Privacy-preserving Information Sharing within an Audit Firm

Alexander Kogan & Cheng Yin

Introduction

- This paper explores the possibility of sharing firm-level information within an audit firm in a privacy-preserving manner. It demonstrates the benefits of doing so under the assumption that the same audit firm serves multiple clients competing in the same industry.
- Additionally, we introduce an empirical approach for utilizing current accounting information from peer companies without violating clients' confidentiality.
- We observe significant improvements in estimation accuracy, and error detection performance., when sharing contemporaneous information gathered from peer companies.
- We find that auditors can achieve a comparable level of benefit regardless of whether they share self-generated estimation residuals (errors), or share prediction and actual accounting numbers. Based on this, in order to satisfy stricter privacy concerns, we propose a scheme based on sharing categorical information derived from prediction errors.

Related Work & Research Questions

- *Related Work*:

- The effectiveness and usefulness of using peer firms as a benchmark.
- Based on the usefulness of peer firms, previous papers also have investigated the way of choosing peers (economically-comparable firms).
- A number of both financial accounting and auditing studies have extensively examined the importance of information transfer and industry expertise in providing high-quality audits.

- *Research Questions*:

- When done in a privacy-preserving manner, do auditors within the same firm benefit from sharing contemporaneous peer audit data ?

- How does the level of sharing affect the prediction performance of the scheme?

- How does the level of sharing affect the error detection performance of the scheme ?

Sample Selection

- *Data*:

- A sample of 20 industries containing the most firms experiencing various sales growth rates from 1991–2015, were selected through their 4 digit SIC code.
- Quarterly data of total revenues, cost of revenues, accounts receivable, and accounts payable was downloaded from the Compustat fundamentals quarterly database for the period 1991 – 2015.

SIC	Number of Firms	Account Payable	Cost of Goods Sold	Account Receivable	Revenue	Growth Rate
7372	320.00	28.82	35.71	109.56	166.50	14.05%
6798	236.00	68.56	65.47	204.38	105.89	11.22%
1311	216.00	205.40	307.19	202.43	438.93	23.63%
7370	180.00	209.38	245.57	470.39	468.90	19.30%
2834	152.00	160.39	156.02	403.59	597.10	25.22%
3674	140.00	85.14	120.34	142.48	292.63	12.98%
4911	134.00	280.97	516.87	350.11	734.13	4.86%
5812	124.00	48.97	209.97	37.91	287.86	9.52%
7373	120.00	42.22	79.94	112.21	133.65	13.57%
2836	111.00	64.21	47.92	107.46	158.05	26.51%
3845	100.00	14.80	21.99	49.34	62.58	17.13%
4813	99.00	359.07	438.57	662.59	873.85	14.88%
3663	82.00	187.46	292.45	269.43	461.72	11.05%
3841	68.00	34.87	38.31	65.74	92.55	17.46%
9995	67.00	94.34	45.49	154.13	60.18	5.92%
7990	65.00	28.08	100.50	41.79	171.47	14.63%
3714	63.00	244.00	403.37	338.75	497.17	9.75%
6331	62.00	1807.07	975.98	3666.59	1143.98	10.15%
6211	60.00	9534.34	379.00	12763.90	741.76	12.74%
3576	58.00	35.81	96.10	151.49	267.99	7.86%
3661	54.00	15.84	27.89	39.87	54.83	12.98%

Research Design

- *Peer Selection* :

- Based on size rank and growth rate rank

- *Sharing Schemes*:

- A generic sharing scheme
- Low-level sharing – standardized errors from peer companies.
- Medium-level sharing – standardized predicted value from peer companies.
- High-level sharing – standardized true value from peer companies.
- Categorical Sharing scheme – the sign of prediction errors and the level of deviations

- *Model Specification*:

$$SALE_t = \alpha + \beta_1 SALE_{t-12} + \beta_2 AR_t + \varepsilon_t$$
$$COGS_t = \alpha + \beta_1 COGS_{t-12} + \beta_2 AP_t + \varepsilon_t$$
$$SALE_t = \alpha + \beta_1 SALE_{t-12} + \beta_2 AR_t + IND\_ERROR_t + \varepsilon_t$$
$$COGS_t = \alpha + \beta_1 COGS_{t-12} + \beta_2 AP_t + IND\_ERROR_t + \varepsilon_t$$
$$SALE_t = \alpha + \beta_1 SALE_{t-12} + \beta_2 AR_t + IND\_PREDICT_t + \varepsilon_t$$
$$COGS_t = \alpha + \beta_1 COGS_{t-12} + \beta_2 AP_t + IND\_PREDICT_t + \varepsilon_t$$
$$SALE_t = \alpha + \beta_1 SALE_{t-12} + \beta_2 AR_t + IND\_ACTUAL_t + \varepsilon_t$$
$$COGS_t = \alpha + \beta_1 COGS_{t-12} + \beta_2 AP_t + IND\_ACTUAL_t + \varepsilon_t$$
$$SALE_t = \alpha + \beta_1 SALE_{t-12} + \beta_2 AR_t + IND\_SIGN_t + \varepsilon_t$$
$$COGS_t = \alpha + \beta_1 COGS_{t-12} + \beta_2 AP_t + IND\_SIGN_t + \varepsilon_t$$
$$SALE_t = \alpha + \beta_1 SALE_{t-12} + \beta_2 AR_t + IND\_DEVIATION_t + \varepsilon_t$$
$$COGS_t = \alpha + \beta_1 COGS_{t-12} + \beta_2 AP_t + IND\_DEVIATION_t + \varepsilon_t$$
$$SALE_t = \alpha + \beta_1 SALE_{t-12} + \beta_2 AR_t + IND\_SIGN_t + IND\_DEVIATION_t + \varepsilon_t$$
$$COGS_t = \alpha + \beta_1 COGS_{t-12} + \beta_2 AP_t + IND\_SIGN_t + IND\_DEVIATION_t + \varepsilon_t$$

Results

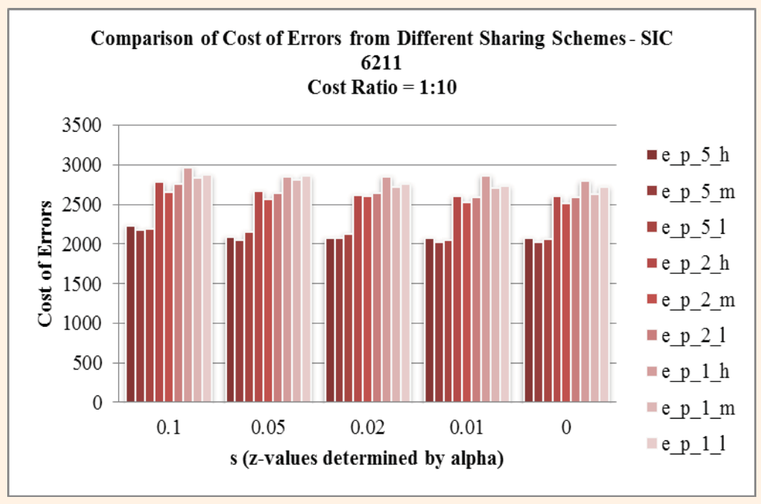
- *Estimation Accuracy*:

SIC	# Firms	E(MAPE) _O	E(MAPE) _E	E(MAPE) _P	E(MAPE) _A
7372	316	1.57	0.73	0.73	0.73
1311	212	4.54	2.00	1.85	2.06
7370	180	0.77	0.45	0.41	0.34
2834	150	0.58	0.42	0.34	0.38
3674	140	0.39	0.25	0.23	0.24
4911	126	0.31	0.18	0.19	0.18
5812	121	0.11	0.08	0.08	0.08
7373	120	0.33	0.20	0.21	0.20
2836	111	1.92	0.85	0.85	0.82
3845	100	0.53	0.31	0.29	0.31
4813	98	0.31	0.21	0.22	0.21
3663	82	0.28	0.21	0.20	0.20
4931	73	0.25	0.14	0.15	0.14
3841	68	0.44	0.29	0.24	0.28
9995	67	0.90	0.60	0.60	0.54
7990	65	0.30	0.19	0.16	0.17
3714	63	0.20	0.13	0.13	0.13
6331	62	0.30	0.21	0.20	0.21
6211	59	0.26	0.17	0.16	0.17
3576	58	0.27	0.18	0.18	0.18

We observe that, when comparing peer models to benchmark models, 19 of the 20 industries experience prediction improvements out of which 18 differences are significant and 1 barely significant.

- *Error Detection*:

Example (SIC 6211)



We observe that with the different prediction intervals the shape of columns stays the same, which implies that the cost of errors among different sharing schemes is similar. In other words, the low-level sharing, medium-level sharing and high-level sharing schemes perform similarly in error detection.

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Imagineering Audit 4.0

Jun Dai and Miklos A. Vasarhelyi

Background

Advances in Cyber-Physical Systems (CPS), Internet of Things (IoT), Internet of Service (IoS), and Smart factory promote a new industry revolution.

Industry 4.0 became publicly known at Hannover Fair in 2011 The German federal government announced Industry 4.0 as one of the key initiatives to implement the German high-tech strategy 2020.

This project foresees the impact of the Industry 4.0 on the auditing profession, imagineers the use of new schemata for audit purposes, and identifies challenges in the transformation towards the new generation of auditing: "Audit 4.0".

