An Evidential Reasoning Approach to Integrating Fraud Schemes into Fraud Risk Assessment

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Prepared for presentation at the Midyear AAA Audit Section Meeting
January 17-18, 2008

We appreciate the helpful comments of Prakash Shenoy, Mike Ettredge, John Keating, and participants at the 2005 annual conference of E&Y CARAT at the University of Kansas, and thank GRF, University of Kansas, for the financial support during 2004 summer.

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ABSTRACT: This paper investigates how fraud schemes can be integrated into the fraud risk assessment process and be incorporated into audit planning. A framework for assessing fraud risk using an evidential reasoning approach based on the belief-function formalism was developed in this paper. The framework extends fraud risk assessment models in prior fraud research in three respects. First, it integrates fraud schemes, both account schemes through which accounts are manipulated, and evidence schemes through which frauds are concealed, into a single framework. Second, the approach integrates empirical frequency information through Conditional OR relationships among assertions. The empirical information is based on previous fraud cases disclosed in Accounting and Auditing Enforcement Releases issued by the Securities and Exchange Commission. Third, the approach provides a structured approach for connecting risk assessment, audit planning, and evaluation of audit results. This paper uses a real fraud case to illustrate the application of the proposed framework and provides evidence of its usefulness in improving fraud risk assessment and audit planning.

Key words: Fraud Risk Assessment, Fraud Schemes, Audit Program Planning, Evidential Reasoning Approach

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I. INTRODUCTION

In recent years, management fraud has drawn heightened attention from all sectors of the economy due to the occurrence of fraud in several major public companies (Nelson et al. 2003; Wilks and Zimbelman 2004a). Concurrently, the American Institute of Certified Public Accountants (AICPA) released Statement of Auditing Standards (SAS) 99 (AICPA 2002) to replace SAS 82 (AICPA 1997) on consideration of fraud in financial statement audits. The new standard emphasizes the importance of evaluating fraud risk from the view of fraud triangle factors[1] and the use of brainstorming sessions to assess fraud risk and evaluate how fraud could be perpetrated. However, SAS 99 does not provide detailed instructions on how auditors should consider fraud schemes in risk assessment or how auditors should adjust audit programs to respond to the assessed fraud risk.

This paper investigates how fraud schemes can be integrated into fraud risk assessment and audit program planning and develops a framework of risk assessment using an evidential reasoning approach based on the belief-function formalism. The framework includes both account schemes and evidence schemes. Account schemes are used by management to manipulate account balances, while evidence schemes are used to deceive auditors and conceal fraud (Gao and Srivastava 2007). The framework integrates empirical frequency information of fraud schemes, obtained from previous fraud cases disclosed by the SEC, into a framework designed to help improve the efficiency and effectiveness of fraud detection.

[1] SAS 99 (AICPA 2002, p. 31) states, "The auditor may identify events or conditions that indicate incentives/pressures to perpetrate fraud, opportunities to carry out the fraud, or attitudes/rationalizations to justify a fraudulent action. Such events or conditions are referred to as 'fraud risk factors.' Fraud risk factors do not necessarily indicate the existence of fraud; however, they often are present in circumstances where fraud exists."

In addition, this paper uses a real fraud case to illustrate the application of the framework. The illustration demonstrates how to make preliminary fraud risk assessment, to plan audit programs, to aggregate audit evidence, and to make a final assessment of fraud risk. Based on the case study, we perform a comparison between two models using different relationships (OR and Conditional OR) between the assertion and its sub-assertions to estimate the impact of integrating fraud schemes into fraud risk assessment.

By comparing the proposed evidential network with fraud risk assessment models without integrating fraud schemes, we show that the integration of fraud schemes into fraud risk assessment can help auditors evaluate how fraud could have been perpetrated and concealed, and can assist them in responding to fraud risk by adjusting audit programs. Secondly, the integration of fraud scheme information can help auditors identify high-risk areas and assist them in allocating audit resources and planning audit procedures. Finally, the integration of proposed audit procedures into the evidential network helps to build connections between preliminary fraud risk assessment, audit program planning, aggregation and evaluation of audit evidence, and the final judgment of fraud risk.

The remaining sections of this paper are organized as follows. Section II reviews prior literature on fraud risk assessment. Section III proposes a general evidential reasoning framework for fraud risk assessment. Section IV uses a real fraud case to illustrate how auditors may use evidential networks to perform fraud risk assessment, to plan audit programs, and to evaluate audit results. Section V concludes the paper with a discussion on contributions and future research.

II. PRIOR RESEARCH

Prior studies on fraud risk assessment focus largely on using fraud risk factors, "red flags," to assess the overall risk of fraudulent financial reporting. In this approach, which has been adopted in SAS 99 (AICPA 2002), the auditor identifies the presence or absence of certain red flags and then assesses the risk of fraud (Bell and Carcello 2000; Eining et al. 1997; Pincus 1989; Fischhoff et al. 1978).

To facilitate the use of red flags, various decision aids have been developed, such as checklists, regression models and expert systems. Although the checklist is the most common decision aid, it is also likely to be ineffective (Pincus 1989). Prior research does find that regression models perform better than a simple checklist (Bell and Carcello 2000; Eining et al. 1997) and that expert systems, by incorporating judgment of auditors during the fraud risk assessment process, perform better than either checklists or regression models (Eining et al. 1997).

One major limitation of current approaches is that they are developed to assess overall fraud risk without considering the impact of the fraud schemes which are used by management to perpetrate and conceal fraud. Other approaches such as neural network[2] (Green and Choi 1997) and strategic auditing[3] (Pattern and Noel 2003; Bloomfield 1997) are also restricted to the assessment of the overall fraud risk. Thus, even if the auditor correctly identifies a high-fraud-risk situation, an auditor may not be able to design effective fraud detection procedures because he or she could be misled by manipulated evidence provided by the management.

[2] A neural-network-based fraud prediction model builds a classification model by finding existing patterns in financial data, which could indicate the existence of fraud (Green and Choi 1997).

[3] In strategic models, the audit process is treated as if it were a game, with auditors and management functioning as the players. The interactions between auditors and management and their behaviors are investigated under certain conditions such as different levels of auditor penalty, auditing standards, internal control quality, and audit fees (Patterson and Neol 2003, Matsumura and Tucker 1992).

Zimbelman (1997) finds that a separate assessment of fraud risk leads to an overall increase in budgeted hours but not a change in the nature of audit procedures. Asare and Wright (2004) also find no significant relationship between fraud risk assessment and audit program effectiveness. Mock and Turner (2001) find that although auditors identified and documented fraud risk cases, they sometimes choose to extend ineffective procedures. These results indicate that there may be a weak connection between fraud risk assessment and audit program planning.

In this paper, we explore the possibility of constructing a fraud risk assessment network that incorporates fraud schemes and provides appropriate connections between risk assessment and audit program planning. The network also integrates frequency data from previous fraud cases to improve the effectiveness and efficiency of detecting fraud.

The proposed network uses Belief Functions as the formalism for computing fraud risk. Belief Functions provide an effective way of mapping uncertainty judgments in auditing and incorporating ambiguity within the decision-making process (Harrison et al. 2002, Srivastava and Mock 2000, Srivastava and Mock 2005). Compared to risk assessments based on probability, plausibility measures based on belief assessments provide a more conservative measure of risk (see, e.g., Srivastava, Mock and Turner, 2007, Srivastava and Shafer 1992, and Sun et al 2006).

III. A GENERAL EVIDENTIAL NETWORK FOR FRAUD RISK ASSESSMENT

This paper uses evidential reasoning approach to develop a framework for assessing fraud risk. Evidential reasoning involves making decisions based on relevant evidence. Under this approach, an auditor can assess states of unknown variables or assertions based on knowledge of other variables or assertions (Pearl 1990) that are related to the variable of interest. When applied to auditing, evidential reasoning involves the evaluation and combination of audit evidence.

Components of an evidential reasoning diagram include assertion nodes, relational nodes, and evidence nodes (See Figure 1). The assertion nodes include different levels of assertions where sub-assertions are connected to the main assertion through relational nodes. Assertions may be related by 'and', 'or', 'weighted average', or a combination of these relationships. Evidence nodes provide the inputs for the level of support in favor of or against the corresponding assertions or sub-assertions.

The first step in developing an evidential diagram is constructing the framework that clarifies the relationships among the main assertions, sub-assertions, and evidence nodes. The next step is to assess and represent the strength of the evidence collected. The strength of evidence refers to the extent that a piece of evidence supports or negates the corresponding assertion. An evidential network can use different frameworks to assess evidential strength and to compute the overall assurance whether the assertion or sub-assertion is true or not true. In this paper, we use Dempster-Shafer theory of belief functions (Shafer 1976). We encourage readers to see Srivastava (1993), and Srivastava and Mock (2005) for an introduction to belief functions.

