# Individual Investors' Financial Literacy and Numerical Skills

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## ABSTRACT

Behavioral research in financial accounting often aims to address issues relevant to individual, nonprofessional investors, citing the importance of individual investors to capital markets or regulators' concerns for the "average" investor. Nevertheless, many such studies utilize convenience samples of graduate business student participants in their experiments. This research analyzes a relatively large sample of participants recruited from Amazon's Mechanical Turk platform (n>2,000) in order to assess how the broader range of investors' numerical skills can impact extant accounting research results. Because we know relatively little about the characteristics of the individual investor, this research begins by examining investors' demographic characteristics and numerical skills relative to non-investors, benchmarked against national samples of financial capability skills in the United States. A set of three extant financial accounting research experiments are then replicated. Results show that investors with higher numerical skills are more sensitive to others' incentives and are more likely to incorporate that understanding into their judgments than are investors with lower numerical skills or non-investors. These findings suggest that limiting the pool of participants in the original research increases the power of the original statistical tests, and emphasizes the need for careful consideration of the potential match between the applied theory and the population of interest in empirical research.



**Keywords:** financial literacy; numeracy; quantitative reasoning; individual investor; average investor; Amazon Mechanical Turk (MTurk)

**JEL:** M49; I29; G10

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## 1. Introduction

Behavioral research in financial accounting often aims to address issues relevant to individual or nonprofessional investors, citing regulators' concerns for the "average" investor (e.g., Rennekamp 2012) or the importance of individual investors in the U.S. capital market (e.g., Koonce and Lipe 2010). While a small number of such studies access investor groups (e.g., via investment clubs or associations such as in Kelly, Low, Tan, and Tan [2012]), many such studies utilize convenience samples of graduate business student participants in experiments, who likely have relatively well developed financial and quantitative numerical skills. The current research analyzes a relatively large sample of participants recruited from Amazon's Mechanical Turk platform (MTurk; n>2,000) in order to assess how the broader range of investors' financial and quantitative skills can impact extant accounting research results.

Notwithstanding the common application of graduate business student participants, only one study to date (Elliott, Hodge, Kennedy, and Pronk 2007) purposefully examines whether MBA students can represent valid proxies for nonprofessional investors, using members of the National Association of Investors Corporation (an association of investment clubs). The current study revisits the question of whether the proxies typically applied in accounting research represent valid proxies for individual investors when not limited to members of investment clubs. In doing so, my study extends De Bondt's (1998) and Hodge's (2003) descriptions of nonprofessional investors. By documenting the range of financial and quantitative skills in the broader individual investor population, I also provide a partial reconciliation of accounting research participants with the U.S. Securities and Exchange Commission (SEC) Staff's (2012) *Study Regarding Financial Literacy Among Investors As Required by Section 917 of the Dodd-Frank Wall Street Reform and Consumer Protection Act*, which reviewed related studies suggesting that American investors lack basic financial literacy knowledge and skills.

Obtaining a relatively large and broad-based sample of participants is therefore a substantial obstacle for this research and, until recently, unobtainable without significant resources. However, recruiting participants from MTurk now presents a potential solution to this obstacle. MTurk has become

a popular source of participants for social scientists (Brandon et al 2014; Ipeirotis 2010) and has recently been applied in accounting research (e.g., Rennekamp 2012). Concurrent research has replicated extant accounting studies with MTurk participants to assess the validity of using this participant pool, either as an initial step in the research (Koonce, Miller, and Winchel 2013) or as the main contribution of the research (Farrell et al. 2014; Owens 2014). My study contributes to this developing trend in accounting research by providing an extensive description of MTurk participants along dimensions of particular interest to financial accounting researchers (i.e., investment experience and numerical skills), and by benchmarking the resulting sample of investors against nationwide samples selected to be representative of U.S. Census distributions (FINRA Foundation 2009a, 2009b).

Further, my study examines how the range of participants' financial and quantitative skills impacts the replication of a sample of existing accounting research experiments, thereby contributing to a long-standing research literature on the effect of individual cognitive characteristics on judgment and decision making in accounting settings (Bonner 2008, Libby and Luft 1993). Little research to date has examined the impact of investors' numerical skills on their processing of firms' financial disclosures. Admittedly, if graduate business students tend to exhibit information processing biases, then less sophisticated individual investors may likely do the same, and two recent research papers suggest that less sophisticated investors are more likely to rely on language-based heuristic processing of firm disclosures (Elliott, Grant, and Rennekamp 2013; Tan, Wang, and Zhou 2014). However, to the extent that graduate business students effortfully process firm disclosures, prior research has generally not assessed conditions under which results would replicate with a broader range of individual investors.[1] My study therefore contributes to this developing area of research by examining the impact of relevant numerical skills on individual investors effortful processing of information in financial accounting settings.

Understanding the impact of the wide range of individual investors' skills is important for financial accounting research for at least three related reasons: First, regulators have generally voiced

[1] One exception is Han and Tan (2007), who document that a lack of detailed, context-specific knowledge decreases the likelihood that graduate business student participants react to benchmarks that are implicitly associated with different forms of management guidance. Rather than detailed knowledge *per se*, my study examines the effect of more general numerical skills.

concerns regarding the interests of the individual or average investor (e.g., Han and Tan 2007). For example, the current Chair of the SEC recently discussed the need to protect individual investors as part of the SEC's mission, recognizing that "the retail investor population represents a broad spectrum of Americans" (White 2014).[2] In contrast, accounting standard setters have institutionalized an emphasis on investors who have a "reasonable understanding of business and economic activities and willing to study the [financial accounting] information with reasonable diligence" (FASB 1978, ¶34; IASB 2010, QC32), hereafter, "reasonably informed investors." Accounting knowledge is therefore a legitimate prerequisite for the investigation of particular financial accounting issues. Notwithstanding, financial accounting research often investigates broader issues, such as investors' reactions to potential conflicts of interest in financial analysts' reports (as in Hirst et al. 1995), for which the same restriction does not apply.

Second, the population of individual investors substantially impacts capital markets, including U.S. capital markets. For example, Koonce and Lipe (2010, p. 868) discuss how "nonprofessional, individual investors are an important group, with 33.8 million individuals investing directly in the stock markets (NYSE 2002) and owning nearly 34% of all shares outstanding (Bogle 2005)." Although the percentage of U.S. equities owned by individuals fell to about 25% in 2009 (NYSE 2010, p. 12), it remains a substantial percentage. Analytic models also suggest that the presence of less sophisticated investors (such as individual investors) can affect market prices and expectations (see, e.g., DeLong, Shleifer, Summers, and Waldman 1990a, 1990b; Elliott, Krische, and Peecher 2010; Hirshleifer, Subrahmanyam, and Titman 2006; Shleifer and Vishny 1997).

Third, the impact of individual investors may be even greater in particular components of the U.S. capital market. For example, Jiang, Petroni, and Wang (2013) discuss how the Pink Sheets market consists of mostly individual investors (citing Ang, Shtauber, and Tetlock 2013), with the market capitalization of the Pink Sheets and OTCBB reaching $846 billion in 2005 or more than twice the size of AMEX (citing SEC 2006). Likewise, the Jumpstart Our Business Startups (JOBS) Act, signed into law in

[2] Specific regulatory examples citing concerns for the individual or average investor include the SEC's Plain English initiative (SEC OIEA 1998), communications from open-end management investment companies (SEC 1998), and its contemplation of abbreviated financial statements (SEC 1995).

2012, requires the SEC to adopt rules to allow crowdfunding, or raising financing through small contributions from large numbers of investors via the Internet.[3]

Results show that individual investors tend to be older and are more likely to be male, more likely to be employed on a full-time basis, and more highly educated than non-investors. Investors are also more likely to have engaged in planning for their retirement, more confident in their numeric and financial abilities, and score higher on a set of basic financial literacy questions. On average, individual investors answer 74 percent of the financial literacy questions correctly (vs. 55 percent for non-investors).

These differences between investors and non-investors are consistent with data from nationwide samples selected to be representative of U.S. Census distributions (FINRA Foundation 2009a, 2009b). Though the investors sampled in this research (i.e., through MTurk) are less confident in their financial abilities, they also do not significantly differ from random selections from the representative national data in terms of having engaged in planning for their retirement or in their financial literacy scores.

Extending prior analyses, additional measures provide further insight into investors' skills and educational experiences. Specifically, investors also achieve higher mean scores in numeracy and quantitative analytical skills. For those who have attended some amount of college, investors report a higher mean number of courses taken in accounting, auditing, finance, math, and statistics than do non-investors. Still, fewer than 60 percent of investors who have attended some amount of college report having completed one or more courses in accounting or one or more courses in finance.

These findings hold across two investor definitions: (1) any stock or mutual fund investment, and (2) any direct stock or mutual fund investment reported history, i.e., non-retirement. However, education-based proxies for individual investors yield mixed results. First, individuals who report some college education with at least one accounting and one finance course tend to display similar financial literacy, numeracy, and quantitative reasoning skills as investors. Second, limiting the proxy to individuals who report some graduate-level education as well as at least one accounting and one finance course severely

[3] As Bloomfield (2013) notes, the SEC released a proposal on crowdfunding in October 2013 (SEC 2013). The SEC's Investor Advisor Committee issued its recommendations on crowdfunding in April 2014 (SEC IAC 2014). To my knowledge, the proposed rule has not yet been finalized.

restricts participant availability to at most 10 percent of the investor sample. This proxy also leads to more extreme differences than in investors (for example, even higher numerical skill outcomes), limiting generalizability from these individuals to the broader investor population. Third, this proxy likely understates the differences between individual investors and graduate business students, whose skills are found to be substantially higher than those of the investors and the other education-based proxies.

To examine the impact of investment experience and numerical skills, participants in the MTurk sample are randomly allocated to experimental conditions to replicate a sample of accounting research studies (Elliott et al. 2007; Kadous, Koonce, and Towry 2005; Nelson and Rupar 2011). Each of the studies recruited MBA students as research participants and involve theory regarding participants' understanding other people's incentives in the related financial context, although the studies vary in the degree of accounting information to be incorporated into participants' judgments. Across the studies, the results generally replicate with the wider participant pool available through MTurk; however, in three of the four experiments, results tend to be driven by MTurk participants with investment experience and higher numerical skills. Investors with higher numerical skills are more sensitive to others' incentives and are more likely to incorporate that understanding into their judgments than are investors with lower numerical skills or non-investors. These findings suggest that limiting the pool of participants in the original research to graduate business students increases the power of their statistical tests, but emphasizes the need for careful consideration of the potential match between the applied theory and the population sampled in empirical research.

Libby et al. (2002, p. 802) recommend that potential participants be matched to the goals of the experiment, while avoiding the use of more sophisticated participants than necessary to achieve those goals. Based on the current findings, researchers interested in issues broadly relevant to nonprofessional U.S.-based investors could legitimately access such individuals via Amazon's Mechanical Turk platform by employing an investment filter during the recruiting process. Depending on the theory applied, these researchers should also consider collecting additional characteristics (such as the financial and quantitative skills collected in this study) as additional explanatory variables for their analyses.

The remainder of the paper is organized as follows: The next section provides background information and develops the research questions. The third section describes the MTurk survey, including the experimental replications, as well as two comparative datasets employed for benchmarking (FINRA Foundation 2009a, 2009b; graduate business students). The fourth section describes the results, and the final section summarizes and discusses implications and directions for future research.

**2. Background**

Although behavioral research in financial accounting cites regulators' concerns for the average investor (e.g., Rennekamp 2012, Han and Tan 2007) or the importance of individual investors in the U.S. capital market (e.g., Koonce and Lipe 2010), the characteristics of the fabled average investor, including his or her level of financial expertise, are largely unknown.

Section 917(a)(1) of the *Dodd-Frank Act* directed the U.S. Securities and Exchange Commission (SEC) to identify the existing level of financial literacy among investors and particular subgroups of interest. To fulfill that mandate, the SEC contracted with the Library of Congress to conduct a review of the quantitative studies on the financial literacy of U.S. retail investors published since 2006. Citing the Library of Congress review, the SEC Staff [2012] report states that

> *studies show consistently that American investors lack basic financial literacy. For example, studies have found that investors do not understand the most elementary financial concepts, such as compound interest and inflation. Studies have also found that many investors do not understand other key financial concepts, such as diversification or the differences between stocks and bonds, and are not fully aware of investment costs and their impact on investment returns… The Library of Congress Report concludes that "low levels of investor literacy have serious implications for the ability of broad segments of the population to retire comfortably, particularly in an age dominated by defined-contribution retirement plans."* (SEC Staff [2012], p. vii-viii)

In comparison, consider a relatively early paper in the current generation of behavioral financial accounting research studies, demonstrating "that investors' reactions to information in financial analysts' research reports depend on characteristics of both the analyst and the report" (Hirst, Koonce, and Simko [1995], p. 335). That research employed graduate business students from a large state university, most of whom were completing the first year of an M.B.A. program after two or more years of work experience, and, on average, had completed four accounting and two finance courses. While 94 percent indicated that

they had invested or planned to invest in common stock (Hirst et al. 1995, p. 340), and therefore legitimately represent a subpopulation of U.S. investors, their high level of financial education appears inconsistent with the lack of basic financial literacy described in the SEC Staff (2012) report.

Similar convenience samples are common in behavioral financial accounting research. While a small number of studies aiming to address issues relevant to individual or nonprofessional investors access investor groups (e.g., via investment clubs or associations such as in Kelly et al. 2012), most such studies utilize convenience samples of graduate business student participants in experiments.[4] As Libby et al. (2002, p. 803) explain,

> *Other experiments focus on the judgments of general or novice investors, and so require subjects who possess only basic familiarity with accounting and investing. Student populations that have such basic familiarity are appropriate here as well. MBA students and executive-program participants are particularly useful, as they often have some accounting knowledge and investing experience.*

This discussion presumes that general investors also possess basic familiarity with accounting and investing concepts, an assumption which the SEC Staff paper (2012) calls into question.[5]

***Investor characteristics***

Multiple definitions of "an investor" have been applied in prior surveys, making cross-study comparisons problematic. The Library of Congress (2011) review includes several studies of the general public but it also identifies three studies focused on investors, each of which applied a different definition: "adults who invest in stocks, bonds, and/or mutual funds, outside of an employer-sponsored retirement plan" (Abt SRBI 2008); adults who "performed at least one stock, bond, or mutual fund transaction" within a specified six-month time period (Applied Research and Consulting 2003); and adults living in private households who self-identify as "a person who makes decisions about where their savings are placed including CDs, stocks, bonds and mutual funds" (Opinion Research Corporation 2007). Others have

[4] A review of experiments examining investors' or financial statement users' judgments published in the top six academic accounting journals (*Accounting Organizations and Society*, *The Accounting Review*, *Contemporary Accounting Research*, the *Journal of Accounting and Economics*, the *Journal of Accounting Research*, and the *Review of Accounting Studies*) between the years of 2005 and 2012, inclusive, identified 32 such studies, of which 27 (84 percent) recruited graduate business students as some of the experiment participants and 21 (66 percent) recruited only current business students as experiment participants.

[5] Recent research has also documented that undergraduate accounting students do not respond differently from experienced retail investors when evaluating analyst stock recommendations (Kelly et al. 2012), and display the same patterns of order effects in evaluating a set of simultaneous vs. sequential information (Pinsker 2011), suggesting that general differences across these two groups may be smaller than often expected.

excluded mutual funds from their definition of investing, focusing specifically on investments in individual company equity securities (e.g., De Bondt 1998) or equity and debt securities (e.g., Elliot et al. 2007). As discussed, accounting standard setters have institutionalized concerns for reasonably informed investors (FASB 1978, ¶34; IASB 2010, QC32). However, cross-study comparisons become problematic as only a single definition of investor is typically considered within a study.

The characteristics of the individual investor are similarly ambiguous. The Opinion Research Corporation (2007) reports that the percentage of respondents who self-identify as investors increases with their age (at least until age 65), education, and income. A subset of investors that has been employed as investor-participants in accounting research are members of investment clubs (e.g., Kelly et al. 2012), particularly the National Association of Investors Corporation (NAIC) in the U.S. (e.g., Hodge 2003, De Bondt 1998, Elliott et al. 2007). For example, Hodge (2003) reports that the membership base of the NAIC as a whole is 69 percent female, with a median age of 53 years, and with 70 percent of members having a college education. Hodge's own sample of 414 NAIC members contained a higher percentage of college-educated investors (75 percent), but with a similar gender composition and median age. De Bondt's (1998, p. 838) sample of 45 participants recruited from an NAIC conference was silent on education, was again somewhat older (mean of 58 years old), but predominantly male (30 of 45 participants), and reported a mean financial portfolio value of $310,000 (excluding real estate) of which 72 percent was invested in stocks. Whether investment club members are generally representative of the broader investor population remains unclear.

Prior research has certainly suggested links between investment decision making and financial literacy. For example, Hung, Parker, and Yoong (2009) analyze RAND's American Life Panel, finding that financial literacy increases with age, college education, and income, superficially matching the Opinion Research Corporation (2007) description and available descriptions of NAIC members. Hung et al. also find that financial literacy is higher for men. In multivariate analyses, these authors document that financial literacy, age, and income are significant predictors of planning for retirement, with age and education being predictors of 401K retirement savings balances (see also Lusardi and Mitchell 2011b).