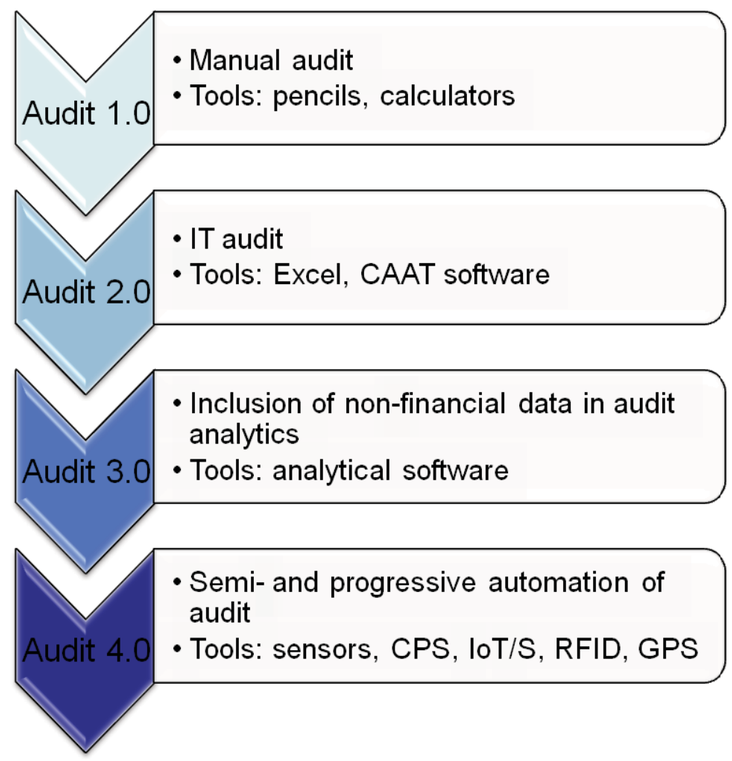
Audit 4.0 Definition

Audit 4.0 will piggyback on technology promoted by Industry 4.0, especially the IoT, IoS, CPS, and smart factories, to collect financial and operational information, as well as other audit-related data from an organization and its associated parties.

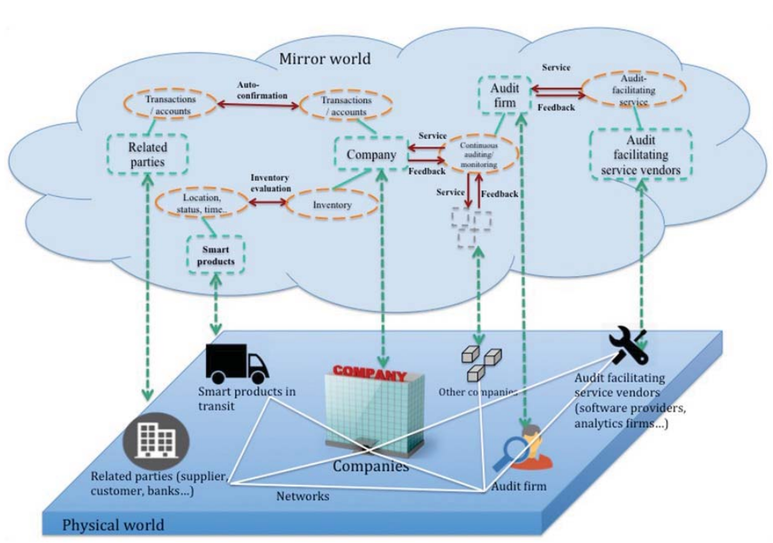
It analyzes, models, and visualizes data in order to discover patterns, identify anomalies, and extract other useful information for the purpose of providing effective, efficient, and real-time assurance.

It is typically an overlay of Industry 4.0 business management processes and uses a similar infrastructure, but for assurance purposes.

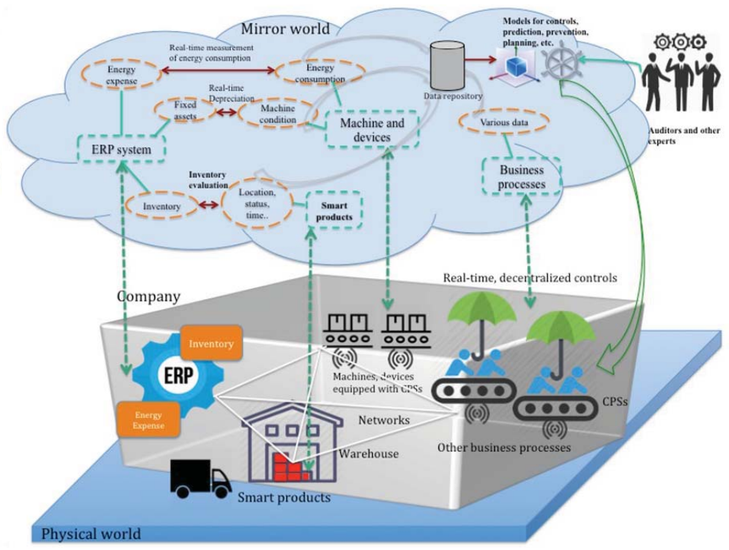
Evolution of Auditing: From 1.0 to 4.0



Audit 4.0 - Overall



Audit 4.0 – Intra-business



Challenges & Research Questions

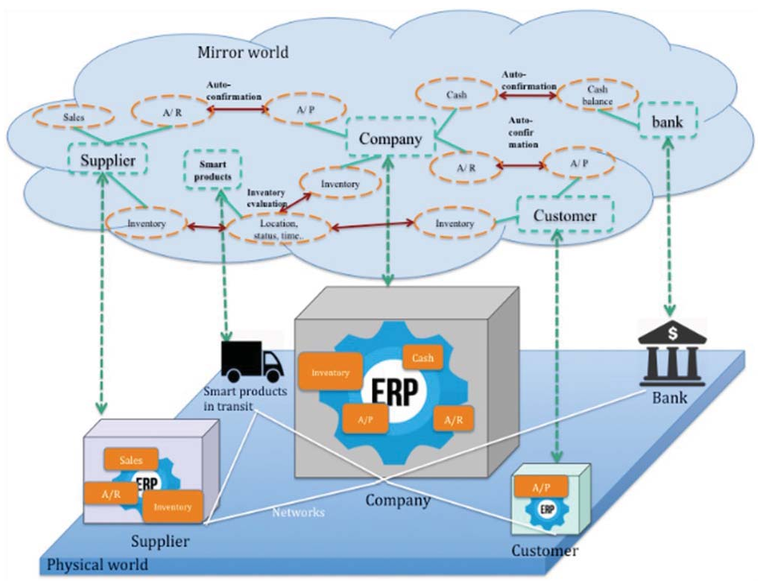
CHALLENGES:

- *Digital crime: technique given, technique taken*
- *Security and privacy issues of companies' data*
- *Standardization of information and data*

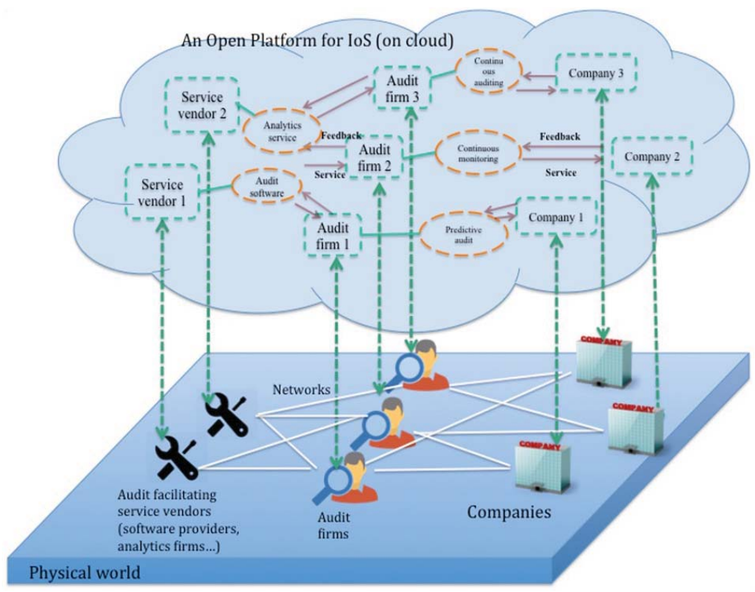
RESEARCH QUESTIONS

- What new types of audit evidence can be generated and collected in the context of Audit 4.0?
- How should the auditing standards be changed to adapt to the next auditing environment?
- What are the new audit procedures to be developed/ created in Audit 4.0?
- What new knowledge should auditors obtain to perform audits in Audit 4.0?

Audit 4.0 – Inter-businesses



Audit as a Service



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Towards Blockchain-based Accounting and Assurance

Jun Dai and Miklos A. Vasarhelyi

Motivation

Blockchain is a public ledger that provides a secure infrastructure for transactions among unfamiliar parties without a single central authority. It is:

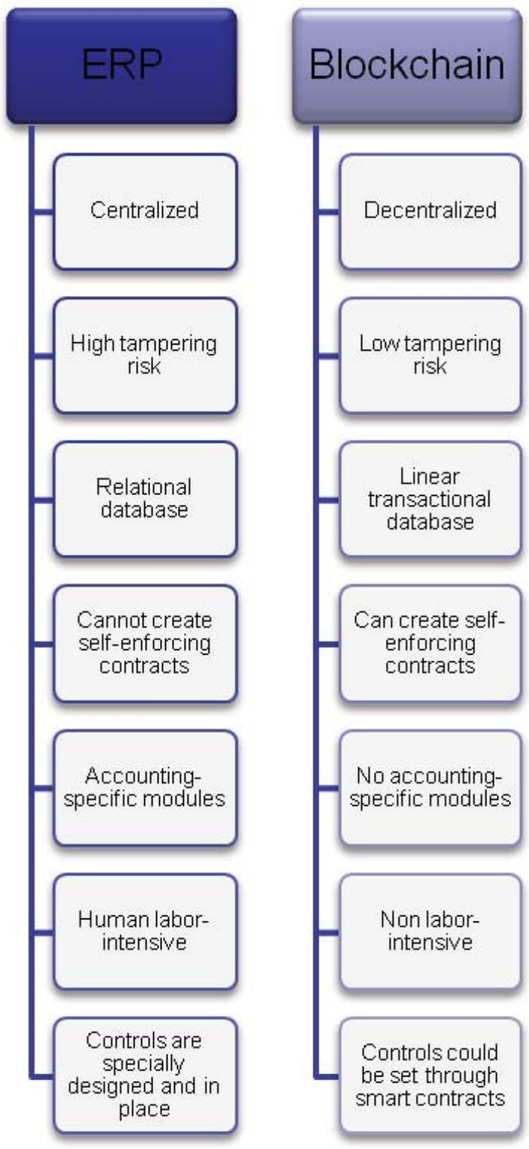
- Decentralized
- Strong Authentication
- Tamper-resistance

