

Evidentiary Triangulation in an Electronic Audit Workpaper Environment

Abstract

In this study we examine how well auditors triangulate audit evidence in an electronic workpaper environment. Evidentiary triangulation is an audit evidence evaluation technique argued to help auditors face the challenges of the contemporary audit and, in particular, more appropriately assess the risk of financial statement fraud. We note that the way in which electronic workpapers are linked might assist auditors in dealing with the cognitive challenges of evidentiary triangulation, and investigate triangulation performance across audit experience and different linking structures. We find that inexperienced auditors (seniors) have difficulty in successfully triangulating audit evidence and different workpaper linking structures do not overcome these difficulties. Experienced auditors (managers) are more successful in triangulating audit evidence and their performance is superior when workpapers are linked by way of a hyperlinked index rather than by way of cross referencing hyperlinks embedded in the workpapers. Our results have implications for audit firms both in terms of the ability of their auditors to triangulate audit evidence and the way in which they should structure their electronic presentation of workpapers.

Key words: Audit Evidentiary Triangulation; Electronic Workpapers; Strategic Systems Auditing.

JEL Classification: M42

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1. Introduction

The challenges faced by the contemporary financial statement auditor are considerable (see Solomon, 2008). The environment within which corporations operate is increasingly complex and the incentives for management to perpetrate financial statement fraud are increasingly salient (Peecher *et al.*, 2007). Moreover, the techniques management use to perpetrate and then conceal financial statement fraud are increasing in their sophistication. There seems to be no end to the list of audit failures with Enron, Worldcom, Parmalat, HIH Insurance and Satyam notable examples with global ramifications. Furthermore, the ongoing global economic crisis provides even greater incentives for management to meet increasingly difficult financial and other performance targets through manipulative and fraudulent means. The heightened scrutiny and elevated standards with which the work of auditors are assessed and evaluated are likely to be enduring characteristics of the contemporary audit environment.

With the benefit of hindsight, audit failures have been attributed, at least in part, to the fact that auditors have not concurrently considered evidence from sources differing in their specificity and source (Erickson *et al.*, 2000; Peecher *et al.*, 2007). It has been argued that a consideration of multiple sources of evidence would have revealed inconsistencies which, with further investigation, would have allowed the auditor to identify reported results *too good to be true*, and uncover concealed financial statement frauds (Erickson *et al.*, 2000; Bell *et al.*, 2005).

Bell, *et al.* (2005) significantly expanded on the process of simultaneously considering evidence from multiple sources and introduced a process of *evidentiary triangulation* (hereafter referred to as triangulation). Triangulation is a strategy of obtaining audit evidence from multiple sources using multiple approaches in formulating and revising well-justified beliefs through which the auditor forms their professional judgment. Bell *et al.* (2005) advance thought on evidence evaluation by specifying the three types of evidence that must be simultaneously triangulated. “Triangulation occurs when the auditor understands the degree to which the same audit conclusion is supported by

evidence of and from all three fundamental sources: [Entity Business States (EBS), Management Information Intermediaries (MII), and Management Business Representations (MBR)]” (Bell *et al.*, 2005, p.27). “EBS are the business strategies, conditions, and processes and economic actions/events and relationships with other entities that pertain to the audited entity and its economic web. MII are transforming information intermediaries such as applicable financial reporting and internal control frameworks (including oversight by corporate governors), computer networks and information systems, documentation (e.g., invoices), as well as people and policies. MBR are management’s representations of selected EBS within accounting journals or ledgers, conference calls, financial statements (including footnotes), interviews, MD&A, presentations and press releases” (Bell *et al.*, 2005, p.4).

Triangulation is argued to amplify the informativeness of audit evidence and is particularly useful when the focus is on the detection of intentional misstatement (Peecher *et al.*, 2007). This is because most EBS are not easily subjected to management manipulation. Triangulation not only makes the identification of intentional misstatements more likely, it discourages management from engaging in fraudulent activity in the first place (Bell *et al.*, 2005). Triangulation therefore represents a significant advancement in audit thought, providing an avenue through which auditors may face the challenges of contemporary auditing.

While the merits of evidence triangulation are hard to deny, the complexity of simultaneously considering the relationship between, and implications of, several sources of audit evidence places considerably greater demands on the cognitive activities of the auditor. These evidence items are likely to be scattered through the workpaper file. Auditors must, therefore, maintain an accurate memory of the evidence items from the different sources or be prepared to revisit workpapers for which they have inaccurate memories. Individuals, however, have only a limited ability to acquire and integrate information, relying instead on simplifying decision heuristics (Newel and Simon, 1972). More specifically, auditors have been shown to be at least as confident in their incomplete and inaccurate memories of audit evidence as they are in their accurate memories (Moeckel and

Plumlee, 1989), and efficiency concerns often result in auditors relying on memory rather than revisiting workpapers (Libby and Trotman, 1993).

Highlighting the difficulties of successfully triangulating audit evidence, Trotman and Wright (2009) found that fraud risk assessments were no higher when the EBS was inconsistent, as compared to consistent, with the MBR and MII. Successful triangulation would have been revealed in higher fraud risk assessments when the EBS was inconsistent with the MBR and MII, and the fact that this was not the case casts some doubt over the ability of auditors to perform such a cognitively demanding task. Elements of the contemporary audit environment may, however, assist auditors triangulate evidence.

A characteristic of the way in which contemporary auditors go about their work is the increasing use of technology facilitating a wide range of audit functions (Dowling and Leech, 2007). One area in which technology has been embraced is the preparation, presentation, review, and storage of audit workpapers in electronic form. The presentation of workpapers in electronic form and, in particular, the way in which they are hyperlinked, may facilitate the triangulation process. It is the relationship between different forms of electronic workpaper hyperlinking and triangulation performance that is the focus of this study. We do not set out to test or draw conclusions as to the merits of an electronic workpaper environment over a traditional paper based environment. Rather, we acknowledge the proliferation of electronic workpaper environments (Zarowin, 2006; Kepczyk, 2007) and examine how such an environment may facilitate triangulation performance.¹

In this study, we investigate two types of hyperlinking; indexed hyperlinks and embedded hyperlinks. We select these two types of hyperlinking on the basis that they are already being adopted by accounting firms in various forms, reflect electronic equivalents of traditional paper based environments, can be easily implemented by firms not presently applying these practices,

¹ In our study, auditors, on average, indicated that 65.94% of workpapers they reviewed were in an electronic format.

and, most importantly, because our theory suggests that these two types of hyperlinking will be more or less effective in facilitating triangulation depending on those who are using them.