These relationships are generally consistent with Swedish (Almenberg and Dreber 2011; Almenberg and Widmark 2011) and Danish (van Rooij, Lusardi, and Alessie 2011) analyses. Investors with higher financial literacy are also more likely to invest in lower-cost rather than actively managed mutual funds (Muller and Weber 2010, using German data) and to diversify their investments (Abreu and Mendes 2010, using Portuguese data).[6]

***Financial literacy and related numerical skills***

Financial literacy is often defined on the basis of fundamental financial knowledge or understanding, for example, "knowledge of basic financial concepts, such as the working of interest compounding, the difference between nominal and real values, and the basics of risk diversification" (Lusardi 2008, p. 2).[7] As Hasting, Madrian, and Skimmyhorn (2013) discuss, there are multiple measures of financial literacy available (e.g., FINRA undated; see Knoll and Houts 2012 or Hung et al. 2009 for a discussion), but the measure developed by two particular researchers (A. Lusardi and O. Mitchell) has been used repeatedly in recent research (e.g., Almenberg and Widmark 2011; Li, Baldassi, Johnson, and Weber 2011) and nationwide surveys (e.g., FINRA Foundation 2009a, 2009b, 2012). This measure consists of a straightforward set of quiz questions, typically covering the concepts of compound interest, inflation, present value, and diversification.

Financial literacy as applied in this literature is therefore quite different from the term as used in the context of accounting research on Audit Committee members (e.g., McDaniel, Martin, and Maines 2002; Krishnamoorthy, Wright, and Cohen 2002). Recall that the Blue Ribbon Committee (1999) recommended NYSE- and NASD-listed companies (over a minimum market capitalization) have an audit committee comprised of a minimum of three "financially literate" directors. That report described financial literacy as "the ability to read and understand fundamental financial statements, including a company's balance sheet, income statement, and cash flow statement" (Blue Ribbon Committee 1999,

[6] Some question the economic significance of these effects (Guiso and Viviano 2013). Others suggest that related omitted variables (such as numeracy, propensity to plan, and risk preferences) may partially or fully explain the impact of financial literacy on financial decision making (Fernandes, Lynch, and Netemeyer 2013), questioning whether dedicated financial education is in society's best interest (Willis 2011). Neither detracts from the purpose of this research: to examine investors' demographic characteristics and numerical skills, and to consider related implications for accounting research.

[7] Hung et al. (2009) agree that the most common definition is knowledge or understanding, but note that financial literacy has also be defined as the *ability* to apply that knowledge, *perceived knowledge*, good financial *behavior*, and even financial *experiences*.

p. 26), hereafter "accounting literacy." The extant financial literacy literature does not yet appear to have extended to accounting literacy and its impact on individual investment decision making.[8]

Two supporting skills are also considered in this paper: numeracy and quantitative analytical reasoning. The dividing line between financial literacy and numeracy has not always been consistent in the literature (Hung et al. 2009). Numeracy or numerical literacy is generally defined as familiarity with fundamental probability and numerical concepts (e.g., Schwartz et al. 1997; Lipkus, Samsa, and Rimer 2001). Basic numeracy involves "an understanding of the real number line, time, measurement, and estimation" whereas higher-order levels of numeracy would incorporate "basic logic and quantitative reasoning skills, knowing when and how to perform multistep operations, and an understanding of ratio concepts, notably fractions, proportions, percentages, and probabilities" (Reyna et al. 2009, p. 945). Numeracy has been found to be related to risk perceptions as well as susceptibility to extraneous factors in decision making, such as the effects of mood, the format in which information is presented (e.g., as frequencies vs. percentages), and to other biases in judgment and decision making (e.g., framing and ratio bias effects). Recently, concurrent research (Elliott et al. 2013) has also found that numeracy can affect judgments within a class of investor; specifically, lower numeracy increases the likelihood that investors (proxied by graduate business students) will rely on the style of language firms use in a Corporate Social Responsibility setting to assess subsequent firm disclosures.

An important aspect of higher-order numeracy involves quantitative analytical reasoning. Separate measures of analytical reasoning have been developed, such as the Raven's Standard or Advanced Progressive Matrices (non-verbal, multiple-choice measures in which participants are asked to identify the missing element that completes a pattern in a series of 12, 36, or 60 questions—e.g., Bols and Stokes 1998). An alternate measure, the Cognitive Reflection Test, consists of three quantitative questions in which the intuitive responses differ from the correct responses (Frederick 2005).[9]

[8] Nevertheless, research at the firm level finds a relationship between Board member accounting literacy and firm performance (Coates, Marais, and Weil 2007) and a lower likelihood of accounting restatements (Aier, Comprix, Gunlock, and Lee 2005).
[9] Cokely et al. (2012) reports that the three-item Cognitive Reflection Test from Frederick (2005) had a Cronbach's alpha of 0.62, a mean duration 2.5 minutes, and a moderate correlation of 0.40 with the 12-item short form of the Raven's Matrices (which is intended to be administered in approximately 20 minutes or less; Bols and Stokes 1998, p. 384).

Given the potential commonalities across the concepts of financial literacy, accounting literacy, numeracy, and quantitative analytical reasoning, this research examines investors' related numerical skills and demographic characteristics, relative to non-investors, under alternative investor categorizations. Education-based proxies for investment experience are also evaluated, consistent with the frequent recruiting of graduate business students in behavioral financial accounting research. More formally:

*RQ1: How does the distribution of numerical skills differ in investors relative to non-investors, under alternative definitions of "an investor"?*

*RQ2: How does the distribution numerical skills differ in investors relative to education-based proxies for investment experience, under alternative definitions of "an investor"?*

***Impact of financial literacy and related numerical skills***

Although in some circumstances the theory applied in accounting research is highly situational (and accounting specific), the theory in other accounting research is broadly based, such as in the expected influence of incentives and persuasion tactics. How incentives are expected to affect others' actions is fundamental to at least two streams of research in financial accounting: research in conflicts of interest (including the independence of financial advisors [e.g., Hirst et al. 1995; Kelly et al. 2012], members of Boards of Directors [e.g., Rose et al. 2013], and auditors [e.g., Dopuch, King, and Schwartz 2003; Kaplan and Mauldin 2008; Mayhew and Pike 2004]), and research in earnings management or disclosure management (e.g., Elliott 2006; Han and Tan 2007; King 1996; Nelson and Rupar 2011).

Prior research, however, suggests that individual investors, on average, may be at a disadvantage in understanding the influence of others' incentives. For example, Malmendier and Shanthikumar (2007) suggest that small investors are relatively naïve about analysts' incentives and the resulting distribution of their stock recommendations. As well, Han and Tan (2007) document that a lack of context-specific knowledge regarding management guidance decreases the likelihood that graduate business student participants react to benchmarks *implicitly* associated with different forms of management guidance. Together, these findings suggest that understanding how incentives are expected to affect others' actions should be a useful area in which to explore the impact of individual investors' financial literacy and numeracy skills.

In such situations, tacit managerial knowledge of the situation would be required to understand how incentives apply,[10] and, if in an investment setting, that knowledge should be more likely with investing experience and prior exposure to similar situations. More generally, however, the Persuasion Knowledge Model (Friestad and Wright 1994) suggests that both "topic knowledge" (in this context, financial knowledge) and "persuasion knowledge" (or, the ability "to recognize, analyze, interpret, evaluate, and remember persuasion attempts and to select and execute coping tactics believed to be effective and appropriate;" Friestad and Wright 1994, p. 3) would be necessary for the studies' results. Because individuals can also develop context-specific persuasion knowledge (Friestad and Wright 2005, p. 187), a person may need both investment experience and higher quantitative skills to process the expected influence of incentives in financial accounting settings into his or her judgments.[11] More formally, therefore, the third and fourth research questions are:

*RQ3: Does investment experience moderate the expected influence of incentives on judgment for a sample of extant accounting research studies?*

*RQ4: How do participants' numerical skills affect the impact of investment experience on the sample of accounting research findings?*

**3. Method**

The current research analyzes a relatively large sample of participants recruited from MTurk (n>2,000) in order assess how the broader range of investors' numerical skills can impact extant accounting research results. As the first step, this research providing an extensive description of MTurk participants along dimensions of particular interest to financial accounting researchers (i.e., investment experience and numerical skills), benchmarking the resulting sample of investors against nationwide samples selected to be representative of U.S. Census distributions (FINRA Foundation 2009a, 2009b) and

[10] Tacit managerial knowledge is knowledge of "how to manage oneself, manage others, and manage one's career" (see, e.g., Tan and Libby 1997; Bonner 2008, p. 59). By comparison, technical knowledge is knowledge of "the facts, rules, and relationships within a domain," while functional knowledge is knowledge of "the operations of the entities that are pertinent to a particular task" (Bonner 2008, p. 59).

[11] Financial accounting experiments with graduate business students often assess participants' investment experience (see, e.g., Hirst et al. 1995). This information is typically collected as a control variable or as a covariate, with results not significantly affected by the inclusion of participants' investment experience. The lack of an incremental effect of investment experience in such samples would be consistent with graduate business education successfully proxying for actual investment experience, or with limiting the sample to a relatively sophisticated group (compared to the typical individual investor) such that incremental improvements in judgment are minimal.

against a convenience sample of graduate business students. Participants are then randomly allocated to experimental conditions in a series of accounting experiments to examine the impact of investment experience and the extent to which participants' numerical skills contribute to the prior findings.

***MTurk participants***

Amazon's Mechanical Turk platform is becoming a popular source of experiment and survey participants for social scientists (Ipeirotis 2010), and has recently started to be applied in accounting research (e.g., Koonce et al. 2013; Rennekamp 2012).[12] The U.S.-based MTurk population has been documented to be at least as representative of the U.S. population as more traditional convenience samples (Buhrmester, Kwang, and Gosling 2011; Paolacci, Chandler, and Ipeirotis 2010), with little evidence to suggest that data collected online is of poorer quality than data collected from other subject pools (Krantz and Dalal 2000; Gosling et al. 2004). In a review of commercial participant recruitment services, Brandon et al (2014) suggest that the potential benefits of MTurk include relatively inexpensive access to participants and control over incentive mechanisms, while maintaining the benefits of more traditional online survey panels (i.e., large participant pool and the ability to screen participants based on characteristics, such as with SurveyMonkey Analysis or Qualtrics panels). Similar to other web-based experiments, however, it has been suggested that MTurk participants are less likely to pay attention to experimental materials, reducing statistical power (Goodman, Cryder, and Cheema 2012) and emphasizing the need for "catch trials" or "manipulation checks" that identify inattentive subjects (Oppenheimer, Meyvis, and Davidenko 2009). This research will, therefore, benchmark the sample of MTurk participants against the national Financial Capability Studies in the United States (FINRA

[12] MTurk started in 2005 as:

> *a crowdsourcing web service that coordinates the supply and the demand of tasks that require human intelligence to complete. Mechanical Turk is named after an 18th century chess playing 'automaton' that was in fact operated by a concealed person. It is an online labor market where employees (called* workers*) are recruited by employers (called* requesters*) for the execution of tasks (called* HITs*, acronym for Human Intelligence Tasks) in exchange for a wage (called a* reward*). Both workers and requesters are generally anonymous although responses by a unique worker can be linked through an ID provided by Amazon. Requesters post HITs that are visible only to workers who meet predefined criteria (e.g., country of residence or accuracy in previously completed tasks). When workers access the website, they find a list of tasks sortable according to various criteria, including size of the reward and maximum time allotted for the completion. Workers can read brief descriptions and see previews of the tasks before accepting to work on them... A requester can reward good work with bonuses and punish poor quality work by refusing payment or even blocking a worker from completing future tasks* (Paolacci et al. 2010, p. 411-412).

Horton and Chilton ([2010], p. 209) document the "reservation wages of a sample of workers from Amazon's [MTurk as] approximately log normally distributed, with a median wage of $1.38/hour."

Foundation 2009a, 2009b) based on demographic characteristics and financial literacy, before extending the investigation to other numerical skills.

*Recruiting*

To attract a broad sample, the MTurk posting (Human Intelligence Task, or HIT) was entitled "Survey: How do you decide things?" and described as "General problem-solving, plus decision-making in a business/investment setting" with keywords "survey, demographics, judgment and decision-making." The survey was further described as "an academic survey about decision-making," noting that "the survey should take less than 45 minutes complete in a single session. (Prior responses suggest it will only take about 30 minutes on average, but the maximum time is set to 90 minutes to prevent you from being accidentally timed-out!)."[13] The HIT further indicated that participants would "be presented with a common business or investment situation and asked to answer a series of questions about that situation" and would "also be asked some demographic questions and a short series of follow-up questions." The HIT then provided a link to the study along with a text box into which participants were asked to paste the code they would receive at the end of the survey in order to receive payment. Eligibility for the HIT was set to a minimal level: a prior HIT Approval Rate for all Requesters' HITs greater than or equal to 95 percent (to help address the concern of participants paying attention; see also Peer, Vosgerau, and Acquisti 2013), and the Worker Location being in the U.S. (to allow for benchmarking against the national Financial Capability Studies in the United States). Clicking on the survey link led potential participants to a Qualtrics survey, which presented two screening questions (verifying that participants were 18 years of age or older, and that they currently resided in the U.S.) and then the IRB-approved informed consent form before continuing with the study. Payment for completing the HIT was set at $1.00, with a maximum time limit of 90 minutes[14] and the number of assignments (unique Workers) set at 2,000.[15] Data collection for this survey was completed in approximately 5 days.

[13] An initial sample (n~200) was collected prior to the current reported survey to gain familiarity with MTurk and to pretest materials.
[14] Qualtrics recorded the time at which each participant started and ended the survey. The overall mean (median) length to complete the survey was 28.7 (26.0) minutes. Participants classified as investors (defined later in this research) tended to take longer to complete the survey compared to non-investors (e.g., mean of 29.8 for the broadest investor classification versus 27.1 minutes for non-investors). This implies a mean effective hourly wage for the overall sample of $2.09, which is above

*Research instrument and procedures*

The survey instrument consists of three parts: an introduction (including financial confidence), experiment replication, and participant descriptives (including demographics and numerical skills).

**Introduction (including financial confidence).** Participants were thanked and instructed to (i) ensure that they had sufficient time available to complete the survey in a single session, (ii) answer the questions in the order provided, (iii) not use any outside resources other than a calculator if needed, and (iv) not speak with anyone while they completed the study. Participants were also warned not to hit the "back button" on their browser because doing so would prevent them from continuing with the survey.

Four self-assessed financial confidence questions followed, replicated from the FINRA Foundation (2009a, 2009b) surveys (see Appendix A). The confidence questions were asked prior to the experimental study replications and the collection of numerical skills because of the potential for participants' normal level of confidence to be affected by perceived performance in these later tasks.

**Experiment replication.** Participants then are randomly allocated to between-subject experimental conditions in a set of four extant accounting experiments: Elliott et al.'s (2007) Experiment 1, Kadous et al.'s (2005) Experiments 1 and 2, and Nelson and Rupar's (2011) Experiment 1.[16] Existing research studies are examined, rather than developing new experimental materials, so the focus can remain on the impact of investment experience and the extent to which participants' numerical skills contribute to the findings, rather than on potential issues inherent in the experimental materials themselves.

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reservation wage of $1.38 documented by Horton and Chilton (2010) but lower than the effective hourly wage reported by Rennekamp (2012, p. 1328) of $3.75. An earlier version of Koonce et al. (2013) reports that those authors paid $2 for completing their experimental task, but they do not report effective hourly wages. Anecdotally, reservation wages are likely rising (e.g., Amazon now includes a statement for the requester to consider how long it will take a worker to complete the task, noting that "a 30 second task that pays $0.05 is a $6.00 hourly wage"); however, Buhrmester et al.'s (2011) findings suggest that lower payment levels do not appear to affect data quality, rather the length of the overall data collection period.

[15] While 2,000 assignments were available for payment within MTurk, the final number of surveys completed within Qualtrics is higher at 2,097. Of the 2,000 assignments within MTurk, thirteen were rejected (most commonly for not providing the unique code provided at the end of the Qualtrics survey, which was needed to match responses within Qualtrics and MTurk). Additional surveys completing within Qualtrics are considered only if complete, defined as those surveys which Qualtrics has designated as complete (i.e., participants viewed the final completion screen) together with those surveys in which participants answered the final check question on the last content page of the survey. It is important to note that participants retained the option of omitting individual questions within the survey; for most questions, participants who initially skipped a question were provided with a pop-up reminder that the question had not been answered and a question about whether they wanted to continue without answering the omitted question.

[16] Participants were randomly assigned to one of the 12 between-subject experimental conditions across all of the replicated studies. The number of participants is notably larger than in the original research so that, as subsamples of investors and of higher-skilled investors are identified, a sufficient number of participants should remain for analysis.

The replication of Elliott et al.'s (2007) Experiment 1 acts as a primary basis of comparison because that research purposefully examined whether MBA students can represent valid proxies for nonprofessional investors (using members of the NAIC). The experiment is itself based on a partial replication of Hirst et al. (1995). Participants (n=285) in the role of an investor assess an analyst report on a firm, with or without the analyst maintaining an investment banking relationship with the firm. The theory underlying the effect of the investment banking relationship is one of awareness of analysts' incentives and how those incentives could influence their reports.

To replicate Kadous et al.'s (2005) Experiments 1 and 2, participants (n=682 and 683, respectively) in the role of a supervising manager face a decision regarding whether or not to postpone routine but expensive maintenance on machinery for one division of the company. The proposal varies in the presentation of quantitative information (both Experiments), the level of subjectivity of that information (Experiment 1), and whether the division manager's incentives are consistent or inconsistent with the firm's long-run best interests (Experiment 2). The underlying theory is one of understanding potential persuasion tactics in a business setting (rather than in an individual investor setting *per se*). Nevertheless, the authors' participant pool was limited to MBA students, the common proxy for individual investors (though here proxying for firm managers).

To replicate Nelson and Rupar's (2011) Experiment 1, participants (n=767) are asked to assess a firm's commodity price risk based on the provided information, which varies the format of the numerical information (dollar vs. percentage), whether the disclosing firm has a choice of format or the format is mandated, and, in an additional within-subject manipulation, the extent of the manager's incentive to achieve a preferred reporting result. Thus, like Elliott et al.'s (2007) study, persuasion knowledge or tacit managerial knowledge of the situation is required to understand the potential impact of incentives, but technical accounting knowledge may be more relevant than general investing experience.