Blockchain's applications include:

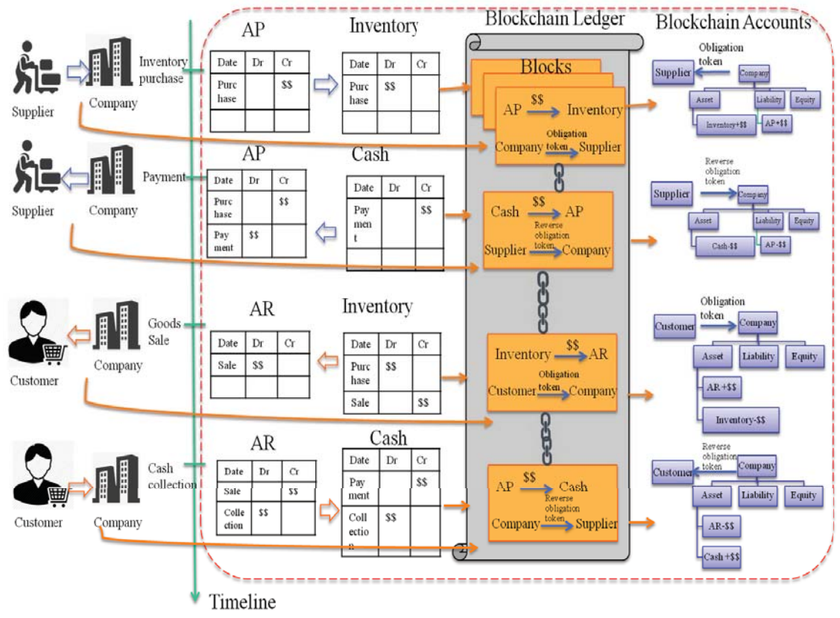
- banking, financial markets, insurance, voting systems, leasing contracts, government service, etc.
- accounting and assurance: under-explored

This project aims to provide an initial discussion on how blockchain could enable a real-time, reliable, and transparent accounting ecosystem. It also discusses how it could help the current auditing paradigm become a more precise, timely, and automatic assurance system.

ERP vs. Blockchain



A Triple-entry Accounting



Blockchain-based Accounting Ecosystem

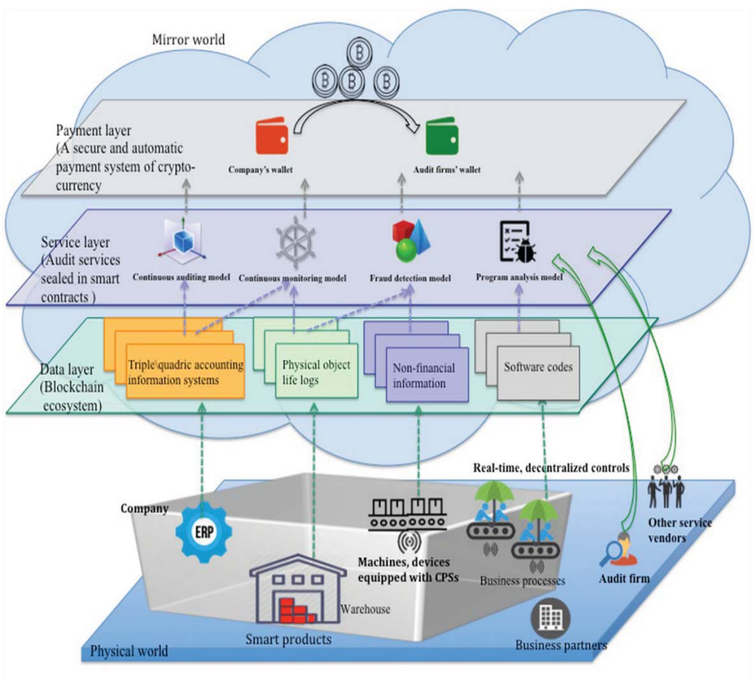
Blockchain could document business transactions and activities in a public, decentralized, and secure ledger, and provide reliable, unchangeable, and timely financial information to interested parties.

Automatic information verification, processing, storing, and reporting could be combined to form a self-sufficient accounting ecosystem.

Smart contracts would operate as autonomous software agents on blockchain and execute various pre-specified or pre-approved accounting tasks under the control of accounting and business rules.

Smart contracts could be combined with IoT technology that can capture the actual conditions and activities of physical objects to monitor the recording process.

Applying Blockchain to Continuous Assur-



Challenges and Research Questions

CHLLENGES

- *Highly demanding of storage and computational power*
- *The scope of necessary accounting data and other information to be posted to blockchain*
- *Changes of corporate processes*
- *Technical training*

RESEARCH QUESTIONS

- How could a multi-entry system work and interface with evolving traditional systems?
- How should accounting standards be changed? Should there be parallel standards created for this transformation?
- Which accounting data should be recorded in blockchain? What other information (such as IoT data) should be loaded to blockchain in order to provide better assurance?
- Would auditing be needed/ necessary with a secure blockchained data stream? In which areas?

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Information Technology Capability, Management Forecast Accuracy, and Analyst Forecast Revisions

Feiqi Huang and He Li

Introduction

- A firm's information technology (IT) capability is defined as its ability to mobilize and deploy IT-based resources in combination with other resources and capabilities (Bharadwaj 2000). Prior research demonstrates that the effective use of IT resources can boost a firm's performance and increase firm value (Muhanna and Stoel 2010; Santhanam and Hartono 2003; Shin 2006).
- Accurate management forecasts, which rely on effectiveness and efficiency of management information systems, reduce information asymmetry (Coller and Yohn 1997). They also improve a firm's reputation for transparent and credible reporting (Garham, Harvey, and Rajgopal 2005). However, little is known about whether IT capability can enhance management's prediction of their firm's future performance.
- The purpose of this study is to examine whether firms with a high IT capability have more accurate management forecasts. In addition, we test whether analysts incorporate information from management forecasts into their revisions for such firms. We consider firms listed on InformationWeek 500 as having high IT capability.

Literature Review and Hypotheses Development

- A stream of literature focuses on IT-enabled information management capability, and demonstrates that such capability improves firm-level performance (Kohli and Grover 2008; Sambamurthy, Bharadwaj, and Grover 2003). IT capability contributes to information management capability, which is defined as a firm's ability to design and manage an effective performance measurement and analysis system (Mithas et al. 2011). In addition, firms equipped with both IT infrastructure and tools, such as data analytics, have a better chance of understanding how to exploit their data and convert them into credible and useful information (Kohli and Grover 2008).
- Prior research also documents the relationship between firm's IT capability and internal controls. Chen et al. (2014) suggest that IT capability contributes to a strong and integrated IT infrastructure to support effectively built-in controls, which significantly enhance the effectiveness of internal controls, especially the effectiveness of IT-related internal controls.

H1: Ceteris paribus, management forecast accuracy is positively influenced by firm's IT capability.

- Firms with high IT capability tend to create intangible benefits (Bharadwaj 2000; Brynjolfsson and Hitt 1997). However, higher levels of intangible resources and assets will also lead to a larger magnitude of mismatched revenues and expenses being reported for these high-intangible firms. This will increase uncertainty about future earnings (Barron et al. 2002; Dehning, Pfeiffer, and Richardson 2006).
- Analysts' information advantage resides at the macroeconomic level, while managers' information advantage is most pronounced in cases where analysts find it hard to anticipate managers' response to unusual operating situations (Hutton et al. 2012). In addition, analysts have incentive to issue accurate earnings forecasts, and overweight management forecasts when they are useful and credible (Feng and McVay 2010).

H2: Ceteris paribus, the extent that analysts incorporate management forecasts is positively influenced by firm's IT capability.

Methodology

- We use data from five sources: InformationWeek, Standard and Poor's Compustat, Company Issued Guidelines (CIG) of Thomson Financial's First Call Database, CRSP US Stock Databases, and the Institutional Brokers Estimation System (I/B/E/S) database of analyst forecast and actual EPS.
- Following Feng et al. (2009) and Heckman (1979), we employ a two stage model to control for the endogeneity issue of voluntary provision of management forecasts, and to test the first hypothesis.

$$\begin{aligned} GUIDANCE = {} & \beta_0 + \beta_1 AT + \beta_2 BETA + \beta_3 LNAGE + \beta_3 BIG4 + \beta_4 ABSCHGROA + \beta_5 LOSS \\ & + \beta_6 EARNING\ VOLATILITY + \beta_7 CASHFLOW\ VOLATILITY \\ & + \beta_8 SALE\ VOLATILITY + \beta_9 GROWTH + \beta_{10} LEVERAGE + \beta_{11} SEGMENT \\ & + \beta_{12} FOREIGN + \beta_{13} ICW + \beta_{14} SI + \beta_{15} M\&A + \beta_{16} RESTRUCTURING \\ & + \beta_{17} R\&D + \beta_{18} STDAF + \beta_{19} LNANALYST \\ & + \sum \beta_i\ Industry\ and\ year\ Indicators + \varepsilon \end{aligned} \quad (1)$$

$$\begin{aligned} MFERROR = {} & \beta_0 + \beta_1 ITC + \beta_2 LNAT + \beta_3 BETA + \beta_4 LNAGE + \beta_5 BIG4 + \beta_6 ABSCHGROA \\ & + \beta_7 LOSS + \beta_8 EARNING\ VOLATILITY + \beta_9 CASHFLOW\ VOLATILITY \\ & + \beta_{10} SALE\ VOLATILITY + \beta_{11} GROWTH + \beta_{12} LEVERAGE + \beta_{13} SEGMENT \\ & + \beta_{14} FOREIGN + \beta_{15} ICW + \beta_{16} SI + \beta_{17} M\&A + \beta_{18} RESTRUCTURING \\ & + \beta_{19} R\&D + \beta_{20} DISPFOR + \beta_{21} HORIZON + \beta_{22} ABSREVISION + \beta_{23} IMR \\ & + \sum \beta_i\ Industry\ and\ year\ Indicators + \varepsilon \end{aligned} \quad (2)$$