Under the belief-function framework, items of audit evidence are combined using Dempster's rule of combination (Shafer 1976). Shenoy and Shafer (1988, 1990) and Shenoy (1989) have developed "local computation" technique for belief-function propagation in an evidential network. In this paper, we use the computer program "Auditor's Assistant" developed by Shafer et al. (1988) to construct the proposed evidential diagrams and compute the overall beliefs regarding the financial statement assertions.

A General Evidential Diagram for Fraud Risk Assessment

We present a general evidential diagram for fraud risk assessment in Figure 1. The oval-shaped boxes represent assertions and sub-assertions, the rectangular boxes represent items of

audit evidence, and circles represent relational nodes connected to assertions and sub-assertions. Variables are connected by lines. Dotted lines are used to represent those assertions or evidence that could have been connected to related assertions but were omitted in the diagram for simplification.

------ Insert Figure 1 Here ------

Network Development

We use the risk-based approach in developing assertions and sub-assertions for the evidential network for our situation. For example, "Fraud is present in Account A" is the main assertion in Figure 1. "Fraud is committed through General Account Scheme I" represents a sub-assertion in the evidential network in Figure 1. We have four levels of sub-assertions beyond the main assertion dealing with the risk assessment process. The first level of assertions deals with what general account schemes (categorized mainly based on violated financial statement assertions) were used to commit fraud. The second level of assertions deals with what specific account schemes were used to commit fraud. The third level of assertions deals with whether fraud was committed without the use of any evidence schemes or with the use of evidence schemes. The forth level of assertions deals with which specific evidence schemes were used to commit fraud. The proposed structure of the evidential network is based on the argument how fraud is perpetrated by management in a given account. Assertions and sub-assertions are connected through “Conditional or” (CR) relationships, which will be explained later in this section. As shown in Figure 1, each assertion is connected to one or more items of evidence that the auditor would collect and evaluate to determine the level of support in favor of or against the corresponding assertion.

Normally, if management has not used any evidence schemes to conceal account schemes, the fraud might be detected by an auditor through regular audit procedures. Therefore, the assertion that fraud occurred without the use of evidence schemes is linked to evidence gathered by regular audit procedures (see Figure 1). However, if the management has used evidence schemes to conceal fraud, auditors should assess what specific evidence schemes could have been used to defraud and what special audit procedures can be used to detect fraud.

The "Conditional or" (CR) Relationship

Gao and Srivastava (2007) report that certain types of account schemes, e.g., fictitious sales and premature revenue recognition, have higher likelihoods of occurrence than other types, and the use of different types of evidence schemes are related to specific types of account schemes. Therefore, one should not assume that there are equal likelihoods for different types of fraud schemes to occur. Such frequency knowledge can be integrated into the network to help auditors determine the focus, nature, and extent of audit tests.

To integrate historical frequencies of fraud schemes into the evidential network, we propose a new relationship called the "Conditional or" represented by the symbol 'CR' in the framework. Before explaining CR relationship, let us first look at OR relationship between an assertion and its sub-assertions. We know that under OR relationship the main assertion would be true if at least one of its sub-assertions is true. For example, suppose that the main assertion "Z" is related to two sub-assertions "X" and "Y" through the OR relationship. This relationship implies that Z is true when X is true, or Y is true, or both X and Y are true. However, Z is not true under only one condition when both X and Y are not true. Such a relation can be defined under belief functions as (Srivastava et al 2005):

$$m(\{zxy, z{\sim}xy, zx{\sim}y, {\sim}z{\sim}x{\sim}y\}) = 1,$$

where m(..) represents the belief mass assigned to the state space in the parenthesis, z represents that Z is ture and ~z represents that Z is false, similar definitions are associated with x, ~x, and y and ~y. As seen above, a belief mass of 1.0 is assigned to the set of all possible values of the joint space {zxy, z~xy, zx~y, ~z~x~y} to represent the OR relationship.

A CR relationship extends OR relationship by integrating the empirical frequency information of the occurrence of sub-assertions given the occurrence of the main assertion. Suppose that when z is true, x is true with a belief of, say 'a', and y is true with a belief of, say, 'b', such that 'a' + 'b' = 1. On the other hand, if z is not true, both x and y are not true. The CR relationship can be modeled through following m-values:

$$m(\{zxy, zx\sim y, \sim z\sim x\sim y\}) = a$$

$$m(\{zxy, z\sim xy, \sim z\sim x\sim y\}) = b$$

The above representation of CR relationship has modeled the assumed relationship among the three variables. In other words, when we know about the sub-assertions X and Y, then the knowledge about Z is inferred correctly as inferred under OR relationship, and when we know about the main variable Z that it is true (i.e., z is true), the relationship provides 'a' level of belief that x is true and 'b' level of belief that y is true as desired. The parameters 'a' and 'b' can be interpreted as the conditional belief that x is true given that z is true, and y is true given that z is true, respectively. In modeling the above CR relationship, we have assumed that the sub-assertions X and Y are mutually exclusive with the conditional beliefs adding to 1.[4]

To illustrate the CR relationship, let us consider the following example. Suppose z represents that fraud is present in a given account A, and x and y represent that fraud has been

[4] When there are overlaps between sub-assertions, in other words, when sub-assertions are not mutually exclusive and thus the sum of conditional beliefs is larger than 1. CR relationship can also be used to model such a relationship. Using the above example, when a + b>1, suppose c = a+b-1 (overlap of x and y), then the CR relationship can be modeled as: m({zxy, zx~y, ~z~x~y}) = a - c, m({zxy, z~xy, ~z~x~y}) = b - c, and m({zxy, ~z~x~y}) = c. As for the present case, we assume no overlap of assertions and therefore c = 0.

committed through two account schemes. Also, assume that we know from experience that if fraud is present in account A then 60% of the time it is present through the presence of scheme x, and 40% of the time through the presence of scheme y. The corresponding conditional beliefs can be written in terms of conditional belief masses as: m(x|z) = 0.6, and m(y|z) = 0.4. These conditional beliefs define 'a' and 'b' in the CR relationships, i.e., a = 0.6, and b = 0.4. The CR relationship with a = 0.6 and b = 0.4 implies that if we know that there is fraud in A then we know that 0.6 level of belief that it is due to x and 0.4 level of belief that it is due to y.

However, if we know that ~z is true with certainty then we know that ~x is true with certainty and ~y is true with certainty. This is what we expect in such a relationship. If we know that there is no fraud for sure then we know that there is no fraud committed through either x or y. We use the conditional beliefs for determining the parameters of the CR relationships. We further elaborate the construction of evidential network and the establishment of the CR relationship among assertions and sub-assertions in the next section through a real case.

IV. A CASE STUDY OF FRAUD RISK ASSESSMENT USING A FRAUD-SCHEME-INTEGRATED FRAMEWORK

Background Information about the Fraud Case

To illustrate how auditors can use the evidential networks to assess fraud risk and plan audit programs, we use a fraud case disclosed in AAERs[5] by the SEC. The fraud was committed by the management of FLIR Systems, Inc. (FLIR), a NASDAQ listed company designing and manufacturing thermal imaging and broadcast camera systems that detect infrared radiation. FLIR engaged in a wide range of schemes to inflate revenue and earnings in 1998 and 1999. These schemes were carried out by senior management at FLIR.

[5] Please refer to AAER No. 1637 and No. 1639, and the Complaints of No. 1649, and No. 1670 announced by the SEC during September and November of 2002.

FLIR began its improper revenue recognition in the first quarter of 1998 and continued each quarter to overstate revenue by recognizing sham sales, improper bill-and-hold sales, sales with contingent terms, or sales without fixed commitment or price. Most of these improper practices were carried out at the end of each quarter. In this section, we first construct an evidential diagram for this case. Next, we discuss how auditors could use the evidential diagram to make a preliminary assessment of the presence of management fraud, and then discuss how this assessment would help the auditor to further plan the audit, and collect, evaluate and aggregate audit evidence to finally determine whether fraud is committed or not.

Evidential Diagram for Assessing Fraud Risk in FLIR Systems, Inc

Figure 2 represents an evidential diagram for assessing the presence of fraud in the revenue account of FLIR Systems, Inc. We use the approach described in the previous section to construct this diagram. First, we draw the main assertion "Fraud is present in Revenue" as a variable node depicted by a rectangular box with rounded corners in Figure 2. Next, we identify all the possible general account schemes that might have been used by the management of FLIR to commit revenue fraud. These general account schemes represent the next set of variable nodes as sub-assertions. These sub-assertions are connected to the main assertion through the "conditional or" relationship, CR, as described earlier. The parameters of this CR relationship are determined from the frequency knowledge of the revenue fraud cases as described in the AAERs issued by the SEC from 1997 to 2002 (See Table 1 for the values of these parameters).

