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ABSTRACT

This study examines how visualization and interactivity affect accuracy, confidence, and calibration in a financial decision-making context. Decision-makers are typically overconfident and this research proposes that visualization and interactivity can reduce calibration, increasing overconfidence. An experiment was conducted with 157 participants and the results showed that visualization and interactivity features can increase decision-maker confidence independently. However, interactive visualization, both interface features, are required to increase accuracy. As a result, when interactivity and visualization are offered individually, decision-makers become overconfident, less calibrated. Implications for designers are discussed.

Keywords (Required)

Visualization, interactivity, confidence, accuracy, calibration.

INTRODUCTION

While financial information is commonly presented in formats such as tables and graphs, advances in technology now provide companies with more advanced options for delivering financial information to investors. Particularly, the increased use of XBRL (eXtensible Business Reporting Language), a variant of XML (eXtensible Markup Language), fundamentally changes how financial information is acquired, processed, and presented. Using XBRL, companies can now provide financial data in a universal format, enabling users to dynamically render this data with interactive visualization features. As a result, users can quickly display the data in a variety of visual formats, interacting with specific data dimensions with ease. Past research has examined how different presentation formats (e.g., tables and graphs) impacts financial decision-making, but there has been limited research on dynamic visualization and interactivity in this context.

Further, existing financial decision-making research has primarily focused on accuracy and efficiency as outcome variables when studying the effect of presentation formats. Decision confidence and calibration (i.e., the measurement of one's confidence relative to decision accuracy) have received little attention in this research context. Confidence is what gives an individual the certainty to act on a decision, and ideally, one's confidence level in the accuracy of a decision should match the actual accuracy level of the decision. However, a decision-maker's confidence often deviates from the accuracy of the decision, leading to over- or under-confidence. One's confidence in a decision can be swayed by task characteristics, and interface elements such as visualization and interactivity can change these characteristics. Thus an examination of how interactive visualization impacts financial decision-making should consider not just accuracy but also confidence and calibration.

In this study, we investigate how interactive visualization impacts calibration with financial decision-making. An experiment with 157 participants was conducted using an experimental financial presentation website. The remainder of the paper is organized as follows. The literature on visualization, interactivity, and calibration are reviewed and hypotheses are proposed. The experimental study and analysis are then described, following by a discussion of the results, implications and limitations.

LITERATURE REVIEW

Visualization

Visualization, also called "information visualization", "data visualization", or scientific visualization", refers to "the selection, transformation, and presentation of data (including spatial, abstract, physical, or textual) in a visual form that facilitates exploration and understanding" (Lurie and Mason, 2007, p. 161). Various techniques can be utilized to provide visualization such as color, size, shape, texture, orientation, and brightness. In this research, we define visualization as utilizing visual symbol sets such as charts and images to facilitate the information processing of users.

Researchers from many disciplines have studied the effects of various presentation formats (e.g., Blanco et al, 2010). Early research in this area primarily focused on the "graph versus table" comparison (Dull and Tegarden, 1999) and the results were mixed. For example, some research found that graphic representation can substantially improve financial statement users' decision-making (Desanctis and Jarvenpaa, 1989). In contrast, Kaplan (1988) investigated the effects of graphic versus tabular presentation on auditors' prediction of future account balances and found no difference between graphs and tables. Others have examined the contingent effects of task characteristics. For example, Blocher et al (1986) found that graphic representation is better when the level of task complexity is low and tabular representation is better when the level of task complexity is high. Davis (1989) found that graphic representation is better only when it can provide relevant visual cues for answering the question.

While there have been extensive comparisons of graphs versus tables, little research has examined the potential improvement in financial decision-making by integrating graphic and textual data to convey information through multiple symbol sets. According to Media Synchronicity Theory (MST), symbol sets are "the number of ways in which a medium allows information to be encoded for communication", including words, images, table, animation, etc. (Dennis et al., 2008. p. 11). Many modern digital media, allow multiple symbol sets to be transmitted simultaneously (Dennis et al., 2008). MST proposes that the use of media with symbol sets that are better suited to the content of message is more likely to lead to better performance. By conveying information through multiple symbol sets, users are able to choose symbol sets that best fit their specific needs. Thus, we suggest that communication using multiple symbol sets is more likely to provide a better match between message content and communication context, thereby leading to better performance.

Interactivity

Interactivity can be defined in many ways depending on whether the focus is user-machine interaction, user-user interaction, or user-message interaction (Liu and Shrum, 2002). In this research, we adopt a user-machine interaction view and define interactivity as the "extent to which users can participate in modifying the form and content of a mediated environment in real time" (Steuer, 1992, p. 84).

Most interactivity research has been conducted in an ecommerce product evaluation setting. For example, Fiore et al. (2005) found that interactivity improved customers' global attitudes, purchase intention, and willingness to patronize an online store. Similarly, Jiang and Benbasat (2004) found that visual and functional control, which allowed customers to control visual presentation and functions, increased flow as well as perceived diagnosticity. Jiang and Benbasat (2007) reported that interactivity and vividness had a significant impact on diagnosticity, which ultimately influenced customers' purchase intention. Cyr et al. (2009) examined perceived interactivity from both cognitive and affective perspectives and found positive relationships with efficiency, effectiveness, trust, and enjoyment of the website.

While ecommerce research has shown that interactivity can help consumers with their online decision-making, there has been limited research on how interactivity may enhance financial decision-making.