Kadous et al.'s (2005) experiments and Nelson and Rupar's (2011) Experiment 1 serve important roles by providing conceptual replications of the impact of investment experience and the extent to which participants' numerical skills contribute to the findings. Replication is important, particularly if results

might be affected by small design changes (Kahneman 2012; Yong 2012; see also Bamber, Christensen, and Gaver 2000), although accounting journals seldom publish stand-alone replications (Cooper and Morgan 2008). Both of the additional experiments reference theory regarding understanding of the likely impact of others' incentives, and recruits MBA students as participants, although they vary in the nature of the investment judgment or decision context. These experiments were selected in part because they also reference theory regarding the processing of quantitative information. Moreover, Nelson and Rupar's (2011) Experiment 1 serves to extend the investigation to a more technical context, namely assessing a firm's commodity price risk based on the provided accounting disclosures.

**Participant descriptives (including demographics and numerical skills).** In the final section of the survey, participants were informed that they would be asked a series of background questions about themselves and their experiences, with a short series of follow-up questions in order to help understand why their responses might differ from those of other participants. Demographic questions (see Appendix A) included: gender; age category; employment activities during the prior week; highest level of education; investment history in individual company's stocks and in mutual funds (either directly versus through a pension or formal retirement account); home ownership; and, retirement planning. Participants who reported some level of college education were also asked about their major in college (and graduate majors for those indicating graduate education), as well as the number of courses completed in accounting, auditing, finance, statistics, and other specialized mathematics such as calculus. Participants who reported an investment history were also asked the approximate value of their investment portfolio in individual companies' stocks and in mutual funds (responding separately for investments made directly versus through a pension or formal retirement account). Participants who reported an investment history in stocks were asked how often they examine a company's financial statements as part of their evaluation of a potential investment in a company's stock.

Numerical skills were then assessed along a variety of dimensions (and are also provided in Appendix A). *Financial literacy* was assessed using a series of five questions previously applied in nationwide samples selected to be representative of U.S. Census distributions (FINRA Foundation 2009a,

2009b, 2012), each of which had been applied in prior research in a multiple choice format (e.g., Lusardi and Mitchell 2011a; van Rooij et al. 2011). These questions cover fundamental concepts of interest compounding, inflation, diversification, and present value.[17] *Numeracy* fundamentals were assessed using a series of three questions from Schwartz et al. (1997) to examine basic numeracy skills (covering simple probabilities and conversions between simple probabilities and frequencies) and four questions from Cokely et al. (2012) to examine higher-order numeracy skills (covering simple probability estimates as well as Bayes' Theorem), all presented in a multiple choice format.[18] Because Cokely et al.'s materials were designed specifically for educated and highly educated samples (e.g., college students, business professionals), I follow their suggestion to include the Schwartz et al. questions in order to increase discriminability and reduce skewness in the data for this broader-based sample. *Quantitative analytical reasoning* was measured based on Frederick's (2005) research on cognitive reflection (three quantitative questions in which the initial intuitive response differs from the correct response).[19]

Participants were also presented with a short series of other reasoning questions for supplemental analyses. Specifically, two questions assessed participants' tendencies towards probability matching (West and Stanovich 2003), which may be related to quantitative analytical reasoning. Tversky and Kahneman's classic (1983) "Linda" question on the conjunction fallacy was included to assess probability judgment in a non-numerical format. Two questions from Farrell, Krische, and Sedatole's (2011, Study 2) examination of the use of simple anchors in subjective valuations of stock options, adapted to a multiple choice format, were included for an assessment of a technical financial issue which employees may realistically face outside of other stock market participation decisions.

Finally, as participants who fail to read instructions decrease the reliability of the data, accounting researchers typically include instructional manipulation check questions in their experimental materials. Because this may be particularly important for online instruments (Goodman et al. 2012; Oppenheimer et

[17] An alternative measure of financial literacy focused on debt literacy from Lusardi and Tufano (2009) was also included.
[18] The multiple choice format for the Cokely et al. (2012) questions was adopted for this survey, and multiple choice versions of the Schwartz et al. (1997) questions were developed based on the most frequent responses in pretesting. A fifth (alternate) question was also included, adapted from Cokely et al.'s (2012) web-based version (available at: http://riskliteracy.org.temp.realssl.com/TryIt.aspx), with no notable differences in inferences drawn based on the original four questions as reported or with the alternate question substituted into the measure.
[19] The multiple choice format used in the current survey was developed based on the most frequent responses in pretesting.

al. 2009), a final check question was included in the study, independent from any of the experimental replications, asking what participants believed to be the purpose of the study. Within a relatively long textual paragraph, participants were instructed to choose the "other" option and to type the word "effort" as their response (see, e.g., Oppenheimer et al. 2009; Tuncel et al. 2013).

**Follow-up accounting literacy survey**. On the final screen, participants who reported some investment history were invited to participate in a second survey that "evaluates accounting knowledge in individuals who have previously invested in either stocks or mutual funds." The survey was described as consisting of 35 accounting questions for an additional $1 bonus payment, with the initial screening question asking participants to enter either their MTurk Worker ID or the unique payment identification code that would be provided at the end of the first survey (to match responses to the first survey and to award the bonus payments for completion of the second survey.) Of the 1,218 eligible participants, 640 completed follow-up responses were obtained, for a response rate of 52.5 percent.[20] Ten questions were adapted from financial accounting review chapters of a financial statement analysis textbook (Easton et al. 2013; presented in Appendix B), with the remaining 25 questions reproduced from a financial literacy survey developed by R. Weil and K. Schipper, previously administered to Board of Directors members and executive MBA students, covering a broad range of accounting issues (Coates et al. 2007; Weil 2012).

***Comparative data:***

*National Financial Capability Studies*

The FINRA Investor Education Foundation commissioned the first national study of the financial capability of American adults in 2009, in consultation with the U.S. Department of the Treasury and President Bush's Advisory Council on Financial Literacy (FINRA Foundation 2009a, 2009b). The overall objectives of these studies were to "benchmark key indicators of financial capability and evaluate how these indicators vary with underlying demographic, behavioral, attitudinal and financial literacy

[20] Approximately two weeks after the primary survey was completed, a reminder email was sent via the MTurk system to all eligible participants who had not yet responded to the follow-up survey request. The follow-up survey remained open for four weeks following the primary survey. Anecdotal evidence (specifically, email correspondence from potential respondents) suggests that those who completed the follow-up survey may be more advanced in their knowledge of accounting issues than those who did not complete the follow-up survey.

characteristics."[21] The "state-by-state" survey (FINRA Foundation 2009a) was collected nationwide via existing online survey panels. The survey collected over 25,000 American adults (approximately 500 per state, plus the District of Columbia), with participants selected to be representative of Census distributions of each state in terms of age, gender, ethnicity, and education. The "national" survey (FINRA Foundation 2009b) consisted of a national, random-digit-dialed telephone survey of 1,488 respondents, with a primary sample of 1,200 respondents selected to be representative of Census distributions and some over-sampling in certain ethnic and educational levels (to include a minimum of 150 in those categories). The surveys include questions on demographic characteristics, financial capability (e.g., accounts, debts), financial literacy (described along with the MTurk survey questions above), financial behaviors (e.g., credit card habits, access to professional financial advice), and financial attitudes (e.g., confidence and risk preferences).[22]

*Graduate Business Students*

Graduate business students enrolled in recent financial statement analysis course sections were asked to complete the same numerical skill measures completed by the MTurk participants, as well as the accounting quiz and Board accounting literacy questions completed by the subsample of MTurk participants who self-identified as investors. Students were invited to participate in the survey to earn one percent of extra course credit. Reponses are analyzed for only for those who explicitly granted permission for their responses to be used in research publications (n=45 of 53, 83 percent).

## 4. Results

### *Research questions 1 and 2: Investor characteristics and skills*

Table 1 presents the comparison of investors relative to non-investors for two investor definitions: (1) any stock or mutual fund investment, and (2) any direct stock or mutual fund investment reported

[21] Refer to http://www.finrafoundation.org/programs/capability/index.htm.

[22] These questionnaires and data are publicly available at: http://www.usfinancialcapability.org/downloads.php . The FINRA Foundation (2009a, 2009b) data are combined in the reported analysis, but results are similar when only the "state-by-state" survey (FINRA Foundation 2009a) is analyzed. A similar state-by-state study was repeated in 2012 (FINRA Foundation 2012). However, this more recent study omitted one of the two questions to determine participants' standing as investors and, therefore, the FINRA Foundation (2012) data are omitted from the reported analyses. Nevertheless, results are similar when the FINRA Foundation (2012) is included in the analyses when possible.

history, i.e., non-retirement.[23] Across both investor definitions, results of the demographic characteristics (Table 1, Panel A) show that investors are more likely to be male, tend to be older, are more likely to be employed on a full-time basis, and are more highly educated than non-investors. These differences in characteristics are consistent with recent Swedish (Almenberg and Dreber 2011; Almenberg and Widmark 2011) and Danish (van Rooij, Lusardi, and Alessie 2011) analyses. Also across both investor definitions, results of the financial literacy measures (Table 1, Panel B) show that investors are more likely to have engaged in planning for their retirement (approximately 60 percent and 26 percent of investors and non-investors, respectively, have ever tried to figure out how much they would need to save for retirement), have higher self-assessed financial abilities (approximately 5.2 and 4.5 on a scale out of 7 for investors and non-investors, respectively), and higher financial literacy quiz scores (approximately 74 percent and 56 percent of the quiz questions were answered correctly for investors and non-investors, respectively).

Importantly, these directional differences in characteristics and skills between investors and non-investors are consistent with results applying representative national samples (untabulated; FINRA Foundation 2009a, 2009b). To further assess whether the investors sampled from MTurk are significantly different from the investors identified through representative national samples (i.e., FINRA Foundation 2009a, 2009b) while controlling for the differences in sample size, I randomly selected 1,000 samples of 2,000 observations (i.e., a similar size as the MTurk sample) from the representative national samples in order to compute 95 percent confidence intervals for each sample variable of interest.[24] Results for the demographic characteristics in Table1, Panel A, show that investors sampled through MTurk are younger (e.g., with 44 percent and 79% of investors sampled through MTurk and the representative national samples, respectively, over the age of 35) with a higher level of undergraduate education (with 66 percent and 54% of investors sampled through MTurk and the representative national samples, respectively,

[23] Within investors, investment in mutual funds is more commonly reported through a pension or formal retirement account (57 percent) than as direct (35 percent). The opposite holds for individual companies' stocks—investment in individual companies' stocks is more commonly reported as direct (49 percent) than through a pension or formal retirement account (42 percent). Findings are qualitatively similar when the investor definitions exclude mutual funds.

[24] Specifically, each bootstrap sample is generated by randomly sampling with replacement the observations from the combined FINRA Foundation (2009a, 2009b) datasets. I then compute the mean for each variable of interest for each resulting non-investor or investor subsample. Two-sided 95 percent confidence intervals are determined with the 2.5$^{th}$ and 97.5$^{th}$ percentiles of the sample means. Means for the MTurk sample are significantly different from the representative national samples (FINRA Foundation 2009a, 2009b) if the mean observed from the MTurk sample falls outside of the 95 percent confidence interval.

having earned a college degree), although the percentages of investors indicating that they have completed high school or that they have completed some level of post-graduate college education do not significantly differ. Results for the numerical skills in Table1, Panel B, indicate that investors sampled through MTurk are significantly less confident in their financial abilities than the representative national samples. Nevertheless, investors sampled through MTurk do not significantly differ from the representative national samples in terms of having engaged in planning for their retirement or in their financial literacy quiz scores.[25]

Table 2 presents additional measures of numerical skills (including numeracy, quantitative reasoning, and accounting literacy) not previously available through national samples (FINRA Foundation 2009a, 2009b, 2012). Perhaps not surprisingly given their higher education, investors (both definitions) have higher levels of basic and higher-order numeracy and quantitative reasoning than non-investors. Investors who have some college education also report being substantially more likely than non-investors who have some college education to complete at least one class in accounting, auditing, or finance (approximately 56, 20, and 50 percent vs. 32, 6, and 30 percent for investors vs. non-investors, respectively), while being somewhat more likely to have completed at least one class in statistics or other advanced mathematics (both approximately 20 percent vs. 12 and 10 percent for investors vs. non-investors, respectively). This may contribute to investors' higher levels of numeracy and financial literacy. Additional accounting literacy measures were only requested from individual investors (i.e., those who reported some history of stock or mutual fund investment).[26] Approximately 34 percent of the accounting quiz questions and only 12 percent of the Board accounting literacy questions were answered correctly, with percentages consistent across participants who reported direct investment histories rather than through a pension or formal retirement account.[27]

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[25] In contrast, both investors recruited through MTurk and the representative national samples (FINRA Foundation 2009a, 2009b) appear to differ from the type of individual investor that has been employed as investor-participants in accounting research, particularly the National Association of Investors Corporation (NAIC) in the U.S. (e.g., Hodge 2003, De Bondt 1998, Elliott et al. 2007). Rather, the typical investor appears to be younger, more likely male, and somewhat less likely to have a college degree than NAIC members (see Hodge 2003).

[26] This design choice was made based on the low incidence of accounting courses completed by non-investors in pre-testing.

[27] Investors who reported some investment history in an individual company's stock (either directly or through a pension or formal retirement account; n=978) were also asked how often they examined a company's financial statements as part of their

Table 3 presents a comparison of investors' numerical skills compared to participants proxying for investors based on two measures of business education, and compared to graduate business students enrolled in recent financial statement analysis course sections.

First, separating individuals who report some amount of college education and also report completing at least one accounting and one finance course (28 percent of the MTurk sample, 76 percent of whom are also individual investors) leads to similar differences in financial literacy, numeracy fundamentals and quantitative analytical reasoning as the actual investor classifications. By definition, participants in this proxy group report higher mean numbers of courses in accounting and finance, and, therefore not surprisingly, higher mean numbers of courses in auditing and statistics, as well as higher measured accounting literacy.

Second, separating individuals who report some amount of graduate-level education and also report completing at least one accounting and one finance course severely restricts participant availability (at most 10 percent of individual investors, broadly defined)[28] and often leads to greater differences than the actual investor classifications. As with the first education-based proxy, by definition, participants in this proxy group report higher mean numbers of courses in accounting and finance, and therefore not surprisingly, higher mean numbers of courses in auditing and statistics, as well as higher measured accounting literacy. However, they also consistently report higher levels of financial confidence, financial literacy, numeracy, and quantitative analytical skills.

Third, these results likely understate the differences between the average investor and graduate business students.[29] Graduate business students in recent financial statement analysis course sections were asked to complete four of the same five multiple choice questions for financial literacy, a mixture of

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evaluation of a potential stock investment. Approximately one-third of such investors report that they "never" or "rarely" do so (34.0 percent) and another third report that they "sometimes" do (32.7 percent). The percentage of stock investors who "never" or "rarely" examine a company's financial statements as part of their evaluation is higher for investors who reported investing in an individual company's stock through a pension or formal retirement account (46.0 percent of n=389) rather than directly (26.0 percent of n=589). Investors' use of financial intermediaries was not considered in the MTurk survey.

[28] This estimate is based on the assumption that 100 percent of these participants were also individual investors, although only 86 percent self-reported any investment history.

[29] Less than one quarter of MTurk participants classified as investors and who have some college education majored in a business-related discipline (Table 2). That percentage increases to about one third for respondents who have some college education and have taken at least one accounting and one finance class (untabulated).

multiple choice and fill-in-the-blank measures of higher-order numeracy, and fill-in-the-blank measures of basic numeracy and quantitative reasoning (with the responses used to develop the multiple choice response options employed in the MTurk survey). For those granting permission for their responses to be used in research publications (n=44 of 53, 83 percent), the mean percentages correct for the financial literacy, basic numeracy, and higher-order numeracy measures (97, 84 and 54 percent, respectively) are substantially higher than for any investor classification or other education-based proxy reported in Table 3.[30] The graduate business students were also asked to complete the same accounting quiz and Board accounting literacy questions. The mean percentages correct were again substantially higher than any of the investor classifications or other proxies reported in Table 3, with a mean of 71 and 21 percent correct for those who completed the accounting quiz and Board accounting literacy questions, respectively. While these graduate business students' recent exposure to related concepts in their coursework could improve their ability to access and apply these concepts, the same would be true for the graduate business students who participate in accounting research studies.

Table 4 presents logistic regressions in which participants' classification as an investor or non-investor is modeled as a function of their demographic characteristics and financial literacy. Because of the significant correlations between the financial literacy quiz, numeracy fundamentals, and quantitative analytical reasoning measures, a first principal component is computed for use in this and later analyses.[31] Using the three defined measures of financial literacy, numeracy fundamentals, and quantitative analytical reasoning, Cronbach's Alpha is 0.62. The first principal component has an eigenvalue of 1.78, explaining 59.2 percent of the variance in the data.[32] For each investor classification, three models are considered: The first includes the numerical skills principal component only (Model 1). The remaining two models

[30] The mean percentage correct for the quantitative reasoning measure is similar to non-investors at 34 percent correct. The mean is likely reduced by the fill-in-the-blank response mode rather than multiple choice options used in the MTurk survey.
[31] For each replication, the principal components are recalculated separately, with the eigenvalues and percentages of variance explained for the first principal component similar across replications.
[32] A widely applied rule of thumb is for Cronbach's Alpha to be greater than 0.70. However, Hatcher (1994, p. 137) notes that "the social science literature does sometimes report studies employing variables with coefficient alpha reliabilities under .70 (and sometimes even under .60!)." The second principal component has an eigenvalue of only 0.75 and explains only 25.0 percent of the variance in the data. Inferences from the logistic regressions do not change when the second principal component is included in the models as a control, and results using the first principal component for the experimental replications do not replicate when the second principal component is instead applied in the analyses.

include demographic characteristics previously documented to affect financial literacy, or ownership of stocks and mutual funds, as control variables (gender, age, owning one's home, education, full time employment, and having considered the amount required for retirement; e.g., Hung et al. [2009], van Rooij et al. [2011]). Because only participants indicating some level of college education were asked about specialized courses, Model 2 includes general indicator variables for education while Model 3 includes two higher education indicators plus the specialized course measures.