------ Insert Figure 2 Here ------

------ Insert Table 1 Here ------

The variables or sub-assertions at the next level are the specific account schemes used by the management to commit revenue fraud. These variables are connected to their corresponding

general account schemes again through a CR relationship whose parameters are determined from the historical frequency knowledge of fraud data obtained from AAERs of 1997 to 2002. In Figure 2, we only show the specific account schemes that pertain to the general account scheme "Premature revenue recognition" for simplicity of illustration. A complete diagram will have variables associated with all specific account schemes pertaining to all general account schemes for revenue fraud. The variables or the sub-assertion at the final level are the processes through which a specific account scheme for revenue fraud was committed. Again, for simplicity of presentation, we show only the sub-assertions pertaining to specific account scheme "Revenue recognition on contingent sales".

The rectangular boxes in Figure 2 represent items of evidence pertaining to the variable or variables to which they are linked. The items of evidence depicted in Figure 2 are for illustrative purpose only; they are not meant to be exhaustive. However, to bring the reality into the case, we contacted two volunteers from a Big Four accounting firm, one a manager with 9 years of audit experience and the other a senior with 4 years of audit experience, to provide potential audit procedures or items of evidence they would gather in a case of revenue fraud. These procedures are listed in Table 2.

------ Insert Table 2 Here ------

Preliminary Fraud Risk Assessment in FLIR Systems, Inc

According to SAS 99 (AICPA 2002), when assessing fraud risk, auditors should consider fraud risk factors and perform analytical procedures. We believe that such assessment should not only include the assessment of overall fraud risk but also assessment of the risk of fraud in a specific account.

Based on the descriptions of AAERs regarding the FLIR case and FLIR's 1998 annual report, we identify several factors that might indicate a risk of revenue fraud, primarily by analyzing fraud triangle factors that are suggested by SAS No. 99 (AICPA 2002) for auditors to use when assessing fraud risk. Panel A in Table 3 lists risk factors in the second column, related fraud assertions in the third column, and the strength of the evidence in the last column, in terms of m-values, supporting or negating the assertions.

------ Insert Table 3 Here ------

The process described here for assessing the risk is just an illustration based on our analysis of the information available on FLIR. We notice that throughout 1998 and 1999, FLIR's senior management had established budgets that expected growth in FLIR's results. The company's actual earnings per share in 1998 generally met or exceeded analysts' estimates, but revenues did not (AAER No. 1637, SEC 2002). Second, FLIR acquired AGEMA Infrared Systems in December 1997 and merged with Inframetrics, Inc. in March 1999. Both mergers exacerbated the pressure on management to achieve financial goals. Third, FLIR's bonus policy stated that management could "receive a salary plus significant annual bonuses based, in large part, on FLIR's pre-tax profit performance" (SEC complaint, AAER No. 1639). The CEO at the time of the fraudulent activity received a bonus of $180,000 on a salary of $225,726 and $240,049 in restricted stock grants, and also 25,000 stock options in 1998. Other senior management also received substantial bonuses and stock options. Although these factors are not sufficient evidence to prove the occurrence of fraud, they do indicate risk of fraud. We use the above individual pieces of information as items of evidence pertaining to the main assertion "Fraud is present in Revenue" and assess a low level of belief, say 0.05, on a scale of 0-1, for each item of evidence represented by E.T.1, E.T.2, and E.T.3 in Figure 2 and Table 3.

Another piece of evidence that pertains to the risk of fraud is the change of CEO during 1998. This evidence is represented by E.T.4 in Table 3, and described as follows. Early in 1998, FLIR's CEO informed Stringer, his successor, that he would be retiring by the middle of 1998. Stringer later acted as the *de facto* CEO of FLIR throughout 1998 and strove to have the promotion made permanent. Stringer officially became FLIR's president and CEO in January 1999 (SEC complaint of AAER No. 1639). He was actively involved in the daily operations of FLIR, particularly as they related to sales and financial performance. We consider this change as a fraud risk factor and assess the strength of this evidence to be at a low level again, say 0.1 on a scale of 0–1, supporting the present of fraud in the revenue.

The next piece of evidence (E.T.5 in Figure 2 and Table 3) that pertains to the risk of fraud in revenue is the international business activities by FLIR. International operation is listed in SAS 99 (AICPA 2002) as a risk factor because different environments may provide opportunities for fraud. International sales accounted for approximately 55% of the company's revenue in 1998. Thus we identify it as a piece of evidence at the main assertion level providing a low level of support, say 0.05.

The next piece of evidence (E.C.1 in Figure 2 and Table 3) relates to the internal control of sales and accounting systems of FLIR. The SEC Complaint of AAER No. 1639 states that, in sales operations, FLIR's management frequently authorized the entry of sales without purchase orders. Through the audit of the company's internal control, the auditor might identify weaknesses in FLIR's control of authorization and responsibilities of management regarding sales activities. We assess the strength of this evidence to be again at a low level, say 0.05, that fraud is present in revenue of FLIR.

Next, we use the analytical procedures results (E.AP.1 in Figure 2 and Table 3) to assess the risk of fraud in the revenue of FLIR. At the end of 1998, FLIR reported a 67.7% increase of sales revenue and an increase of pretax margin from 9.9% to 14.4% in its annual report. Such an abnormal increase of sales and profitability might indicate a risk of fraudulent revenue. We identify it as a piece of evidence with a low level of support, say 0.1, that fraud in revenue is present. Furthermore, the cash flow from operations (CFFO) decreased by more than three times in 1998 than in 1997. The ratio of CFFO to revenue decreased from negative 0.07 to negative 0.17. Such a huge decrease of CFFO indicates that the company had difficulty liquidating its accounts receivable, which may be a result of fraudulent revenue. We consider this information as a piece of evidence (E.AP.2 in Figure 2 and Table 3) and assess a low level of support, say 0.1, that fraud is present in FLIR's revenue.

Another piece of evidence under analytical procedures is the analysis of the quarterly financial statements of FLIR. We notice that FLIR had an abnormal increase in sales revenue and profitability ratios in the fourth quarter of 1998, as compared to previous quarters and the same quarter of previous years, and a dramatic decrease in the first quarter of 1999. Such a huge increase of revenue and profitability before year end and an immediate decrease after year end might indicate a risk of fraud. We assess this evidence (E.AP.3 in Figure 2 and Table 3) to provide a low level of support, say 0.15, that fraud is present in FLIR's revenue.

Evidence Pertaining to Specific Account Schemes

As described in FLIR’s 1998 annual report, a substantial proportion of FLIR’s revenue, e.g. 17.7% for year 1998, was derived from sales to agencies of the U.S. government. Many customers of FLIR were aircraft integrators responsible for assembly or customization of aircraft for their own customers (end-users), which were often government agencies. The agencies

normally wouldn't pay FLIR until end-users had ordered and paid. Therefore, sales in FLIR were often accompanied with contingent terms. We identify this industrial attribute as a piece of evidence pertaining to the risk that the company may prematurely recognize revenue. We assess the strength of this evidence (E.T.6 in Figure 2 and Table 3) to be at a low level, say 0.1.

Throughout the year of 1998, FLIR engaged in a significant number of bill-and-hold sales, which indicated a risk of improperly recognized bill-and-hold sales. We assess the strength of this evidence to be 0.1, represented by E.T.7 in Figure 2 and Table 3.

A majority of FLIR's customers were foreign customers. While waiting for export licenses, FLIR used a third-party warehouse (the "bonded warehouse") to hold goods for shipments. Due to the delays between the application and receipt of license, FLIR allowed revenue to be recognized upon shipment to the bonded warehouse (SEC complaint of AAER No. 1639). The use of a third-party warehouse and the policy of revenue recognition upon shipment to the third-party warehouse might provide opportunities to accelerate revenue recognition by arranging sham shipments to bonded warehouse. For this reason, we consider this information to be a piece of evidence indicating that fraud could have been committed through use of evidence scheme of forged shipment documents or sham shipments. This evidence is depicted as E.T.8 in Figure 2 and Table 3. The strength of this evidence is assessed to be again at a low level, say 0.1.

Compared to the years 1996 and 1997, FLIR had a continuous increase in its inventory turnover rate during 1998, particularly during the third and fourth quarter indicating that the inventory holding period was shortened in 1998. It might indicate a risk of fraud schemes relating to shipments and the completion status of inventories. At the same time, FLIR had a relatively stable accounts receivable turnover rate during 1998. In other words, although inventory moved fast, the cash collection from sales was not improving. Both ratios then dropped

dramatically in the first quarter of 1999. We assess the abnormal increase in the inventory turnover as a risk factor, represented by E.AP.4 in Table 3, providing support to two assertions: revenue recognition on incomplete products or services and forged shipment documents or sham shipments. The strength is assessed to be 0.075.

Evidence Pertaining to Evidence Schemes

Prior research finds that the concealment of fraud can be affected by auditor type, report type, threat of bankruptcy, and industry (Gao and Srivastava 2007; Gao 2007). Such findings can also be integrated, as items of evidence, into the evidential network of fraud risk assessment.