Confidence and Calibration

Calibration, or the appropriateness of confidence, is generally measured as the correspondence between the subjective confidence assigned to a decision and the objective quality of that decision. We say a decision is perfectly calibrated if one's confidence level on a decision exactly matches the quality level of the decision.

The phenomenon of overconfidence is widespread and has long been documented in the psychology and behavioral science literature based on data from interviews, surveys, and experiments (e.g., Lichenstein and Fischhoff, 1977; Caliendo and Huang, 2008). For instance, 68% of lawyers in civil cases believe that their side will prevail, and 82% of drivers say that they are in the top 30% of safe drivers. The overconfidence phenomenon is also persistent in a financial decision making context (Caliendo and Huang, 2008). Prior research indicates that investors persistently overestimate the average rate of return to their assets and underestimate uncertainty associated with the return (Caliendo and Huang, 2008). Deaves, Luders, and Schroder (2010) surveyed 350 financial market specialists and found that even professional market analysts are persistently overconfident and the degree of their overconfidence increases over time.

Having judgments that are accurately calibrated is critical for decision-makers. Overconfidence may cause people to take an action that they shouldn't, possibly leading to suboptimal outcomes. Whereas, under-confident people may have an accurate judgment, but fail to act upon it, thereby missing a valued opportunity. As mentioned, confidence and calibration have been extensively investigated in the psychology literature (e.g., Lichenstein and Fischhoff, 1977). A general finding is that people tend to be overconfident, and that the nature of the task can influence confidence. For example, when tasks are extremely easy people tend to be under-confident, but when tasks are more difficult and require more processing and effort, people tend to be over-confident (Lichtenstein and Fischhoff, 1977).

HYPOTHESES

Visualization

There are several reasons why visualization can improve judgment and decision-making. First, visualization can enhance individuals' problem-solving capabilities, as explained by Dual Coding Theory and Cue Summation Theory. Dual Coding Theory (Paivio, 1986) posits that visual and verbal information are processed differently in distinct channels. Specifically, the symbolic coding system processes verbal information, whereas the analogue coding system processes visual information. More importantly, the two systems complement rather than compete with one other, having additive effects on human memory and understanding.

Cue Summation Theory (Severin, 1967) postulates that the effectiveness of learning increases as the number of relevant stimuli and cues increase. Specifically, the use of multiple sensory channels to convey related information will lead to more effective communication and learning due to the summation of cues across channels. However, multichannel communications that convey unrelated information will result in inferior communication and less effective learning because the added channel provides irrelevant cues. By conveying the same information through both verbal and visual channels, visualization provides additional cues or stimuli to users, thereby improving users' learning effectiveness.

Thus, we propose that:

H1a: Participants in a high visualization condition will have higher decision accuracy than those in a low visualization condition.

Visualization is also believed to improve users' confidence. Koriat et al. (1980) posit that confidence is determined by the amount and strength (or quality) of information supporting the decision. As discussed before, visualization can bring more information cues to users through multiple symbol sets. The increased information available allows people to generate more reasons to justify their decisions and hence increases their confidence (Schwenk, 1986). Various psychology studies have demonstrated that the availability of more information leads to higher confidence (e.g., Oskamp, 1965).

Visualization can also influence users' perception of information quality through vividness. Empirical findings (e.g., Yonelinas, 1997) suggest that "when retrieved information is vivid and detailed, people are relatively confident that it represents a veridical memory" (Robinson et al., 2000, p. 208). Therefore visualization should increase users' confidence by providing more vivid information. Therefore, we propose that

H1b: Participants in a high visualization condition will have higher confidence than those in a low visualization condition.

Interactivity

Research suggests that interactivity can improve decision quality (Ginzberg and Stohr, 1982). Interactivity provides users with autonomy and flexibility, allowing them to determine what information they want to examine, the pace at which they want to proceed, and how the information is presented to them (Jiang and Benbasat, 2007). Autonomy and flexibility enabled by the system give users a sense of control (Ariely, 2000; Jiang and Benbasat, 2007), which should instill a high level of involvement in the cognitive process (Jiang and Benbasat, 2007). In addition, interactivity allows users to actively acquire and process information in a preferred way. As a result, users can restructure the information environment to create a better fit between the individual, the task, and the decision environment, thereby improving decision quality and/or reducing the effort required (Eick and Wills, 1995). Thus, we propose that:

H2a: Participants in a high interactivity condition will have higher decision accuracy than those in a low interactivity condition.

Interactivity may also improve users' confidence. As discussed before, interactivity enables autonomy and flexibility, giving users a sense of control which should be able to induce confidence. For instance, Ariely (2000, p. 233) found that the control of information flow can help users "better match their preferences, have better memory and knowledge about the domain they are examining, and be more confident on their judgments". In addition, interactivity induces a higher level of cognitive engagement. As a result, users will put more cognitive resources into solving problems. Greater effort is generally expected to result in better performance (Yate and Kulick, 1977), and people expect a positive association between effort and accuracy in judgment (Paese and Sniezek, 1991). Thus, increased effort should induce a higher level of confidence. Therefore, we propose

H2b: Participants in a high interactivity condition will have higher confidence than those in a low interactivity condition.