Indexed hyperlinking involves listing each workpaper on the side of the screen in the form of a list of hyperlinks. By clicking on a hyperlink, the linked workpaper opens on the other side of the screen. This is similar to the hyperlinks investigated by Hodge (2001). There are no hyperlinks embedded in the workpapers themselves. Indexed hyperlinking can be seen as the electronic equivalent of a paper based filing system with the hyperlinked index mirroring tab markers in a traditional paper based workpaper file.

Embedded hyperlinks are placed within the content of the workpaper. The related workpaper link is placed adjacent to the information to which it relates. This is similar to the hyperlinks studied by Bible *et al.* (2005) and is normally adapted to replace the traditional workpaper cross references seen in paper based formats. Normally, the hyperlinks are reciprocal, that is, if there is a hyperlink on workpaper A to access workpaper B, there is also a hyperlink on workpaper B to access workpaper A.

Our results based on responses from audit managers and seniors reveal that triangulation performance does vary across hyperlinking formats and experience. Triangulation effectiveness was superior in an environment where workpapers were linked with an index and inferior in an environment with links embedded in the workpapers. Where both index and embedded links were provided, the results suggest that only experienced auditors are able to identify the elements of the combined hyperlinked structure that facilitate performance while avoiding those elements that inhibit performance. These results support the use of an indexed hyperlink structure, and avoidance of embedded hyperlinks, where triangulation is being encouraged.

Our paper makes a number of contributions to the literature. It is one of only a very limited number of papers to empirically test the emerging audit technique of triangulation. Indeed Trotman and Wright (2009) is the only other paper that we are aware of to investigate this audit technique. While triangulation has been suggested as a means by which auditors may form better justified

beliefs and risk assessments (Bell *et al.*, 2005), the limited research that has been undertaken to date highlights the difficulties auditors face in applying this technique. We investigate environmental circumstances that have the potential to facilitate and/or inhibit triangulation performance. Second, the study recognizes the widespread use of electronic workpapers and examines the circumstances when the use of this technology enhances and inhibits audit effectiveness. In doing so, it guides audit firms in their design and implementation of electronic workpaper technology. Third, although we do not focus directly on management fraud, choosing instead to examine a relationship between evidence triangulation and non-error explanations, our study, by examining the process of evidence triangulation also contributes to an understanding of how auditors may increase the likelihood of identifying management fraud should it exist. In doing so, it answers Peecher *et al.*'s (2007) call for "...empirical research to demonstrate more precisely the conditions under which EBS based evidence can help the auditor better detect material misstatements, especially such misstatements that stem from material fraud"(p.483).

The remainder of our paper is organized as follows. The following section reviews the relevant literature and develops the hypotheses to be tested. Thereafter, the study's methodology and results are discussed. This is then followed by the conclusions, limitations, and opportunities for future research.

2. Theoretical Development and Hypotheses

Two aspects of a hyperlinked electronic workpaper environment are argued to improve triangulation effectiveness; the proximity of related information, and unconstrained searching. We discuss each of these in turn followed by a discussion of the boundary conditions within which these benefits are argued to be realized.

2.1 Information Proximity

Prior research in psychology and accounting has shown that proximity of encounter facilitates the identification of the meaningful relationships that exist between separate pieces of information

(Larkin and Simon, 1987; Moeckel, 1991). For example, Moeckel (1991) provides evidence that proximity of encounter improves reviewers' identification of inconsistent evidence received piecemeal from different workpapers. This is because information integration can only occur if two or more pieces of information with implications for one another, either from workpapers or partly from workpapers and partly from the auditor's memory, are activated simultaneously (i.e., co activated) in the auditor's working memory (Moeckel, 1991; Waller and Felix, 1984). This is consistent with the proximity compatibility principle which espouses physical proximity of data if the task demands its integration (Wickens and Todd, 1990; Wickens, 1992; Wickens *et al.*, 1994).

Hyperlinked workpapers shorten the distance between different workpapers and significantly reduce the time required to move from one workpaper to the other. It therefore has the potential to enhance the proximity of encounter and information integration. In this regard, Hodge (2001) found that when evaluating information in a hyperlinked environment, investors blend the documents together and perceive them as originating from one comprehensive source.² Similarly, Hodge *et al.*, (2004) found that technology (i.e., XBRL search functions in an electronic environment) that reduces the distance between related information and signals that information items are related and should be simultaneously considered (also characteristics of a hyperlinked environment) can improve investor judgments.

2.2 Search Constraints

Hyperlinking also reduces the extent to which an auditor's search of the audit workpapers is constrained. In a traditional paper based environment, difficulties associated with moving between workpapers encourages a sequential search while constraining other search strategies. Hyperlinking promotes non linear (i.e., non sequential) processing of information (e.g., Spiro and Jehng, 1990). It also facilitates decision maker driven search strategies (Mills *et al.*, 2002).

Hoffman *et al.*, (2003) show that superior performance can be achieved when the auditor is unconstrained in their search. An unconstrained search also allows for a goal oriented and directed

² Interestingly, this consequence of the hyperlinked environment was detrimental to the task studied by Hodge (2001). In Hodge's study, individual documents viewed via hyperlinks (i.e., audited and unaudited documents) lost their distinctiveness and financial statement users were less able to distinguish audited from unaudited information.

search which has been shown to be more effective than a sequential search (e.g., Barrick and Spilker, 2003; Hunton and McEwen, 1997) and minimizes exposure to irrelevant information that can inappropriately influence judgments (Shelton, 1999).