Results show that, for each investor classification, the numerical skills principal component is a strongly significant predictor (Model 1), and remains so after including control variables (Models 2 and 3). Among the demographic characteristics, it is worth noting that gender is significant before considering educational course content (Model 2); after doing so, the effect is reduced (Model 3), suggesting that self-selection and differences in educational training have likely contributed to the gender effects documented in the prior literature (e.g., Almenberg and Dreber 2011).

***Research questions 3 and 4: Impact of investment experience and numerical skills***

*Replication 1: Elliott et al.'s (2007) experiment 1*

In this first replication, participants (n=285) in the role of an investor assess an analyst report on a firm, with or without the analyst maintaining an investment banking relationship with the firm. Panel A of Table 5 presents the main results from Elliott et al. (2007, Experiment1) and the replication using the MTurk sample. Specifically, the analyst's credibility is viewed as significantly higher and the analyst is perceived to have a significantly lower incentive to please management when there is no investment banking relationship present. Correspondingly, the percentage of funds invested in the firm is significantly higher when there is no investment banking relationship present. There is no significant difference in perceived earnings potential or price appreciation for the firm, either in the Elliott et al. (2007) findings or with the MTurk sample. Thus, except for the proportion preferring to invest in the firm, the overall results for the main dependent variables are replicated using this broader subject pool.

Nevertheless, there is evidence that the results are moderated by investment experience and numerical skills, respectively. Specifically, in Panel B of Table 5, the reported results are not significant

in the non-investor subsample, but all remain significant in the investor subsamples. In Panel C of Table 5, investor participants are divided into tertiles based on the numerical skills principal component, and responses are compared for the top and bottom tertiles. The results remain significant in the high-skills investor subsamples while not significant for the low-skills investor subsamples. These results suggest that limiting the participants in the original research increases the power of the statistical tests.

Panel D of Table 5 presents the results of the replication using a proxy for investment experience (completing some college education and at least one accounting and one finance course) rather than reporting investing history.[33] Results for the investor proxy are weakened overall, but are again moderated by numerical skills, with three of the four dependent variables found to be significantly affected by the presence of the investment banking relationship in the high-skills subsamples,[34] while not significant or marginally significant in the opposite direction in the low-skills subsamples.

*Replication 2: Kadous et al.'s (2005) Experiments 1 and 2*

In the second replication, participants in the role of a supervising manager (n=682 and 683 for Experiments 1 and 2, respectively) face a decision regarding whether to postpone routine but expensive maintenance on machinery for one division of their company. The proposal varies the presentation of quantitative information (both Experiments), the level of subjectivity of that information (Experiment 1), and whether the division manager's incentives are consistent with the firm's long-run best interests (Experiment 2). Panel A of Table 6 reproduces the main results from Kadous et al. (2005) and presents the replication using the MTurk sample. In Experiment 1 (Experiment 2), the highest perceived likelihood of postponement occurs when the materials are quantified and objective (consistent), highlighted lower left corner of each of the 2 x 2 tables. The main contrasts used to test the interaction hypotheses are significant for both experiments. Thus, the results documented by Kadous et al. (2005) are replicated using the broader subject pool.

[33] The second education-based proxy (i.e., some level of graduate-level education and also at least one accounting and one finance course) is not analyzed due to insufficient sample size (n=15).

[34] Note that the "proportion preferring to invest" in the focal firm is significant in this subsample, whereas it is directionally consistent but not significant in any of the MTurk investor subsamples, perhaps due to greater familiarity with the ratios.

For Experiment 1, Panel B of Table 6 reproduces the main results across investor subsamples. Within the non-investor subsample, the main contrast remains significant, but supplemental contrasts indicate that the result is largely due to the main effect of quantification. Within the investor subsamples, however, supplemental contrasts better identify the nature of the interaction, with evidence of a significant objectivity effect when quantification is high, but not when quantification is low. Panel C of Table 6 examines the impact of numerical skills on these results. The supplemental contrasts consistently find simple effects of quantification for the low-skills investor subsamples. However, the supplemental contrasts again find a clearer interaction for the high-skills investor subsamples, with the effect of objectivity significant with high quantification and not significant with low quantification. These results suggest that the interactive effect documented by Kadous et al. (2005) is driven at least in part by participants with investment experience and higher numerical skills.

For Experiment 2, Panels D and E of Table 6 assesses the main result across investor subsamples and the impact of numerical skills within investor subsamples, respectively. The planned contrast remains significant, but supplemental contrasts do not consistently provide evidence of an interaction.

Panel F of Table 6 presents the results of the replication using a proxy for investment experience: completing some college education and at least one accounting and one finance course. Results are weakened overall for Experiment 1, with significant contrasts only for the impact of quantification (and for both low- and high-skill participants). Results are somewhat strengthened for Experiment 2, with some evidence of an interaction effect between consistency and quantification differing in direction between the low- and high-skills subsamples.

*Replication 3: Nelson and Rupar's (2011) Experiment 1*

In the third replication, participants (n=767) are asked to assess a firm's commodity price risk based on the accounting disclosures presented, which varies the format of the numerical information (dollar vs. percentage), whether the disclosing firm has a choice of format or the format is mandated, and the extent of the manager's incentive to achieve a preferred reporting result. Panel A of Table 7 reproduces the main results from Nelson and Rupar (2011, Experiment 1) and presents the replication using the MTurk sample.

As the original research states directional hypotheses, I apply specific contrasts to test directional effects using a repeated measures analysis. Consistent with the original hypotheses, I find a significant main effect of numerical format (H1). The simple effect of numerical format remains significant in all conditions except with high management opportunity and high incentives for management, highlighted in the lower right corner of each 2 x 2 x 2 table. The result is a significant directional two-way interaction for H2 between format and opportunity in the high-incentive conditions (and not in the low-incentive conditions) and a significant directional three-way interaction for H3. Thus, the results documented by Nelson and Rupar (2011) are generally replicated using this broader subject pool.

In Panel B of Table 7, this pattern weakly replicates for the non-investor subgroup, obtaining a significant directional two-way interaction between format and opportunity in the high-incentive conditions (and not in the low-incentive conditions) but failing to obtain a significant directional three-way interaction. For each of the investor subsamples, the pattern of results repeats, with a significant directional two-way interaction between format and opportunity in the high-incentive conditions for one of the two investor subsamples (and not in the low-incentive conditions) and with a marginally significant directional three-way interaction for both investor subsamples.

Panel C of Table 7 presents evidence that the results in the investor subgroups are moderated by numerical skills. The directional three-way interaction remains significant in the high-skills investor subsamples, while not significant for the low-skills investor subsamples. These results again suggest that the initial results are driven by participants with investment experience and higher numerical skills.

Panel D of Table 7 presents the results of the replication using a proxy for investment experience: completing some college education and at least one accounting and one finance course. Results are weaker overall, but are again moderated by numerical skills. For the high-skills subsample, the pattern repeats, with a significant directional two-way interaction between format and opportunity in the high-incentive conditions (and not in the low-incentive conditions) and a significant directional three-way interaction. For the low-skills subsample, the interactions are generally not significant or in the opposite direction.

***Supplemental analyses***

In three of the experiments replicated using the broader MTurk subject pool, the results are driven, at least in part, by participants with both investment experience and higher numerical skills, motivating three additional analyses: First, the effects of investor classification and numerical skills, while correlated, are not conceptually identical and can have different implications for research applications. Two variables used to illustrate this point: probability matching (West and Stanovich 2003) and the conjunction fallacy (Tversky and Kahneman 1983). For each of the two probability matching questions in West and Stanovich (2003), approximately one-quarter of participants answer the question correctly, and only 15 percent of participants answer both correctly (untabulated). With the conjunction fallacy, again only about one-quarter of participants answer the question correctly (untabulated). Spearman rank correlations of the numerical skills measures (including financial literacy, numeracy, quantitative analytical reasoning, and the first principal component of these measures) indicate a significant positive correlation with both the ability to correctly answer the probability matching questions and the conjunction fallacy question (all $p<0.042$ two-sided). In contrast, however, investor classification is not significantly correlated with correctly answering the conjunction fallacy question (both $p>0.634$ two-sided), although it remains positively correlated with correctly answering the probability matching questions (all $p< 0.011$ two-sided). Future research could examine the contextual characteristics under which numerical skills operate separately from investment experience.

Second, the effects of investor classification and numerical skills are often presumed to improve judgment and decision making (as in each of the replicated studies), but this does not hold under all circumstances. For example, consider Farrell et al.'s (2011, Study 2) examination of the use of simple anchors in subjective valuations of stock options. Adapted to a multiple choice format, spearman rank correlations reveal that, not surprisingly, non-investors are significantly more likely to report that they do not know the answer to the valuation question (both $p<0.001$ two-sided, untabulated) than investors. For those who chose a numerical response, investors are more confident in their selection (both $p<0.001$ two-sided), but investors are no more likely to have chosen the correct response than non-investors (negative

correlation with p>0.138 two-sided, positive correlation with p>0.841), despite their increased confidence. Similarly, lower numerical skills are also correlated with participants reporting that they do not know the answer to the valuation question posed (all p<0.075 two-sided). However, for those who chose a numerical response, higher numerical skills often work against the participant, being correlated with an increase in confidence (all p<0.050 two-sided), an increase in the tendency to select one of the incorrect heuristic responses (all p<0.035 two-sided), and, correspondingly, a decrease in accuracy (all p<0.001 two-sided). One interpretation of these findings is that investment experience and high numerical skills, while generally helpful, do not necessarily imply a sufficient level of technical expertise for more advanced accounting settings and, therefore, may not by themselves allow participants to be identified as "reasonably informed investors" as conceptualized by accounting standard setters.

Third, the level of care and effort with which participants completed the survey could reasonably affect responses. Nevertheless, it is unlikely that participant effort can fully explain the findings in this research. Participants' responses to the final check question included in the survey (i.e., independent from any of the experimental replications) is applied as a measure of overall participant care and effort. Applying spearman rank correlations (untabulated), whether participants correctly answered the final question is positively correlated with investor classification (both p<0.042 two-sided) and the numerical skills measures (all p<0.001), as would be expected under this explanation. Whether participants correctly answered the final question is also positively correlated with their answering the probability matching questions correctly (all p<0.001), positively correlated with the choice of a heuristic response for the stock option valuation question (p<0.001), and correspondingly negatively correlated with their accuracy on the stock option valuation question (p<0.001). However, whether participants correctly answered the final question is not significantly correlated with participants' tendency to indicate that they do not know the answer to the stock option valuation question (p=0.866), nor with their level of reported confidence when they did provide a response to the stock option valuation question (p=0.243). Further, using a logistic regression to predict whether participants correctly answered the final question does not reveal any significant interaction between their investor classification and their numerical skills principal

component, which would be necessary to explain the findings for the experiment replications.[35] Thus, it is unlikely that participant effort can fully explain the findings in this research.

**5. Conclusions and Discussion**

This paper provides the necessary starting point for a more ambitious research agenda aimed at assessing the impact of individual investors' characteristics and skills. Individual investors are found to be older, more likely to be male, more likely to be employed on a full-time basis, more highly educated, and more likely to have engaged in retirement planning. Individual investors also tend to be more confident in their numeric and financial abilities, and score higher on a set of basic financial literacy questions. These differences are consistent across a large sample of participants from Amazon's MTurk and national samples (FINRA Foundation 2009a, 2009b). Extending prior analyses, results also show that investors score higher on numeracy fundamentals and on quantitative analytical skills.

Although these differences confirm investors' relative sophistication compared to non-investors, the findings arguably remain inconsistent with the "reasonably informed investors" as examined in financial accounting experiments and proxied by graduate business students. Individual investors answer an average of 74 percent of the basic financial literacy questions correctly. Fewer than 60 percent of investors who have attended some amount of college report having completed one or more courses in accounting or one or more courses in in finance.

Separating individuals who report some graduate-level education and also report completing at least one accounting and one finance course severely limits generalizability to general investment populations (at most ten percent of individual investors, broadly defined), leading to more extreme differences than the actual investor classifications. These individuals tend to have higher mean scores in accounting literacy, financial literacy, numeracy fundamentals, and quantitative analytical skills.

These initial findings raise questions about the extent to which accounting research with graduate business students as participants would replicate and generalize to more typical investor populations. To

[35] For example, in the replication of Elliott et al. (2007), whether participants correctly answered the final question does not significantly interact with the investment banking manipulation in affecting participants' dependent judgments of credibility, incentives to please management, or the percentage of funds invested (the interpretation of which remains unchanged).

examine the impact of investment experience and related numerical skills on such studies, participants were randomly allocated to experimental conditions in a selected set of extant accounting research studies. Across the replications, the results tend to be moderated by investment experience; however, numerical skills further moderate the effects within the investor subsample. Specifically, investors with higher numerical skills are more sensitive to others' incentives and are more likely to incorporate that understanding into their judgments than are investors with lower numerical skills, suggesting that limiting the pool of participants in the original research increases the power of the statistical tests.

Libby et al. (2002, p. 802) recommend that potential participants be matched to the goals of the experiment, while avoiding the use of more sophisticated participants than necessary to achieve those goals. By benchmarking investor participants against recent nationwide samples selected to be representative of Census distributions (FINRA Foundation 2009a, 2009b), the current study helps inform the growing body of research employing MTurk participants. The current research provides an extensive description of MTurk participants along the dimensions most likely to be of interest to accounting researchers (i.e., investment experience and numerical skills). Based on the current findings, researchers interested in issues broadly relevant to nonprofessional U.S.-based investors could legitimately access such individuals via Amazon's Mechanical Turk platform by employing an investment filter during the recruiting process. Depending on the theory applied, these researchers should also consider collecting additional characteristics (such as the numerical skills collected in this study) as additional explanatory variables for their analyses.

Behavioral research aiming to address issues relevant to individual or nonprofessional investors, motivated in part to help inform regulators, may need to consider implications not only for higher skilled investors but also the wider range of skill sets represented in the investor population and documented in the current research. Nevertheless, future behavioral research should also examine the generalizability of the current results to tasks that involve more specific financial accounting settings (such as the derivative disclosures in Koonce et al. 2013) or tasks that are relatively high in integrative complexity (such as Elliott et al.'s [2007] Experiment 2). Further, while this research documents that U.S. investors tend to

have better numerical skills than the general U.S. population, investor classification and numerical skills are not perfectly correlated concepts. Circumstances also exist in which improvement in numerical skills does not necessarily lead to improvement in judgment (such as in the use of simple anchors in subjective valuations of stock options documented in this research). Future research should therefore examine the situational characteristics that allow numerical skills to operate and to improve performance in financial settings, both contingent on and independently from investor status.

Finally, behavioral finance has recognized that investors have limited attention and processing power (e.g., Hirshleifer and Teoh 2003). This paper documents the range and impact of investors' numerical skill limitations, helping to explain how and why prior researchers have found empirical results consistent with limited attention and processing power (e.g., Jiang et al. 2013; Malmendier and Shanthikumar 2007). Similar to earlier research that began to differentiate amongst institutional investors (e.g., Bushee 2001), future research should consider identifying empirical proxies that could be applied in archival settings (beyond trade size, e.g., Malmendier and Shanthikumar 2007) to capture individual investors' numerical skills and relative sophistication.

## APPENDIX A
## Financial Confidence, Demographic and Numerical Skills Survey Questions

This appendix presents the financial confidence, demographic, and numerical skills questions from the MTurk survey sample. Question numbers are included below to represent the order of the questions as presented to participants; however, participants did not see these numberings as part of the survey. Sources for the questions, if applicable, are provided within parentheses following the text of the question (also not provided to the survey participants). Conditional questions are described in italicized text, generally following the question that would have triggered the presentation of that conditional question.

### *Financial confidence*

How strongly do you agree or disagree with the following statements?
Seven-point scale from "Strongly Disagree" to "Strongly Agree"
*(Source: FINRA Foundation 2009a, 2009b)*

1. I am good at dealing with day-to-day financial matters, such as checking accounts, credit and debit cards, and tracking expenses
2. I am pretty good at math
3. I regularly keep up with economic and financial news.