Calibration

Psychology research on calibration suggests that accuracy and confidence may be affected differently by various factors (Tsai et al., 2008). Specifically, prior research indicates that confidence is more easily influenced by contextual factors compared to accuracy (Allwood and Montgomery, 1987). As a result, people's confidence may be easily increased or decreased, while their performance may change slowly or not change at all. For example, various studies found that people's confidence unduly increased without affecting their performance (e.g., Oskamp, 1965). Kottemann et al. (1994) investigated computer-assisted decision-making and suggested that technology "may increase decision makers' effort and active involvement, engendering the illusion of control and leading to inflated performance beliefs" (p. 34). As a result, they found that participants had higher confidence in their decision with accuracy unimproved. Visualization and interactivity may similarly induce user's confidence without improving accuracy, leading to overconfidence. As users are provided with these novel interface tools, they may learn to utilize the tools, but not in the most effective way. As a result, their accuracy may not increase as rapidly as their confidence, leading to overconfidence. Therefore, we propose that:

H3a: Participants in a high visualization condition will have less calibration than those in a low visualization condition.

H3b: Participants in a high interactivity condition will have less calibration than those in a low interactivity condition.

RESEARCH METHOD

A 2 x 2 between-subjects, experimental design with 157 undergraduate business students (93 males) from an introductory Accounting course was used to test the hypotheses, with the two independent variables of visualization (low or high) and interactivity (low or high). Screenshots of four treatments are shown in appendix A. Details of the treatments and experimental procedures are described below.

Treatments

We manipulated visualization at two levels (high or low) by varying the presentation format. In high visualization conditions, participants were provided with tabular income statements as well as graphic information. In low visualization conditions, participants were only provided with tabular income statements.

Interactivity was manipulated at two levels (high or low) by varying the ability of users to interact with the interface. In high interactivity conditions, participants had high control over what and how the information was presented. For example, in the high-visualization/high-interactivity condition, participants were able to filter out any item they had no interest in. They could also render any financial item or combination of items in different types of charts (bar, column, or line chart) based on their preference. In the low-visualization/high-interactivity condition, participants were able to filter out any item, although no graphic information was provided. In contrast, in low interactivity conditions, participants had less control over how and what the information was displayed. For instance, in the low-visualization/low-interactivity condition, participants were only provided with three tabular income statements which they could not manipulate. In the high-visualization/low-interactivity condition, participants were provided with three tabular financial income statements and a line chart which they could not manipulate. In these low-interactivity treatments, the interactivity was limited to participants only being able to show an item in a line chart by selecting the financial item from an income statement.

Task and procedures

Subjects were randomly assigned to one of the four treatments and were provided a decision scenario with three companies' most recent financial information, displayed using the different interfaces mentioned above. To be comparable, the companies were from the same industry for the same period (2003–2006). Before the experiment, tutorials were provided to ensure that participants were familiar with the experimental interface. After the tutorial, participants were asked to answer a few example questions so that they were more familiar with the tool. Participants were then asked to analyze the financial information provided and answer a series of questions based on the financial information provided, as shown in appendix B.

Dependent variables

Decision accuracy, confidence, and calibration (overconfidence) were used as performance measures. Consistent with the psychology literature, accuracy was measured as the proportion of questions answered correctly out of eight questions (the number of questions answered correctly/total number of questions * 100). Confidence was calculated as the subjects' average confidence in their answers on the questions (the sum of all confidence ratings/total number of questions). Calibration was measured by overconfidence, calculated as the difference between confidence and accuracy. A positive difference indicates overconfidence and a negative difference indicates underconfidence. In addition, a large absolute difference between confidence and accuracy indicates lower calibration.

DATA ANALYSIS AND RESULT

Data analysis was performed using SPSS 18.0. Two simple T-tests were conducted to assess the manipulation of visualization ($t(148)=6.38$, $p<0.01$) and interactivity ($t(145)=3.10$, $p<0.01$) and were found to be significant.

Hypotheses Test

A two-factor MANOVA with visualization and interactivity as the independent variables and decision accuracy and confidence as the dependent variables was conducted. Both main effects were significant ($p<0.01$), and thus separate ANOVAs were conducted. The descriptive statistics of decision accuracy, confidence, and overconfidence are shown in Table 1. The effect of visualization ($F(1, 153)=13.88$, $p<0.01$) on decision accuracy was statistically significant and the effect of interactivity ($F(1, 153)=3.12$, $p<0.10$) on decision accuracy approached significance. Thus, H1a was supported and H2a was not supported. In addition, the interaction ($F(1, 153)=2.17$, $p>0.10$) between visualization and interactivity on decision accuracy was not significant.

The effects of visualization ($F(1, 153)=6.95$, $p<0.01$) and interactivity ($F(1, 153)=4.18$, $p<0.05$) on confidence were significant. Thus, H1b and H2b were supported. In addition, the interaction between visualization and interactivity approached significance ($F(1, 153)=3.05$, $p<0.10$).

To examine the effects of visualization and interactivity on overconfidence (calibration), we conducted a two-factor ANOVA with visualization and interactivity as the independent variables and overconfidence as the dependent variable. Consistent with the psychology literature, the results show that participants in all conditions were overconfident. The effect of visualization ($F(1, 153)=2.93$, $p<0.10$) on overconfidence approached significance but with means in the opposite direction to what was proposed in hypothesis H3a. We hypothesized that visualization would lead to higher overconfidence. However, the results suggest that visualization reduced overconfidence. Thus, H3a was not supported. The results also found that the effect of interactivity ($F(1, 153)=0.05$, $p>0.10$) on overconfidence was not significant. Thus, H3b was not supported. However, there was a significant interaction ($F(1, 153)=7.71$, $p<0.01$) between visualization and interactivity on overconfidence as shown in Figure 1. The hypotheses testing results are summarized in Table 2.