- To test hypothesis 2, that firms' IT capability will influence the extent that analysts incorporate management forecasts, we construct the following regression model.

$$\begin{aligned} ANAREV = {} & \beta_0 + \beta_1 MAGREV + \beta_2 ITC + \beta_3 MAGREV * ITC + \beta_4 DOWN + \beta_5 MAGREV \\ & * DOWN + \beta_6 AGREE + \beta_7 MAGREV * AGREE + \beta_8 REPUTATION \\ & + \beta_9 MAGREV * REPUTATION + \beta_{10} ICW + \beta_{11} MAGREV * ICW + \beta_{12} LNAT \\ & + \sum \beta_i\ Industry\ and\ year\ Indicators + \varepsilon \end{aligned} \quad (3)$$

Results and Contributions

- Empirical results support both H1 and H2.
  - In the regression estimation (2), the coefficient of ITC is negative and statistically significant (-0.004; p-value<0.01). This suggests that on average, management's forecast errors involving firms with high IT capability is 0.004 lower than those of other firms. Given that the mean management forecast error is 0.011 for the full sample, our result is economically significant. It shows that IT capability can reduce forecast errors by more than 36 percent.
  - In regression model (3), the variable of interest (MAGREV*ITC), that captures the analyst's incremental incorporation for firms with high IT capability, is both positive, and significant (0.326; p-value<0.01). This indicates that analysts perceive management forecasts to be more useful and credible when a firm has high IT capabilities, and thus enhance the extent of incorporation in revised analyst forecasts.
- This paper makes several contributions:
  - First, we fill a void in prior literature by demonstrating the relationship between IT capability and management forecasts. The amount of information present in management forecasts is of great interest to investors, analysts, and academic researchers. By isolating one factor that both statistically and economically influences management forecast accuracy, we provide some value in understanding the credibility and usefulness of management forecasts.
  - Second, we contribute to analyst forecasting literature by showing that analysts do in fact consider IT capability as a critical variable when making their revisions.
  - Third, this paper also has implications for IT literature and IS literature. We document that IT capabilities can significantly enhance management's ability to predict future performance. This provides further evidence that investing in IT is valuable (Mithas et al. 2012).

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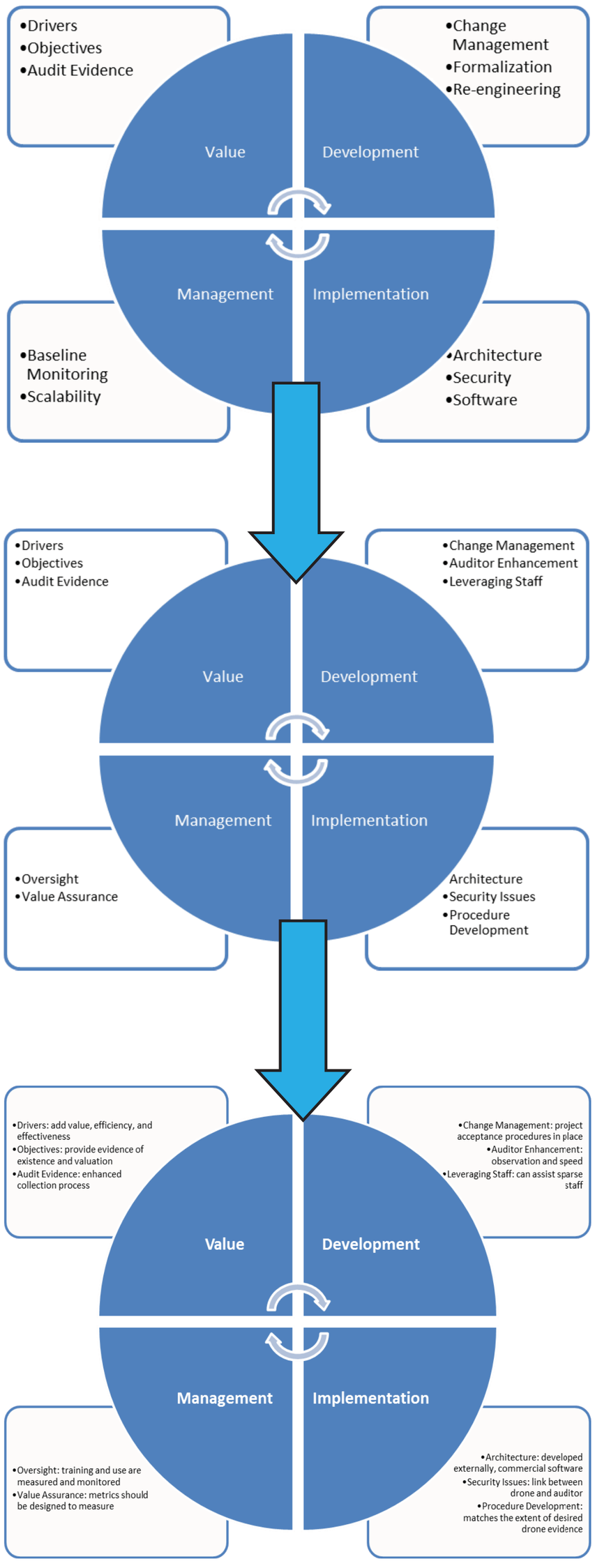
Using Drones in Internal and External Audits:

An Exploratory Framework

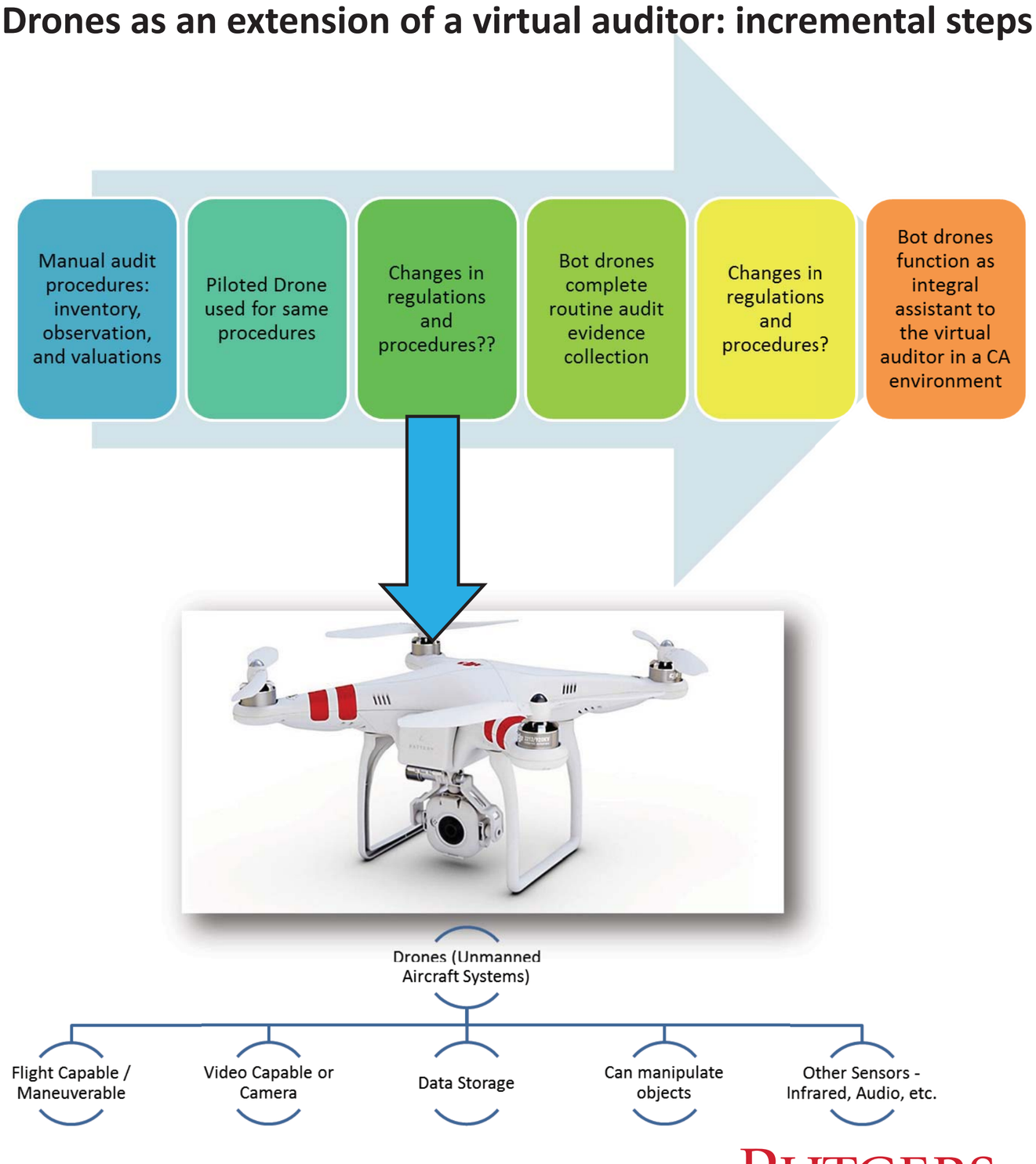
Deniz Appelbaum and Robert Nehmer

Audit Drone Automation Steps:



