overall investment easier to predict

Please answer the questions below, about fund Epsilon
Investing in Epsilon would...
− ...increase the risk that my overall investment loses money in the long run
− ...increase the chance that my overall investment makes money in the long run
− ...increase the fluctuations of my overall investment (meaning moving up and down widely)
− ...increase the chance that my overall investment yields stable returns
− ...make the returns of my overall investment easier to monitor
− ...make the returns of my overall investment easier to predict

***

Do you personally invest in financial markets (bonds, stocks, mutual funds...)
☐ Yes, I manage personally my assets
☐ No, I have assets in financial markets but they are managed by a professional
☐ No, I don't have assets in financial markets.

How would you evaluate your knowledge of financial investment? [7-point scale ranging from Very poor to Very good]

***

[19 item financial literacy questionnaire on 19 separate pages, in random order. See Appendix A]

***

In what year were you born [textbox]

What is your gender?
☐ Male
☐ Female
☐ Other/Rather not say

What is your nationality?
☐ American (U.S.)
☐ Other (please specify) [textbox]

Language spoken at home
☐ English
☐ Other (please specify) [textbox]
Thank you for participating in this study. This study is about financial decisions. If you know nothing about finance, don't worry, you can still complete the test and your answers still matter to us!

Please imagine that you inherited one mutual fund (Gamma) from a family member. You will find below the performance of this fund over the past 7 years.

Please take a minute to read this scenario and look at the graphs. Please read everything carefully.

Now please imagine that you also inherited some cash, and you want to invest that money in a second mutual fund (in addition to Gamma). You have a long-term investment horizon (you want to keep your two funds for at least 10 years).

You have narrowed down your selection to two funds, both offered by investment firms with a solid reputation: Epsilon, and Sigma. Both funds have yielded satisfying returns in the past, but there is a key distinction between these funds (as shown in the figures below):

- In the past, Gamma (the fund you own) and Epsilon have tended to perform very similarly: yielding positive returns at the same time, and negative returns at the same time.
- In the past, Gamma (the fund you own) and Sigma have tended to perform quite differently: When Gamma yielded positive returns, Sigma yielded negative returns. When Gamma yielded negative returns, Sigma yielded positive returns.

In which two funds would you prefer being invested in?
- Definitely Gamma & Epsilon
- Rather Gamma & Epsilon
- I'm indifferent
- Rather Gamma & Sigma
- Definitely Gamma & Sigma

Imagine that you inherited money from a family member. You want to invest that money in two mutual funds, and you have a long-term investment horizon (you want to keep your two funds for at least 10 years).

You have narrowed down your selection to three funds, all offered by investment firms with a solid
reputation: Gamma, Epsilon, and Sigma. Although all funds have yielded satisfying returns in the past, there is a key distinction between these funds (as shown in the table below):

- **In the past, Gamma and Epsilon have tended to perform very similarly**: yielding positive returns at the same time, and negative returns at the same time.
- **In the past, Gamma and Sigma have tended to perform quite differently**: When Gamma yielded positive returns, Sigma yielded negative returns. When Gamma yielded negative returns, Sigma yielded positive returns.

[Here: “Simultaneous Choice” table presented in Appendix B: Participants are randomly shown Version A or B]

In which two funds would you prefer being invested in ?

- Definitely Gamma & Epsilon
- Rather Gamma & Epsilon
- I'm indifferent
- Rather Gamma & Sigma
- Definitely Gamma & Sigma

***

[From now on: all conditions]
The next questions ask you to compare a portfolio including **Gamma and Epsilon**, and a portfolio including **Gamma and Sigma**.