		Decision Accuracy		Confidence		Overconfidence	
		Visualization		Visualization		Visualization	
		Low	High	Low	High	Low	High
Interactivity	Low	64.47 (19.61) (N=38)	70.93 (18.04) (N=43)	75.81 (17.04) (N=38)	85.34 (13.44) (N=43)	11.34 (17.39) (N=38)	14.41 (19.11) (N=43)
	High	65.31 (19.91) (N=40)	80.21 (12.81) (N=36)	84.05 (12.90) (N=40)	85.99 (9.92) (N=36)	18.74 (18.53) (N=40)	5.78 (16.87) (N=36)

Mean is shown as the number outside of parenthesis, standard Deviation is shown as the number in parenthesis

Table1. Descriptive Statistics by Treatment

Hypothesis	Dependent Variable	Independent Variable	F-value	Results
H1a	Decision Accuracy	Visualization	13.88***	Supported
H1b		Interactivity	3.12*	Marginal
H2a	Confidence	Visualization	6.95***	Supported

H2b		Interactivity	4.18**	Supported
H3a	Overconfidence	Visualization	2.93*	NOT Supported (Opposite direction)
H3b		Interactivity	0.05	NOT Supported, but interaction significant
*** significant at .01, ** significant at .05, * approached significance at .10				

Table 2: Two-way ANOVA Results

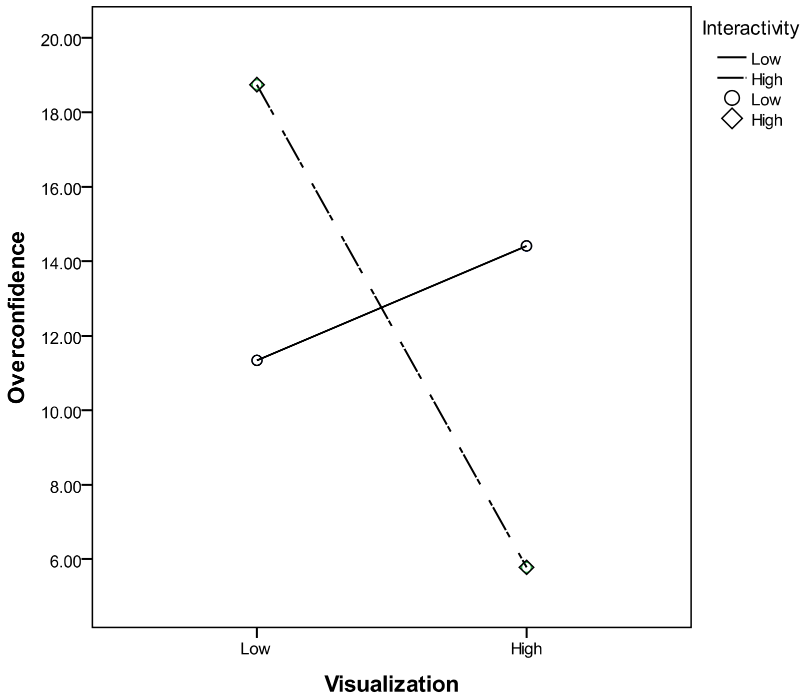

Figure 1: The effects of interactivity and visualization on overconfidence

As main effects are uninterpretable when the interaction effect is significant, it is necessary to further investigate the differences across treatments. A one-way ANOVA was conducted to further examine the difference in overconfidence across the four treatments and indicates that there were significant differences ($F(3, 153)=3.46$, $p<0.05$). A post hoc analysis shows that the high-visualization/high-interactivity condition was not significantly different from the low-visualization/low-interactivity condition but was significantly different from the other two conditions (high-visualization/low-interactivity, low-visualization/high-interactivity). Thus, the results suggest that visualization and interactivity had a different impact on user calibration depending upon whether high visualization and high interactivity were provided simultaneously or alone. When high-levels of both were provided, participants had lower overconfidence, or improved calibration. In contrast, when visualization or interactivity was provided alone, participants had higher overconfidence or reduced calibration. In other words, interactive visualization led to better calibration, whereas non-interactive visualization or non-visualized interactivity reduced participants' calibration.

As miscalibration arises from the varying effects on accuracy and confidence, it is meaningful to examine the impact of visualization and interactivity on accuracy and confidence separately across treatments. A one-way ANOVA was conducted with the four treatments as the independent variable and decision accuracy as the dependent variable. The results ($F(3, 153)=6.05$, $p<0.01$) indicate there was a significant difference across treatments. The post hoc analysis (LSD) shows that the high-visualization/high-interactivity condition was significantly different from the other three conditions, while there was no difference among high-visualization/low-interactivity, low-visualization/high-interactivity, and low-visualization/low-interactivity condition. As shown in Figure 2, the results suggest that although visualization and interactivity improved decision accuracy, the improvement seemed to only come from interactive visualization. In other words, although visualization-only and interactivity-only condition could provide some benefit for decision accuracy, the improvement seemed to be trivial. In contrast, interactive visualization led to higher improvement in decision accuracy.