The ability to guide the order with which information is received can also allow for presentation format to match an auditor's mental representation of the problem solving task and/or knowledge structure. The basic tenet of cognitive fit theory (Vessey, 1991) is that the problem representation (i.e., the format in which the information is presented) should match the problem solving task (i.e., what the decision maker is trying to accomplish) in order for optimal decision making to take place. In accounting contexts, the presentation of information and its relationship to goal and knowledge structure of the decision maker has been shown to affect performance (e.g., O'Donnell and Schultz, 2003; Ricchiute, 1992; Wright and Berger, 2006). Different auditors with different mental models and different triangulation goals will have different problem solving task requirements. Hyperlinked electronic workpapers facilitate the self directed search for information thereby facilitating each auditor's unique triangulation needs.

2.3 Boundary Conditions

While we argue that hyperlinking can beneficially impact triangulation performance, there are boundaries to this benefit. In particular, hyperlinking can create navigation problems that encourage auditors to employ a search strategy inconsistent with their optimal approach to the problem, increasing the likelihood of cognitive overload.

Inexperience is argued to limit the extent to which hyperlinking facilitates triangulation. Less experienced auditors do not have well developed knowledge structures to guide their evaluation of audit evidence and are more data driven in their processing (e.g., Waller and Felix, 1984). "Experience is necessary for localization to result in attention direction. If the required information is localized to one place within a representation but the user does not have the experience to recognize the localization, the user's attention will not be directed to that part of the presentation" (Dunn and Grabski, 2001).

This suggests that inexperienced auditors without adequate task relevant knowledge may not be able to apply hyperlinking effectively. In a review of the literature on expert/novice differences in hypertext navigation, Chen *et al.*, (2006) conclude that experts perform better than novices due to superior, knowledge guided, navigation and lower levels of disorientation. This leads us to expect that even though hyperlinking facilitates navigation, inexperienced auditors lack of a well-developed knowledge structure and evidence processing strategy may hinder their ability to take advantage of hyperlinked workpapers. Supporting these expectations, Rosman *et al.*, (2007) found that those who successfully identified seeded workpaper errors in an electronic environment navigated less but processed more. That is, they examined fewer items of evidence but subjected that reduced evidence set to more processing. This is consistent with the understanding that successful use of a hyperlinked environment requires a clear understanding of what information is important, and where that information is, in order to avoid the cognitive overload often associated with electronic environments.

In addition to an immature knowledge structure limiting an inexperienced auditor's ability to benefit from directing their search, researchers in domains other than accounting have commented and demonstrated that users often become disoriented when navigating in a hyperlinked environment (e.g., Hill and Hannafin, 1997; McDonald and Stevenson, 1996). Users have only limited information processing capacity (Kahneman, 1973) and any capacity that must be devoted to navigation and/or orientation will limit the cognitive capacity that can be devoted to the task at hand. In addition to the incremental cognitive demands associated with a hyperlinked environment, other detrimental impacts on performance include users following an interesting thread and losing sight of their original goals, forgetting to return from a previous digression, or forgetting to follow an interesting path that they had earlier planned to follow (e.g., Foss, 1989). These navigation and orientation issues are collectively referred to as the "lost in hyperspace" phenomenon.³ Indeed,

³ The literature distinguishes between two types of disorientation; "context in the large" and "context in the small" (e.g., Nielsen, 1990). Context in the large is concerned with disorientation within the entire portfolio of hyperlinked documents. Context in the small is concerned with disorientation within a single large document that, for example, is so large that it cannot fit on a single screen and the user must scroll around the document. Given the focus of this study on

Bedard *et al.*, (2007) report that one of the main reasons for ‘working around’ an electronic environment (e.g., printing hard copies of the electronic documents) arise from auditors attempting to deal with the difficulties associated with the electronic workpaper environment in the early stages of its implementation.

In an auditing context, both Bible *et al.* (2005) and Bedard *et al.* (2006) suggest that navigational problems impede auditors’ performance in hyperlinked electronic workpapers. Bedard *et al.* (2006) survey data reveals that auditors have difficulties in navigating around electronic workpapers. Bible *et al.*’s (2005) results suggest that navigation problems in electronic workpaper systems contribute towards reviewers identifying fewer seeded errors in electronic workpaper systems than in traditional paper-based workpaper systems.

We argue that these boundary conditions interact with hyperlinking structure and experience to influence triangulation performance. We formally state our hypotheses in the following section.

2.4 Hypotheses

We anticipate that more experienced auditors (i.e., managers), compared to less experienced auditors (i.e., seniors), will exhibit more effective triangulation performance, independent of the type of hyperlinking. However, within experience levels, certain types of hyperlinking structures are likely to be more effective than others, and that the effectiveness of each type of hyperlinking structures will not be the same across different levels of experience.

For inexperienced auditors, we argue that triangulation performance will be superior for indexed hyperlinks decreasing with embedded hyperlinking and then combination indexed and embedded hyperlinking. Inexperienced auditors do not have the task specific experience or knowledge structure to be able to effectively self direct their search for information. Their search and processing of information will be most effective if evidence is evaluated sequentially. Indexed hyperlinks facilitate, and may even encourage, a sequential search, thereby directing inexperienced auditors towards their most effective strategy.

hyperlinking, we focus on context in the large while controlling for context in the small by ensuring that all documents fit comfortably on the screen.

While embedded hyperlinks have the potential to improve triangulation performance by enhancing the proximity with which related information is encountered and allowing a more decision maker directed search, inexperienced auditors are argued to be unable to realize these benefits. Inexperienced auditors do not have the knowledge structures and experience to know which links to follow. They will be directed away from their optimal sequential search and are likely to suffer cognitive overload and disorientation as they follow too many of the available links. In short, inexperienced auditors do not have the knowledge structures to take advantage of the benefits embedded hyperlinks have to offer or to avoid the deleterious consequences of information overload and disorientation.

The combination of indexed and embedded hyperlinks may allow inexperienced auditors to be directed in their sequential search (using the index) while at the same time allowing for the benefits of embedded hyperlinks to be realized. We argue, however, that this will lead to a further deterioration in triangulation performance. Inexperienced auditors do not have enough self insight of their own abilities and are unable to select the most appropriate approach to the task. Rather than effectively supplementing indexed hyperlinks, we argue that the addition of embedded hyperlinks will increase cognitive load and disorientation. This increased cognitive load and disorientation will result in a further deterioration in triangulation effectiveness.