***

[All the following pages are presented in random order. On each of those pages, we showed again the table of past returns shown at the beginning of the questionnaire. For each question, participants answer on a 5-point scale, labelled “Definitely Gamma-Epsilon”, “Somewhat Gamma-Epsilon”, “Both Portfolios Equally”, “Somewhat Gamma-Sigma”, “Definitely Gamma-Sigma” ]

- Which portfolio seems **riskier**?
- Which portfolio seems **safer**?
- Which portfolio seems **more dangerous**?  
  ***
- Which portfolio is likely to **fluctuate more over time** (meaning sharply moving up and down)  
  ***
- Which portfolio would be **easier to track**?
- Which portfolio would be **more complicated to track**?
- Which portfolio would be **more confusing**?  
  ***
- Which portfolio would it be **easier to get familiar with**?
- Which portfolio would it be easier to **get used to”?**
- Which portfolio would it be easier to **get accustomed to”?**  
  ***
- Which portfolio would have **more predictable future performances**?
- Which portfolio makes you feel **more certain about future performances**?
- With which portfolio would you **know better what to expect about future performances**?  
  ***
- Which portfolio is more likely to be **profitable in the long run**?
- Which portfolio is more likely to **lose money in the long run**?  
  ***

[The rest of the survey is identical to Study1, starting from “Do you personally invest in financial markets”]
STUDY 3

[Consent form]

Thank you for participating in this study.
This study is about financial decisions. If you know nothing about finance, don't worry, you can still complete the test and your answers still matter to us!

[Risk Avoiding Condition]

Please take a minute to read this scenario and look at the graphs. Please read everything carefully.

Imagine that you inherited money from a family member. You want to invest that money in two mutual funds. You have narrowed down your selection to three funds, all offered by investment firms with a solid reputation: Gamma, Epsilon, and Sigma. Although all funds have yielded satisfying returns in the past, there is a key distinction between these funds (as shown in the table below): In the past, Gamma and Epsilon have tended to perform similarly over time, while Gamma and Sigma have tended to perform quite differently over time.

Your task is to choose two funds to invest in (either Gamma & Epsilon, or Gamma & Sigma). This is important: when choosing between "Gamma & Epsilon" and "Gamma & Sigma", you want to make a low-risk investment. You don't care about trying to make huge returns, you only care about making a safe, low-risk investment.

[Here: table presented in Appendix B; Participants are randomly shown Version A or B]

In which portfolio of two funds would you prefer investing in? Please recall that you don't care about trying to make huge returns, you only care about making a safe, low-risk investment.

☐ Definitely Gamma & Epsilon
☐ Rather Gamma & Epsilon
☐ I'm indifferent
☐ Rather Gamma & Sigma
☐ Definitely Gamma & Sigma

[Risk Seeking Condition]

Please take a minute to read this scenario and look at the graphs. Please read everything carefully.

Imagine that you inherited money from a family member. You want to invest that money in two mutual funds. You have narrowed down your selection to three funds, all offered by investment firms with a solid reputation: Gamma, Epsilon, and Sigma. Although all funds have yielded satisfying returns in the past, there is a key distinction between these funds (as shown in the table below): In the past, Gamma and Epsilon have tended to perform similarly over time, while Gamma and Sigma have tended to perform quite differently over time.

Your task is to choose two funds to invest in (either Gamma & Epsilon, or Gamma & Sigma). This is important: when choosing between "Gamma & Epsilon" and "Gamma & Sigma", you want make an investment with high returns. You don't care about whether your investment is risky or unsafe, you only care about making a high-return investment.

[Here: table presented in Appendix B; Participants are randomly shown Version A or B]

In which portfolio of two funds would you prefer investing in? Please recall that you don't care about whether your investment is risky or unsafe, you only care about making a high-return investment.
[From now on: all conditions. We showed again the table of past returns. For each question below, participants answer on a 5-point scale, labelled “Definitely Gamma-Epsilon”, “Somewhat Gamma-Epsilon”, “Both Portfolios Equally”, “Somewhat Gamma-Sigma”, “Definitely Gamma-Sigma”]

− Which portfolio is more likely to lose money in the long run?
− Which portfolio feels riskier?
− Which portfolio is more likely to be profitable in the long run?
− Which portfolio is likely to fluctuate more over time (meaning sharply moving up and down)?