Gao (2007) finds that clients of Big-Five firms are more likely to use evidence schemes to conceal fraud. In addition, Gao and Srivastava (2007) find clients of Big-Five firms are more likely to collude with third parties, e.g. customers, to deceive auditors. Gao (2007) also finds companies are more likely to use evidence schemes to conceal fraud when preparing an annual report, and especially to use the evidence scheme of altered documents. Since FLIR was a client of PwC during all relevant times in this case, and the fraudulent financial statements are the annual financial statements, we assess that these are preliminary evidence in support of the assertion “evidence schemes used to conceal fraud” and the assertions of the specific evidence schemes “require customers to send false confirmations” and “remove contingent terms from sales documents” in the evidential network. These items of evidence are represented by E.OF.1 and E.OF.2 in Figure 2 and Table 3. Since these items of evidence are prevalent among all companies with similar company and report characteristics, we assign a low of belief, say 0.025, in support of related assertions.

The strength of evidence in terms of m-values was entered into the evidential network using Auditor’s Assistant, computer software developed by Shafer et al. (1988). This software

combines the strength of all the items of evidence in the network. Figure 2 presents the results of the preliminary risk assessments. As seen from Figure 2, the belief that FLIR had fraudulent revenues is assessed to be 0.693, a high degree of belief that fraud has occurred. With such a high belief that fraud had occurred in revenue recognition, the auditor must perform specific procedures to detect the occurrence of fraud and take appropriate action if fraud is really detected. This aspect is discussed next.

Audit Program Planning

Bedard et al. (1999) suggest that evidential planning, which has a significant impact on audit effectiveness and efficiency, entails determining which accounts to focus on, the nature, extent, and timing of tests, as well as personnel assignment. This paper will focus on the nature of audit tests, in other words, the decision of what procedures should be performed.

To improve the effectiveness and efficiency, when planning audit programs, auditors can first focus on testing those assertions where there is a high risk of fraud. In FLIR case, the preliminary risk assessment using the evidential network shows that the company had a high belief, Belief(fraud in revenue) = 0.693, that fraud is present in revenue of FLIR, and 0.539 level of belief that the fraud could have been committed through the premature revenue recognition process and 0.246 level of belief that it could have been perpetrated through fictitious sales. These results show that the auditor should, first of all, put more effort into testing the existence of premature revenue recognition since the belief that fraud could have been perpetrated through this scheme is the highest. When looking into its sub-assertions, contingent sales (belief = 0.408), bill and hold sales (belief = 0.141), and revenue recognition on incomplete products (belief = 0.139) are of higher risk and should be paid more attentions. For illustration purpose, we will discuss only the assessment of the existence of contingent sales.

Given the risk of contingent sales, Figure 2 indicates that there is a high risk that management might use evidence schemes to conceal fraud (belief = 0.396). In particular, following evidence schemes are most likely to be used: hidden side letters (belief = 0.261), forged shipment documents or sham shipments (belief = 0.180), forged sales documents (belief = 0.096) and collusions with customers (belief = 0.091). The planning of audit programs should, first of all, focus on those procedures that may be effective in detecting these evidence schemes.

When deciding nature of audit tests, auditors should select those procedures that are relatively more effective in detecting fraudulent activities related to high-risk assertions and those that can be effective in detecting multiple schemes. For illustration purpose, we select several procedures from the list of procedures in Table 2 that were assessed by interviewed auditors as more effective in detecting high-risk fraud schemes[6]. The procedures that are effective in detecting hidden side letters include: (1) to review subsequent cash collection and analyze cash collection ratios, (2) to send confirmations to customers to confirm balances and terms of sales, (3) to review debit and credit memos during the period and subsequent to period end, and (4) to analyze subsequent product return, reversal entries, aging of A/R, and compare accumulated cash collection to sales revenue for high-risk customers.

To detect forged shipping documents or sham shipments, auditors can perform the following procedures: (1) to compare volumes of sales and shipments at the end of the year and each quarter to those of the beginning of the next period, (2) to compare the amount of subsequent product returns to the sales and shipments around the period's end; obtain print-outs of documentation of sales transactions close to the period's end, and (3) to perform on-site observation of the last day's shipping activities.

[6] The effectiveness of these proposed procedures was evaluated by the same two experienced auditors, a manager with 9 years of audit experience and a senior with 4 years of audit experience, as discussed previously.

Besides these procedures, the auditor should also perform regular procedures, and, most importantly, increase their professional skepticism when assessing audit evidence. Examples of such regular procedures include reviewing sales documents on high-risk customers and transactions, examining them for consistency; performing cut-off tests of sales and shipments; and reviewing and testing events specified in sales contracts. When identifying a suspicious transaction or customer, the auditor should delve into the details of the transaction, and not be convinced to relinquish doubts solely by client representation or immateriality.

Evidence Collection and Aggregation

After performing the proposed audit procedures, auditors should evaluate the evidence collected and assess the beliefs (m-values) regarding the related assertions in the evidential network. Table 4 lists the suggested audit procedures, related assertions, and the assumed belief inputs based on the evidence collected by these procedures.

------ Insert Table 4 Here ------

Since the actual audit evidence collected by FLIR's auditor was not disclosed publicly, we assessed the belief inputs based on the information about the audit and the fraud disclosed in related AAERs. The assessed beliefs are mainly for illustration purpose and not to be considered as final judgments on the case. We will use several examples to illustrate how to evaluate the collected audit evidence and assess the belief values for related assertions in the evidential network.

From previous discussions of the fraudulent schemes used in FLIR, we find all of the schemes were conducted at the end of a reporting period. After the auditor performed the analytical procedures to compare sales by month and by customer, he/she should have identified the transactions close to the period's end as of high risk and performed additional procedures to

collect evidence about those transactions and the customers involved. In fact, FLIR's auditor noticed the high-risk customers and selected them for additional tests (SEC Complaint of AAER No. 1639).

Sending confirmations to customers, a standard audit procedure providing evidence to multiple assertions, has been widely used in auditing and was also used by FLIR's auditor to confirm accounts receivable (A/R) balances. The sales representative who was involved in a $4.1 million sales transaction, which was prematurely recognized by FLIR, and the sham shipments of the incomplete units refused to return the confirmation. Such an abnormal non-response from a customer should have signaled to the auditor that the sale might have been fraudulent. As stated on line 3 represented by E.S.C.1 in Table 4, we assess the strength for this evidence to be 0.4 that all relevant assertions are true. The additional procedure performed by the auditor of FLIR was to obtain a representation letter from FLIR's management, which stated that the $4.1 million sale had satisfied all requirements for recognition of sales. Although this evidence should negate the assertion that the transaction was fraudulent, it was possible that management had made improper (false) statements in their representations. For this reason, as stated on the last line of Table 4 represented by E.S.MR, we assess that the management representation letter provides support, say 0.5, for the negation of the assertion if other evidence schemes are present.

As discussed previously, management may collude with customers to provide auditors with improper confirmations. Although not disclosed in the AAERs that such collusions occurred in the FLIR fraud case, it is still necessary for auditors to perform procedures that may detect such collusions. Such procedures include the analysis of subsequent cash collection, subsequent product returns, reversal entries, and the aging of A/R. In FLIR's case, for several major transactions close to period end, the company did not receive any cash payments from its

customers. We assess the strength of this evidence to be 0.2 in support of most of the related assertions, which is stated on line 2 represented by E.A.4 in Table 4. Since this evidence might provide more support to the assertion of collusions with customers, removal of contingent terms, and hidden side letters, we assess that the evidence provides a 0.3 level of support to these three assertions.

From the analysis of product returns, the auditor might have noticed that the company dealt with large numbers of product returns, which were actually caused by shipments of incomplete products and by sales with contingencies throughout the year. The auditor should have performed procedures to investigate the reason of large amount of product returns. As stated on line 9 represented by E.S.R.11 in Table 4, we assess the strength of this evidence to be 0.2 supporting the assertions of hidden side letters and collusions with customers.

A special procedure that is not normally performed by auditors is to appear on-site on the last day of the reporting period to observe shipping activities and obtaining shipment records for the last several days. By performing this procedure, the auditor could have detected that the shipped items were different from the products described on the purchase orders. In that situation, the auditor would have detected the fraud of revenue recognition on incomplete products, and the belief value would be 1 in support of that type of fraud. It is also possible that auditors may ignore the inconsistency. Therefore, we assess the strength of the evidence, represented by E.F.5 in Table 4, to be 0.3 supporting the assertion of forged shipment documents or sham shipments.

The process of assessing evidence collected by other procedures is similar to those described in above and thus are skipped for discussion. It should be mentioned that the evidence collected by special procedures might also be manipulated, and other procedures should be performed to examine the validity of the collected evidence.