Physical Inventory:	Current physical audit procedure	Audit procedure with MANNED drone	Audit procedure with UNMANNED drone
1.evaluate	Verifying that certain procedures and controls are in compliance	Drone could capture images of flow charts and read/analyze results	Drone could capture images of flow charts and read/analyze results
2.observe	Observe/watch the procedure	Drone could observe and watch procedure, as directed or piloted by the auditor	Drone could observe and watch procedure based on video input and sensor tracking
3.inspect	Visually and/or physically inspect the inventory	Drone could observe the worker physically inspecting or observe/view the inventory condition itself.	Drone could observe and watch inspection based on video input and sensor tracking
4.perform	May need to recount inventory; re-perform inventory numbers	Drone could recount inventory if needed – data feeds automatically into audit app which re-performs process	Drone is recounting inventory all the time – data feeds automatically into audit app which re-performs process.
Occurrence:			
1.observe	Watch process or control activity	Drone may watch process or control activity	Drone could watch and follow based on video input and analysis
Valuation:			
1.inspect	Visually inspect the asset for impairment	Visually inspect the asset for impairment, safety is not an issue	Drone could visually inspect based on video feed and GPS sensors

Drones as an extension of a virtual auditor: incremental steps



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Examination of Audit Planning Risk Assessments Using Verbal Protocol Analysis: An Exploratory Study

Andrea Rozario, Helen Brown-Liburd, Miklos Vasarhelyi, Theodore Mock

Introduction

Auditors operate in a complex environment and are often required to make judgments that can have a direct impact on the quality of an audit. When planning for an audit engagement, the auditor must assess audit risk to evaluate the likelihood of issuing an incorrect audit opinion. The risk assessment process helps auditors determine the nature, timing, and extent of audit procedures. Furthermore, the AICPA's audit risk model has been traditionally used to assess audit risk and plan audit procedures which achieve an acceptable level of audit risk. Based on the assessment of inherent risk and control risk, the auditor determines a tolerable level of detection risk. The audit planning literature is abundant with experimental and archival studies which examine the different components of the audit risk model as well as the factors that impact the risk assessment process. However, very few studies have examined the risk assessment process of senior level auditors in practice. As a result, there is minimal knowledge about how higher level auditors evaluate information and how they make subsequent judgments with respect to risk assessment. Thus, examination of the strategies auditors use during the risk assessment process and the resulting decisions reached, will provide data that can be used to improve the risk assessment task, as well as enhance the effectiveness of the audit process.

This study uses a modified verbal protocol analysis methodology to understand the nature of the information incorporated and the reasoning and judgment process related to risk assessment during audit planning. More specifically, an incoming manager to the engagement and a recurring partner engaged in a risk assessment discussion about the auditee.

Literature and Research Questions

- **Inherent Risk Assessment**: Audit risk literature emphasizes the factors that influence inherent risk and how auditors judge inherent risk (Helliar et al., 1996; Peters et al., 1989; Boritz et al., 1987). Furthermore, auditors assess inherent risk qualitatively, on an account by account basis or at the financial reporting level (Peters et al., 1989; Martinov-Bennie and Roebuck 1998).
- RQ 1: What is the nature of the information processing operations which auditors perform during a planning stage client risk assessment task?
- RQ 2: What is the nature and frequency of risks which are verbalized? How are the risks categorized?
- RQ 3: What are the key audit decisions that result from the planning discussion?
- **Combined Risk Assessment**: There may be dependencies between inherent risk and control risk and auditors may perform a combined assessment of these components (Martinov-Bennie and Roebuck, 1998; Waller 1993; Cushing and Loebbecke 1983; Messier et al. 2000; Elder and Allen 2003; Miller et al., 2012). However, the audit risk model suggests inherent risk and control risk are independent.
- RQ 4: Do auditors perform a combined risk assessment?
- **Risk Assessment Approach:** The business risk-based approach may lead to higher accuracy in assessing the risk of material misstatement at both the entity level and business process level (Kochetova-Kozloski and Messier, 2011; Kochetova-Kozloski et al. 2013).
- RQ 5: Do auditors evaluate risks using a top-down approach or a directed approach?

Methodology

Modified verbal protocol analysis (VPA) was employed to capture four verbal protocols for audit partners and managers during the planning discussion. Anecdotal evidence suggests the manager and the partner of an audit engagement perform the risk assessment process during a planning discussion. Therefore, the purpose for the modification of the VPA is to emulate a realistic setting . Experts are less able to verbalize their knowledge as they become more competent (Johnson 1983). Hence, having a new manager on the engagement asking questions about the client may illicit greater information from the audit partner. In this manner, the modified verbal protocols can help obtain information that may not have been verbalized in traditional verbal protocols.

We recorded, transcribed and coded about 45,000 words 6,000 operators into the following categories:

1.Task Structuring—involves the process of understanding the task.

2.Information Acquisition—involves the process of obtaining or retrieving information.

3.Information Processing—involves processes used in the evaluation of information.

4.Decisions—involves the process used in arriving at decisions.

Conclusion

This is the first study, to our knowledge, that investigates audit judgments that are currently made by more experienced auditors (managers and partners) as part of the risk assessment process. By understanding the process of how audit risk assessment is evaluated and the decisions that are derived from those evaluations, this study seeks to provide knowledge that can potentially lead to improved audit risk judgments. This study also contributes to professional practice as it can serve as a baseline in developing audit procedures that can guide auditors in performing more effective risk assessments. Future research can use the data obtained from this verbal protocol analysis to develop a decision support system for risk assessment that can improve audit judgment. Overall, the findings of this study provide valuable insight that can potentially enhance the risk assessment process.

Results

RQ 1: Information primarily retrieved from memory; evaluation for risk assessments; decision processes are largely the reasons or basis for a particular decision.

	Total Operators Coded	% within Category	Overall % of total operations
Task Structuring operators	170		3%
SG: Assigned to verbalizations related to understanding the task.	170	100%	3%
Information Acquisition Operators	1,282		21%
R: Read a document [indicate what document if feasible, e.g. audit documentation, standards]	0	0%	0%
IRM: Information Retrieval from Memory[9]	993	78%	17%
IRW: Information retrieval from workpapers, notes, etc.	167	13%	2%
IOET: Information obtained from other members of the engagement team	118	9%	2%
AC: Algebraic Calculation of relevant item	4	0%	0%
Information Processing Operators	2,412		40%
GA: Generate an Assumption, a premise.	435	18%	7%
CN: Comparison	109	4%	2%
GO: Generate a Query	426	18%	7%
E: an Evaluation, a risk assessment judgment	1,442	60%	24%
Decision Operators	2,100		35%
DS: Decision support	1,394	67%	23%
DR: Decision rule	51	2%	<1%
AD: Audit Decisions	655	31%	12%
TOTALS	5,964		100%

RQ 2: Financial and non-financial information used to identify risks and similar risks are consistently evaluated; certain risks (e.g., related parties) required to be evaluated by the standards were not discussed; RQ 2 (cont'd): focus on risks at the financial statement account level.

		Verbal Protocol			
Risk Type		**VP # 1**	**VP # 2**	**VP # 3**	**VP # 4**
Client Industry		**Electronics/Publicly held**	**Equipment rental company in CA/ Owned by PE**	**Restaurant/Publicly held**	**Retail-Home/Publicly held**
Non Financial	Business Strategy	Business Strategy	Business Strategy	Business Strategy	Business Strategy
	Cyber Security		Cyber Security	Cyber Security	Cyber Security
	Industry	Industry	Industry	Industry	Industry
	Litigation	Litigation	Litigation	Litigation	Litigation
	Management	Management	Management	Management	Management
	Corporate Governance		Corporate Governance	Corporate Governance	Corporate Governance
	Customer Base	Customer Base	Customer Base	Customer Base	
		Economic	Economic		
	Analysts Following				
	Weather		Geography/Weather	Geography/Weather	
	Market Competition	Market Competition	Market Competition		
	Regulatory	Regulatory	Regulatory	Regulatory	
Financial	Accounting Estimates	Accounting Estimates	Accounting Estimates	Accounting Estimates	
	Earnings Management	Earnings Management			
	Valuation	Valuation	Valuation	Valuation	
	Consolidation/Segment Reporting		Consolidation/Segment Reporting	Consolidation	
	Materiality	Materiality	Materiality	Materiality	
	Financial Statement Account Level	Financial Statement Account Level	Financial Statement Account Level	Financial Statement Account Level	
	Financial Statement Level	Financial Statement Level	Financial Statement Level	Financial Statement Level	
	Fraud	Fraud	Fraud	Fraud	
	Controls	Controls	Controls	Controls	
	Going Concern	Going Concern	Going Concern	Going Concern	
	Revenue Recognition	Revenue Recognition	Revenue Recognition	Revenue Recognition	
	Use of Specialist		Use of Specialist	Use of Specialist	
	Impairment	Impairment	Impairment	Impairment	
	Prior Period	Prior Period	Prior Period	Prior Period	
	Related Parties	Related Parties	Related Parties		
Consistency of information discussed		96%	78%	93%	78%

RQ 3: Decisions may or may not be expressed in detail (e.g "perform recalculation of earnings per share" vs. to "focus on earnings per share"); consistent with RQ2, more decisions about risks at the financial statement account level; RQ 3 (cont'd): Materiality discussed at a high level ("consider materiality for group audits") yet auditors consider "material non-significant accounts" .