[The rest of the survey is identical to Study1, starting from “Do you personally invest in financial markets”]
Thank you for participating in this study. This study is about financial decisions. If you know nothing about finance, don't worry, you can still complete the test and your answers still matter to us!

Please take a minute to read this scenario and look at the tables. Please read everything carefully: your decision in this task will determine your bonus payment!

You want to invest money in a portfolio of two mutual funds. All the funds shown here are offered by banks with a solid reputation.

- A first bank suggests investing in a portfolio made of funds Gamma and Epsilon. As you notice on the table of historical returns below, Gamma and Epsilon have tended to perform quite similarly over time.
- Another bank suggests investing in a portfolio made of funds Omega and Sigma. As you notice on the table of historical returns below, Omega and Sigma have tended to perform quite differently over time.

In which portfolio of two funds would you prefer investing in?

In order to motivate you to make a choice that you think is best for you, your bonus payment will be determined by your portfolio choice. You will start with a bonus of 10 cents. Then, we will randomly determine one year of returns (it could be 2011, or 2012, or 2013, etc.) and add or subtract the overall return of the chosen portfolio of two funds on that year, where 1% = 1 cent.

For instance, if the overall portfolio return on the randomly selected year is 10%, then you will receive a bonus of 20 cents (= the 10 cents you started with PLUS 10 cents corresponding to the 10% positive return of the portfolio). However, for instance, if the overall portfolio return on the randomly selected year is -10%, then you won't receive any bonus (= the 10 cents your started with MINUS 10 cents corresponding to the -10% negative return of the portfolio).

Please choose your portfolio below.

- Portfolio Gamma & Epsilon
- Portfolio Omega & Sigma

[We showed again the table of past returns. For each question below, participants answer on a 5-point scale, labelled “Definitely Gamma-Epsilon”, “Somewhat Gamma-Epsilon”, “Both Portfolios Equally”, “Somewhat Omega-Sigma”, “Definitely Omega-Sigma”]

- Which portfolio feels riskier?
- Which portfolio is likely to fluctuate more over time (meaning sharply moving up and down)?

[The rest of the survey is identical to Study 1, starting from “Do you personally invest in financial markets”]
Replication of Study 4 without financial incentive (See Appendix H)

[Consent form]

***
Thank you for participating in this study.
This study is about financial decisions. If you know nothing about finance, don't worry, you can still complete the test and your answers still matter to us!

***
Please take a minute to read this scenario and look at the tables. Please read everything carefully.

Imagine that you inherited money from a family member. You want to invest that money in two mutual funds, and you have a long-term investment horizon (you want to keep your two funds for at least 10 years).

All the funds proposed here are offered by banks with a solid reputation.

- **A first bank suggests investing in Gamma and Epsilon.** As you notice on the table of historical returns below, Gamma and Epsilon have tended to perform quite similarly over time.
- **Another bank suggests investing in Omega and Sigma.** As you notice on the table of historical returns below, Omega and Sigma have tended to perform quite differently over time.

[Here: Table presented in Appendix B; Participants are randomly shown Control Version A, Control Version B, Portfolio Returns Version A, or Portfolio Returns Version B]

In which portfolio of two funds would you prefer investing in? Remember that you want to keep your two funds for at least 10 years.

- [ ] Definitely Gamma & Epsilon
- [ ] Rather Gamma & Epsilon
- [ ] I'm indifferent
- [ ] Rather Omega & Sigma
- [ ] Definitely Omega & Sigma

***

[We showed again the table of past returns. For each question below, participants answer on a 5-point scale, labelled “Definitely Gamma-Epsilon”, “Somewhat Gamma-Epsilon”, “Both Portfolios Equally”, “Somewhat Omega-Sigma”, “Definitely Omega-Sigma”]

- Which portfolio feels **riskier**?
- Which portfolio is likely to **fluctuate more over time** (meaning sharply moving up and down)?