Evaluation of Audit Results

After assessing the collected evidence with regard to the related assertions, the auditor should incorporate these beliefs into the evidential network. The network will automatically aggregate belief inputs from evidence nodes and propagate all of the beliefs to the assertions in the network based on the structure of the network. After putting the belief values for this case, the revised belief in fraudulent revenue increases to a positive 0.999, which is very close to 1, indicating that the auditor is almost sure that FLIR's revenues are fraudulent[7]. The evidential network after incorporating the belief values from evidence is presented in Figure 3.

------ Insert Figure 3 Here ------

Unless auditors perform additional procedures to negate the belief in this fraud assessment or propose audit adjustments to exclude fraudulent sales, the auditor of FLIR should not have expressed an unqualified opinion on the FLIR's 1998 financial statements.

Additional Analysis: Comparisons amongst Different Evidential Reasoning Models

To evaluate the impact of the integration of fraud schemes and the use of CR relational nodes, we perform several tests by removing assertions and/or altering relational nodes in the evidential networks, and present the results of the preliminary and final fraud risk assessments in Table 5. All of the values in the table represent belief values of related assertions.

------ Insert Table 5 Here ------

[7] The value of belief in fraudulent revenue, computed in this paper, could have been affected by the lack of negative evidence, which contradicts the assertion of fraud, as input for evidence nodes in the evidential diagram. Two main reasons account for that: first, for simplification consideration; and second, for the reason of data restriction. As the primary purpose of AAERs is to criticize what management and auditors did wrong in the fraud case, the disclosures in AAERs about the fraud case lacks enough discussions of what evidence supporting no fraud might have been collected by the auditor. In order to include more of such evidence, we need to make assumptions of what might have been collected by the auditor. Considering the accuracy of the obtained values of beliefs in the assertions of the evidential diagram, we relied more on the disclosed information in AAERs. Although the lack of negative evidence should affect the fraud risk assessment, such impact might not be crucial. The CR relation assumes that as long as there is evidence supporting the occurrence of certain fraud schemes, then the main assertion, fraud occurred in an account, is true.

Impact of the "Conditional OR" Relationship

The first four columns in Table 5 represent the preliminary fraud risk assessments using CR logic and OR logic. In order to analyze the impact of relational nodes on fraud risk assessment, in the first two columns, we list the beliefs at various levels of fraud based on the items of evidence pertaining to only the main assertion (risk assessment at the overall level - fraudulent revenue), that are listed in Panel A in Table 3. The next two columns represent preliminary risk assessment based on all the evidence, which includes both the evidence pertaining to the main assertion and the evidence pertaining to assertions at the level of fraud schemes, as listed in Panels A and B in Table 3.

From Table 5, we notice that the change of relational logics will not affect the overall belief in fraudulent revenues, but it will affect belief at the level of fraud schemes. The reason for this is that the CR logic has incorporated into the model empirical frequency information about different types of fraud schemes given the risk of fraudulent revenue, which was obtained from previous fraud cases.

Table 5 shows that when there are only those items of evidence that provide support to the main assertion, the beliefs for all sub-assertions, assessing the risk of different types of account schemes and evidence schemes, would remain 0 in an OR-logic-based risk assessment framework. In other words, the auditor might find the model based on OR logic provides no knowledge of where the fraud could be and as a result he/she might perform all possible procedures without a focus. Such an approach could be less efficient, by assigning equal effort to most areas, and could also be less effective due to inadequate effort assigned to high-risk areas. However, when a CR-logic-based network is used, the auditor could determine the risk of fraud at various levels and allocate more effort to high-risk areas. For example, from the second

column of Table 5, we see, based on the preliminary assessment of fraud risk, that the risk of having fraud in revenue is much higher using "Premature Revenue" scheme than using any other schemes. Thus it would be more efficient for the auditor to focus more in looking for fraud in premature revenue area than in other areas.

Impact of the Incorporation of Evidence Schemes

For the purpose of analyzing the impact of incorporating evidence schemes, we compare the overall beliefs at various assertions and sub-assertions with and without the evidence schemes. Also, we consider the two possible relationships, "CR" and "OR" among the assertions and their corresponding sub-assertions. The belief values for these cases are given in columns 6-9 in Table 5.

Comparing the results in columns six and seven of Table 5, we notice that the risk assessments at all levels are higher for the first model, which integrates evidence schemes, than the model which does not integrate evidence schemes. This difference is mainly caused by the additional information obtained from the procedures performed for evidence-scheme-related assertions. It is important to note that without integrating the evidence schemes in the evidential reasoning network, the auditor may not notice risk of evidence schemes and thus may not perform corresponding procedures, which would affect both efficiency and effectiveness of the audit process. For instance, suppose an auditor receives a clean confirmation from a major customer of the auditee. If the auditor used the model without incorporating assertions related to evidence schemes, he/she might assign a high level of belief to the negation of the assertion of fraudulent revenue. On the other hand, if the auditor used the model incorporating evidence schemes, he/she may notice the risk of collusions between clients and their customers. Therefore, the auditor could have allocated a lower level of belief to the negation of the assertion of

fraudulent revenue based on the positive confirmation received from the client. At the same time, they could have performed additional procedures to test whether collusions had occurred. This finding suggests that the integration of evidence schemes into the framework could be helpful to auditors in planning effective and efficient audit programs and evaluating audit evidence.

V. SUMMARY AND CONCLUSIONS

This paper proposes a fraud-scheme-integrated framework of fraud risk assessment using an evidential reasoning approach. The proposed framework extends the fraud risk assessment models developed in prior research by integrating fraud schemes and empirical frequency information based on the previous fraud cases disclosed by the SEC, and by providing a structured approach for building connections between risk assessment, audit program planning, and evaluation of results. The approach is illustrated using a real fraud case which involves several audit stages including preliminary fraud risk assessments, audit program planning, evidence aggregation and evaluation, and a final fraud risk assessment. The model's analysis suggests that to improve the efficiency of fraud detection, auditors should, depending upon the preliminary risk assessment, choose procedures that are known to be effective in detecting high-risk fraud schemes or that provide evidence to multiple assertions.

In addition, in this paper we compare the results of two fraud risk assessment models using evidential reasoning approach, one with the "Conditional or" (CR) relationship among the assertions and the corresponding sub-assertions and the other with the "OR" relationship. The CR relationship incorporates the empirical frequency data into the evidential reasoning approach whereas the "OR" relationship does not. We further compare the performance of the above two models with and without the consideration of evidence schemes. The results indicate that a CR-relationship-based model is more comprehensive regarding fraud risk assessment and more

instructive in assisting auditors in assigning audit efforts in designing audit programs that would respond to specific risks related to specific evidence schemes used by management to defraud the auditor than a simple OR-relationship-based model that does not highlight the potential high risk areas.

A comparison between the performance of the model incorporating evidence schemes and of the model without the evidence schemes suggests that the model with evidence schemes not only provides a more conservative risk assessment (a higher value) of management fraud but also signals the way management may have perpetrated and concealed the fraud. This, in turn, helps the auditor plan an effective and efficient audit program.

As the first attempt to integrate fraud schemes into the assessment of fraud risk, the suggested framework is still a conceptual network and evaluations of its performance should be subject to further examinations in experiments or in practice. In addition, since the evidential networks developed in this paper focuses more on the assessment of fraud schemes and on the planning of audit programs given an initial assessment of fraud risk based particularly on the assessment of fraud triangle factors, it is important to incorporate the interrelationships among fraud triangle factors. We have simplified the model by ignoring the interrelationships among these fraud triangle factors. Lastly, the frequency information integrated into the fraud risk assessment model through the CR relationship is also subject to data limitations, such as disclosure bias, which may affect the accuracy of fraud risk assessment.

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Figure 1: The General Evidential Diagram for Assessing the Risk of Fraud Having Occurred in an Account