4. On a scale from 1 to 7, where 1 means "Very Low" and 7 means "Very High," how would you assess your overall financial knowledge? *(Source: FINRA Foundation 2009a, 2009b)*

### *Demographic questions*

5. What is your gender?
   Multiple choice: Male; Female

6. How old are you?
   Multiple choice: Under 18; 18-25; 26-34; 35-54; 55-64; 65 or over

7. How old were you when you first learned to speak English? *(Source: Greenberg, Jin and White 2007, A-8)*
   Multiple choice: Less than 5 years old; 5-10 years old; 11-15 years old; 16-20 years old; 21 years or older

8. Do you consider your political views to be... *(Source: Kadous 2001, adapted)*
   Multiple choice: More liberal; More conservative

9a. What you were doing last week? (Please choose all that apply.) *(Source: Greenberg et al. 2007, D-1)*
   Multiple choice:
   - Working a full-time job for pay or profit, that is, 35 hours or more?
   - Working for pay or profit part-time, that is, 1-34 hours?
   - Working two or more part-time jobs for pay, totaling 35 or more hours?
   - Unemployed, laid off, or looking for work?
   - With a job but not at work because of temporary illness, vacation, or work stoppage?
   - With a job but on family leave (maternity or paternity leave)?
   - In school?
   - Keeping house?
   - Doing volunteer work?
   - Other (please specify)

*Conditional question, presented if one of first six responses was selected for question 9a:*

9b. For what kind of business or industry do you or did you work? Choose one from the list below that best matches the job you consider to be your primary employment. *(Source: Kutner et al. 2007, adapted from Table 4-1)*

Multiple choice: Construction and Extraction; Farming, Fishing, and Forestry; Installation, Maintenance, and Repair; Office and Administrative Support; Management, Business, and Financial; Production; Professional and related; Sales and related; Service; Transportation and Material Moving; Other (please specify) or not applicable [*Fill-in-the-blank box provided*]

*Definitions of each category followed but are not replicated here.*

10a. What is the highest level of education you have completed? *(Source: Greenberg et al. 2007, adapted from B-1)*

Multiple choice: Less than High School (0-8 years); Some High School (9-12 years, but did not graduate); GED or High School Equivalency; High School Graduate; Attended a Vocational or Trade School after High School; Some College (no degree); 2-year College Degree (Associate's degree); 4-year College Degree (BS, BA, or similar); Some postgraduate (no degree); Postgraduate (MS, MA, PhD, MD, etc.)

*Conditional question, presented if "Some College", "2-year College", or "4-year College" was selected for question 10a:*

10b. What is or was your major in college? [*Fill-in-the-blank box provided*]

*Conditional questions, presented if "Some postgraduate" or "Postgraduate" was selected for question 10a:*

10c. What was your undergraduate major? [*Fill-in-the-blank box provided*]

10d. What is or was your graduate major? [*Fill-in-the-blank box provided*]

*Conditional question, presented if "Some College" or higher levels of education were selected for question 10a:*

10e. Approximately how many of the following courses have you completed?

Accounting — Multiple choice: None; 1-3; 4-10; 10+

Auditing — Multiple choice: None; 1-3; 4-10; 10+

Finance — Multiple choice: None; 1-3; 4-10; 10+

Statistics — Multiple choice: None; 1-3; 4-10; 10+

Other specialized mathematics (for example, calculus) — Multiple choice: None; 1-3; 4-10; 10+

11a. Have you ever invested in... (Choose all that apply.)

An individual company's stock — Multiple choice: Yes, directly; Yes, through a pension or formal retirement account; No

A mutual fund — Multiple choice: Yes, directly; Yes, through a pension or formal retirement account; No

*Conditional question, presented if "Yes, directly" or "Yes, through a pension or formal retirement account" was selected for either "Individual company stocks" or "Mutual funds" in question 11a:*

11b. Approximately what is the current value of your investment portfolio in...
… Individual company stocks— Invested directly [*Fill-in-the-blank box provided*];
Held through retirement accounts [*Fill-in-the-blank box provided*]
… Mutual funds— Invested directly [*Fill-in-the-blank box provided*];
Held through retirement accounts [*Fill-in-the-blank box provided*]

*Conditional question, presented if "Yes, directly" or "Yes, through a pension or formal retirement account" was selected for "Individual company stocks" in question 11a:*

11c. When evaluating a company's stock as a potential investment, how often do you examine a company's financial statements (for example, through its annual report or SEC filings) as part of your evaluation? *(Adapted from Abt SRBI [2008], p.12)*
Multiple choice: Never; Rarely; Sometimes; Most of the Time; Always

12. Do you rent or own your home?
Multiple choice: Rent; Own;
Neither — I am staying with family or friends without either renting or owning;
Neither — I do not currently have a home.

13a. Have you ever tried to figure out how much you or your household would need to save for retirement? *(Source: Lusardi and Mitchell 2008, 2011b)*
Multiple choice: Yes; No

*Conditional question, presented if "Yes"was selected for question 9a:*

13b. Have you developed a plan for retirement saving? *(Source: Lusardi and Mitchell 2008, 2011b)*
Multiple choice: Yes; No

*Conditional question, presented if "Yes"was selected for question 9a:*

13c. How often have you been able to stick to this plan? *(Source: Lusardi and Mitchell 2008, 2011b)*
Multiple choice: Always; Mostly; Rarely; Never

14. How do you see yourself: Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks? *(Source: Dohmen et al. 2010, 2011)*
10-point scale, numbered from 1 ("Not at all willing to take risks") to 10 ("Very willing to take risks")

15. Which of the statements below comes closest to the amount of financial risk that you are willing to take when making investments or saving? *(Source: Sages and Grable 2010)*
Multiple choice: Take substantial financial risk expecting to earn substantial returns;
Take above-average financial risks expecting to earn above-average returns;
Take average financial risks expecting to earn average returns;
Not willing to take any financial risk.

***Numeracy fundamentals***

16. Imagine that we flip a fair coin 1,000 times. What is your best guess about how many times the coin would come up heads in 1,000 flips? *(Source: Schwartz et al. 1997, adapted to multiple choice format)*
    Multiple choice: 50 times out of 1,000; 100 times out of 1,000; 500 times out of 1,000; 505 times out of 1,000; None of the above; Don't know

17. In the BIG BUCKS LOTTERY, the chance of winning a $10 prize is 1%. What is your best guess about how many people would win a $10 prize if 1,000 people each buy a single ticket to BIG BUCKS? *(Source: Schwartz et al. 1997, adapted to multiple choice format)*
    Multiple choice: 1 person out of 1,000; 10 people out of 1,000; 100 people out of 1,000; 990 people out of 1,000; None of the above; Don't know

18. In ACME PUBLISHING SWEEPSTAKES, the chance of winning a car is 1 in 1,000. What percent of tickets to ACME PUBLISHING SWEEPSTAKES win a car? *(Source: Schwartz et al. 1997, adapted to multiple choice format)*
    Multiple choice: 0.001%; 0.1%; 1%; 10%; None of the above; Don't know

19. Imagine we are throwing a five-sided die 50 times. On average, out of these 50 throws how many times would this five-sided die show an odd number (1, 3 or 5)? *(Source: Cokely et al. 2012, adapted multiple choice options)*
    Multiple choice: 5 out of 50 throws; 20 out of 50 throws; 25 out of 50 throws; 30 out of 50 throws; None of the above; Don't know

20. Out of 1,000 people in a small town, 500 are members of a choir. Out of these 500 members in the choir, 100 are men. Out of the 500 inhabitants that are not in the choir, 300 are men. What is the probability that a randomly drawn man is a member of the choir? Please indicate the probability in percent. *(Source: Cokely et al. 2012, adapted multiple choice options)*
    Multiple choice: 10%; 20%; 25%; 40%; None of the above; Don't know

21. Imagine we are throwing a loaded die (6 sided). The probability that the die shows a 6 is twice as high as the probability of each of the other numbers. On average, out of these 70 throws how many times would the die show the number 6? *(Source: Cokely et al. 2012, adapted multiple choice options)*
    Multiple choice: 20 out of 70 throws; 23 out of 70 throws; 35 out of 70 throws; 40 out of 70 throws; None of the above; Don't know

22. In a forest, 20% of mushrooms are red, 50% brown and 30% white. A red mushroom is poisonous with a probability of 20%. A mushroom that is not red is poisonous with a probability of 5%. What is the probability that a poisonous mushroom in the forest is red? *(Source: Cokely et al. 2012, adapted multiple choice options)*
    Multiple choice: 4%; 15%; 25%; 50%; None of the above; Don't know

23. Consider each of the following pairs separately. *(Source: Cokely et al. 2012, alternate, added "no preference" options)*
    (a) Which option do you prefer?
    Multiple choice: $3,800 next month; $3,400 now; No preference
    (b) Which option do you prefer?
    Multiple choice: $100 for sure; 60% chance to win $250; No preference
    (c) Which option do you prefer?
    Multiple choice: Lose $100 for sure; 70% chance to lose $200; No preference

***Financial literacy***

24. Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow? *(Source: Lusardi and Mitchell 2011a; FINRA Foundation 2009a, 2009b)*
    Multiple choice: Less than $102; Exactly $102; More than $102; Don't know

25. Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account? *(Source: Lusardi and Mitchell 2011a; FINRA Foundation 2009a, 2009b)*
    Multiple choice: More than today; Less than today; Exactly the same; Don't know

26. If the interest rate falls, what should happen to bond prices? *(Source: van Rooij et al. 2011; FINRA Foundation 2009a, 2009b)*
    Multiple choice: Rise; Fall; Stays the same; Don't know

27. Please indicate whether this statement is true or false: Buying a single company's stock usually provides a safer return than a stock mutual fund. *(Source: Lusardi and Mitchell 2011a; FINRA Foundation 2009a, 2009b)*
    Multiple choice: True; False; Don't know

28. Please indicate whether this 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. *(Source: van Rooij et al. 2011; FINRA Foundation 2009a, 2009b)*
    Multiple choice: True; False; Don't know

***Quantitative analytical reasoning***

35. A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost? *(Source: Frederick 2005, adapted to multiple choice format)*
    Multiple choice: 5 cents; 10 cents; 50 cents; 105 cents; None of the above; Don't know

36. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? *(Source: Frederick 2005, adapted to multiple choice format)*
    Multiple choice: 5 minutes; 20 minutes; 100 minutes; 500 minutes; None of the above; Don't know

37. In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? *(Source: Frederick 2005, adapted to multiple choice format)*
    Multiple choice: 12 days; 24 days; 47 days; 96 days; None of the above; Don't know

***Other reasoning***

*Probability Matching*

29. A card deck has only 10 cards: 7 of the cards have the letter "a" on the down side. 3 of the cards have the letter "b" on the down side. The 10 cards are randomly shuffled. Your task is to guess the letter on the down side of each card before it is turned over. Pretend that you will win $100 for each card's down side letter you correctly predict. You must make your prediction for all 10 cards before you get to see any of the cards being turned over. Indicate your predictions for each of the 10 cards below: *(Source: West and Stanovich 2003)*
    Card #1 will be... Card #2 will be... Card #3 will be... Card #4 will be... Card #5 will be...
    Card #6 will be... Card #7 will be... Card #8 will be... Card #9 will be...
    Card #10 will be... [*Each Card with multiple choice: a, b*]

31. A die with 4 red faces and 2 green faces will be rolled 60 times. Before each roll you will be asked to predict which color (red or green) will show up once the die is rolled. Pretend that you will be given one dollar for each correct prediction. Assume that you want to make as much money as possible. What strategy would you use in order to make as much money as possible by making the most correct predictions? *(Source: West and Stanovich 2003)*
    Multiple choice: Strategy A: Go by intuition, switching when there has been too many of one color or the other;
    Strategy B: Predict the more likely color (red) on most of the rolls but occasionally, after a long run of reds, predict green.
    Strategy C: Make predictions according to the frequency of occurrence (4 of 6 for red and 2 of 6 for green). That is, predict twice as many reds as greens.
    Strategy D: Predict the more likely color (red) on all of the 60 rolls.
    Strategy E: Predict more red than green, but switching back and forth depending upon "runs" of one color or the other.

*Conjunction fallacy*

30a. Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations. Which alternative is most likely? *(Source: Tversky and Kahneman 1983)*
    Mutiple choice: Linda is a bank teller and is active in the feminist movement; Linda is a bank teller.

30b. Follow-up: Have you seen the "Linda" question before? *(Source: Suggested by Paolacci et al. 2010)*
    Mutiple choice: No; Yes (please indicate where — e.g. textbook, survey)
    [*Fill-in-the-blank box provided*]

*Debt literacy*

32. Suppose you owe $1,000 on your credit card and the interest rate you are charged is 20% per year compounded annually. If you didn't pay anything off, at this interest rate, how many years would it take for the amount you owe to double? *(Source: Lusardi and Tufano 2009)*
Multiple choice: 2 years; Less than 5 years; 5 to 10 years; More than 10 years; Don't know

33. You owe $3,000 on your credit card. You pay the 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? *(Source: Lusardi and Tufano 2009)*
Multiple choice: Less than 5 years; Between 5 to 10 years; Between 10 and 15 years; Never, you will continue to be in debt; Don't know

34. You purchased an appliance which costs $1,000. To pay for this appliance, you are given the following two options:
(a) Pay 12 monthly installments of $100 each; or,
(b) Borrow at a 20% annual interest rate and pay back $1,200 a year from now.
Which is the more advantageous offer? *(Source: Lusardi and Tufano 2009)*
Multiple choice: Option (a); Option (b); They are the same; Don't know

*Anchors in subjective valuations of stock options*

38a. Assume you work for a firm and earn an $80,000 base salary. The firm also grants you Employee Stock Options (ESOs) on a regular basis.¶ To date, you have received one such ESO grant. Please use the information provided below about your ESO grant to answer the questions that follow.

| | |
|---|---|
| ESO Grant Number of options: | 1,000 |
| Grant date: | 1 year ago |
| Vesting date: | 4 years from today |
| Expiration date: | 9 years from today |
| Stock price today: | $30 per share |
| Exercise price: | $20 per share |
| Risk-free interest rate: | 4 percent |
| Stock price volatility: | 30 percent |

If you were to leave the firm today, the total value of your first grant of 1,000 ESOs that you would forfeit would be about what amount? All values below are rounded to the nearest $1,000. Please do not consider possible income tax implications. *(Source: Farrell et al. 2011, adapted to multiple choice format)*
Multiple choice: $0; $10,000; $12,000; $18,000; $20,000; $30,000; None of the above (Please provide your estimate below) [*Fill-in-the-blank box provided*]; Don't know

*Conditional question, presented if a response other than "Don't know" was selected for question 34a:*
38b. How confident are you that your above estimate is accurate? *(Source: Farrell et al. 2011)*
Eleven-point Likert scale, anchored with "Not at all confident" to "Extremely confident"

*Instructional check*

39. What do you think was this study about? Research in decision making shows that people, when making decisions and answering questions, prefer not to pay attention and minimize their effort as much as possible. Some studies show that over 50% of people don't carefully read questions. If you are reading this question and have read all the other questions, please select the box marked 'other' and type 'effort' in the box below. Thank you for participating and taking the time to read through the questions carefully! *(Source: Oppenheimer et al. 2009, adapted; see e.g., Tuncel et al. 2013)*
    Multiple choice: Numeracy; Financial literacy; General decision making;
    Financial decision making; Other [*Fill-in-the-blank box provided*]

## APPENDIX B
## Accounting Quiz Questions

This appendix presents the accounting quiz questions adapted from Easton et al. (2013) and included in the MTurk survey sample. Question numbers are included below to represent the order of the questions as presented to participants; however, participants did not see these numberings as part of the survey. The remaining 25 questions adopted from a financial literacy survey developed by R. Weil and K. Schipper are available from the original authors on request (Coates et al. 2007; Weil 2012) and so are not reproduced in this appendix.

1. Indicate which of the following items would be reported in a company's balance sheet. (Check all that apply.)
   Multiple choice: Wages expense; Retained earnings; Sales; Accumulated depreciation; Wages payable; Net income; Interest expense; Interest payable; Depreciation expense; Don't know

2. The total assets of Dell, Inc. equal $15,470 million and its equity is $4,873 million. What is the amount of its liabilities, and what percentage of financing is provided by Dell's owners?
   Multiple choice: $20,343 million, 76.0% ; $10,597 million, 31.5% ; $10,597 million, 68.5% ; $20,343 million, 24.0% ; Don't know

3. At the beginning of a recent year, The Walt Disney Company's liabilities equaled $26,197 million. During the year, assets increased by $400 million and year-end assets equaled $50,388 million. Liabilities decreased $100 million during the year. What were beginning and ending amounts for Walt Disney's equity?
   Multiple choice: $26,197 million beginning equity and $24,291 million ending equity; $23,791 million beginning equity and $24,291 million ending equity; $23,791 million beginning equity and $27,042 million ending equity; $27,042 million beginning equity and $25,183 million ending equity; Don't know

4. The table below contains selected income statement and balance sheet data for four companies, each in different industries.

| *($millions)* | Sales | Cost of Goods Sold | Gross Profit | Net Income | Assets | Liabilities | Stockholders' Equity |
|---|---|---|---|---|---|---|---|
| Harley-Davidson | 5,342 | 3,302 | 2,040 | 960 | 5,255 | 2,171 | 3,084 |
| Nike, Inc. | 13,740 | 7,624 | 6,116 | 1,212 | 8,794 | 3,149 | 5,645 |
| Starbucks Corp. | 6,369 | 2,605 | 3,764 | 494 | 3,514 | 1,423 | 2,091 |
| Target Corp. | 51,271 | 34,927 | 16,344 | 2,408 | 34,995 | 20,790 | 14,205 |

(a) Which company in the table reports the ***highest ratio of net income to equity***?
   Multiple choice: Harley-Davidson; Nike, Inc.; Starbucks Corp.; Target Corp.; Don't know

(b) Which company in the table reports the ***highest percentage of liabilities to equity***?
   Multiple choice: Harley-Davidson; Nike, Inc.; Starbucks Corp.; Target Corp.; Don't know

5. Colgate- Palmolive reports the following dollar balances in its retained earnings account:

| *($millions)* | 2005 | 2004 |
|---|---|---|
| Retained earnings | $8,968.1 | $8,223.9 |

During 2005, Colgate-Palmolive reported net income of $1,351.4 million. What amount of dividend, if any, did Colgate-Palmolive pay to its shareholders in 2005?
Multiple choice: $301.2 million ; $607.2 million ;$744.2 million ; No dividends were paid ; Don't know

6. Healy Corporation recorded service revenues of $200,000 in 2007, of which $80,000 were on credit and $120,000 were for cash. Moreover, of the $80,000 credit sales for 2007, Healy collected $20,000 cash on those receivables before year-end 2007. The company also paid $40,000 cash for 2007 wages. Its employees also earned another $20,000 in wages for 2007, which were not yet paid at year-end 2007. Compute the company's net income for 2007.
Multiple choice: $160,000 ; $140,000 ; $80,000 ; $60,000 ; Don't know

7. Plexi Corporation recorded service revenues of $150,000 in 2009, of which $80,000 were on credit and $70,000 were for cash. Moreover, of the $80,000 credit sales for 2009, Plexi collected $30,000 cash on those receivables before year-end 2009. The company also paid $30,000 cash for 2009 wages. Its employees also earned another $20,000 in wages for 2009, which were not yet paid at year-end 2009. How much net cash inflow did the company generate in 2009?
Multiple choice: $40,000 ; $120,000 ; $100,000 ; $70,000 ; Don't know

8. Suppose that the following events took place at Hypothetical, Inc. When each transaction was recorded, what was the directional effect on (i) Total Assets, (ii) Total Sales, (iii) Net Income, and (iv) Total Shareholders' Equity? ¶ Indicate your response by selecting the appropriate directional effect. Unless otherwise specified, assume the transaction was recorded on the last day of Hypothetical's current fiscal year (December 31, 2012). Ignore income tax effects.