***

[The rest of the survey is identical to Study1, starting from “Do you personally invest in financial markets”]
STUDY 5

[Consent form]

Thank you for participating in this study. This study is about financial decisions. If you know nothing about finance, don't worry, you can still complete the test and your answers still matter to us!

[Abstract condition]

Imagine that you want to invest in two of the following three company stocks: Omega, Gamma, and Epsilon. All companies are profitable, but the expected returns of the stocks depend on the future economic situations.

If Situation A occurs in the future If Situation B occurs in the future

<table>
<thead>
<tr>
<th>Stock</th>
<th>Omega</th>
<th>Gamma</th>
<th>Epsilon</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+30% expected returns</td>
<td>-10% expected returns</td>
<td>-10% expected returns</td>
</tr>
</tbody>
</table>

As you can see in the table, you can expect two kinds of economic situations: Situation A or Situation B. **Situations A and B are equally likely to occur in the future.**

- If Situation A occurs, then Omega and Gamma are expected to yield +30% positive returns, whereas Epsilon is expected to yield -10% negative return.
- If Situation B occurs, then Omega and Gamma are expected to yield -10% negative returns, whereas Epsilon is expected to yield +30% positive return.

In which two stocks would you prefer investing in?

- Strongly prefer Omega & Gamma
- Somewhat prefer Omega & Gamma
- I'm indifferent
- Somewhat prefer Omega & Epsilon
- Strongly prefer Omega & Epsilon

[Concrete condition]

Imagine that you want to invest in two of the following three videogame company stocks: Omega Games, Gamma Games, and Epsilon Games. All companies are profitable, but the expected returns of the stocks depend on the future success of videogame consoles.

Omega and Gamma both have an exclusivity deal with the videogame console "GameStation", while Epsilon has an exclusivity deal with the videogame console "GameBox". Usually, only one videogame console is successful and wins the market. Hence:

If GameStation wins the market in the future If GameBox wins the market in the future

<table>
<thead>
<tr>
<th>Stock</th>
<th>Omega</th>
<th>Gamma</th>
<th>Epsilon</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+30% expected returns</td>
<td>-10% expected returns</td>
<td>-10% expected returns</td>
</tr>
</tbody>
</table>
As you can see in the table, you can expect two kinds of situations: GameStation wins the market, or GameBox wins the market. **These situations are equally likely to occur in the future.**

- If GameStation wins the market, then Omega and Gamma (which produce games for GameStation) are expected to yield +30% positive returns, whereas Epsilon (which does NOT produce games for GameStation) is expected to yield a -10% negative return.
- If GameBox wins the market, then Omega and Gamma (which do NOT produce games for GameBox) are expected to yield -10% negative returns, whereas Epsilon (which produces games for GameBox) is expected to yield a +30% positive return.

**In which two stocks would you prefer investing in?**

- [ ] Strongly prefer Omega & Gamma
- [ ] Somewhat prefer Omega & Gamma
- [ ] I'm indifferent
- [ ] Somewhat prefer Omega & Epsilon
- [ ] Strongly prefer Omega & Epsilon

---

**Financial literacy test**

---

**Demographic questions**

---

This is the last question. There is no right or wrong answer!

Imagine that you hesitate between two financial investments.

- Option A has 50% chance of yielding a +30% return, and 50% chance of yielding a -10% negative return.
- Option B has 100% chance of yielding a +10% return

Which investment do you prefer?

- [ ] Strongly prefer Option A
- [ ] Somewhat prefer Option A
- [ ] I'm indifferent
- [ ] Somewhat prefer Option B
- [ ] Strongly prefer Option B
APPENDIX D – ADDITIONAL ANALYSES (STUDY 1)

Exploratory questions were included for the second batch of participants in Study 1. These questions were placed after the open-ended question (see Appendix C).