Risk Type	**VP #1**		**VP # 2**		**VP # 3**		**VP # 4**	
Client Industry	**Electronics/Publicly held**	**# of ADs**	**Equipment rental company in CA/ Owned by PE**	**# of ADs**	**Restaurant/Publicly held**	**# of ADs**	**Retail-Home/Publicly held**	**# of ADs**
Non Financial	Business Strategy	4	Business Strategy	7	Business Strategy	3	Business Strategy	1
	Cyber Security	2			Cyber Security	1	Cyber Security	1
	Industry	6	Industry	5	Industry	3	Industry	1
	Litigation	2	Litigation	1	Litigation	2	Litigation	1
	Management	5	Management	3	Management	8	Management	2
	Corporate Governance	2			Corporate Governance	1	Corporate Governance	2
	Customer Base	1	Customer Base	2	Customer Base	1		
			Economic	2	Economic	1		
	Analysts Following	1						
	Weather	1			Geography/Weather	3	Geography/Weather	1
	Market Competition	1	Market Competition	1	Market Competition	1		
	Regulatory	3	Regulatory	1	Regulatory	6	Regulatory	3
Financial	Accounting Estimates	9	Accounting Estimates	4	Accounting Estimates	10	Accounting Estimates	14
	Earnings Management	1	Earnings Management	1				
	Valuation	11	Valuation	6	Valuation	7	Valuation	13
	Consolidation/Segment Reporting	9			Consolidation/Segment Reporting	1	Consolidation	6
	Materiality	1	Materiality	2	Materiality	2	Materiality	1
	Financial Statement Account Level	16	Financial Statement Account Level	22	Financial Statement Account Level	25	Financial Statement Account Level	17
	Financial Statement Level	1	Financial Statement Level	1	Financial Statement Level	1	Financial Statement Level	4
	Fraud	5	Fraud	7	Fraud	4	Fraud	2
	Controls	4	Controls	1	Controls	10	Controls	8
	Going Concern	3	Going Concern	1	Going Concern	1	Going Concern	2
	Revenue Recognition	5	Revenue Recognition	5	Revenue Recognition	6	Revenue Recognition	2
	Use of Specialist	2			Use of Specialist	4	Use of Specialist	8
	Impairment	2	Impairment	3	Impairment	7	Impairment	1
	Prior Period	1	Prior Period	1	Prior Period	1	Prior Period	1
	Related Parties	1	Related Parties	1	Related Parties	1		
Total Audit Decisions		99		77		110		91

RQ 4: Auditors perform a combined risk assessment however, they largely focus on a discussion of the control environment.

	Verbal Protocol			
	VP # 1	**VP # 2**	**VP # 3**	**VP # 4**
Client Industry	**Electronics/Publicly held**	**Equipment rental company in CA/ Owned by PE**	**Restaurant/Publicly held**	**Retail-Home/Publicly held**
Control Environment	Management is focused on getting things right; management's operating style; company is well structured	Nicely run company; stringent budget; appropriate tone in the company; management want to do what's right;	Management has robust processes in place; Controller is competent; transparency in reporting of compensation elements	Well run company (good culture/tone at the top); company is transparent, no surprises
Control Activities	What controls are in place to mitigate opportunities for doing something inappropriate with recognizing; understand controls in place for contract management; incorporate acquisitions into control testing (controls will fail); may be able to reduce testing if good entity level controls are in place; controls around cybersecurity; automated and manual controls for revenue	Discussion around risks of IT infrastruture	Proper segregation of duties; operational controls and procedures; impact of technology; controls over revenue analysis; controls over payroll process; controls over rental/lease system	Data protection and security is a big area; understand quality of IT system; how they secure data, processes and procedures are important; IT controls for inventory, timeliness of markdowns; policies and procedures for shrinkage; ERP systems critical from controls perspective; IT and application controls; data used to perform control and audit procedures; understanding of systems; especially with acquisitions; application level controls for EPS

RQ 5: Three of the four assessments employ a top-down approach.

	Verbal Protocol			
Assessment Approach	**VP # 1**	**VP # 2**	**VP # 3**	**VP # 4**
Client Industry	**Electronics/Publicly held**	**Equipment rental company in CA/ Owned by PE**	**Restaurant/Publicly held**	**Retail-Home/Publicly held**
Top down		• Risk assessment was discussed first from a global economic and environmental (e.g., weather) perspective (systematic strategy). The focus then turned to key changes from prior period audit, with a focus on management incentives to manage earnings (e.g., compensation, debt covenants, etc.), as well as, any significant changes in key financial statement accounts, such as revenue. Finally, risk was assessed at a financial statement account level.	• Risk discussion was based on macro level perspectives (economic, weather, and regulatory factors). Risks more specific to the company included cyber security, fair value measurement, management turnover, and financial reporting policies. Finally, financial statement	• The risk assessment strategy is more systematic; addressed business risk at a macro level and then focused on risk at the account level
Directed	• Approach appears to focus on financial reporting risks (i.e., where in the company most susceptible to fraudulent financial reporting);thus, the risk assessment process is more of a directed strategy;			

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Formalization of Internal Control Assessment: A Process Mining Application

Abdulrahman Alrefai

Introduction

The Sarbanes-Oxley Act and other regulatory compliance requirements in the area of Internal Controls, force firms to report on the effectiveness of their internal controls. Auditors are required to measure a firm's internal control system and issue an opinion. Traditionally, auditors have used qualitative methods in order to complete this process. These methods are neither consistent nor efficient at measuring controls objectively. Moreover, there are dire consequences if an auditor, who relies on these methods, fails to accurately measure the effectiveness of internal controls. Motivated by these factors, auditors should be eager to embrace a more formal internal control assessment process with quantitative outcomes.

The aim and contribution of this study is to provide a quantitative methodology whereby the effectiveness of internal controls can be measured. Specifically, this paper develops a conceptual model that illustrates how process mining can be used to test internal controls to provide an overall formalized measure of the effectiveness of the internal control system for a business process. It also extends the methodology by developing a framework that can incorporate different testing methodologies, such as matching the control settings of the information system to a well-defined benchmark, or applying text mining techniques for contract compliances, and aggregate the results to assists auditors in formalizing their opinion over the internal control system. Basically, the system attempts to run tests on a dataset relative to a specific audit function, produce results, and based on those results, provide a formalized measure for the effectiveness of the internal control system.

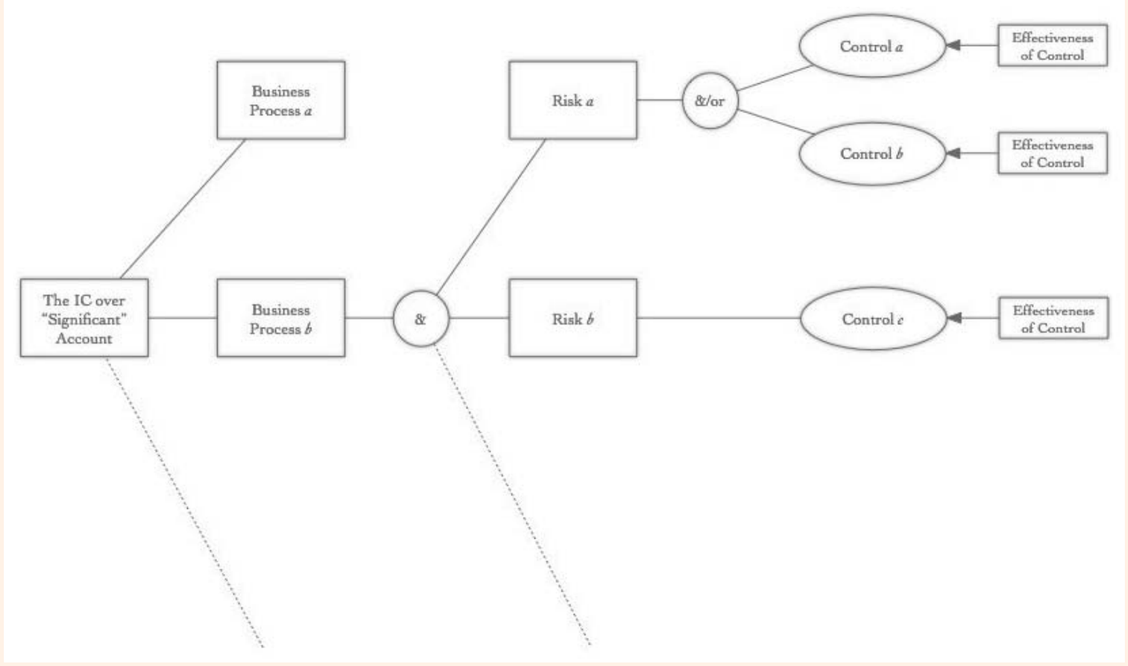
Methodology

Step 1: Identify the controls which need to be implemented by a firm seeking to protect assertions and mitigate risks.

Step 2: Apply process mining techniques as a method for acquiring direct evidence on the controls' compliance, highlighting any deficiencies within the internal control system.

Step 3: Calculate the effectiveness of each control based on the severity of deficiencies and exceptions that were generated.

Step 4: Measure the total effectiveness of the internal control system for the overall business process.