We therefore test the following hypothesis:

H1: For inexperienced auditors, triangulation performance decreases in the order of indexed hyperlinks, embedded hyperlinks, and combination indexed and embedded hyperlinks.

For experienced auditors, we expect superior triangulation performance to be exhibited when both indexed and embedded hyperlinks are presented in combination, decreasing with embedded hyperlinks and then indexed hyperlinks.

Indexed hyperlinks constrain an experienced auditor's search of the evidence by requiring them to follow a predominately sequential approach. This not only reduces the proximity with which

related evidence items are encountered, it also limits the extent to which experienced auditors can benefit from their more developed knowledge structures and their ability to direct their search.

Embedded hyperlinks allow auditors to follow useful links and improve the proximity of encounter. They facilitate co-activation, help experienced auditors use their more extensive knowledge and superior knowledge structures to appreciate the importance of the relationship between evidence items, build more effective mental pictures of the organization, and identify any inconsistencies in the evidence. The benefits are, however, limited by the fact that the embedded hyperlinks, consistent with cross referencing practice, support, confirm, and provide more information for the evidence or conclusion noted in the original workpaper. While the embedded hyperlinking might allow experienced auditors to build and better understand a mental picture of the organization so that inconsistent evidence, when encountered, is more salient, the embedded hyperlinking will not provide direct links to the inconsistent evidence or information. The auditor will still need to maintain an accurate memory of inconsistent evidence that was or will be encountered separate from the hyperlinked evidence and/or manually return to this evidence in order to confirm its contents. Navigating back to the original workpaper will require the auditor to scroll through each page of the workpapers. In such a situation, co-activation is less likely as proximity is reduced. Additionally, the effort required to return to previously encountered workpapers means auditors will be less likely to return to original workpapers, choosing instead to rely on their potentially inaccurate memories.

We argue that the most benefit from embedded hyperlinks will be realized when they are provided in conjunction with index hyperlinking. In such a situation, not only can an experienced auditor build a superior understanding of the client and more easily identify inconsistent evidence, proximity of encounter with the inconsistent evidence is facilitated by the hyperlinked index. The hyperlinked index allows the auditor to quickly move to anywhere in the workpaper file, even if a link is not embedded in the original workpaper. Also, the ease with which workpapers can be

accessed means that auditors are more likely to confirm their potentially inaccurate and incomplete memory of evidence encountered in the previous workpapers.

Accordingly, we test the following hypothesis:

- H2: For experienced auditors, triangulation performance decreases in the order of combination indexed and embedded hyperlinks, embedded hyperlinks, and the indexed hyperlinks.

The relationships proposed in hypotheses 1 and 2 are reflected in Figure 1

Insert Figure 1 about here

3. Methodology

3.1 Experimental Design and Participants

The hypotheses were examined with a 3 (hyperlinking condition) x 2 (experience) design with both variables manipulated between subjects. Hyperlinking was manipulated across three levels (indexed hyperlinking, embedded hyperlinking, combination indexed and embedded hyperlinking). Experience was manipulated across two levels (senior and manager).

Participants were managers and seniors drawn from the Hong Kong offices of international (big-4 and second tier) audit practices. In total 36 managers and 72 seniors participated in the study. Data from each participant was collected individually and required approximately one hour of time. Each participant was provided with a \$50 Hong Kong Dollar store voucher and a 1 in 60 chance of winning a \$5,000 Hong Kong Dollar store gift voucher. Demographic data is reported in the results section.

3.2 Context

The hypotheses were investigated within the context of a planning analytical procedures task. The simultaneous consideration of multiple pieces of evidence in terms of their implications for the financial information presented for audit makes planning analytical procedures a task that can significantly benefit from effective evidence triangulation. Should an actual explanation for unusual fluctuations in financial ratios not be identified as a possibility at this planning stage, the audit effectiveness and efficiency implications can be severe.

3.3 Case Materials

An original research case involving a hypothetical listed manufacturer of headsets (e.g., music headphones) was constructed. The focus of the case was a preliminary analytical review of the company's unaudited income statement, revealing a significant fall in the gross profit margin for the year ended 31 December 2007.⁴ Gross profit margin fell from 23.07% in 2006 to 17.82% in 2007. Participants were required to review the audit evidence (presented as electronic workpapers) with a view to identifying or discounting potential explanations for this fall.

The background information (which was not part of the programmed materials) included a narrative description of the client (type of business, industry, location, reporting currency, management structure, mission statement, state of economy, customers, suppliers, and alliances), a discussion of the company's critical success factors, and a summary of the audit planning meeting which provided further context within which the case was situated. This information was neutral with regard to any potential explanation for the fall in gross profit margin.

In this study, we limit ourselves to non error explanations for the fall in gross profit margin. Previous experience and encounters with error and fraud would not have been consistent across our sample of auditors and would have interacted with the variables of interest in this study. To minimize the possibility that fraud and error would be perceived as accounting for the fall in the gross profit margin, the background information included statements that the internal auditors had carried out a comprehensive audit of the company's internal control system and no major control weaknesses were found. In addition, the background information noted that the key members of the company's management team were headset industry experts and were well respected in the headset industry. There was also no information suggesting that the company was under pressure to perform.

The benefit of triangulation is argued to derive from the consideration of EBS (which is less susceptible to management manipulation) in addition to MII and MBR (Bell *et al.*, 2005; Peecher *et*

⁴ A fall, as opposed to an increase, in the gross profit margin was selected so as to minimize the perceived likelihood that a management fraud accounted for the change.

al., 2007). With this in mind, two evidence sets each consisting of an item of MII, MBR, and EBS evidence were constructed such that each item of evidence was uniquely diagnostic to the specific explanation for the fall in gross profit margin, and the MII and MBR evidence differed from the EBS evidence in that one supported and the other contradicted the potential explanation. In this way, the benefit of triangulating contradictory EBS evidence with MII and MBR evidence is clear. The two potential explanations for the fall in the gross profit margin were ‘a decrease in selling price of individual product(s)’ and ‘an increase in production costs’.⁵ The MII, MBR and EBS evidence items for each of these two explanations are reported in Table 1.