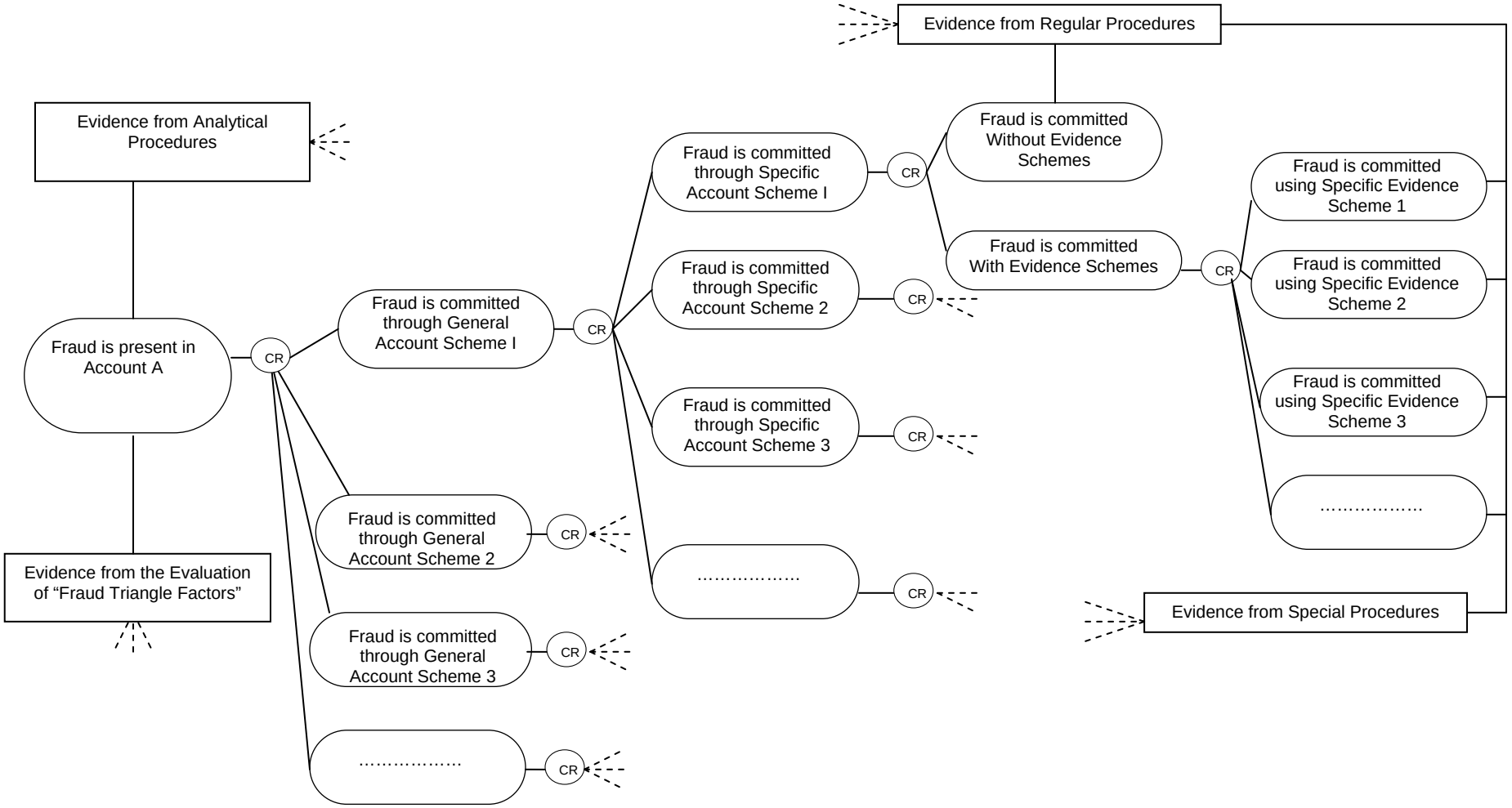

Figure 2: Preliminary Fraud Risk Assessment for FLIR Using Evidential Reasoning Approach

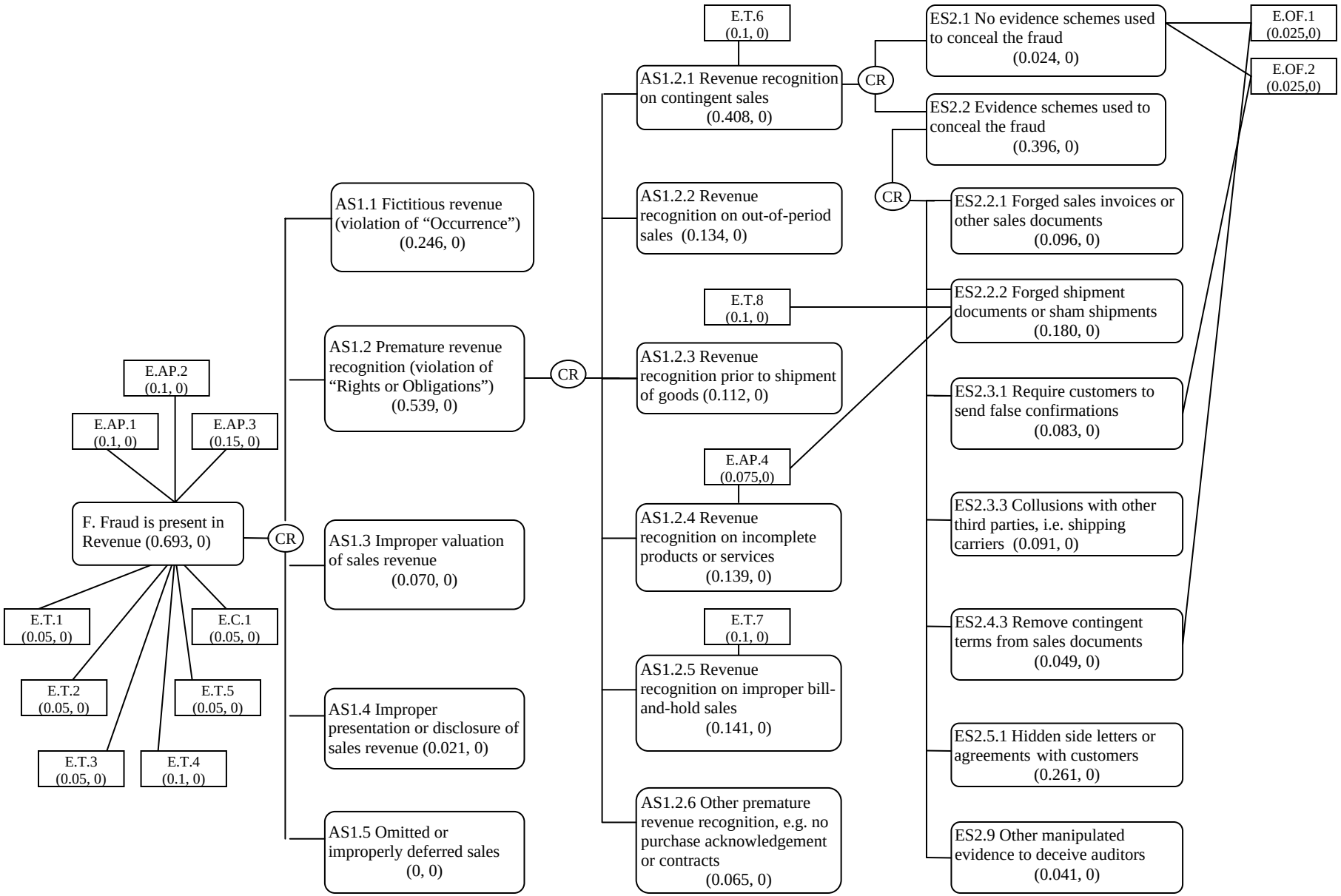

Figure 3: Final Fraud Risk Assessment for FLIR Using Evidential Reasoning Approach