All items below rated on a 5-point scale ranging from “Definitely false” to “Definitely true”

<table>
<thead>
<tr>
<th>Item</th>
<th>Item</th>
<th>Financial literacy</th>
<th>Non-diversifying fund</th>
<th>Diversifying fund</th>
<th>p-value*</th>
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<td></td>
<td>Mean</td>
<td>S.D.</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>...increase the chance that my overall investment <strong>loses money in the long run</strong></td>
<td>Top (N=101)</td>
<td>3.07</td>
<td>1.17</td>
<td>2.30</td>
<td>1.14</td>
</tr>
<tr>
<td></td>
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<td>3.11</td>
<td>1.07</td>
<td>2.75</td>
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<tr>
<td></td>
<td>3rd (N=131)</td>
<td>3.04</td>
<td>1.03</td>
<td>2.91</td>
<td>0.96</td>
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<tr>
<td></td>
<td>Bottom (N=114)</td>
<td>2.86</td>
<td>1.05</td>
<td>3.09</td>
<td>1.02</td>
</tr>
<tr>
<td>...increase the chance that my overall investment <strong>makes money in the long run</strong></td>
<td>Top (N=101)</td>
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<td>1.00</td>
<td>3.08</td>
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</tr>
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<td>...increase the fluctuations of my overall investment (meaning moving up and down widely)</td>
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<tr>
<td></td>
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<td>3.20</td>
<td>0.97</td>
<td>3.24</td>
<td>1.11</td>
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<tr>
<td>...increase the chance that my overall investment <strong>yields stable returns</strong></td>
<td>Top (N=101)</td>
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<td>1.11</td>
<td>3.64</td>
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<td>3.32</td>
<td>0.94</td>
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<td>1.04</td>
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<td>Top (N=101)</td>
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<td>3.78</td>
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<tr>
<td>...make the returns of my overall investment <strong>easier to predict</strong></td>
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</table>

*t-test of difference between correlated and uncorrelated asset
### TOP QUARTILE

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#### Structural equation model

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#### Indirect effects

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#### Direct effects

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#### Total effects

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2nd QUARTILE

. sem (riskyindex <- flupredifami, riskyindex <- fluctu) (all <- riskyindex flupredifami fluctu) if sc0==10 & sc0<13 & attentionch
> eck==0, vce(bootstrap, reps(500)) standardized
> (running sem on estimation sample)

Bootstrap replications (500)

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Structural equation model

Number of obs   =     96
Log likelihood  =  -521.12582
Replications    =     500

|            | Standardized |          | Bootstrap |             | Normal-based |              |
|------------|--------------|----------|-----------|-------------|--------------|
|            |              |          |            |              |              |
|            |              |          |            |              |              |
|            |              |          |            |              |              |
|            |              |          |            |              |              |
|            |              |          |            |              |              |

Total effects

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end of do-file
### 3rd QUARTILE

> `sem (riskyindex <- flupredifami)(riskylnessy <- fluctu) (all <- riskyindex flupredifami fluctu) if sc0>=7 & sc0<10 & attentionlow`  
> `vce(bootstrap, reps(500)) standardized`  
> `estat teffects`  
> `estat techart`

#### Structural equation model

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<th>Normal-based</th>
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<td></td>
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<td>Std. Err.</td>
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<tr>
<td>Fluctu</td>
<td>-.424504</td>
<td>.0808175</td>
<td>-5.27</td>
</tr>
<tr>
<td>Fluctu</td>
<td>.050398</td>
<td>.0411466</td>
<td>1.22</td>
</tr>
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<td>-2.11</td>
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<td>Log likelihood = -536.31259</td>
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#### Direct effects

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<td>Conf.</td>
<td>Std. Err.</td>
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#### Indirect effects