(a) A decision was reached to decrease the company's current 'allowance for bad debts' by $37.
Multiple choice: Increase / Decrease / No effect / Don't Know for each of
(i) Total Assets, (ii) Total Sales, (iii) Net Income, and (iv) Total Shareholders' Equity

(b) The company received products of $80 that it had previously ordered, and a corresponding account payable was recorded.
Multiple choice: Increase / Decrease / No effect / Don't Know for each of
(i) Total Assets, (ii) Total Sales, (iii) Net Income, and (iv) Total Shareholders' Equity

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**TABLE 1: Comparison of Demographic Characteristics and Financial Literacy by Investor Classification, Benchmarked to National Samples**

**Panel A: Demographic Characteristics**

| | Non-Investors (N~878) | | | | Investor Def$^{n}$ 1: Any (N~1,218) | | | | Investor Def$^{n}$ 2: Direct (N~716) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Variable** | **Mean Result** | | **Expected Mean** | **Confidence Interval** | **Mean Result** | | **Expected Mean** | **Confidence Interval** | **Mean Result** | | **Expected Mean** | **Confidence Interval** |
| Gender (Male) | **41.1%** | | 41.9% | 38.7% - 44.9% | **47.8%** | * | 53.0% | 49.7% - 56.2% | **55.2%** | | 52.4% | 48.9% - 55.9% |
| Age (minimum) | | | | | | | | | | | | |
| 25 | **51.1%** | * | 83.9% | 81.6% - 86.3% | **81.4%** | * | 94.3% | 92.9% - 95.8% | **78.2%** | * | 94.2% | 92.6% - 95.8% |
| 35 | **16.3%** | * | 64.9% | 61.8% - 68.1% | **43.8%** | * | 78.6% | 75.9% - 81.3% | **44.1%** | * | 79.8% | 76.8% - 82.5% |
| 55 | **2.4%** | * | 27.8% | 24.9% - 30.9% | **9.3%** | * | 35.3% | 32.0% - 38.4% | **11.6%** | * | 39.1% | 35.5% - 42.5% |
| 65 | **0.2%** | * | 13.7% | 11.4% - 16.0% | **1.6%** | * | 16.4% | 14.0% - 18.7% | **2.2%** | * | 19.5% | 16.8% - 22.3% |
| Education (minimum) | | | | | | | | | | | | |
| High school degree | **97.7%** | * | 96.0% | 94.7% - 97.1% | **99.3%** | | 99.2% | 98.6% - 99.7% | **99.6%** | | 99.1% | 98.3% - 99.7% |
| College degree | **42.3%** | * | 26.0% | 23.2% - 28.9% | **65.7%** | * | 53.7% | 50.3% - 57.0% | **67.0%** | * | 54.3% | 50.6% - 58.0% |
| Some post-graduate | **10.4%** | * | 7.3% | 5.8% - 9.1% | **21.0%** | | 22.3% | 19.7% - 25.1% | **22.3%** | | 23.3% | 20.3% - 26.6% |
| Employed full time | **26.8%** | * | 38.9% | 35.6% - 42.0% | **50.9%** | * | 59.1% | 55.8% - 62.4% | **50.3%** | * | 54.9% | 51.4% - 58.7% |
| Own home | **19.4%** | * | 49.7% | 46.5% - 52.7% | **44.7%** | * | 79.8% | 77.0% - 82.5% | **45.9%** | * | 81.3% | 78.4% - 84.2% |

**Panel B: Financial Literacy**

| | Non-Investors (N~878) | | | | Investor Def$^{n}$ 1: Any (N~1,218) | | | | Investor Def$^{n}$ 2: Direct (N~716) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Variable** | **Mean Result** | | **Expected Mean** | **Confidence Interval** | **Mean Result** | | **Expected Mean** | **Confidence Interval** | **Mean Result** | | **Expected Mean** | **Confidence Interval** |
| Retirement planning | **26.2%** | | 28.9% | 25.9% - 31.8% | **59.4%** | | 63.3% | 59.4% - 66.5% | **62.2%** | | 64.5% | 60.9% - 67.9% |
| Financial confidence | **4.5** | * | 5.0 | 5.0 - 5.1 | **5.1** | * | 5.6 | 5.5 - 5.7 | **5.3** | * | 5.6 | 5.6 - 5.7 |
| Financial literacy | **59.4%** | * | 55.4% | 53.6% - 57.2% | **73.3%** | | 74.2% | 72.6% - 75.7% | **74.4%** | | 73.9% | 72.0% - 75.6% |

This table presents a comparison of demographic characteristics (Panel A) and financial literacy (Panel B), benchmarked against data from representative national samples (FINRA Foundation 2009a, 2009b), for investors relative to non-investors, classified according to two investor definitions: (def$^{n}$ 1) any stock or mutual fund investment, and (def$^{n}$ 2) any direct stock or mutual fund investment reported history, i.e., non-retirement. Non-investors are those not classified as investors under either definition. Mean results are presented for the current research sample (MTurk), where * indicates that the observed mean is significantly different from expectations based on the 95% confidence interval for that variable. Expectations are based on representative national samples (FINRA Foundation 2009a, 2009b), with confidence intervals constructed based on 1,000 randomly selected samples of 2,000 observations (i.e., a similar size as the MTurk sample) from the representative national samples. Specifically, each bootstrap sample is generated by randomly sampling with replacement the observations from the combined FINRA Foundation (2009a, 2009b) datasets, then separated into investor and non-investor subsamples, with the mean for each variable computed for each resulting subsample. Two-sided 95 percent confidence intervals are then determined by observing the 2.5$^{th}$ and 97.5$^{th}$ percentile. Observed means for the MTurk sample are significantly different from the representative national samples (FINRA Foundation 2009a, 2009b) if the mean observed from the MTurk sample falls outside of the 95 percent confidence interval.

Investors are identified from the (FINRA Foundation 2009a, 2009b) based on two questions, one for non-retirement account investments and one on retirement account investments in stocks or mutual funds invested in stocks. All other questions used to collect each variable are presented in Appendix A. All demographic variables (Panel A) and Retirement planning (Panel B) represent the percentage of participants meeting the criteria for that variable (e.g., 41.1% for Gender indicates that 41.1% of participants in that category are male; 26.2% for Retirement planning indicates that 26.2% of participants in the category have tried to figure out how they would need to save for retirement). Financial confidence is the mean rating for four self-assessed financial confidence questions replicated from FINRA Foundation (2009a, 2009b) on a scale from 1 (Very Low) to 7 (Very High)—see Appendix A, Questions 1 through 4. Financial literacy is the percentage of questions participants answered correctly from a series of five financial knowledge quiz questions replicated from FINRA Foundation (2009a, 2009b) on a scale from 1 (Very Low) to 7 (Very High)—see Appendix A, Questions 24 through 28.

**TABLE 2: Additional Measures of Numerical Skills by Investor Classification**

| | Non-Investors (N~878) | | Investor Def$^{n}$ 1: Any (N~1,218) | | Investor Def$^{n}$ 2: Direct (N~716) | |
|---|---|---|---|---|---|---|
| **Variable** | **Mean** | **Median** | **Mean** | **Median** | **Mean** | **Median** |
| Numeracy: | | | | | | |
| Basic numeracy | **62.4%** | 66.7% | **66.4%** | 66.7% | **68.1%** | 66.7% |
| Higher order numeracy | **30.9%** | 25.0% | **34.5%** | 25.0% | **35.5%** | 25.0% |
| Numeracy fundamentals (combined basic and higher-order numeracy) | **44.4%** | 42.9% | **48.2%** | 42.9% | **49.5%** | 42.9% |
| Quantitative analytical reasoning | **33.1%** | 33.3% | **40.3%** | 33.3% | **42.4%** | 33.3% |
| Specialized education:[(a)] | | | | | | |
| At least one course in… | | | | | | |
| Accounting | **31.6%** | No | **55.5%** | Yes | **59.5%** | Yes |
| Auditing | **6.4%** | No | **19.3%** | No | **22.8%** | No |
| Finance | **30.4%** | No | **49.2%** | No | **56.2%** | Yes |
| Statistics | **58.6%** | Yes | **70.3%** | Yes | **76.1%** | Yes |
| Math | **67.6%** | Yes | **76.9%** | Yes | **80.7%** | Yes |
| Business education | | | | | | |
| Undergraduate | **11.9%** | No | **18.8%** | No | **21.3%** | No |
| Graduate | **10.0%** | No | **19.1%** | No | **20.0%** | No |
| Investors responding to follow-up survey:[(b)] | | | | | | |
| Accounting quiz | **N/A** | N/A | **33.8%** | 31.3% | **35.1%** | 37.5% |
| Board acctg literacy | **N/A** | N/A | **12.4%** | 12.0% | **12.9%** | 12.0% |

This table presents means and medians for additional measures of numerical skills not previously available through national samples (FINRA Foundation 2009a, 2009b, 2012) for investors relative to non-investors, classified according to two investor definitions: (def$^{n}$ 1) any stock or mutual fund investment, and (def$^{n}$ 2) any direct stock or mutual fund investment reported history, i.e., non-retirement. Non-investors are those not classified as investors under either definition.

Numeracy measures are the percentage of questions participants answered correctly from a series of three questions on basic numeracy skills (covering simple probabilities and conversions between simple probabilities and frequencies—see Appendix A, Questions 16 through 18) and four questions on higher-order numeracy skills (covering simple probability estimates as well as Bayes' Theorem—see Appendix A, Questions 19 through 22). Quantitative analytical reasoning is the percentage of questions participants answered correctly from a series of three questions on cognitive reflection (three quantitative questions in which the initial intuitive response differs from the correct response— see Appendix A, Questions 35 through 37). Course and business education variables represent the percentage of participants meeting the criteria for that variable (e.g., 31.6% for Accounting indicates that 31.6% of participants in that category who attended some amount of college completed at least one accounting course). The Accounting quiz and Board acctg literacy measures are the percentage of questions participants answered correctly from two series of questions— specifically, questions for the Accounting quiz were adapted from the financial accounting review chapters of a financial statement analysis textbook (see Appendix B), while questions for the Board acctg literacy measure were adopted from a financial literacy survey developed by R. Weil and K. Schipper, previously administered to Board of Directors members and executive MBA students, covering a broad range of accounting issues (Coates et al. 2007; Weil 2012).

(a) Only participants who indicated some level of college education were asked about their major and courses in accounting, auditing, finance, statistics, and other advanced mathematics. This resulted in 703, 1105, and 648 eligible non-investors, investors under def$^{n}$ 1, and investors under def$^{n}$ 2, respectively, to answer the course and undergraduate major questions, and in 91, 256, 160 eligible non-investors, investors under def$^{n}$ 1, and investors under def$^{n}$ 2, respectively, to answer the graduate major question.

(b) Only participants who indicated some investment history were eligible to participate in the follow-up survey in which the accounting literacy measures were collected (Acctg quiz and Board Acctg Literacy). All respondents to the follow-up survey (N=640) therefore qualified as investors under def$^{n}$ 1, of whom 367 also qualified as investors under def$^{n}$ 2.

**TABLE 3: Comparison of Numerical Skill Measures across Investor Classifications and Education-Based Proxies for Investors**

| | Investor Def$^{n}$ 1: Any (N~1,218) | | Investor Def$^{n}$ 2: Direct (N~716) | | Proxy 1: Acctg & Fin (N~582) | | Proxy 2: Acctg & Fin + Some Grad (N~124) | | | Current Graduate Business Students (N~45) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Variable** | **Mean** | **Median** | **Mean** | **Median** | **Mean** | **Median** | **Mean** | **Median** | | **Mean** | **Median** |
| Financial confidence | **5.1** | 5.3 | **5.3** | 5.5 | **5.4** | 5.5 | **5.6** | 5.8 | (b) | **N/A** | |
| Financial literacy | **73.3%** | 80.0% | **74.4%** | 80.0% | **72.1%** | 80.0% | **78.1%** | 80.0% | (c) | **95.7%** | 100.0% |
| Numeracy: | | | | | | | | | | | |
| Basic numeracy | **66.4%** | 66.7% | **68.1%** | 66.7% | **65.3%** | 66.7% | **75.0%** | 66.7% | | **82.6%** | 100.0% |
| Higher order numeracy | **34.5%** | 25.0% | **35.5%** | 25.0% | **33.4%** | 25.0% | **42.9%** | 50.0% | | **50.0%** | 50.0% |
| Numeracy fundamentals (combined basic and higher-order numeracy) | **48.2%** | 42.9% | **49.5%** | 42.9% | **47.1%** | 42.9% | **56.7%** | 57.1% | | **64.1%** | 57.1% |
| Quantitative analytical reasoning | **40.3%** | 33.3% | **42.5%** | 33.3% | **39.3%** | 33.3% | **44.4%** | 33.3% | | **31.9%** | 33.3% |
| Investors responding to follow-up survey:[(a)] | | | | | | | | | | | |
| Accounting quiz | **33.8%** | 31.3% | **35.1%** | 37.5% | **40.3%** | 37.5% | **43.0%** | 37.5% | | **71.9%** | 75.0% |
| Board acctg literacy | **12.4%** | 12.0% | **12.9%** | 12.0% | **15.0%** | 16.0% | **15.5%** | 16.0% | | **20.6%** | 20.0% |

This table presents means and medians for numerical skill measures across two investor definitions (def$^{n}$ 1: any stock or mutual fund investment; def$^{n}$ 2: any direct stock or mutual fund investment reported history, i.e., non-retirement) and two education-based proxies for investors (proxy 1: participants who report some amount of college education and also report completing at least one accounting and one finance course; proxy 2: participants who report some amount of graduate-level education and also report completing at least one accounting and one finance course severely). As an additional benchmark, comparatives are presented for graduate business students (N=45) enrolled in recent financial statement analysis course sections.

Financial confidence is the mean rating for four self-assessed financial confidence questions replicated from FINRA Foundation (2009a, 2009b) on a scale from 1 (Very Low) to 7 (Very High)—see Appendix A, Questions 1 through 4. Financial literacy is the percentage of questions participants answered correctly from a series of five financial knowledge quiz questions replicated from FINRA Foundation (2009a, 2009b) on a scale from 1 (Very Low) to 7 (Very High)—see Appendix A, Questions 24 through 28. Numeracy measures are the percentage of questions participants answered correctly from a series of three questions on basic numeracy skills (covering simple probabilities and conversions between simple probabilities and frequencies—see Appendix A, Questions 16 through 18) and four questions on higher-order numeracy skills (covering simple probability estimates as well as Bayes' Theorem—see Appendix A, Questions 19 through 22). Quantitative analytical reasoning is the percentage of questions participants answered correctly from a series of three questions on cognitive reflection (three quantitative questions in which the initial intuitive response differs from the correct response— see Appendix A, Questions 35 through 37). The Accounting quiz and Board acctg literacy measures are the percentage of questions participants answered correctly from two series of questions—specifically, questions for the Accounting quiz were adapted from the financial accounting review chapters of a financial statement analysis textbook (see Appendix B), while questions for the Board acctg literacy measure were adopted from a financial literacy survey developed by R. Weil and K. Schipper, previously administered to Board of Directors members and executive MBA students, covering a broad range of accounting issues (Coates et al. 2007; Weil 2012).

(a) Only participants who indicated some investment history were eligible to participate in the follow-up survey in which the accounting literacy measures were collected (Acctg quiz and Board Acctg Literacy). All respondents to the follow-up survey (N=640) therefore qualified as investors under def$^{n}$ 1. Of these respondents, 367 also qualified as investors under def$^{n}$ 2, 230 were included under the first educational proxy, and 70 were included under the second educational proxy.
(b) An alternative subjective measure of financial literacy had been asked of the graduate business students, rather than financial confidence.
(c) Graduate business students were originally asked to complete four of the same five multiple choice questions for financial literacy.