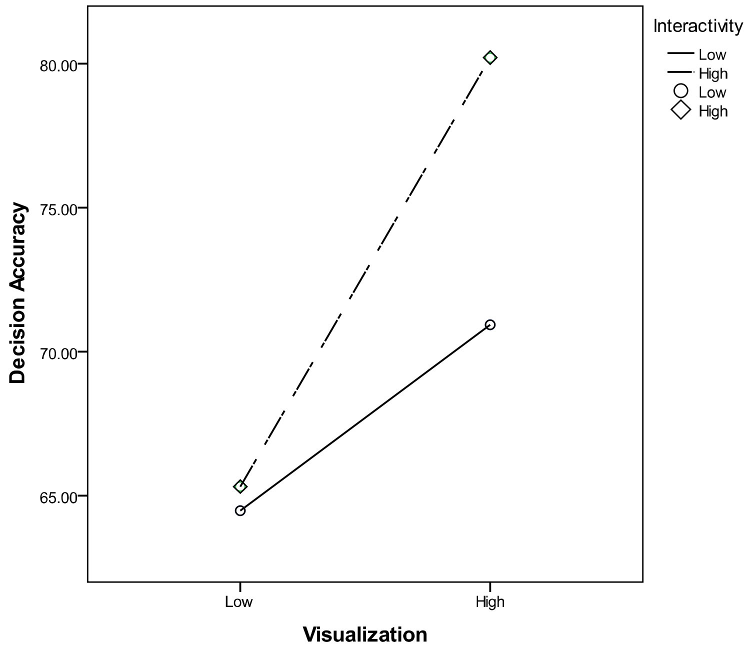

Figure 2: The effects of interactivity and visualization on decision accuracy

Another one-way ANOVA was conducted to examine confidence across treatments. The results indicate that there was a significant difference across treatments ($F(3, 153)=4.62$, $p < 0.01$). The post hoc analysis shows that there was a significant difference between the low-visualization/low-interactivity condition and the other three conditions, while there was no difference among the high-visualization/high-interactivity, high-visualization/low-interactivity, low-visualization/high-interactivity conditions. The results suggest that unlike decision accuracy, confidence can be easily improved through either visualization or interactivity. The effects of visualization and interactivity on confidence are shown in Figure 3.

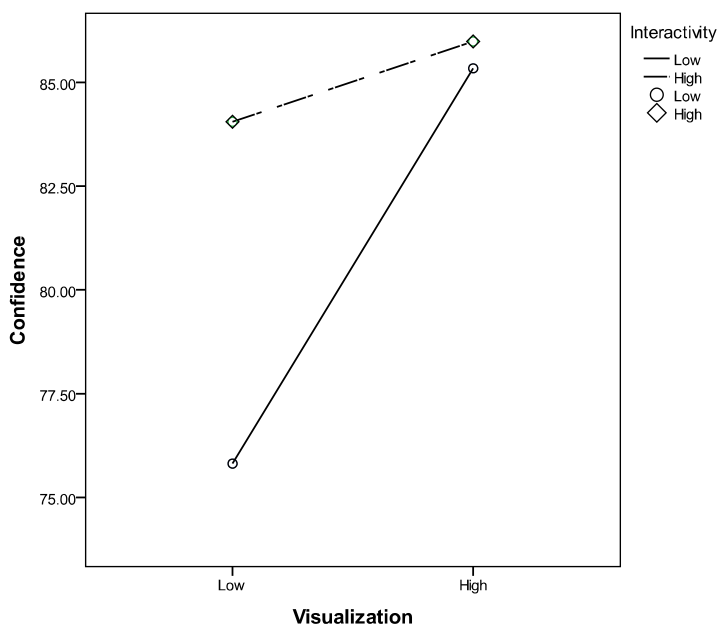

Figure 3: The effects of interactivity and visualization on confidence

DISCUSSION

The overall results suggest that although visualization leads to better calibration, the improvement seemed to only come from interactive visualization. As we can see from Table 1, visualization and interactivity alone actually reduced rather than improved user calibration. The effect on user calibration is due to the different impact of visualization and interactivity on accuracy and confidence. Specifically, the results suggest that participants' decision accuracy is more difficult to improve compared to confidence. As a result, participants had little improvement in accuracy when provided with visualization and interactivity alone. However, their decision confidence was inappropriately enhanced by providing either visualization or interactivity alone, leading to reduced calibration. In contrast, by providing interactive visualization, participants could improve their decision accuracy as well as confidence appropriately, leading to better user calibration.

This research contributes to the decision-making literature in several ways. First, this research examines decision accuracy and confidence simultaneously. Prior research primarily employs decision accuracy as a proxy for performance, and studies that examine accuracy without considering confidence may lead to an incomplete understanding of user performance. This research suggests that when considering calibration, only providing visualization or interactivity may reduce users' overall performance. Instead, only interactive visualization can better align users' decision accuracy and confidence, leading to a more calibrated decision.

Second, this research makes a unique contribution by going beyond the "graph versus table" comparison and studying the interactive visualization advanced by new information technology such as XBRL. Traditional research in this area has generally examined static graphic tools over which users have no control. In fact, "interactivity distinguishes many current visualization tools from more traditional graphic representations" (Lurie and Mason, 2007, p. 163). This research contributes to financial decision-making research by showing that interactivity or visualization alone is significantly different from interactive visualization. Non-interactive visualization or non-visualized interactivity does not necessarily improve users' performance, and both interactivity and visualization are needed.

Finally, this research also informs design science. Specifically, when designing systems, developers should integrate interactivity into visualization. By providing interactive visualization, users can have tailored information and a presentation format that best fits their preferences. As a result, these interface tools can better serve users' needs leading to a more calibrated decision.