Insert Table 1 About Here

With the assistance of audit firm practitioners, we then created extra working papers being careful not to suggest any error or non error explanation for the fall in the gross profit margin. In total, our final materials consisted of 31 workpapers. Prior to programming into an electronic environment, we extensively pilot tested the materials with a view to ensuring that only two possible explanations for the fall in the gross profit margin were suggested by the workpapers and the seeded MII, MBR and EBS evidence items had the intended implications for the two possible non error explanations.

3.4 The Hyperlinked Electronic Working Environment

Following from the fact that we drew participants from several big-4 and second tier international accounting firms, a generic set of hyperlinked materials was developed. Although firm specific practices were reviewed as part of the process leading to the development of the experimental materials, no one firm’s hyperlinking format was overly represented.

The workpapers discussed in the previous section were first formatted in working paper style and then cross referenced in accordance with standard practice.⁶ These cross references were checked by auditors from different firms with a view to ensuring that they reflected current practice.

⁵ We also considered (and constructed evidence sets) for other non-error explanations (e.g., exchange rate fluctuations). It was, however, difficult to generate evidence sets that met the criteria specified above.

⁶ The cross references support and/or provide additional information on conclusions, assertions, calculations, etc., that are contained in the workpapers.

The workpapers each contained a unique piece of information (either background information or one of the evidence items). The 31 workpapers were structured around a generic, yet understandable, index. In order that proximity was not facilitated by a sequential search, the EBS, MII and MBR evidence relating to each of the two potential explanations was positioned in such a way that they were not adjacent in the index. The workpapers were then converted into html format and uploaded onto an intranet for online viewing. The online presentation of the workpapers was designed and programmed in such a way that the workpaper index was presented on the left 20% of the computer screen and is always visible while the workpapers occupied the remaining 80% of the screen. The workpapers could be viewed on a single screen without the need to scroll up, down, or to the side.

In the indexed hyperlinked workpapers, participants were able to 'click' on any workpaper shown in the index at any time, with the selected workpaper immediately appearing on the right hand side of the screen. 'Next' and 'Previous' buttons were also presented at the bottom of the screen so as to allow participants to move to the next or previous workpaper in the index (with reference to the workpaper presently displayed). The workpapers included the cross referencing, but participants were not be able to access the cross referenced workpaper by clicking on that reference. That is, the cross reference was not hyperlinked.

The embedded hyperlinked workpapers were exactly the same as the indexed hyperlinked workpapers except for the fact that the index was not hyperlinked (although it remained visible) and the cross references in the workpapers were hyperlinked. In the combined condition, both the index and the workpaper cross references were hyperlinked.

A finish button was constantly available on the bottom left hand side of the screen which brought the review task to an end following confirmation that the participant had, indeed, finished the review to their satisfaction.

3.5 Measures of Triangulation Effectiveness

Triangulation is a means by which auditors may identify inconsistencies in the evidence. Rather than confirming beliefs, it is a technique that is more likely to raise questions that need to be resolved before well justified beliefs are settled on. Once triangulation has identified an issue, other audit techniques can be used to resolve the issue. Accordingly, to look at the success with which triangulation is applied in forming audit conclusions, we examined assessments relating to the amount of evidence consistent / inconsistent with each of the two potential non error explanations. Given that there was both confirming and disconfirming evidence relating to each of the two explanations, effective triangulation would result in a more balanced representation of the confirming and disconfirming evidence. Poor triangulation would result in a failure to identify and or integrate opposing evidence with more definitive and extreme assessments as to the balance of evidence. In such a situation, auditors may come to premature (and potentially incorrect) conclusions with deleterious effectiveness and efficiency considerations. Indeed, Peecher *et al.* (2007) highlight that one variant of the skepticism that auditors should direct towards their judgments is to avoid a rapid move towards cognitive closure.

A less definitive response may, however, reflect successful triangulation or an overly conservative interpretation of the incomplete evidence. To distinguish successful triangulation from excessive conservatism we also asked about a third possible explanation for the fall in the gross profit margin for which there was no evidence supporting the explanation and indirect evidence disconfirming that explanation, that being, an inaccurate counting of year end inventory. Should participants be overly conservative, they would also provide less definitive responses to this question.

For each of the three potential explanations for the fall in the gross profit margin, participants were asked to indicate on an 11 point scale the percentage of evidence that was consistent / inconsistent with the explanation in question. Each point on the scale was labeled with two percentages such that the evidence consistent and evidence inconsistent had to equal 100%. The

endpoints were labeled 0% / 100% and 100% / 0% consistent and inconsistent with the explanation, respectively.

3.6 Administration

In order to ensure that the participants were familiar with the hyperlink structure employed in the study and the technology involved, a simple practice exercise relating to personal tax assessment terminology was provided. Brief instructions on how to navigate the practice exercise were given to the participants.

The participant was then provided with the initial instructions which explained that the audit related to a continuing audit client with no major problems / issues encountered in the preceding two years, highlighted that an unexpected reduction in gross profit margin had been identified in the current year, detailed the calculation of the reduction in gross profit margin, explained that evidence relating to the company in the preliminary planning stage has been collected and compiled in the planning working paper file, noted that the participant could assume that the information was competently prepared and did not contain any errors, and indicated that his/her task was to work through the materials as a reviewer.

After indicating that they understood the requirements of the study and had no further questions, they were asked to log into an intranet using a unique user name and password. Participants were taken to the first workpaper (A1000) which showed the calculations surrounding the fall in gross profit margin (same as that in the written instructions). While all participants were shown this workpaper first, they were then free to work through the materials as they wish from that point forward. When participants finished reviewing the planning file, they clicked the “finish” button to close the file.

Once participants had worked through the materials to their satisfaction, they were instructed to log out of the workpaper file and complete the questions that measured triangulation performance.

Participants were not able to print any documents in the electronic environment, but were provided with pens, paper and a calculator should there be a need for them to take notes and/or perform calculations while completing the task.