## TABLE 4: Logistic Regression of Investor Classification based on Individual Characteristics

| | Investor Def$^{n}$ 1: Any | | | | | | Investor Def$^{n}$ 2: Direct | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Model 1** (N~1,216 of 2092) | | **Model 2** (N~1,215 of 2091) | | **Model 3** (N~1,043 of 1712) | | **Model 1** (N~716 of 2092) | | **Model 2** (N~716 of 2091) | | **Model 3** (N~609 of 1712) | |
| **Parameter** | **Est (Err)** | | **Est (Err)** | | **Est (Err)** | | **Est (Err)** | | **Est (Err)** | | **Est (Err)** | |
| Intercept | 0.341 | *** | -1.731 | *** | -1.739 | *** | -0.672 | *** | -2.886 | *** | -2.373 | *** |
| | (0.045) | | (0.456) | | (0.174) | | (0.047) | | (0.641) | | (0.183) | |
| Gender (Male) | | | 0.418 | *** | 0.169 | | | | 0.704 | *** | 0.426 | *** |
| | | | (0.110) | | (0.126) | | | | (0.106) | | (0.119) | |
| *Age (minimum):* | | | | | | | | | | | | |
| 25 | | | 0.511 | *** | 0.555 | *** | | | -0.023 | | 0.006 | |
| | | | (0.126) | | (0.143) | | | | (0.135) | | (0.152) | |
| 35 | | | 0.836 | *** | 0.872 | *** | | | 0.405 | *** | 0.382 | *** |
| | | | (0.143) | | (0.165) | | | | (0.128) | | (0.141) | |
| 55 | | | 0.407 | | 0.337 | | | | 0.746 | *** | 0.795 | *** |
| | | | (0.293) | | (0.343) | | | | (0.228) | | (0.263) | |
| 65 | | | 0.671 | | 0.751 | | | | 0.586 | | 1.054 | |
| | | | (0.812) | | (1.096) | | | | (0.546) | | (0.708) | |
| FullTime | | | 0.655 | *** | 0.588 | *** | | | 0.265 | ** | 0.232 | * |
| | | | (0.112) | | (0.126) | | | | (0.108) | | (0.120) | |
| OwnHome | | | 0.514 | *** | 0.537 | *** | | | 0.385 | *** | 0.374 | *** |
| | | | (0.125) | | (0.142) | | | | (0.115) | | (0.128) | |
| *Education (minimum):* | | | | | | | | | | | | |
| High school degree | | | -0.199 | | | | | | 0.811 | | | |
| | | | (0.468) | | | | | | (0.651) | | | |
| Some college | | | 0.453 | *** | | | | | 0.032 | | | |
| | | | (0.171) | | | | | | (0.179) | | | |
| College degree | | | 0.454 | *** | 0.351 | *** | | | 0.408 | *** | 0.231 | * |
| | | | (0.124) | | (0.134) | | | | (0.124) | | (0.133) | |
| Some post-graduate | | | 0.070 | | 0.064 | | | | 0.160 | | 0.107 | |
| | | | (0.162) | | (0.172) | | | | (0.142) | | (0.150) | |
| *Specialized education*[(a)] | | | | | | | | | | | | |
| *At least one course in…* | | | | | | | | | | | | |
| Accounting | | | | | 0.364 | ** | | | | | 0.193 | |
| | | | | | (0.145) | | | | | | (0.138) | |
| Auditing | | | | | 0.478 | ** | | | | | 0.389 | ** |
| | | | | | (0.217) | | | | | | (0.173) | |
| Finance | | | | | 0.178 | | | | | | 0.376 | *** |
| | | | | | (0.154) | | | | | | (0.144) | |
| Statistics | | | | | -0.003 | | | | | | 0.266 | * |
| | | | | | (0.144) | | | | | | (0.142) | |
| Math | | | | | 0.225 | | | | | | 0.187 | |
| | | | | | (0.143) | | | | | | (0.145) | |
| Retirement planning | | | 0.995 | *** | 0.943 | *** | | | 0.721 | *** | 0.596 | *** |
| | | | (0.107) | | (0.122) | | | | (0.104) | | (0.117) | |
| **Numerical Skills Principal Component** | **0.399** (0.047) | *** | **0.246** (0.055) | *** | **0.294** (0.063) | *** | **0.352** (0.047) | *** | **0.178** (0.053) | *** | **0.217** (0.060) | *** |
| *Percent Concordant* | 60.3 | | 79.5 | | 80.7 | | 59.1 | | 71.6 | | 73.6 | |

This table presents logistic regressions in which participants' classification as an investor or non-investor is modeled as a function of their demographic characteristics and numerical skills, as defined in Tables 1 and 2. The Numerical Skills Principal Component is the first principal component of the three defined measures of financial literacy, numeracy fundamentals, and quantitative analytical reasoning (with questions used to collect each of these measures also defined in Tables 1 and 2). Results are presented for two investor definitions: (def$^{n}$ 1) any stock or mutual fund investment, and (def$^{n}$ 2) any direct stock or mutual fund investment reported history, i.e., non-retirement. For each investor classification, three models are considered, with the first including the numerical skills principal component only (Model 1). Because only participants who indicated some level of college education were asked about courses in accounting, auditing, finance, statistics, and other advanced mathematics classes, Model 2 includes indicator variables for education level while Model 3 includes only two higher education indicators plus specific course measures. ***, **, and * indicate that the parameter estimate is significantly different from zero at $p<0.01$, $p<0.05$, and $p<0.10$, respectively.

## TABLE 5: Replication of Elliott et al.'s [2007] Experiment 1: Reactions to financial analysts' research reports

### Panel A: Elliott et al. [2007], As Reported, and Current MTurk Sample, Overall

| | Early MBA, As Reported (N~82) | | | NAIC Investor, As Reported (N~37) | | | Select MBA, As Reported (N~42) | | | MTurk Replication (N~285) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Acquisition variables:** | | | | | | | | | | | | |
| **Percent correct** | | | | | | | | | | | | |
| Analyst position in securities | 81% | | | 97% | | | 86% | | | 75% | | |
| Favorable stock research report | 100% | | | 100% | | | 100% | | | 95% | | |
| Firm coverage of report | 93% | | | 97% | | | 93% | | | 65% | | |
| **Dependent variables:** | | | | | | | | | | | | |
| **Mean (Standard Deviation)** | **NIB (N~40)** | **IB (N~42)** | | **NIB (N~18)** | **IB (N~19)** | | **NIB (N~19)** | **IB (N~23)** | | **NIB (N~142)** | **IB (N~143)** | |
| Credibility composite | 6.8 (1.9) | 4.8 (1.9) | *** | 6.8 (1.8) | 3.7 (2.4) | *** | 7.3 (2.2) | 4.3 (2.0) | *** | 7.7 (1.8) | 7.0 (1.9) | *** |
| Incentive to please management | 4.9 (2.5) | 6.4 (2.5) | *** | 5.3 (2.7) | 8.0 (1.9) | *** | 4.6 (2.9) | 6.9 (2.4) | *** | 5.4 (2.6) | 6.0 (2.5) | ** |
| Earnings potential [(a)] | 7.2 (1.3) | 6.8 (1.3) | *n.s.* | 5.6 (1.8) | 5.1 (1.7) | *n.s.* | 7.2 (1.9) | 7.1 (1.9) | *n.s.* | 8.3 (1.7) | 8.3 (1.3) | *n.s.* |
| Price appreciation [(a)] | 7.0 (1.7) | 6.4 (1.7) | *n.s.* | 5.4 (2.0) | 5.1 (2.1) | *n.s.* | 6.6 (1.9) | 6.4 (2.0) | *n.s.* | 8.0 (1.8) | 8.0 (1.7) | *n.s.* |
| Proportion preferring to invest | 60% | 59% | *n.s.* | 50% | 5% | *** | 84% | 39% | *** | 55% | 49% | *n.s.* |
| Pct of $10K invested | 43% (20%) | 42% (21%) | *n.s.* | 47% (32%) | 13% (16%) | *** | 54% (23%) | 35% (8%) | *** | 44% (22%) | 40% (20%) | * |

### Panel B: Replication By Investor Classification

| | Non-Investor (N~121) | | | Investor Def[n] 1: Any stock or fund (N~164) | | | Investor Def[n] 2: Any direct (N~103) | | |
|---|---|---|---|---|---|---|---|---|---|
| **Acquisition variables:** | | | | | | | | | |
| **Percent correct** | | | | | | | | | |
| Analyst position in securities | 71% | | | 78% | | | 83% | | |
| Favorable stock research report | 92% | | | 97% | | | 95% | | |
| Firm coverage of report | 56% | | | 71% | | | 72% | | |
| **Dependent variables:** | | | | | | | | | |
| **Least Squares Mean** | NIB (N~63) | IB (N~58) | | NIB (N~79) | IB (N~85) | | NIB (N~44) | IB (N~59) | |
| Credibility composite | 7.5 | 7.3 | *n.s.* | 7.8 | 6.7 | *** | 7.8 | 6.5 | *** |
| Incentive to please management | 5.8 | 5.6 | *n.s.* | 5.1 | 6.3 | *** | 4.8 | 6.3 | *** |
| Proportion preferring to invest | 51% | 45% | *n.s.* | 58% | 52% | *n.s.* | 57% | 53% | *n.s.* |
| Pct of $10K invested | 40% | 39% | *n.s.* | 47% | 40% | ** | 48% | 40% | ** |

### Panel C: Top vs. Bottom Tertiles of Numerical Skills Principal Component within Investor Subsets

| | Investor Def[n] 1: Any stock or fund (N~164) | | | | Investor Def[n] 2: Any direct (N~103) | | | |
|---|---|---|---|---|---|---|---|---|
| | Low Skills Tertile (N~52) | | High Skills Tertile (N~56) | | Low Skills Tertile (N~35) | | High Skills Tertile (N~34) | |
| **Acquisition variables:** | | | | | | | | |
| **Percent correct** | | | | | | | | |
| Analyst position in securities | 63% | | 82% | | 74% | | 85% | |
| Favorable stock research report | 90% | | 100% | | 86% | | 100% | |
| Firm coverage of report | 48% | | 79% | | 49% | | 79% | |
| **Dependent variables:** | | | | | | | | |
| **Mean (Standard Deviation)** | NIB (N~29) | IB (N~23) | NIB (N~27) | IB (N~29) | NIB (N~18) | IB (N~17) | NIB (N~13) | IB (N~21) |
| Credibility composite | 7.3 | 7.4 *n.s.* | 8.0 | 6.4 *** | 7.5 | 7.5 *n.s.* | 7.5 | 6.2 ** |
| Incentive to please management | 5.9 | 6.3 *n.s.* | 4.7 | 6.8 *** | 4.9 | 5.7 *n.s.* | 5.5 | 7.2 ** |
| Proportion preferring to invest | 55% | 43% *n.s.* | 59% | 45% *n.s.* | 56% | 47% *n.s.* | 54% | 48% *n.s.* |
| Pct of $10K invested | 41% | 40% *n.s.* | 45% | 34% ** | 47% | 43% *n.s.* | 45% | 33% * |

**TABLE 5 (Continued)**

**Panel D: Analysis applying education-based proxy for investment experience**

| | Proxy, Overall (N~73) | | | Low Skills Tertile (N~25) | | | High Skills Tertile (N~24) | | |
|---|---|---|---|---|---|---|---|---|---|
| **Acquisition variables:** | | | | | | | | | |
| **Percent correct** | | | | | | | | | |
| Analyst position in securities | | 78% | | | 72% | | | 79% | |
| Favorable stock research report | | 99% | | | 96% | | | 100% | |
| Firm coverage of report | | 66% | | | 44% | | | 75% | |
| **Dependent variables:** | | | | | | | | | |
| **Least Squares Mean** | NIB (N~28) | IB (N~45) | | NIB (N~12) | IB (N~13) | | NIB (N~9) | IB (N~15) | |
| Credibility composite | 7.8 | 6.7 | ** | 7.3 | 7.2 | *n.s.* | 7.6 | 6.5 | *n.s.* |
| Incentive to please management | 5.4 | 5.9 | *n.s.* | 7.2 | 6.5 | *n.s.* | 4.3 | 6.0 | * |
| Proportion preferring to invest | 54% | 49% | *n.s.* | 42% | 54% | *n.s.* | 67% | 54% | ** |
| Pct of $10K invested | 45% | 42% | *n.s.* | 31% | 44% | *x* | 59% | 44% | *** |

This table presents the replication of main results from Elliott et al. (2007) using the MTurk sample. Participants in the role of an investor assess an analyst report on a firm, with the analyst maintaining an investment banking relationship with the firm ("IB") or without the analyst maintaining an investment banking relationship with the firm ("NIB"). The replication is presented in Panel A. The effect of investment experience on the results and the effect of numerical skills within the investor categories are examined in Panels B and C, respectively. Panel D presents the results of the replication using an education-based proxy for investment experience (specifically, completing at least some level of college education and also completing at least one accounting and one finance course). The second proxy (i.e., some level of graduate-level education and also completing at least one accounting and one finance course) is not analyzed due to insufficient sample size (n=15). ***, **, *, and n.s. represent p-values of <0.01, <0.05, <0.10, and >0.10, respectively, one-sided for the MTurk sample and two-sided for the tests as reported by Elliott et al. (2007). *x* represents a two-sided p-value of <0.10 in the opposite direction of that predicted.

(a) Omitted from later Panels because effects are *n.s.* in all cases in the original research.

## TABLE 6: Replication of Kadous et al. [2005]: Quantification and persuasion in managerial judgment

### Panel A: Kadous et al. [2005], As Reported, and Current MTurk Sample, Overall

| Mean (median) of likelihood of postponing turnaround | Experiment 1, As Reported (N~75) | | | | Experiment 2 As Reported (N~77) | | | | MTurk Replication, Experiment 1 (N~679) | | | | MTurk Replication, Experiment 2 (N~683) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Inputs* | | | | *Incentives* | | | | *Inputs* | | | | *Incentives* | | | |
| *Quantification* | Objective | | Subjective | | Consistent | | Inconsistent | | Objective | | Subjective | | Consistent | | Inconsistent | |
| Non-quantified | 33.4 | (24.2) | 27.0 | (15.5) | 40.1 | (27.6) | 27.0 | (15.5) | 37.4 | (25.3) | 35.9 | (25.9) | 50.6 | (25.6) | 35.9 | (25.9) |
| Quantified | 48.2 | (27.6) | 30.0 | (22.7) | 54.8 | (22.6) | 30.0 | 22.7 | 52.3 | (28.7) | 47.3 | (28.9) | 58.9 | (27.7) | 47.3 | (28.9) |
| **Excerpts from analysis of variance** | F | p | | | F | p | | | F | p | | | F | p | | |
| Objectivity (E1) or Consistency (E2) | 2.84 | 0.10 | | | 2.97 | 0.09 | | | 2.40 | 0.12 | | | 40.22 | <0.01 | | |
| Quantification | 5.44 | 0.02 | | | 13.67 | <0.01 | | | 69.58 | <0.01 | | | 22.46 | <0.01 | | |
| Quantification by Objectivity (E1) or by Consistency (E2) | 1.26 | 0.27 | | | 1.30 | 0.26 | | | 0.71 | 0.40 | | | 0.58 | 0.45 | | |
| **Contrasts:** | F | p | | | F | p | | | t | p | | | t | p | | |
| E1: Highest perceived likelihood when quantified & objective | 8.89 | <0.01 | two-sided | | | | | | 5.07 | <0.01 | two-sided | | | | | |
| E2: Highest perceived likelihood when quantified & consistent | | | | | 14.73 | <0.01 | two-sided | | | | | | 5.98 | <0.01 | two-sided | |

### Panel B: Experiment 1 Replication By Investor Classification

| Mean (median) of likelihood of postponing turnaround | | Non-Investor (N~284) | | Investor Def$^{n}$ 1: Any stock or fund (N~395) | | Investor Def$^{n}$ 2: Any direct (N~232) | |
|---|---|---|---|---|---|---|---|
| | | *Inputs* | | *Inputs* | | *Inputs* | |
| *Quantification* | | Objective | Subjective | Objective | Subjective | Objective | Subjective |
| Non-quantified | | 39.2 | 38.6 | 36.1 | 34.2 | 38.9 | 33.6 |
| Quantified | | 52.6 | 48.1 | 52.1 | 46.7 | 53.3 | 45.9 |
| **Contrast** | | t | p | t | p | t | p |
| E1: Highest perceived likelihood when quantified & objective | | 2.71 | *** | 4.37 | *** | 3.51 | *** |
| Effect of Objectivity when... | Quantification is low | 0.13 | *n.s.* | 0.52 | *n.s.* | 1.04 | *n.s.* |
| | Quantification is high | 0.93 | *n.s.* | 1.43 | * | 1.5 | * |
| Effect of Quantification when... | Objectivity is low | 1.91 | ** | 3.31 | *** | 2.41 | *** |
| | Objectivity is high | 2.82 | *** | 4.41 | *** | 2.97 | *** |

### Panel C: Experiment 1 – Top vs. Bottom Tertiles of Numerical Skills Principal Component within Investor Subsets

| Mean (median) of likelihood of postponing turnaround | | Non-Investor (N~284) | | | | Invest Def$^{n}$ 1: Any stock or fund (N~395) | | | | Invest Def$^{n}$ 2: Any direct (N~232) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Low Skills Tertile (N~97) | | High Skills Tertile (N~95) | | Low Skills Tertile (N~136) | | High Skills Tertile (N~133) | | Low Skills Tertile (N~75) | | High Skills Tertile (N~77) | |
| | | *Inputs* | | *Inputs* | | *Inputs* | | *Inputs* | | *Inputs* | | *Inputs* | |
| *Quantification* | | Objective | Subjective | Objective | Subjective | Objective | Subjective | Objective | Subjective | Objective | Subjective | Objective | Subjective |
| Non-quantified | | 43.8 | 45.3 | 31.3 | 38.1 | 34.5 | 38.6 | 32.1 | 32.6 | 39.6 | 41.8 | 30.4 | 27.2 |
| Quantified | | 56.9 | 58.5 | 45.2 | 52.4 | 56.5 | 56.6 | 54.2 | 40.8 | 56.3 | 56.3 | 55.0 | 38.3 |
| **Contrast** | | t | p | t | p | t | p | t | p | t | p | t | p |
| E1: Highest perceived likelihood when quantified and objective | | 1.04 | *n.s.* | 0.74 | *n.s.* | 2.57 | *** | 3.64 | *** | 1.42 | * | 3.59 | *** |
| Effect of Objectivity when... | Quantification is low | -0.2 | *n.s.* | -0.74 | *n.s.* | -0.63 | *n.s.* | -0.07 | *n.s.* | -0.24 | *n.s.* | 0.34 | *n.s.* |
| | Quantification is high | -0.17 | *n.s.* | -0.89 | *n.s.* | -0.02 | *n.s.* | 2.11 | ** | 0.00 | *n.s.* | 2.03 | ** |
| Effect of Quantification when... | Objectivity is low | 1.57 | * | 1.54 | * | 2.82 | *** | 1.21 | *n.s.* | 1.65 | * | 1.21 | *n.s.* |
| | Objectivity is high | 1.53 | * | 1.73 | ** | 3.34 | *** | 3.41 | *** | 1.8 | ** | 2.87 | *** |