Limitation

There are limitations to this study. First, college students were used as a proxy for non-professional investors in a laboratory setting. The results should be cautiously generalized to a more heterogeneous subject pool or beyond a laboratory setting. Secondly, the realism of the study could be improved by presenting the subjects with more realistic tasks. Moreover, future research should examine other aspects of performance such as decision time, user satisfaction, etc. Finally, some literature review and citations were omitted due to space limitations. Interested readers are encouraged to contact the authors for the complete references.

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APPENDIX A: EXPERIMENT TREATMENTS

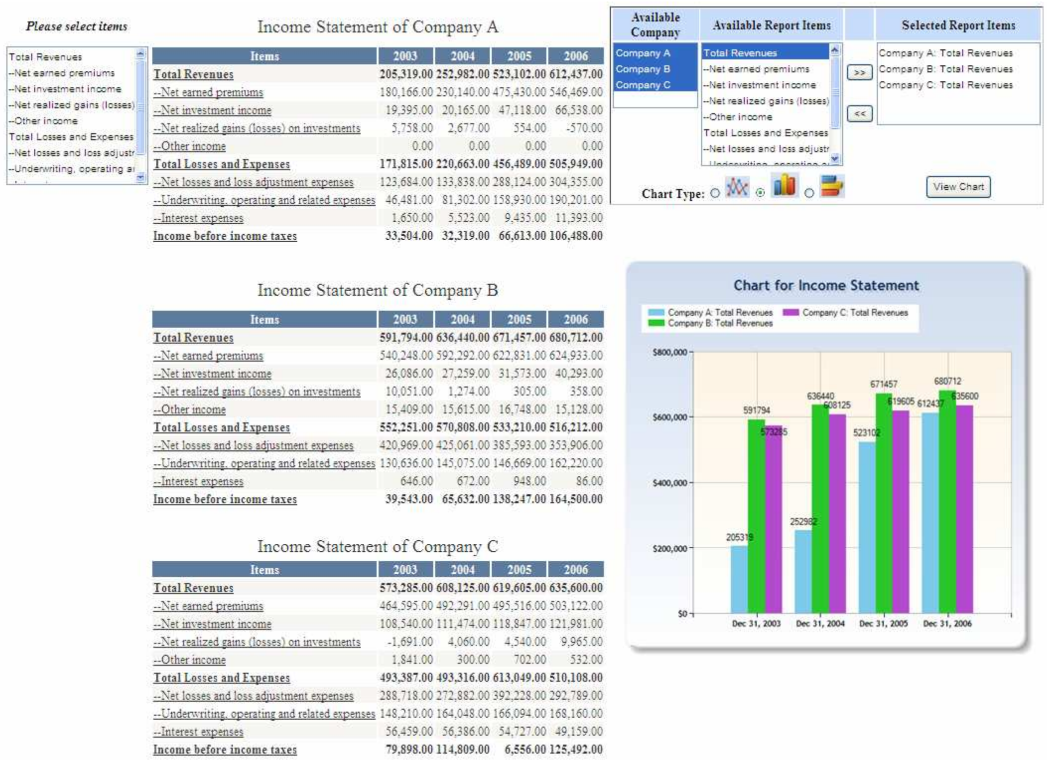


Figure 5: High-Visualization/High-Interactivity Condition

Income Statement of Company A

Items	2003	2004	2005	2006
Total Revenues	**205,319.00**	**252,982.00**	**523,102.00**	**612,437.00**
--Net earned premiums	180,166.00	230,140.00	475,430.00	546,469.00
--Net investment income	19,395.00	20,165.00	47,118.00	66,538.00
--Net realized gains (losses) on investments	5,758.00	2,677.00	554.00	-570.00
--Other income	0.00	0.00	0.00	0.00
Total Losses and Expenses	**171,815.00**	**220,663.00**	**456,489.00**	**505,949.00**
--Net losses and loss adjustment expenses	123,684.00	133,838.00	288,124.00	304,355.00
--Underwriting, operating and related expenses	46,481.00	81,302.00	158,930.00	190,201.00
--Interest expenses	1,650.00	5,523.00	9,435.00	11,393.00
Income before income taxes	**33,504.00**	**32,319.00**	**66,613.00**	**106,488.00**

Income Statement of Company B

Items	2003	2004	2005	2006
Total Revenues	**591,794.00**	**636,440.00**	**671,457.00**	**680,712.00**
--Net earned premiums	540,248.00	592,292.00	622,831.00	624,933.00
--Net investment income	26,086.00	27,259.00	31,573.00	40,293.00
--Net realized gains (losses) on investments	10,051.00	1,274.00	305.00	358.00
--Other income	15,409.00	15,615.00	16,748.00	15,128.00
Total Losses and Expenses	**552,251.00**	**570,808.00**	**533,210.00**	**516,212.00**
--Net losses and loss adjustment expenses	420,969.00	425,061.00	385,593.00	353,906.00
--Underwriting, operating and related expenses	130,636.00	145,075.00	146,669.00	162,220.00
--Interest expenses	646.00	672.00	948.00	86.00
Income before income taxes	**39,543.00**	**65,632.00**	**138,247.00**	**164,500.00**