4. Results

Of the 108 participants who completed the materials, responses from five participants were not included in the analysis on account of the fact that they provided overly conservative responses to the test question on an incorrectly performed stocktake accounting for the fall in the gross profit margin.⁷ The remaining 103 usable responses comprised 34 managers with a mean experience of 84.53 months and 69 seniors with a mean experience of 49.29 months. Participants, on average, indicated that they spend 45.5% of audit time reviewing workpapers, of which, 66.32% were prepared in electronic format. Participants spent an average of 29.30 minutes reviewing the workpapers suggesting an effortful application to the task.⁸

In order to measure triangulation effectiveness, we analyzed responses relating to questions on the two potential explanations for the fall in the gross profit margin, that is, a decrease in the selling price of individual products in 2007 and an increase in production costs of individual products in 2007.⁹ Recall that responses further from the midpoint indicate more definitive interpretation of the evidence suggesting less successful evidence triangulation. The scale for each question was converted such that the midpoint was scored as five decreasing by one point for each observation away from the midpoint (in either direction) with extremes scored as zero. In this manner, the

⁷ Overly conservative responses were those at or one point either side of the midpoint. We also analysed our data excluding conservative responses defined in two other ways; only at the midpoint, and at the midpoint or two points either side of the midpoint. This analysis revealed consistent results although some significance levels were lower (but always $p < .10$). Similarly, including all participants revealed similar results.

⁸ Approximately 30 minutes in addition to the time spent reviewing the workpapers was required to complete the research materials.

⁹ The question on year end inventory stocktake was a control question and not subjected to further analysis beyond identifying those participants who provided overly conservative responses.

higher the score, the more successful is the triangulation.¹⁰ Descriptive statistics are reported in Table 2 and illustrated in Figure 2.

Insert Table 2 About Here

Insert Figure 2 About Here

A 3 x 2 ANOVA for each of the two questions reported in Table 3 revealed statistically significant differences in performance across experience and hyperlinking type for Question 1 (see Panel A) but not as anticipated in our hypothesis. Also of note is the fact that managers performed better than seniors in triangulating audit evidence although this result is driven mainly by the performance of managers when faced with an indexed hyperlinking structure. There were no statistically significant differences in performance across experience and hyperlinking type for Question 2 (see Panel B).¹¹

Insert Table 3 About Here

In order to test Hypothesis 1 which concerned inexperienced auditors, we compared the mean responses across each of the hyperlinking conditions for each of the two questions. This analysis revealed no significant effect for either Question 1 ($F=0.820$, $p=.445$) or Question 2 ($F=1.281$, $p=.285$). A similar analysis examining responses from experienced auditors who were the focus of Hypothesis 2 revealed a significant effect for Question 1 ($F=4.896$, $p=.014$) but not Question 2 ($F=.056$, $p=.945$). Post-hoc Tukey HSD tests at the .05 level revealed that managers performed better in the indexed hyperlinked condition than in the embedded hyperlinked condition.

These results are consistent with an understanding (at least with regard to Question 1) that audit seniors struggle to triangulate audit evidence and that while audit managers exhibit superior triangulation performance, this is derived from their superior ability to use indexed hyperlinks.

¹⁰ We also analyzed our data using a dichotomous dependent variable in a loglinear analysis. The 11 point scale was converted to a score demonstrating poor triangulation (the extreme three observations on either side of the midpoint) and a score indicating superior triangulation (the middle 5 observations). Analysis revealed results consistent with those using the continuous dependent variable.

¹¹ We also analysed our data in a 3 x 2 MANOVA concurrently examining responses to Questions 1 and 2. In such a test, the main effect for experience was not significant ($F=2.316$, $p=.104$). There was a marginally significant effect for hyperlinking type ($F=2.153$, $p=.076$) and the interaction ($F=2.022$, $p=.093$).

Their performance, and superiority over their less experienced senior colleagues, significantly deteriorates when workpapers are linked with embedded hyperlinks. The implications of this are discussed in the following section.

5. Discussion and Conclusion

Motivated by the potential for triangulation to improve audit quality, the difficulties that auditors may face in attempting to triangulate audit evidence, the proliferation of electronic workpaper environments, and the possibility that elements of these electronic environments may facilitate triangulation performance, this study examined whether the way in which electronic audit workpapers are hyperlinked can facilitate triangulation performance.

Although the analysis of our data revealed that different hyperlinking structures are associated with superior and inferior triangulation performance across experience levels, our results were not as anticipated. Contrary to that which was expected, triangulation performance was facilitated by the provision of indexed hyperlinks and inhibited with the provision of embedded hyperlinks. This result, however, held only for experienced auditors (i.e., managers). Inexperienced auditors (i.e., seniors) exhibited poor triangulation performance with no statistically significant differences in performance across hyperlinking conditions. In addition, these results held only in the situation where the EBS evidence supported the non-error explanation (with MBR and MII discounting the explanation). No statistically reliable differences were identified across experience or hyperlinking conditions when the EBS evidence discounted the non-error explanation (with MBR and MII supporting the explanation).

Auditors have been shown to overstate the accuracy and completeness of non-error explanations (e.g., Glover *et al.*, 2000). It may be that EBS evidence is more salient when it supports rather than discounts non-error explanations, and our results are consistent with this conjecture. As was the case in Trotman and Wright (2009), triangulation was least successful in the circumstance when it is argued to be of most benefit. That is, when the EBS, which is less subject to

management manipulation, casts doubt over the veracity of conclusions deriving from the traditional MBR and MII sources.

One potential explanation for our finding is the categorization of managers and seniors as experienced and inexperienced, respectively. Our results for managers were more consistent with our expectations for inexperienced auditors and our results for seniors are consistent with auditors having no or very little triangulation ability. As evidence triangulation is a relatively new audit technique, traditional understanding that managers and seniors are experienced and inexperienced, respectively, may not be appropriate. Peecher *et al.* (2007) note that systems thinking is unlikely to come naturally and a lack of education and training on systems thinking represents a threat to the successful application of strategic systems auditing (of which triangulation is an integral part). While we argued that elements of an electronic workpaper environment may facilitate triangulation performance. If auditors lack ability in this regard, they are unlikely to benefit from the facilitating aspects of such an environment. While auditors may be less likely to rely on their memory for evidence they consider important (Sprinkle and Tubbs, 1998), auditors must first recognize the importance of the evidence in order to benefit from being able to easily and quickly return to previously encountered workpapers.