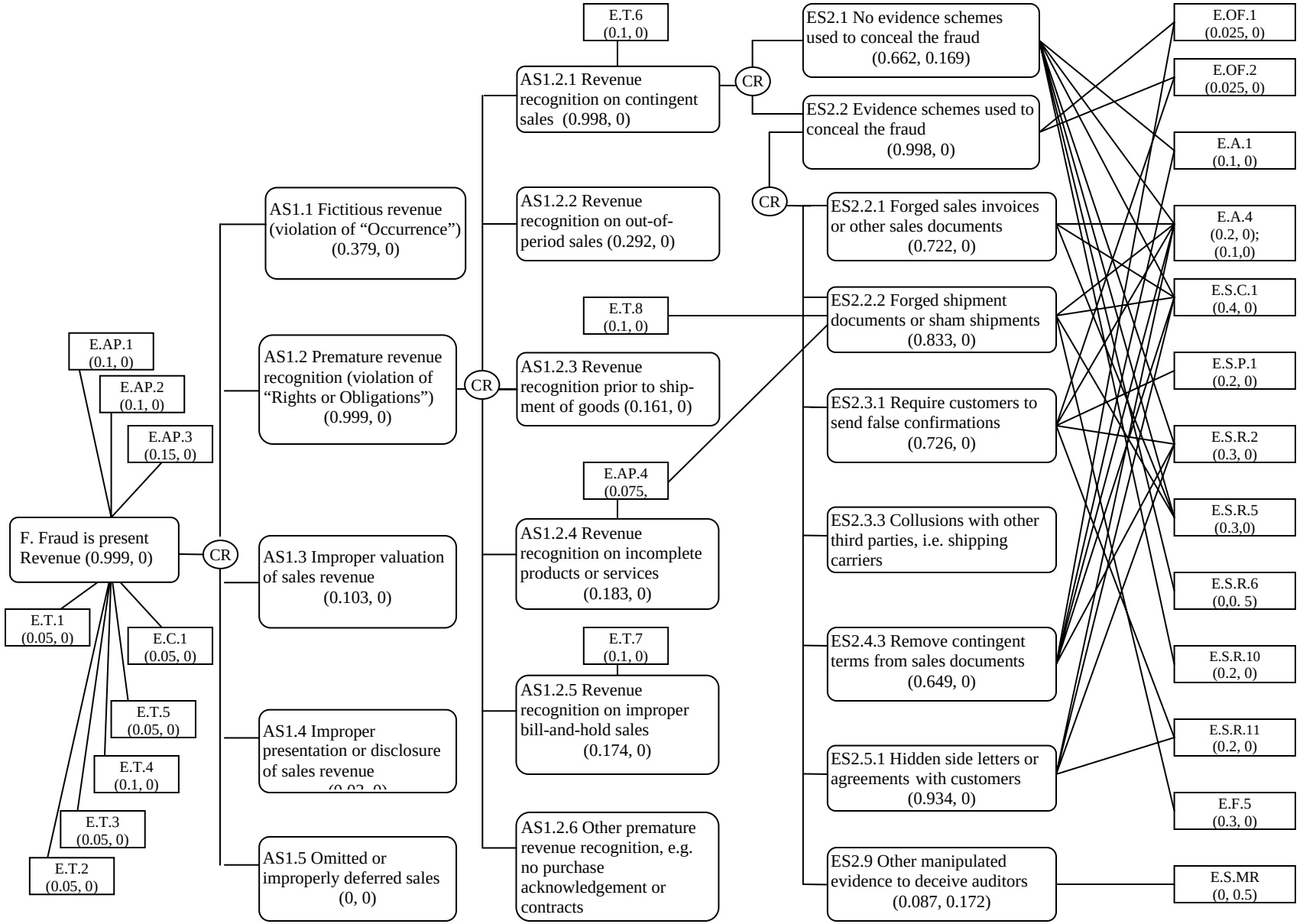

Table 1

Examples of a "Conditional OR" Relational Node

Main Assertion	*Sub-Assertions*	*Conditional OR Logic on Relational nodes*
F	AS 1.1	$(\{f, as_{1.1}, \pm as_{1.2}^{a}, \pm as_{1.3}, \pm as_{1.4}, \pm as_{1.5}\},$ $\{\sim f, \sim as_{1.1}, \sim as_{1.2}, \sim as_{1.3}, \sim as_{1.4}, \sim as_{1.5}\}) =$ **0.33**
F	AS 1.2	$(\{f, \pm as_{1.1}, as_{1.2}, \pm as_{1.3}, \pm as_{1.4}, \pm as_{1.5}\},$ $\{\sim f, \sim as_{1.1}, \sim as_{1.2}, \sim as_{1.3}, \sim as_{1.4}, \sim as_{1.5}\}) =$ **0.54**
F	AS 1.3	$(\{f, \pm as_{1.1}, \pm as_{1.2}, as_{1.3}, \pm as_{1.4}, \pm as_{1.5}\},$ $\{\sim f, \sim as_{1.1}, \sim as_{1.2}, \sim as_{1.3}, \sim as_{1.4}, \sim as_{1.5}\}) =$ **0.10**
F	AS 1.4	$(\{f, \pm as_{1.1}, \pm as_{1.2}, \pm as_{1.3}, as_{1.4}, \pm as_{1.5}\},$ $\{\sim f, \sim as_{1.1}, \sim as_{1.2}, \sim as_{1.3}, \sim as_{1.4}, \sim as_{1.5}\}) =$ **0.03**
F	AS 1.5	$(\{f, \pm as_{1.1}, \pm as_{1.2}, \pm as_{1.3}, \pm as_{1.4}, as_{1.5}\},$ $\{\sim f, \sim as_{1.1}, \sim as_{1.2}, \sim as_{1.3}, \sim as_{1.4}, \sim as_{1.5}\}) =$ **0**

[a] In order to simplify the presentation format, "$\pm$" is used to represent two states of related variables, for instance, $\{f, as_{1.1}, \pm as_{1.2}^{a}, \pm as_{1.3}, \pm as_{1.4}, \pm as_{1.5}\}$, actually includes 2*2*2*2=16 subsets: ($\{f, as_{1.1}, as_{1.2}, as_{1.3}, as_{1.4}, as_{1.5}\}$, $\{f, as_{1.1}, as_{1.2}, as_{1.3}, as_{1.4}, \sim as_{1.5}\}$, $\{f, as_{1.1}, as_{1.2}, as_{1.3}, \sim as_{1.4}, as_{1.5}\}$, $\{f, as_{1.1}, as_{1.2}, as_{1.3}, \sim as_{1.4}, \sim as_{1.5}\}$, $\{f, as_{1.1}, as_{1.2}, \sim as_{1.3}, as_{1.4}, as_{1.5}\}$, $\{f, as_{1.1}, as_{1.2}, \sim as_{1.3}, as_{1.4}, \sim as_{1.5}\}$, $\{f, as_{1.1}, as_{1.2}, \sim as_{1.3}, \sim as_{1.4}, as_{1.5}\}$, $\{f, as_{1.1}, as_{1.2}, \sim as_{1.3}, \sim as_{1.4}, \sim as_{1.5}\}$, $\{f, as_{1.1}, \sim as_{1.2}, as_{1.3}, as_{1.4}, as_{1.5}\}$, $\{f, as_{1.1}, \sim as_{1.2}, as_{1.3}, as_{1.4}, \sim as_{1.5}\}$, $\{f, as_{1.1}, \sim as_{1.2}, as_{1.3}, \sim as_{1.4}, as_{1.5}\}$, $\{f, as_{1.1}, \sim as_{1.2}, as_{1.3}, \sim as_{1.4}, \sim as_{1.5}\}$, $\{f, as_{1.1}, \sim as_{1.2}, \sim as_{1.3}, as_{1.4}, as_{1.5}\}$, $\{f, as_{1.1}, \sim as_{1.2}, \sim as_{1.3}, as_{1.4}, \sim as_{1.5}\}$, $\{f, as_{1.1}, \sim as_{1.2}, \sim as_{1.3}, \sim as_{1.4}, as_{1.5}\}$, $\{f, as_{1.1}, \sim as_{1.2}, \sim as_{1.3}, \sim as_{1.4}, \sim as_{1.5}\}$).

Table 2
Audit Procedures to Detect Premature Revenue Recognition on Contingent Sales

Evid. Nodes	Description of Audit Procedures
E.C.1	Test controls of revenue process, including review of accounting systems by IT auditors
E.A.1	Perform year-to-year and 12-month comparison of sales by customer, current year to budget, gross margin year to year, and comparison to peers
E.A.2	Aging analysis of A/R and compare to prior year
E.A.4	Subsequent cash collection and ratio analysis of cash collection
E.A.5	Compare volumes of sales and shipments at year and quarter end to that of the beginning of the next period
E.A.6	Compare the amount of subsequent product returns to sales and shipments around year and quarter end
E.A.7	Compare the client's sales contracts, rate of product returns, and A/R turnover to peers
E.S.C.1	Send confirmations to customers to confirm A/R balances and terms of agreements (contract terms), handled directly by the auditor
E.S.I.1	Interview with employees at different departments to inquire of significant sales, and shipments.
E.S.I.2	Interview with employees and managers of sales department to inquire of the existence of side letters or oral agreements with customers
E.S.O.1	Observations of physical inventories
E.S.P.1	Obtain print-outs of documents of sales transactions as close as possible to the period end
E.S.R.2	Review debit/credit memos during year & subsequent to period end
E.S.R.3	Review A/R reconciliation
E.S.R.4	Review invoice numbers for out of sequence invoices
E.S.R.5	Review purchase orders, sales invoices, sales contracts, and shipping documents for significant transactions to examine the consistency among sales documents and accounting records
E.S.R.6	Cut-off testing of sales and shipments
E.S.R.7	Get shipping log from shipping department and compare to sales records
E.S.R.9	Perform analysis of rate of product returns and investigate reasons for subsequent product returns
E.S.R.10	Test contracts (event in contracts)
E.S.R.11	Analyze subsequent product return, reversal entries, aging analysis of A/R, and compare accumulated cash collection to sales revenue for concerned customers
E.S.R.12	Review customer complaints
E.S.R.13	Review customary terms and compare to standard terms
E.F.1	Send confirmations to shipping carriers to confirm shipment of significant sales transactions
E.F.2	Obtain original shipping documents from shipping carriers to examine consistency
E.F.5	On site for last day of period for observation of shipping and obtain shipment records of the last several days