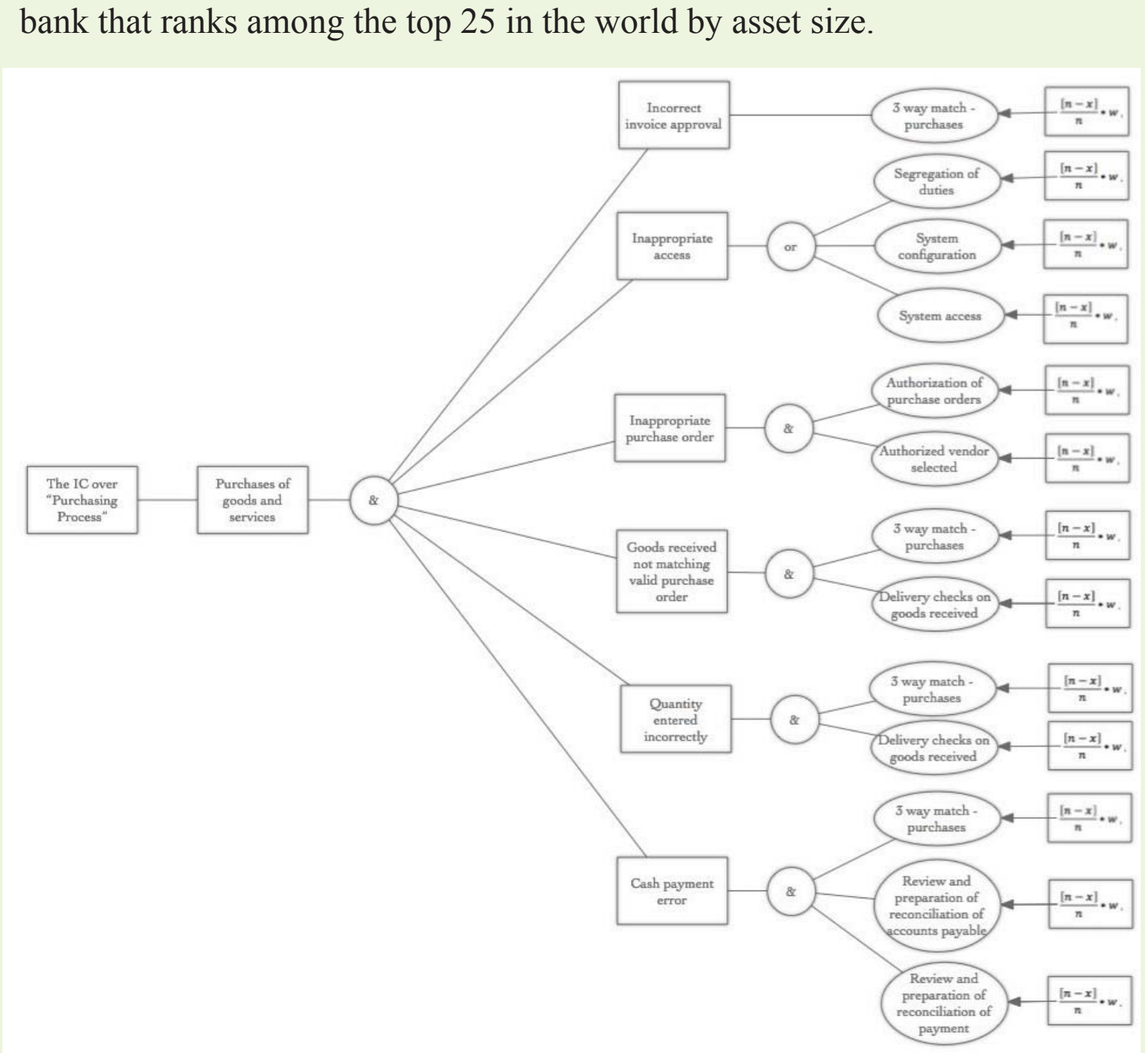


Literature Review

- The assessments generated by qualitative methods alone are insufficient for developing comprehensive internal control evaluation models (Yu & Neter 1973; Mock & Turner, 1981; and Bierstaker and Wright, 2004; Mock et al. 2009).
- Since computers hold advantages in speed, accuracy, memory capacity and processing power, a systematic internal control model should be introduced which aids auditors or management in evaluating internal control system (Bailey et al. 1985).
- The consideration of the whole population of transactions in testing can enhance the effectiveness of an audit and increases the probability that material errors, omissions, fraud, and internal control violations may be detected (Chan and Vasarhelyi 2011).
- Determining the reliability of a control consists of aggregating the possibilities that the control is applied (compliance) and that it is effective (design) (Srinidhi and Vasarhelyi 1989).

Analysis

The data used relates to the procurement process of a leading European bank that ranks among the top 25 in the world by asset size.



Results

Based on testing and measuring the effectiveness of the controls related to the procurement business process, the results indicate that it would get a score of 0.8943 for the overall effectiveness of the internal control system for that business process. This is indicative of a slightly deficient internal control system, albeit being very close to the cutoff point of 0.9 for it to be considered an effective internal control system

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Resisting Change in the Audit Profession: Two Case Studies from Multinational Firms

Ahmad AlQassar and Gerard Brennan

Abstract

Resistance to change is a familiar phenomenon in almost all domains. The accounting profession is not immune to such behavior either. For example, in the 1980s accountants resisted the activity based costing methods proposed by engineers, which they later adopted (Kaplan and Johnson 1987). Nowadays, auditors are resisting technological advancements with respect to their audit processes. This reality has made professional institutions and academics alike expose the outdated approaches and techniques used in the audit profession (AICPA 2012, Alles 2015, Manson et al. 2007). This study presents two cases that shed light on current practices and pave the way for future in-depth research aimed at understanding the reasons behind such a phenomenon.

Objective and Motivation

Understanding why outdated techniques exist in the audit profession is far from trivial. The objective of this paper is to explore this phenomenon via two practical real-life case studies, and briefly present the barriers to change and proposed solutions.

Barriers to Change

In this section we aim to explore some of the probable barriers to adopting technology in the audit profession. The barriers to adopting new technologies in the audit process are many and singling or prioritizing one over the other is nontrivial, and probably requires further research. However, at this stage, we are concerned with presenting the various barriers based on literature and practice. Below are some barriers that may be contributing to the current situation. The points are sorted based on the three major players: Auditors, Auditees, and Standard Setters.

Audit Firms

- IT-related activities are sophisticated
- Dilemma of exposing overlooked cases in the past
- Profitability of the firm might be effected

Auditees

- Protective of their data
- The driver of technology utilization is the demand for it rather than the supply of technology

Standard Setters

- No professional auditing guidance on both the theory and practice of advanced methods in auditing like data analytics and CA/CM (Byrnes et al. 2015)
- The vagueness of standards and guidance in that area might dissuade both auditors and auditees from moving forward.

Case Study 1

The first case involves a large multinational company which has an extensive financial services arm in support of sales and internal financing. They developed a capable continuous monitoring solution that provides assurance and monitoring for more than 250 controls related to operation and compliance on a continuous basis. The continuous monitoring tool was fully accredited by both the internal audit staff and the external auditors for all key IT general controls (ITGC), which helped assure that IT application controls, analytics, and monitoring frequency could not be compromised. Thus, auditors and the company could rely on the assurance provided by the tool. The external auditors proceeded to ask for non-statistical samples from the control system even though the system reports documented that the 250+ controls ran during the exposure period of the audit and that all identified anomalies where remediated and documented.

Case Study 2

The second case involves a large multinational IT service provider and their external audit provider delivering a Third Party Assurance Type II audit. The service provider had three consecutive years of qualified SSAE-16 reports for failures identified via non-statistical sampling. The deficiencies identified were different each year but were mostly in the areas of missed security updates, patching, and network level version upgrades on servers in some of their data centers. Recognizing that using manual identification and remediation methods to identify and update more than 7000 servers is nearly impossible, the service provider developed and purchased an impressive set of CA/CM tools with analytics that monitor all 7000+ servers continuously and automatically install updates and patches for all servers as required. However, the external auditors were unwilling to leverage the tools the service provider already had in place and that were fully accredited .

Conclusion

It is evident that technologies such as CA/CM and analytics can provide a superior level of assurance and deliver it at a much faster rate. Moreover, it is also essential for both the audit standards and practice to keep up with the new business landscape. The need for a change in standards goes beyond replacing sampling and encouraging population-based monitoring. Standards need to incorporate agile, robust, quantitative, and qualitative audit processes that are able to detect more anomalies and deficiencies. Furthermore, standards need to assure that appropriate management judgements are made to remediate and report such issues.

While our paper provides some insight, further research is definitely needed in order to fully explore and explain the presented phenomenon. Our following papers will dig deeper into finding more definitive answers as to why this phenomenon is so entrenched in the modern accounting practice, and how practitioners can alter this behavior.

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The Survived Companies With Going Concern Opinions Are Really Different From Those Bankrupted—

An Exploration About Distressed Companies' Resilience

Alexander Kogan and Jiahua Zhou

Introduction

Both industry and academics consider an auditor's going-concern opinion (GCO) as a signal that a company may face impending bankruptcy. Despite this fact most of these companies who are issued GCOs will survive. This paper aims to observe the differences between companies that were issued GCOs and survived, and those that went bankrupt. The purpose of this is to answer two questions: (1) What kind of information about clients' value creation and strategic features can help to decease auditors' type I error? (2) What are the fundamental factors which lead to a firms resilience under severe financial pressure allowing it to avoid bankruptcy?

Literature Review

There is an abundance of literature which has studied GCO determinants, e.g. Mutchler (1984) and LaSalle and Anandarajan (1996). This literature has provided survey evidence from auditors about the relative importance of different financial ratios used when issuing GCOs. SAS No. 56 (AICPA [1988]) suggests that client financial information should be evaluated over time and related to industry measures. Based on these guidelines, Bell et al. (1991) converted the control variables into both rate-of-change, and industry-standardized measures, effectively extending GCO determinants. For GCO accuracy, several studies have found that 80–90% of companies that receive a GCO, do not fail in the subsequent year (Mutchler et al., 1990; Garsombke et al., 1992; Geiger et al., 1998; Pryor et al., 2002). Methodology literature originally explored discriminant analysis and neural network approaches. More recent studies however, have moved away and began to take Logit and Probit regression (Carson et al., 2013).

Data Description and Hypotheses

The study searched SEC's EDGAR and collected a sample of 2378 manufacture companies with the initial GCOs, whose SIC first two digits range from 20 through 39, between 1998 and 2015. 415 of these companies went bankrupt within 2 years of the GCO. The paper collected detailed, firm-specific, financial data from the two years before and after the GCOs were issued using COMPUSTAT. The final data has 4522 observations, including 994 bankrupted observations. The sample includes 35 variables, 16 of which are industry scaled (scaled by industry mean and standard deviation).

H1a: In the GCO year, the following bankrupted firms have more severe liability problems than following survived firms. Other proxies have no big and significant difference.

H1b: In the posterior first year, the following survived firms can have more efficient cash for their operation than GCO year, and other proxies cannot have significant change.

H1c: In the posterior second year, the general financial states of the following survived firms would have significant change.

H2: In the GCO year, the dynamic financial proxies do not have substantial difference between the following bankrupted and survived companies, but, in the priori second year, these proxies can have faster negative change for the following bankrupted companies.

H3: Strategic cash production ability can have significant difference between the following bankrupted and survived from priori two years through posterior two years.

H4: Industry scaled proxies have stronger prediction for static financial ratios than firm-specific proxies.

Methodology and Results

The paper covered four studies, including two logistic regressions, factor analysis and paired T-test, to show the cascaded map of the evolution of firms' bankruptcy and survival. The study used the dynamic change measurements from three time points to show the evolution of bankruptcy and survival. (1) From two years priori GCO to GCO year, the dynamic financial ratios, including sales, earnings ability, decreased faster for the bankrupted companies than survived companies; (2) In GCO year, liability, especially current liability, have significant difference between survived and bankrupted companies, but there are no significant difference for dynamic financial ratios; (3) From GCO year through the first posterior year, survived companies only improve their cash position, and until the second posterior year, some other proxies for financial states began to significantly improve, and from the third posterior year sales began to increase significantly.