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#### Total effects

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<td>Standardized Coef.</td>
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<td>2.42</td>
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<td>Fluctu</td>
<td>.730247</td>
<td>.0655111</td>
<td>11.79</td>
</tr>
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end of do-file
### Bottom Quartile

- `. est (riskyindex <- flupredifami) (riskyindex <- fluctu) (all <- riskyindex flupredifami fluctu) if sc0<7 & attentioncheck==0, vce`

| Structural Coef.   | Std. Err. | z    | P>|z|     | [95% Conf. Interval] |
|--------------------|-----------|------|---------|---------------------|
| Observed           | Bootstrap | Normal-based |

#### Direct effects

| Structural Coef.   | Std. Err. | z    | P>|z|     | [95% Conf. Interval] |
|--------------------|-----------|------|---------|---------------------|
| Observed           | Bootstrap | Normal-based |

#### Indirect effects

| Structural Coef.   | Std. Err. | z    | P>|z|     | [95% Conf. Interval] |
|--------------------|-----------|------|---------|---------------------|
| Observed           | Bootstrap | Normal-based |

#### Total effects

| Structural Coef.   | Std. Err. | z    | P>|z|     | [95% Conf. Interval] |
|--------------------|-----------|------|---------|---------------------|
| Observed           | Bootstrap | Normal-based |

---

**Structural equation model**

- Log likelihood = -425.30344
- Number of obs = 91
- Replications = 500

### End of do-file

---

71
APPENDIX F – ADDITIONAL ANALYSES (STUDY 3)

For each question below, participants answered on a 5-point scale, labelled “Definitely Gamma-Epsilon”, “Somewhat Gamma-Epsilon”, “Both Portfolios Equally”, “Somewhat Gamma-Sigma”, “Definitely Gamma-Sigma”. The scale was coded from -2 (Definitely Gamma-Epsilon, i.e., the non-diversified portfolio) to +2 (Definitely Gamma-Sigma, i.e., the diversified portfolio), with 0 corresponding to “Both Portfolios Equally”.

<table>
<thead>
<tr>
<th>Item</th>
<th>Financial literacy</th>
<th>Mean</th>
<th>S.D.</th>
<th>t-test of difference from zero (p-value)</th>
<th>t-test of the effect of the risk-seeking manipulation (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which portfolio feels riskier?</td>
<td>Top (N=132)</td>
<td>-0.43</td>
<td>1.21</td>
<td>&lt;.001</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td>2nd (N=177)</td>
<td>0.05</td>
<td>1.21</td>
<td>0.58</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>3rd (N=159)</td>
<td>0.38</td>
<td>1.13</td>
<td>&lt;.001</td>
<td>0.14</td>
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<tr>
<td></td>
<td>Bottom (N=128)</td>
<td>0.27</td>
<td>0.94</td>
<td>0.001</td>
<td>0.33</td>
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<tr>
<td>Which portfolio is likely to fluctuate more over time (or sharply moving up and down)?</td>
<td>Top (N=132)</td>
<td>-0.48</td>
<td>1.30</td>
<td>&lt;.001</td>
<td>0.69</td>
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<tr>
<td></td>
<td>2nd (N=177)</td>
<td>0.17</td>
<td>1.19</td>
<td>0.05</td>
<td>0.78</td>
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<tr>
<td></td>
<td>3rd (N=159)</td>
<td>0.28</td>
<td>1.23</td>
<td>0.005</td>
<td>0.52</td>
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<td>Bottom (N=128)</td>
<td>0.12</td>
<td>1.09</td>
<td>0.2</td>
<td>0.67</td>
</tr>
<tr>
<td>Which portfolio is more likely to lose money in the long run?</td>
<td>Top (N=132)</td>
<td>-0.16</td>
<td>0.80</td>
<td>0.02</td>
<td>0.59</td>
</tr>
<tr>
<td></td>
<td>2nd (N=177)</td>
<td>-0.05</td>
<td>0.83</td>
<td>0.47</td>
<td>0.71</td>
</tr>
<tr>
<td></td>
<td>3rd (N=159)</td>
<td>0.08</td>
<td>0.89</td>
<td>0.29</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td>Bottom (N=128)</td>
<td>0.15</td>
<td>0.86</td>
<td>0.05</td>
<td>0.22</td>
</tr>
<tr>
<td>Which portfolio is more likely to be profitable in the long run?</td>
<td>Top (N=132)</td>
<td>0.17</td>
<td>0.86</td>
<td>0.02</td>
<td>0.76</td>
</tr>
<tr>
<td></td>
<td>2nd (N=177)</td>
<td>0.05</td>
<td>0.93</td>
<td>0.47</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>3rd (N=159)</td>
<td>0.00</td>
<td>1.04</td>
<td>1</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>Bottom (N=128)</td>
<td>-0.07</td>
<td>0.96</td>
<td>0.41</td>
<td>0.08</td>
</tr>
</tbody>
</table>
APPENDIX G – ADDITIONAL ANALYSES (STUDY 4)