Income Statement of Company C

Items	2003	2004	2005	2006
Total Revenues	**573,285.00**	**608,125.00**	**619,605.00**	**635,600.00**
--Net earned premiums	464,595.00	492,291.00	495,516.00	503,122.00
--Net investment income	108,540.00	111,474.00	118,847.00	121,981.00
--Net realized gains (losses) on investments	-1,691.00	4,060.00	4,540.00	9,965.00
--Other income	1,841.00	300.00	702.00	532.00
Total Losses and Expenses	**493,387.00**	**493,316.00**	**613,049.00**	**510,108.00**
--Net losses and loss adjustment expenses	288,718.00	272,882.00	392,228.00	292,789.00
--Underwriting, operating and related expenses	148,210.00	164,048.00	166,094.00	168,160.00
--Interest expenses	56,459.00	56,386.00	54,727.00	49,159.00
Income before income taxes	**79,898.00**	**114,809.00**	**6,556.00**	**125,492.00**

Figure 6: High-Visualization/Low-Interactivity Condition

Please select items

Total Revenues
--Net earned premiums
--Net investment income
--Net realized gains (losses) on investments
--Other income
Total Losses and Expenses
--Net losses and loss adjustment expenses
--Underwriting, operating and related expenses
--Interest expenses
Income before income taxes

Income Statement of Company A

Items	2003	2004	2005	2006
Total Revenues	**205,319.00**	**252,982.00**	**523,102.00**	**612,437.00**
--Net earned premiums	180,166.00	230,140.00	475,430.00	546,469.00
--Net investment income	19,395.00	20,165.00	47,118.00	66,538.00
--Net realized gains (losses) on investments	5,758.00	2,677.00	554.00	-570.00
--Other income	0.00	0.00	0.00	0.00
Total Losses and Expenses	**171,815.00**	**220,663.00**	**456,489.00**	**505,949.00**
--Net losses and loss adjustment expenses	123,684.00	133,838.00	288,124.00	304,355.00
--Underwriting, operating and related expenses	46,481.00	81,302.00	158,930.00	190,201.00
--Interest expenses	1,650.00	5,523.00	9,435.00	11,393.00
Income before income taxes	**33,504.00**	**32,319.00**	**66,613.00**	**106,488.00**

Income Statement of Company B

Items	2003	2004	2005	2006
Total Revenues	**591,794.00**	**636,440.00**	**671,457.00**	**680,712.00**
--Net earned premiums	540,248.00	592,292.00	622,831.00	624,933.00
--Net investment income	26,086.00	27,259.00	31,573.00	40,293.00
--Net realized gains (losses) on investments	10,051.00	1,274.00	305.00	358.00
--Other income	15,409.00	15,615.00	16,748.00	15,128.00
Total Losses and Expenses	**552,251.00**	**570,808.00**	**533,210.00**	**516,212.00**
--Net losses and loss adjustment expenses	420,969.00	425,061.00	385,593.00	353,906.00
--Underwriting, operating and related expenses	130,636.00	145,075.00	146,669.00	162,220.00
--Interest expenses	646.00	672.00	948.00	86.00
Income before income taxes	**39,543.00**	**65,632.00**	**138,247.00**	**164,500.00**

Income Statement of Company C

Items	2003	2004	2005	2006
Total Revenues	**573,285.00**	**608,125.00**	**619,605.00**	**635,600.00**
--Net earned premiums	464,595.00	492,291.00	495,516.00	503,122.00
--Net investment income	108,540.00	111,474.00	118,847.00	121,981.00
--Net realized gains (losses) on investments	-1,691.00	4,060.00	4,540.00	9,965.00
--Other income	1,841.00	300.00	702.00	532.00
Total Losses and Expenses	**493,387.00**	**493,316.00**	**613,049.00**	**510,108.00**
--Net losses and loss adjustment expenses	288,718.00	272,882.00	392,228.00	292,789.00
--Underwriting, operating and related expenses	148,210.00	164,048.00	166,094.00	168,160.00
--Interest expenses	56,459.00	56,386.00	54,727.00	49,159.00
Income before income taxes	**79,898.00**	**114,809.00**	**6,556.00**	**125,492.00**

Figure 7: Low-Visualization/High-Interactivity Condition

Income Statement of Company A

Items	2003	2004	2005	2006
Total Revenues	**205,319.00**	**252,982.00**	**523,102.00**	**612,437.00**
--Net earned premiums	180,166.00	230,140.00	475,430.00	546,469.00
--Net investment income	19,395.00	20,165.00	47,118.00	66,538.00
--Net realized gains (losses) on investments	5,758.00	2,677.00	554.00	-570.00
--Other income	0.00	0.00	0.00	0.00
Total Losses and Expenses	**171,815.00**	**220,663.00**	**456,489.00**	**505,949.00**
--Net losses and loss adjustment expenses	123,684.00	133,838.00	288,124.00	304,355.00
--Underwriting, operating and related expenses	46,481.00	81,302.00	158,930.00	190,201.00
--Interest expenses	1,650.00	5,523.00	9,435.00	11,393.00
Income before income taxes	**33,504.00**	**32,319.00**	**66,613.00**	**106,488.00**

Income Statement of Company B

Items	2003	2004	2005	2006
Total Revenues	**591,794.00**	**636,440.00**	**671,457.00**	**680,712.00**
--Net earned premiums	540,248.00	592,292.00	622,831.00	624,933.00
--Net investment income	26,086.00	27,259.00	31,573.00	40,293.00
--Net realized gains (losses) on investments	10,051.00	1,274.00	305.00	358.00
--Other income	15,409.00	15,615.00	16,748.00	15,128.00
Total Losses and Expenses	**552,251.00**	**570,808.00**	**533,210.00**	**516,212.00**
--Net losses and loss adjustment expenses	420,969.00	425,061.00	385,593.00	353,906.00
--Underwriting, operating and related expenses	130,636.00	145,075.00	146,669.00	162,220.00
--Interest expenses	646.00	672.00	948.00	86.00
Income before income taxes	**39,543.00**	**65,632.00**	**138,247.00**	**164,500.00**