An alternate, yet related, explanation for the ineffectiveness of embedded hyperlinks to facilitate the triangulation efforts of experienced auditors is that experienced auditors may have a predefined problem frame and information needs that lend themselves more to the structure of an index hyperlinked to the entire file rather than incomplete workpapers linking only to a smaller subset of the file. Results consistent with this have been revealed in the financial statement analysis literature, in that experienced investors prefer pdf documents with no hyperlinks over html documents with embedded hyperlinks (e.g., Hodge and Pronk, 2006). These conjectures await further research.

Before considering additional opportunities for future research, a number of limitations should be noted. We note that we have not directly measured the cognitive processes underlying

triangulation performance and recognize that our outcome measure of triangulation performance, namely how balanced responses were with regard to the amount of evidence supporting and discounting the proposed non-error explanations is a noisy measure and may reflect the outcome of cognitive processes in addition to triangulation. In addition, we focus on non-error explanations and are, as a result, unable to draw conclusions on the success of triangulation when management misrepresentation is suspected.

Our results highlight that evidence is less likely to be successfully triangulated by senior auditors and in situations where electronic workpapers are linked via embedded hyperlinks. Future research could usefully examine whether such results hold in situations where the likelihood of management fraud is in question. Given the significant use of electronic workpapers, future research could also usefully examine the underlying processes argued to be driving the facilitating effects of hyperlinked electronic workpapers. Such research will be important in confidently advising audit firms of the appropriate structure with which to link their electronic audit workpapers.

Figure 1
Expected Results

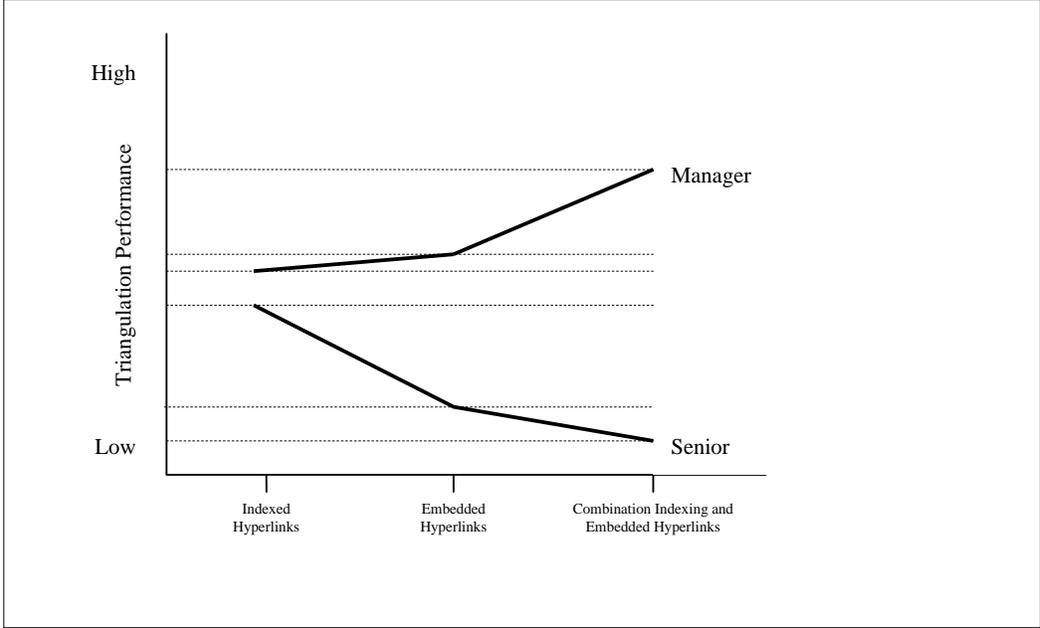
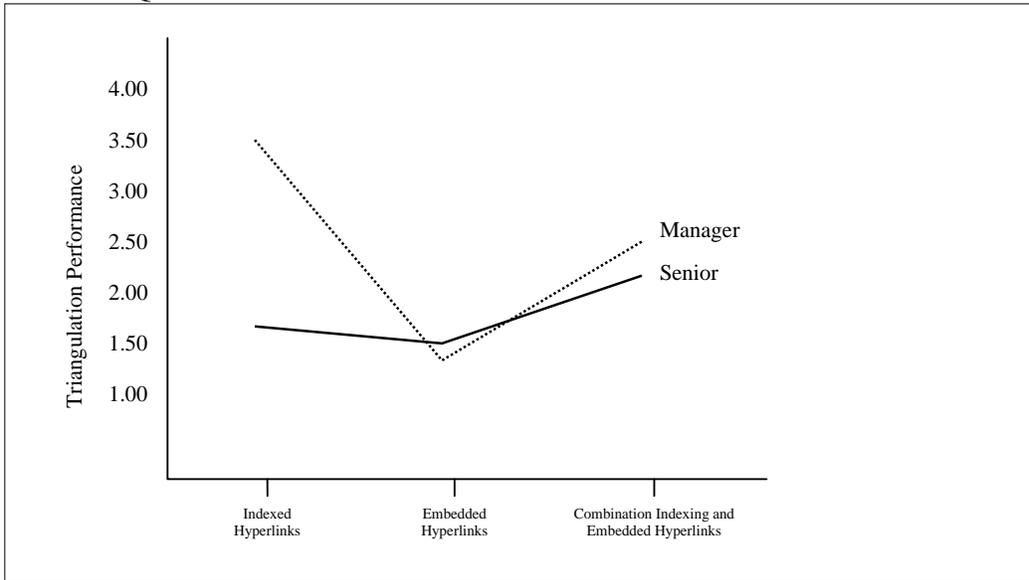