For each question below, participants answered on a 5-point scale, labelled “Definitely Gamma-Epsilon”, “Somewhat Gamma-Epsilon”, “Both Portfolios Equally”, “Somewhat Omega-Sigma”, “Definitely Omega-Sigma”. The scale was coded from -2 (Definitely Gamma-Epsilon, i.e., the non-diversified portfolio) to +2 (Definitely Omega-Sigma, i.e., the diversified portfolio), with 0 corresponding to “Both Portfolios Equally”.

<table>
<thead>
<tr>
<th>Item</th>
<th>Financial literacy</th>
<th>Control Condition</th>
<th>Portfolio returns condition</th>
<th>t-test of the effect of the portfolio return (vs. control) manipulation (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean S.D.</td>
<td>Mean S.D.</td>
<td></td>
</tr>
<tr>
<td>Which portfolio feels riskier?</td>
<td>Top (N=143)</td>
<td>-0.82 1.11 &lt;.001</td>
<td>-0.92 1.06 &lt;.001</td>
<td>0.57</td>
</tr>
<tr>
<td></td>
<td>2nd (N=131)</td>
<td>-0.48 1.17 0.002</td>
<td>-1.05 1.05 &lt;.001</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td>3rd (N=159)</td>
<td>-0.03 1.12 0.84</td>
<td>-0.60 1.20 &lt;.001</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>Bottom (N=149)</td>
<td>0.23 1.14 0.08</td>
<td>-0.58 1.21 &lt;.001</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Which portfolio is likely to fluctuate more over time (meaning sharply moving up and down)?</td>
<td>Top (N=143)</td>
<td>-1.08 1.07 &lt;.001</td>
<td>-1.24 1.09 &lt;.001</td>
<td>0.39</td>
</tr>
<tr>
<td></td>
<td>2nd (N=131)</td>
<td>-0.68 1.37 &lt;.001</td>
<td>-0.92 1.28 &lt;.001</td>
<td>0.29</td>
</tr>
<tr>
<td></td>
<td>3rd (N=159)</td>
<td>-0.30 1.27 0.04</td>
<td>-0.56 1.32 &lt;.001</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>Bottom (N=149)</td>
<td>0.18 1.11 0.16</td>
<td>-0.48 1.44 0.008</td>
<td>0.002</td>
</tr>
</tbody>
</table>
APPENDIX H – REPLICATION OF STUDY 4 WITHOUT FINANCIAL INCENTIVE

Method
407 MTurk participants (57.4% female, mean age=32.8) were paid $1 to participate in this study. We assigned participants to either a “portfolio returns” condition or a control condition.

In the control condition, participants first read a scenario in which one bank was proposing two funds with visibly correlated returns shown on a table (Gamma & Epsilon, the “non-diversified portfolio”), while another bank was proposing two other funds with visibly negatively correlated returns (Omega & Sigma, the “diversified portfolio”). Like in the previous studies, there were two versions of each table (see Appendix B).