**TABLE 6 (Continued)**

**Panel D: Experiment 2 Replication By Investor Classification**

| | Non-Investor (N~277) | | Investor Def$^{n}$ 1: Any stock or fund (N~406) | | Investor Def$^{n}$ 2: Any direct (N~237) | |
|---|---|---|---|---|---|---|
| **Mean (median) of likelihood of postponing turnaround** | ***Incentives*** | | ***Incentives*** | | ***Incentives*** | |
| ***Quantification*** | Consistent | Inconsistent | Consistent | Inconsistent | Consistent | Inconsistent |
| Non-quantified | 46.9 | 38.6 | 53.3 | 34.2 | 51.4 | 33.6 |
| Quantified | 61.4 | 48.1 | 57.4 | 46.7 | 59.7 | 45.9 |
| **Contrast** | t p | | t p | | t p | |
| E2: Highest perceived likelihood when quantified & consistent | 4.14 *** | | 4.34 *** | | 4.13 *** | |
| Effect of Consistency when... Quantification is low | 1.73 ** | | 5.37 *** | | 3.82 *** | |
| Quantification is high | 2.68 *** | | 2.87 *** | | 2.86 *** | |
| Effect of Quantification when... Consistency is low | 1.92 ** | | 3.34 *** | | 2.52 *** | |
| Consistency is high | 1.99 *** | | 1.16 *n.s.* | | 1.82 ** | |

**Panel E: Experiment 2 – Top vs. Bottom Tertiles of Numerical Skills Principal Component within Investor Subsets**

| | Non-Investor (N~277) | | | | Investor Def$^{n}$ 1: Any stock or fund (N~406) | | | | Investor Def$^{n}$ 2: Any direct (N~237) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low Skills Tertile (N~92) | | High Skills Tertile (N~92) | | Low Skills Tertile (N~131) | | High Skills Tertile (N~139) | | Low Skills Tertile (N~85) | | High Skills Tertile (N~78) | |
| **Mean (median) of likelihood of postponement** | ***Incentives*** | | ***Incentives*** | | ***Incentives*** | | ***Incentives*** | | ***Incentives*** | | ***Incentives*** | |
| ***Quantification*** | Consist | Inconsist | Consist | Inconsist | Consist | Inconsist | Consist | Inconsist | Consist | Inconsist | Consist | Inconsist |
| Non-quantified | 47.1 | 45.3 | 44.7 | 40.0 | 51.6 | 38.6 | 56.0 | 35.4 | 48.3 | 41.8 | 56.6 | 33.1 |
| Quantified | 61.2 | 55.5 | 68.0 | 55.9 | 62.5 | 54.1 | 56.5 | 44.5 | 59.7 | 56.3 | 61.6 | 36.3 |
| **Contrast** | t p | | t p | | t p | | t p | | t p | | t p | |
| E2: Highest perceived likelihood when quantified and consistent | 1.58 * | | 2.84 ** | | 2.93 *** | | 2.16 ** | | 1.74 ** | | 2.81 *** | |
| Effect of Consistency when... Quantification is low | 0.22 *n.s.* | | 0.57 *n.s.* | | 2.01 ** | | 3.27 *** | | 0.78 *n.s.* | | 2.67 *** | |
| Quantification is high | 0.58 *n.s.* | | 1.32 * | | 1.28 *n.s.* | | 1.91 ** | | 0.45 *n.s.* | | 2.88 *** | |
| Effect of Quantification when... Consistency is low | 1.09 *n.s.* | | 1.84 ** | | 2.22 ** | | 1.4 * | | 1.75 ** | | 0.33 *n.s.* | |
| Consistency is high | 1.66 ** | | 2.68 *** | | 1.79 ** | | 0.08 *n.s.* | | 1.46 * | | 0.63 *n.s.* | |

**Panel F: Analysis applying education-based proxy for investment experience**

| | Experiment 1 | | Experiment 1 | | | | Experiment 2 | | Experiment 2 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Proxy, Overall (N~193) | | Low Skills Tertile (N~68) | | High Skills Tertile (N~64) | | Proxy, Overall (N~201) | | Low Skills Tertile (N~67) | | High Skills Tertile (N~69) | |
| **Mean (median) of likelihood of postponing turnaround** | ***Inputs*** | | ***Inputs*** | | ***Inputs*** | | ***Incentives*** | | ***Incentives*** | | ***Incentives*** | |
| ***Quantification*** | Obj | Subj | Obj | Subj | Obj | Subj | Consist | Inconsist | Consist | Inconsist | Consist | Inconsist |
| Non-quantified | 37.5 | 36.2 | 32.7 | 37.1 | 37.3 | 30.9 | 52.1 | 36.1 | 50.2 | 39.5 | 57.3 | 27.3 |
| Quantified | 50.6 | 45.6 | 55.5 | 50.6 | 50.1 | 52.7 | 56.4 | 45.6 | 61.6 | 48.2 | 57.2 | 50.5 |
| **Contrast** | t p | | t p | | t p | | t p | | t p | | t p | |
| E1: Highest perceived likelihood when quantified and objective | 2.45 *** | | 1.89 ** | | 1.35 * | | 2.83 *** | | 2.25 ** | | 1.64 * | |
| Effect of Obj/Consist when... Quant is low | 0.24 *n.s.* | | -0.47 *n.s.* | | 0.58 *n.s.* | | 3.16 *** | | 1.17 *n.s.* | | 3.09 *** | |
| Quant is high | 0.87 *n.s.* | | 0.5 *n.s.* | | -0.27 *n.s.* | | 2 ** | | 1.45 * | | 0.73 *n.s.* | |
| Effect of Quant when... Obj (E1)/Consist (E2) is low | 1.63 * | | 1.4 * | | 1.96 ** | | 1.7 ** | | 0.88 *n.s.* | | 2.2 ** | |
| Obj (E1)/Consist (E2) is high | 2.48 *** | | 2.38 ** | | 1.37 * | | 0.88 *n.s.* | | 1.38 * | | -0.02 *n.s.* | |

**TABLE 6 (Continued)**

This table presents the main results from Kadous et al. (2005) and presents the replication using the MTurk sample with the main contrasts used to test the interaction hypotheses for both experiments. Participants in the role of a supervising manager face a decision regarding whether or not to postpone routine but expensive maintenance on machinery for one division of the company. The proposal varies in the presentation of quantitative information (both Experiments), the level of subjectivity of that information (Experiment 1), and whether the division manager's incentives are consistent or inconsistent with the firm's long-run best interests (Experiment 2). The overall replications of both Experiments are presented in Panel A. The effect of investment experience on the results and the effect of numerical skills within the investor categories are examined in Panels B and C, respectively, for Experiment 1, and in Panels D and E, respectively, for Experiment 2. Panel F presents the results of the replication using an education-based proxy for investment experience (specifically, completing at least some level of college education and also completing at least one accounting and one finance course). ***, **, *, and n.s. represent one-sided p-values of <0.01, <0.05, <0.10, and >0.10, respectively.

**TABLE 7: Replication of Nelson and Rupar's [2011] Experiment 1: Numerical formats within risk disclosures and the moderating effect of investors' disclosure management concerns**

**Panel A: Nelson and Rupar [2011], As Reported, and Current MTurk Sample, Overall**

| | ***Nelson and Rupar (2011; N=62)*** | | | | | | | | | ***MTurk Replication (N=767)*** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***Incentives*** | | | | | | | | | ***Incentives*** | | | | | | | | |
| | Low (Initial) [1] | | | | | High (Revised) [2] | | | | Low (Initial) [1] | | | | | High (Revised) [2] | | | |
| | ***Numerical Format*** | | | | | ***Numerical Format*** | | | | ***Numerical Format*** | | | | | ***Numerical Format*** | | | |
| ***Opportunity*** | Percent [1] | | Dollar [2] | | Diff | Percent [1] | | Dollar [2] | | Diff | Percent [1] | | Dollar [2] | | Diff | | Percent [1] | | Dollar [2] | | Diff | |
| Low (Mandatory) [1] | 5.9 | (6.0) | 7.8 | (8.0) | 1.9 | 5.5 | (6.0) | 7.6 | (8.0) | 2.1 | 5.4 | (5.0) | 6.3 | (7.0) | 0.9 | *** | 5.4 | (5.0) | 6.2 | (6.0) | 0.8 | *** |
| High (Discretionary) [2] | 5.9 | (6.0) | 6.5 | (6.0) | 0.6 | 6.7 | (7.0) | 6.8 | (6.0) | 0.1 | 5.6 | (6.0) | 6.5 | (6.0) | 0.9 | *** | 5.9 | (6.0) | 6.1 | (6.0) | 0.2 | n.s. |
| *Higher opportunity lowers difference (H2)* | | | | | (1.3) | | | | | (2.0) | | | | | 0.0 | n.s. | | | | | (0.6) | ** |
| *Higher incentives lowers difference, but more when higher opportunity (H3)* | | | | | | | | | | (0.7) | | | | | | | | | | | (0.6) | * |

| **Excerpts from analysis of variance** | F | p | | F | p | |
|---|---|---|---|---|---|---|
| **H1: Format main effect** | 6.73 | 0.01 | two-sided | 35.29 | <0.01 | two-sided |
| **H2: Format * Opportunity** | 4.21 | 0.05 | two-sided | 2.08 | 0.15 | two-sided |
| **H3: Format * Opportunity*Incentives** | 0.28 | 0.60 | two-sided | 2.54 | 0.11 | two-sided |

**Panel B: Replication by Investor Type**

| | **Non-Investor (N=326)** | | | | | | | | **Investor Def$^{n}$ 1: Any stock or fund (N=441)** | | | | | | | | **Investor Def$^{n}$ 2:Any direct (N=254)** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***Incentives*** | | | | | | | | ***Incentives*** | | | | | | | | ***Incentives*** | | | | | | | |
| | Low (Initial) [1] | | | | High (Revised) [2] | | | | Low (Initial) [1] | | | | High (Revised) [2] | | | | Low (Initial) [1] | | | | High (Revised) [2] | | | |
| | ***Format*** | | | | ***Format*** | | | | ***Format*** | | | | ***Format*** | | | | ***Format*** | | | | ***Format*** | | | |
| ***Opportunity*** | % | $ | Diff | | % | $ | Diff | | % | $ | Diff | | % | $ | Diff | | % | $ | Diff | | % | $ | Diff | |
| Low (Mandatory) [1] | 5.2 | 6.5 | 1.3 | *** | 5.3 | 6.3 | 1.0 | *** | 5.5 | 6.2 | 0.7 | *** | 5.5 | 6.0 | 0.5 | ** | 5.4 | 6.4 | 1.0 | *** | 5.1 | 5.9 | 0.9 | *** |
| High (Discretionary) [2] | 5.7 | 6.5 | 0.8 | *** | 5.9 | 6.2 | 0.3 | n.s. | 5.6 | 6.4 | 0.8 | *** | 5.9 | 6.0 | 0.1 | n.s. | 5.7 | 6.6 | 0.9 | *** | 5.9 | 6.0 | 0.1 | n.s. |
| *Higher opportunity lowers difference (H2)* | | | (0.5) | n.s. | | | (0.7) | ** | | | 0.1 | n.s. | | | (0.4) | n.s. | | | (0.2) | n.s. | | | (0.8) | ** |
| *Higher incentives lowers difference, but more when higher opportunity (H3)* | | | | | | | (0.2) | n.s. | | | | | | | (0.5) | * | | | | | | | (0.6) | * |

**TABLE 7 (Continued)**
**Panel C: Top vs. Bottom Tertiles of Numerical Skills Principal Component within Investor Subsets**

**Investor Def$^{n}$ 1: Any stock or fund (N=441)**

| | Low Skills Tertile (N=147) | | | | | | High Skills (N=146) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***Incentives*** | | | | | | ***Incentives*** | | | | | |
| | Low (Initial) [1] | | | High (Revised) [2] | | | Low (Initial) [1] | | | High (Revised) [2] | | |
| | ***Format*** | | | ***Format*** | | | ***Format*** | | | ***Format*** | | |
| ***Opportunity*** | % | $ | Diff | % | $ | Diff | % | $ | Diff | % | $ | Diff |
| Low (Mandatory) [1] | 5.6 | 6.2 | 0.6 * | 5.6 | 5.7 | 0.1 n.s. | 5.9 | 6.2 | 0.3 n.s. | 5.6 | 6.5 | 0.9 ** |
| High (Discretionary) [2] | 5.8 | 6.9 | 1.1 *** | 5.9 | 6.5 | 0.6 * | 5.6 | 6.1 | 0.5 n.s. | 6.0 | 5.6 | (0.4) n.s. |
| *Higher opportunity lowers difference (H2)* | | | 0.5 n.s. | | | 0.5 n.s. | | | 0.2 n.s. | | | (1.3) ** |
| *Higher incentives lowers difference, but more when higher opportunity (H3)* | | | | | | (0.0) n.s. | | | | | | (1.5) ** |

**Investor Def$^{n}$ 2:Any direct (N=254)**

| | Low Skills Tertile (N=87) | | | | | | High Skills Tertile (N=82) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***Incentives*** | | | | | | ***Incentives*** | | | | | |
| | Low (Initial) [1] | | | High (Revised) [2] | | | Low (Initial) [1] | | | High (Revised) [2] | | |
| | ***Format*** | | | ***Format*** | | | ***Format*** | | | ***Format*** | | |
| ***Opportunity*** | % | $ | Diff | % | $ | Diff | % | $ | Diff | % | $ | Diff |
| Low (Mandatory) [1] | 5.7 | 6.3 | 0.6 n.s. | 5.2 | 5.9 | 0.7 n.s. | 6.1 | 6.9 | 0.8 * | 5.5 | 6.6 | 1.1 ** |
| High (Discretionary) [2] | 5.7 | 7.0 | 1.3 *** | 5.9 | 6.8 | 0.9 * | 5.7 | 6.8 | 1.1 ** | 5.8 | 5.7 | (0.2) n.s. |
| *Higher opportunity lowers difference (H2)* | | | 0.7 n.s. | | | 0.2 n.s. | | | 0.3 n.s. | | | (1.3) * |
| *Higher incentives lowers difference, but more when higher opportunity (H3)* | | | | | | (0.5) n.s. | | | | | | (1.6) ** |

**Panel D: Analysis applying education-based proxy for investment experience**

| | Proxy, Overall (N=202) | | | | | | Low Skills Tertile (N=67) | | | | | | High Skills Tertile (N=69) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***Incentives*** | | | | | | ***Incentives*** | | | | | | ***Incentives*** | | | | | |
| | Low (Initial) [1] | | | High (Revised) [2] | | | Low (Initial) [1] | | | High (Revised) [2] | | | Low (Initial) [1] | | | High (Revised) [2] | | |
| | ***Format*** | | | ***Format*** | | | ***Format*** | | | ***Format*** | | | ***Format*** | | | ***Format*** | | |
| ***Opportunity*** | % | $ | Diff | % | $ | Diff | % | $ | Diff | % | $ | Diff | % | $ | Diff | % | $ | Diff |
| Low (Mandatory) [1] | 5.6 | 6.2 | 0.6 ** | 5.8 | 6.1 | 0.3 n.s. | 5.7 | 5.8 | 0.2 n.s. | 6.6 | 5.5 | (1.1) ** | 5.7 | 6.5 | 0.8 n.s. | 5.5 | 7.0 | 1.5 ** |
| High (Discretionary) [2] | 5.8 | 6.6 | 0.8 ** | 6.1 | 6.1 | 0.0 n.s. | 6.0 | 7.1 | 1.1 * | 6.0 | 7.1 | 1.1 * | 5.8 | 6.8 | 1.0 * | 6.5 | 6.0 | (0.5) n.s. |
| *Higher opportunity lowers difference (H2)* | | | 0.2 n.s. | | | (0.3) n.s. | | | 0.9 n.s. | | | 2.2 xx | | | 0.2 n.s. | | | (2.0) ** |
| *Higher incentives lowers difference, but more when higher opportunity (H3)* | | | | | | (0.5) n.s. | | | | | | 1.3 n.s. | | | | | | (2.2) ** |

**TABLE 7 (Continued)**

This table presents the main results from Nelson and Rupar (2011) and presents the replication using the MTurk sample with one-sided contrasts used to test the interaction hypotheses. Participants are asked to assess a firm's commodity price risk based on the provided information, which varies the format of the numerical information (dollar vs. percentage), whether the disclosing firm has the opportunity to choose the format or the format is mandated, and, in an additional within-subject manipulation, the extent of the manager's incentive to achieve a preferred reporting result. The overall replication is presented in Panel A. The effect of investment experience on the results and the effect of numerical skills within the investor categories are examined in Panels B and C, respectively. ***, **, *, and n.s. represent one-sided p-values of <0.01, <0.05, <0.10, and >0.10, respectively. xx represents a two-sided p-value of <0.05 in the opposite direction of that predicted.