Figure 2
Observed Results

Panel A – Question 1



Panel B – Question 2

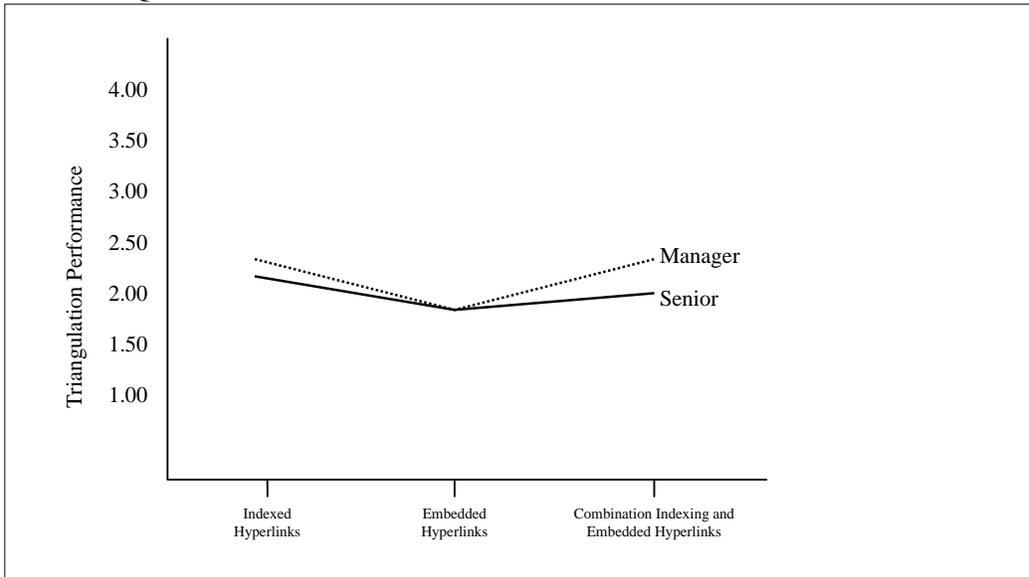


Table 1
EBS, MII, EBS Evidence Items

Panel A: Evidence relating to a possible reduction in selling price accounting for the fall in the gross profit margin.

Workpaper Reference	Evidence Type	Supporting / Discounting	Evidence Item
A8000	EBS	Supporting	Market survey by well respected independent research company reports that the overall worldwide headset market has expanded by 30% in 2007. The major driving force behind such growth is that more and more well known manufacturers of other devices are selling their devices with headsets as a package (i.e., bundling) as evidenced by the increasing headset bundling percentage.
A4000	MBR	Discounting	The sales manager interview notes indicates that BSCL does not compete on pricing but on trendy high quality innovative products. The new products launched in 2006 were a great success and comprise the majority of sales for 2007. BSCL has significantly increased the suggested prices of these products in 2007.
A20041	MI	Discounting	BSCL has successfully converted its information processing system from Infosys Version 8 to Version 9 in January 2007. With Infosys Version 9, the sales invoicing system is able to automatically work out the preferential price to be given on each order based on the significance of the customer and the purchase volume, eliminating the problem of charging customers too low a price due to manually carrying out the process on paper.

Panel B: Evidence relating to a possible increase in production costs accounting for the fall in the gross profit margin.

Workpaper Reference	Evidence Type	Supporting / Discounting	Evidence Item
A9000	EBS	Discounting	The Financial Press reports that BSCL signed a contract with Sino-Viet Manufacturing Co Ltd (“SVMCL”) to purchase 40% of its major headset components for 2007 from SVMCL and the market had reacted positively to this with BSCL’s share price advancing 2% on the day of the announcement. An independent financial analyst also commented that the costs of self-producing the major headset components by BSCL in Mainland China is 50% higher than purchasing them from SVMCL which has its production facilities in Vietnam.
A3000	MBR	Supporting	The production manager interview notes indicated that the general tight labour conditions in the Pearl River Delta region of Mainland China make it very difficult to recruit skilled labour despite the fact that BSCL has raised the wages of the workers by 10% during the year.
A20042	MI	Supporting	In the past, the cost of designers working for customers’ products was charged to the profit and loss account as a periodic cost because it was impossible to identify the number of hours each designer was working for a particular customer and for which product. With Infosys version 9, the time costing system is now able to accurately capture, in a timely manner, such data which enables BSCL to charge the cost of designers working for customers’ products to the cost of production, while the remainder is expensed as a periodic cost.

Table 2
Descriptive Statistics

		Entire Sample n = 103			Inexperienced n = 69			Experienced n = 34		
		Indexed n=33	Embedded n=34	Combined n=36	Indexed n=23	Embedded n=23	Combined n=23	Indexed n=10	Embedded n=11	Combined n=13
Question 1 – The extent to which evidence is consistent with a decrease in selling price.	Mean	2.21	1.50	2.17	1.65	1.57	2.09	3.50	1.36	2.31
	Stand. Dev.	1.64	1.64	1.40	1.34	1.73	1.35	1.65	1.50	1.55
	Range	0 – 5	0 – 5	0 – 5	0 – 4	0 – 5	0 – 5	1 – 5	0 – 5	0 – 5
Question 2 – The extent to which evidence is consistent with an increase in production costs.	Mean	2.39	1.94	2.31	2.48	1.91	2.43	2.20	2.00	2.08
	Stand. Dev.	1.35	1.32	1.33	1.41	1.28	1.31	1.23	1.48	1.38
	Range	0 – 5	0 – 5	0 – 5	0 – 5	0 – 5	0 – 5	1 – 4	0 – 5	0 – 4

Table 3
ANOVA Results

Panel A: A Decrease in Selling Price of Individual Products

Source	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>p</i>
Hyperlinking Type	18.593	2	9.297	4.089	.020
Experience	8.752	1	8.752	3.850	.053
Hyperlinking Type x Experience	16.821	2	8.410	3.700	.028
Error	220.510	97	2.273		

Panel B: An Increase in Production Costs

Source	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>p</i>
Hyperlinking Type	2.383	2	1.191	0.658	.520
Experience	0.757	1	0.757	0.418	.519
Hyperlinking Type x Experience	0.859	2	0.429	0.237	.789
Error	175.740	97	1.812		

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