In the “portfolio returns” condition, the scenario was identical, with the exception that we provided aggregate portfolio returns. It was thus visible and salient that the diversified portfolio had less volatile returns than the non-diversified portfolio.

Then, participants were reminded that they invested for the long term, and chose their investment on a 5-point scale ranging from -2 (“definitely Gamma & Epsilon”) to +2 (“definitely Omega & Sigma”) with a middle point 0 (“I’m indifferent”).

As manipulation checks, we measured risk perception and volatility perception like in the previous studies.

We measured financial literacy with the same test as in the previous studies.

Results and Discussion
Data Exclusion. 17 participants (4.2% of all participants) failed the attention check and were excluded from analysis.

Manipulation Checks. While in the control condition, risk and volatility perceptions were similar to what we found in Study 2, providing portfolio returns made all participants perceive the diversified portfolio as significantly less risky and less volatile, as show in the table below:

<table>
<thead>
<tr>
<th>Item</th>
<th>Financial literacy</th>
<th>Control Condition</th>
<th>Portfolio returns condition</th>
<th>t-test of the effect of the portfolio return (vs. control) manipulation (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which portfolio feels riskier?</td>
<td>Top (N=83)</td>
<td>-0.70</td>
<td>1.02</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>2nd (N=103)</td>
<td>-0.31</td>
<td>1.11</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>3rd (N=91)</td>
<td>-0.12</td>
<td>1.08</td>
<td>0.47</td>
</tr>
<tr>
<td></td>
<td>Bottom (N=113)</td>
<td>0.28</td>
<td>1.08</td>
<td>0.04</td>
</tr>
<tr>
<td>Which portfolio is likely to fluctuate more over time (meaning sharply moving up and down)?</td>
<td>Top (N=83)</td>
<td>-0.68</td>
<td>1.31</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>2nd (N=103)</td>
<td>-0.56</td>
<td>1.27</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>3rd (N=91)</td>
<td>-0.12</td>
<td>1.29</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>Bottom (N=113)</td>
<td>0.11</td>
<td>1.27</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Note. Means indicate response to the questions, where answers are coded from -2 (Definitely Gamma-Epsilon, i.e., the non-diversified portfolio) to +2 (Definitely Omega-Sigma, i.e., the diversified portfolio), with 0 corresponding to “Both Portfolios Equally”.

Investment Decision. We regressed the investment decision on the mean-centered financial literacy score, a binary variable capturing the effect of the manipulation (coded -1 for control and +1 for portfolio returns), and their interaction. We found significant main effects of financial literacy (t(386)=4.66, p<.001) and of “portfolio returns” (t(386)=2.37, p=.02), and a significant interaction effect ((386)=2.78, p=.006), indicating that the “portfolio returns” manipulation had a stronger effect among participants with low financial literacy, as confirmed below.
We then proceeded to a quartile analysis. In the control condition, as shown on the figure below, top quartile participants invested in the diversified portfolio ($M= .83$, $SD=1.20$; significantly different from zero, $t(39)=4.36, p<.001$), while bottom quartile participants invested in the non-diversified portfolio ($M=-.39$, $SD=1.19$; $t(63)=-2.63, p=.01$). As hypothesized (H4), providing portfolio returns made bottom quartile participants invest in the diversified portfolio ($M=.43$, $SD=1.02$). This was significantly different from zero ($t(48)=2.94, p=.005$), and significantly different from the investment in the control condition ($t(111)=3.85, p<.001$). This shows that lay investors are potentially influenced by portfolio volatility, although they cannot infer it from covariance information (i.e., past returns of individual funds).

![Investment decision graph](image)

**Financial Literacy:**
- Top quartile ($N=83$)
- 2nd quartile ($N=103$)
- 3rd quartile ($N=91$)
- Bottom quartile ($N=113$)