Table 3
Preliminary Risk Assessment of Fraudulent Revenue for FLIR Case

Panel A: Overall Fraud Risk Assessment of Fraudulent Revenue

Evidence Nodes	*Description*	*Related Assertions in Evidential Network*	*Belief Values (m-values)*
E.T.1	Pressure to meet earnings projections and analysts estimates	F. Fraudulent Revenue	m (f) = 0.05
E.T.2	Two major mergers in 1997 & 1999	F. Fraudulent Revenue	m (f) = 0.05
E.T.3	Annual bonus based on pre-tax profit performance of quarters and year	F. Fraudulent Revenue	m (f) = 0.05
E.T.4	Change of CEO during year 1998	F. Fraudulent Revenue	m (f) = 0.1
E.T.5	International Business	F. Fraudulent Revenue	m (f) = 0.05
E.C.1	Directors of sales operations, CFO, and senior vice president of sales could authorize to enter and edit purchase orders	F. Fraudulent Revenue	m (f) = 0.05
E.AP.1	Huge increase of revenue, with increases of gross margin and other profitability ratios in 1998	F. Fraudulent Revenue	m (f) = 0.1
E.AP.2	Huge decrease of cash flow from operations in 1998	F. Fraudulent Revenue	m (f) = 0.1
E.AP.3	Abnormal increase of revenue and profitability ratios in the 4^{th} quarter of 1998, followed by an abnormal decrease in the 1^{st} quarter of 1999	F. Fraudulent Revenue	m (f) = 0.15

Panel B: Risk Assessment of Account Schemes and Evidence Schemes

Evidence Nodes	*Description*	*Related Assertions in Evidential Network*	*Belief Values (m-values)*
E.T.6	A Majority of customers are agencies and integrators who have their "end-users"	AS 1.2.1 Contingent Sales	m ($as_{1.2.1}$) = 0.1
E.T.7	Large amounts of bill and hold sales	AS 1.2.5 Bill and Hold Sales	m ($as_{1.2.5}$) = 0.1
E.T.8	Recognize revenue upon shipments to a third-party warehouse ("bonded warehouse")	ES 2.2.2 Sham Shipments	m ($es_{2.2.2}$) = 0.1
E.AP.4	Continuous decrease of inventory turnover rate and relatively stable A/R turnover	AS 1.2.4 Incomplete Products ES 2.2.2	m ($as_{1.2.4}$, $es_{2.2.2}$)= 0.075
E.OF.1	Annual Audit	ES 2.2 Evidence Schemes ES 2.4.3 Remove Contingency	m ($as_{2.2}$, $es_{2.4.3}$) = 0.025
E.OF.2	Client of Big-Five accounting firms	ES 2.2 ES 2.3.1 Collusion w/ Customers	m ($as_{2.2}$, $es_{2.3.1}$) = 0.025

Table 4

Proposed Audit Procedures and Assumed Beliefs of Evidence for FLIR Case

Evidence Nodes	*Description*	*Related Assertions in Evidential Network*	*Assumed Belief Values (m-values)*
E.A.1	Perform year-to-year and 12-month comparison of sales by customer, current year to budget, gross margin year to year, and comparison to peers	ES 2.1, ES 2.4.3	m ($es_{2.1}$, $es_{2.4.3}$)= 0.1
E.A.4	Subsequent cash collection and ratio analysis of cash collections	ES 2.1, ES 2.2.1, ES 2.2.2, ES 2.3.1, ES 2.4.3, ES 2.5.1	m ($es_{2.1}$, $es_{2.2.1}$, $es_{2.2.2}$, $es_{2.3.1}$, $es_{2.4.3}$, $es_{2.5.1}$) = 0.2; m ({ $\pm es_{2.1}$, $\pm es_{2.2.1}$, $\pm es_{2.2.2}$, $es_{2.3.1}$, $es_{2.4.3}$, $es_{2.5.1}$) } = 0.1
E.S.C.1	Send confirmations to customers to confirm A/R balances and terms of agreements (contract terms), handled directly by the auditor	ES 2.1, ES 2.2.1, ES 2.2.2, ES 2.4.3, ES 2.5.1	m ($es_{2.1}$, $es_{2.2.1}$, $es_{2.2.2}$, $es_{2.3.1}$, $es_{2.4.3}$, $es_{2.5.1}$) = 0.4
E.S.P.1	Review journal entries of sales revenue recorded near period end	ES 2.3.1	m ($es_{2.3.1}$) = 0.2
E.S.R.2	Review debit/credit memos during year & subsequent to period end	ES 2.1, ES 2.3.1, ES 2.4.3, ES 2.5.1	m ($es_{2.1}$, $es_{2.3.1}$, $es_{2.4.3}$, $es_{2.5.1}$) = 0.3
E.S.R.5	Review purchase orders, sales invoices, sales contracts, and shipping documents for significant transactions to examine the consistency among sales documents and accounting records	ES 2.1, ES 2.2.1, ES 2.2.2	m ($es_{2.1}$, $es_{2.2.1}$, $es_{2.2.2}$) = 0.3
E.S.R.6	Cut-off testing of sales and shipments	ES 2.1	m (~$es_{2.1}$) = 0.5
E.S.R.10	Test contracts (event in contracts)	ES 2.1	m ($es_{2.1}$) = 0.2
E.S.R.11	Analyze subsequent product return, reversal entries, aging analysis of A/R, and compare accumulated cash collection to sales revenue for concerned customers	ES 2.3.1, ES 2.5.1	m ($es_{2.3.1}$, $es_{2.5.1}$) = 0.2
E.F.5	On site for last day of period for observation of shipping and obtain shipment records of the last several days	ES 2.2.2	m ($es_{2.2.2}$) = 0.3
E.S.MR	Client representations to assure auditors all sales satisfy revenue recognition policies	ES 2.9	m (~$es_{2.9}$) = 0.5

Table 5
Comparisons of Fraud Risk Assessments amongst Different Evidential Reasoning Models

	Preliminary Fraud Risk Assessment				Final Fraud Risk Assessment			
	With Evidence Related to Overall Revenue Fraud Risk Only		With All Evidence		"CR" Logic		"OR" Logic	
Assertion Nodes	"CR" Logic	"OR" Logic	"CR" Logic	"OR" Logic	With assertions related to evidence schemes	Without assertions related to evidence schemes	With assertions related to evidence schemes	Without assertions related to evidence schemes
Account Level								
F. Fraudulent Revenue	0.520, 0	0.520, 0	0.693, 0	0.693, 0	0.999, 0	0.866, 0.017	0.999, 0	0.866, 0
Account Schemes Level								
AS1.1 Fictitious Sales	0.172, 0	0, 0	0.246, 0	0, 0	0.379, 0	0.328, 0.022	0, 0	0, 0
AS1.2 Premature Revenue	0.281, 0	0, 0	0.539, 0	0.359, 0	0.999, 0	0.799, 0.046	0.998, 0	0.722, 0
AS1.3 Other Overstated Revenue	0.052, 0	0, 0	0.070, 0	0, 0	0.103, 0	0.091, 0.018	0, 0	0, 0
AS1.4 Improper Disclosure	0.016, 0	0, 0	0.021, 0	0, 0	0.03, 0	0.027, 0.017	0, 0	0, 0
Specific Account Schemes Level								
AS1.2.1 Contingent sales	0.129, 0	0, 0	0.408, 0	0.288, 0	0.998, 0	0.730, 0.136	0.998, 0	0.675,0.163
AS1.2.2 Out-of-period sales	0.053, 0	0, 0	0.134, 0	0, 0	0.292, 0	0.231, 0.086	0, 0	0, 0
AS1.2.3 Prior to shipments	0.025, 0	0, 0	0.112, 0	0, 0	0.161, 0	0.138, 0.055	0, 0	0, 0
AS1.2.4 Incomplete products	0.022, 0	0, 0	0.139, 0	0.075, 0	0.183, 0	0.160, 0.055	0.075, 0	0.075, 0
AS1.2.5 Improper bill and hold sales	0.017, 0	0, 0	0.141, 0	0.1, 0	0.174, 0	0.155, 0.055	0.1, 0	0.1, 0
AS1.2.6 Other premature revenue	0.034, 0	0, 0	0.065, 0	0, 0	0.120, 0	0.098, 0.046	0, 0	0, 0
Evidence Schemes Level								
ES2.1 No evidence schemes	0.008, 0	0, 0	0.024, 0	0, 0	0.662, 0.169	-	0.645, 0.178	-
ES2.2 With evidence schemes	0.122, 0	0, 0	0.396, 0	0.209, 0	0.998, 0	-	0.994, 0	-
ES2.2.1 Forged sales docs.	0.005, 0	0, 0	0.096, 0	0, 0	0.722, 0	-	0.530, 0	-
ES2.2.2 Forged shipments	0.005, 0	0, 0	0.180, 0	0.168, 0	0.833, 0	-	0.753, 0	-
ES2.3.1 Collusions with customers	0.008, 0	0, 0	0.083, 0	0.025, 0	0.726, 0	-	0.635, 0	-
ES2.3.3 Collusions with other parties	0.010, 0	0, 0	0.091, 0	0, 0	0.484, 0	-	0, 0	-
ES2.4.3 Remove contingencies	0.008, 0	0, 0	0.049, 0	0.025, 0	0.649, 0	-	0.617, 0	-
ES2.5.1 Hidden side letters	0.076, 0	0, 0	0.261, 0	0, 0	0.934, 0	-	0.643, 0	-
ES2.9 Other evidence schemes	0.013, 0	0, 0	0.041, 0	0, 0	0.087, 0.172	-	0, 0.172	-