Income Statement of Company C

Items	2003	2004	2005	2006
Total Revenues	**573,285.00**	**608,125.00**	**619,605.00**	**635,600.00**
--Net earned premiums	464,595.00	492,291.00	495,516.00	503,122.00
--Net investment income	108,540.00	111,474.00	118,847.00	121,981.00
--Net realized gains (losses) on investments	-1,691.00	4,060.00	4,540.00	9,965.00
--Other income	1,841.00	300.00	702.00	532.00
Total Losses and Expenses	**493,387.00**	**493,316.00**	**613,049.00**	**510,108.00**
--Net losses and loss adjustment expenses	288,718.00	272,882.00	392,228.00	292,789.00
--Underwriting, operating and related expenses	148,210.00	164,048.00	166,094.00	168,160.00
--Interest expenses	56,459.00	56,386.00	54,727.00	49,159.00
Income before income taxes	**79,898.00**	**114,809.00**	**6,556.00**	**125,492.00**

Figure 8: Low-Visualization/Low-Interactivity Condition

APPENDIX B: EXPERIMENT TASK

Assume that you are in the beginning of 2007 and would like to invest part of your money in the stock market. As with any investment, you want to look at the long-term possibilities to increase the overall value of the investment. Further assume, after extensive analysis, that you have narrowed your choice to three companies from insurance industry (Companies A, B, and C). You need to analyze the three companies' financial performance to make the final decision.

A web analysis tool with the three companies' most recent audited financial statements is provided to help you make your decision about investing in a company, please click on the hyperlink to open the analysis tool. Then arrange the two windows appropriately so that you can see both the tool and the questions. The following questions may help you make the final decision.

Please answer the questions based on your analysis of three companies' financial information ONLY using the tool provided. Please DO NOT calculate by hand or use other decision aid such as calculator, EXCEL.

1. How much was company B's Other income in 2005?

2. How much was the LOWEST Total Losses and Expenses across all three companies during the 2003–2006 period?

3. How much was the HIGHEST Income before income taxes across all three companies during the 2003–2006 period?

4. How much was the HIGHEST Net earned premiums across all three companies during the 2003–2006 period?

5. Which company had the SMALLEST absolute difference between its highest and second highest Net realized gains (losses) on investments during the 2003–2006 period?

6. Which company had the LARGEST difference between its HIGHEST and LOWEST annual rate of change of Income before income taxes from any one year to the next year?

   Annual rate of change of Income before income taxes is calculated as:

$$\frac{\text{Income before income taxes in current year} - \text{Income before income taxes in previous year}}{\text{Income before income taxes in previous year}}$$

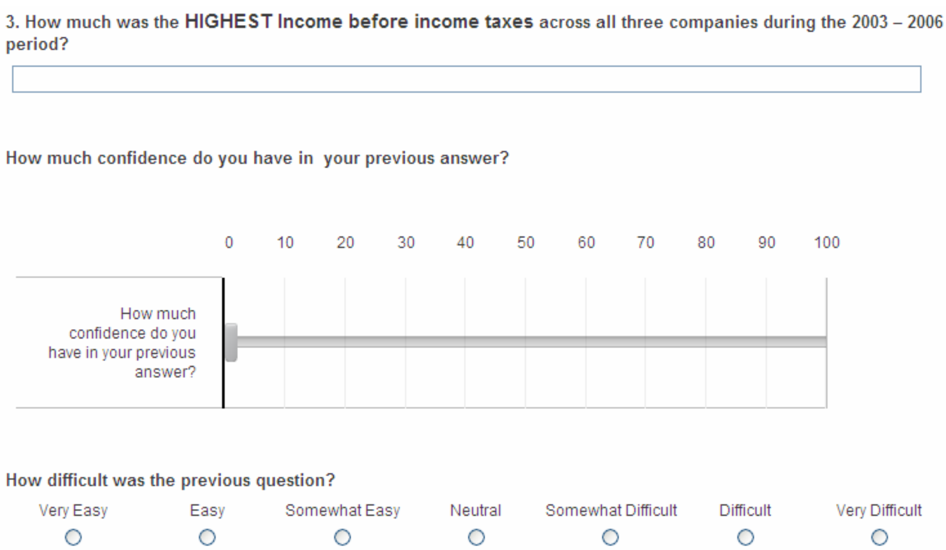
7. Please rank the three companies' annual growth rate of Total Losses and Expenses in 2005 compared to 2004.

   Annual growth rate of Total Losses and Expenses in 2005 is calculated as:

$$\frac{\text{TotalLossesandExpenses2005} - \text{TotalLossesandExpenses2004}}{\text{TotalLossesandExpenses2004}}$$

8. What would you PREDICT the rank of the three companies' annual growth rate of Income before income taxes in 2007 compared to 2006?

An example of accuracy and confidence measures for these questions is shown below in Figure 9.


3. How much was the **HIGHEST Income before income taxes** across all three companies during the 2003 – 2006 period?

How much confidence do you have in your previous answer?

0 10 20 30 40 50 60 70 80 90 100

How much confidence do you have in your previous answer?

How difficult was the previous question?

Very Easy | Easy | Somewhat Easy | Neutral | Somewhat Difficult | Difficult | Very Difficult