Conclusions and Future Research

This research has two main contributions: First, this is the first study to explore the type I error of GCOs in audit literature, and it finds several proxies that should be investigated more closely. Second, The methodology with industry scaled variables offers new findings about the whole picture of firms' bankruptcy and survival. In future research, it is approachable to observe how corporate governance exerts its effect after the initial GCO, and how management plan influence for firms' survival.

Table 2: Selected Result of the Paired T-test in GOC year and posterior two years

Variables	GCO year	Posterior one year	T value	Posterior two years	T value
Working Capital to Total Liability (WCTL)	.65	57.01	-1.01 **(.314)**	1.136	-2.57 **(.010*)**
Net Equity to Total Liability (NETL)	1.299	57.91	-1.01 **(.312)**	1.98	-2.52 **(.0118*)**
Cash Position	.2789	.37	2.22 **(.0264**)**	.357	-1.81 **(.0707*)**
Industry scaled WCTL	-.320	35.27	-1.00 **(.359)**	-.147	-2.56 **(.010*)**
Industry scaled NETL	-.271	25.72	-1 **(.315)**	-.087	-2.72 **(.0068**)**
Industry scaled Cash Position	-.194	-.092	-2.01 **(.045*)**	-.135	-1.08 **(.2804)**
Industry scaled Improve	-.196	-.048	-.46 **(.647)**	-.355	-1.75 **(.0801*)**

Table 1: Selected Results for Two Logistic Regressions

Dependent Variable: Bankruptcy			
Logistic Regression on Extracted Factors		Logistic Regression on change between priori two years to GCO year	
Earnings ability	-.17 **(.3181)**	ChangeAsset	.0016 **(.0098*)**
Liability load	49.05 **(< .0001***)**	ChangeEbitda	-.0006 **(.0001***)**
Liquidity ability	-.007(**.0825***)	ChangeSale	.0006 **(.0118)**
Long-term liability ability	-.073 **(.1196)**	ChangeROIC	-.0212 (.1088*)
Operational inefficiency	.0514 **(.4593)**	ChangeSaleGrow	.0341 **(.0442**)**
The unfitness of sales and operation	.12 **(.0092**)**	Change-FreeCashF	.00341 **(< .0001***)**

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Rule-based Decision Support System For Audit Planning and Audit Risk Assessment

Qiao Li and Miklos Vasarhelyi

Motivation

- As in today's information age, external auditors need to deal with huge amount of information when they evaluate performance of their clients. An effective interactive decision support system that can be used in the risk assessment process will help auditors analyze information and make subsequent judgments with respect to risk assessment. Very few recent studies have focused on examining or developing audit decision support tools that could provide auditors suggestions for the risk assessment process during audit plan.
- This study contributes to literature and practice by providing a proposed audit DSS prototype that can potentially guide auditors to perform more effective risk assessments and lead to improved audit risk judgments in practice.

Purposes of the proposed DSS

- A Interactive Tool

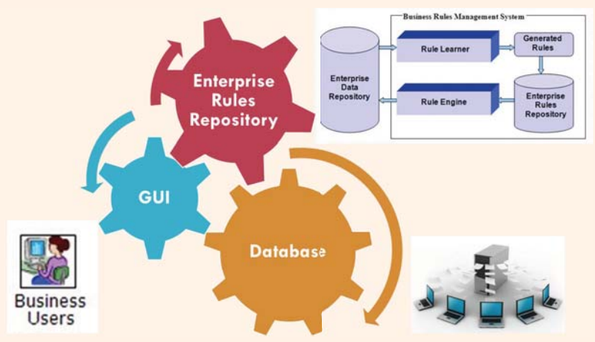
Provide in-time decision aids during risk assessment discussion (responses and suggestions based on calculations, comparisons, ranking algorithms, etc.)

- A Rule-based Tool

Predefine various situations for risk assessment; allow auditors easily to choose and inquire information they need, such as different industries, firms, different categories and level of risks, significant accounts etc.

- A Database that Supplement Memory

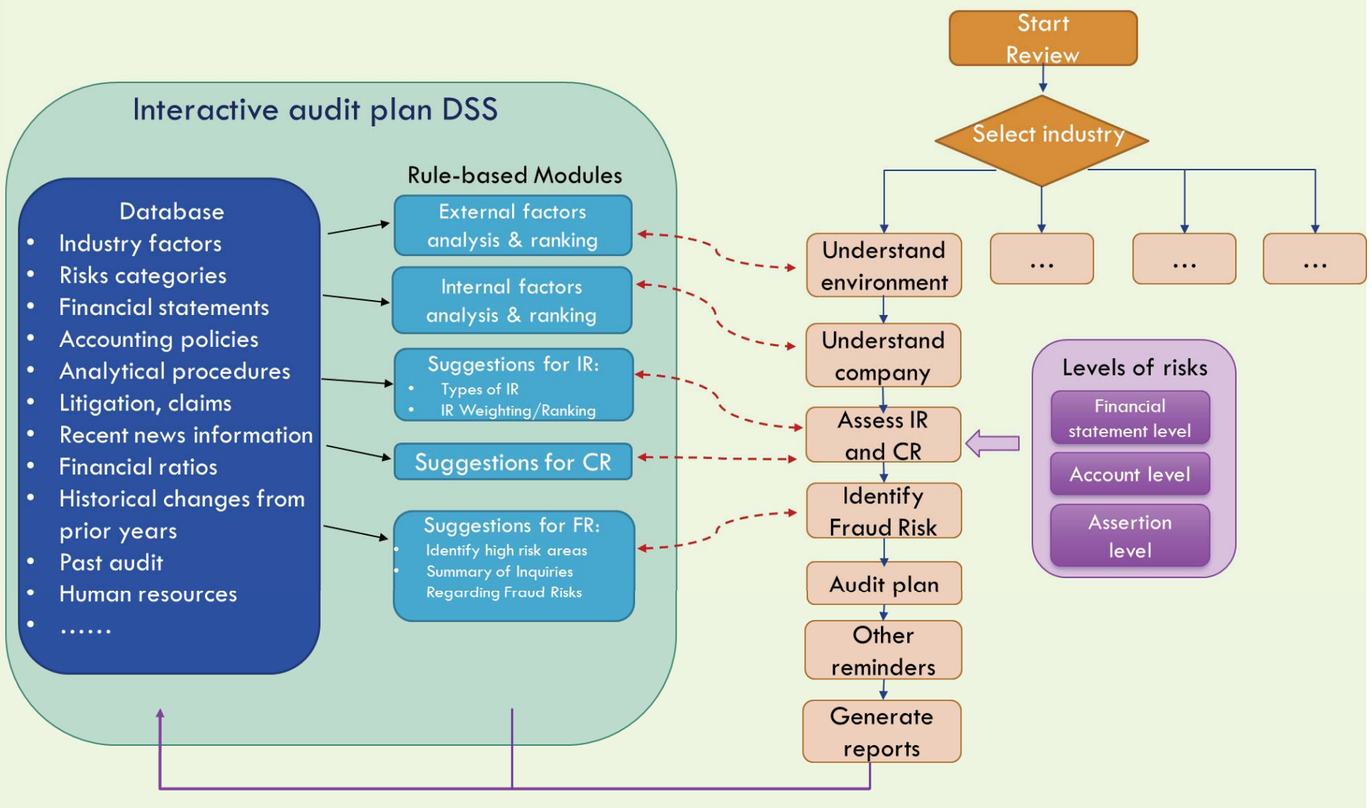
Information can be extracted from multiple sources stored in the DB (traditional sources such as financial statements, news and comments from Internet, predefined policy and rules, etc.)



Partial summarized risk assessment procedures for DSS framework

No.	factors
1	**Understand the company and its environment**
1.1	Industry, regulatory, and other external factors
1.1.1	Industry factors:
	competitive environment
	technological developments
1.1.2	Regulatory environment:
	applicable financial reporting framework
	legal and political environment
1.1.3	External factors:
	general economic conditions
1.2	The nature of the company
	organizational structure and management personnel
	sources of funding
	significant investments
	key supplier and customer relationships
1.3	Company's selection and application of accounting principles
1.4	Company Objectives, Strategies, and Related Business Risks
1.5	Company Performance Measures
2	**Understand Internal Control**
2.1	The control environment
2.2	The company's risk assessment process
2.3	Information and communication
2.4	Control activities
2.5	Monitoring of controls
3	**Considering Information from the Client Acceptance and Retention Evaluation, Audit Planning Activities, Past Audits, and Other Engagements**
3.1	Client Acceptance and Retention and Audit Planning Activities
3.2	Past Audits
3.3	Other Engagements
	……

Preliminary structure of proposed system



Common risk assessment procedures identified from cases through verbal protocol analysis

Common procedure	Material used	Potential support from DSS
Updates understanding of the entity	News, financial statements, memory	-Information retrieval support -Suggestions on areas to focus
Significant accounts	Financial statement, memory	Suggestions/ranking on Significant accounts
Financial statement level risks	Financial statement;	-Suggestions on risk; any new risks -Information retrieval support
Significant risks of error – assertion level	information from performing risk assessment procedures	Ranking
Use of specialists, experts, internal audit and/or others	memory	Information retrieval support
Identify Fraud Risk Factors	Financial statement, memory	Suggestions/ranking on fraud risk factors based on prior experience
Accounting policies	memory	Information retrieval support
Significant IT applications	memory	Information retrieval support
Consideration of Internal Control Over Financial Reporting	memory	Suggestion/ranking of controls to test
Related parties	memory	Information retrieval support
Reporting framework	memory	Information retrieval support
Materiality	Memory, fillings	suggestions
Professional skepticism and alertness for information or conditions affecting fraud risks	memory	suggestions

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Apply Process Mining to Evaluate Internal Control Effectiveness Automatically

Tiffany Chiu, Miklos A. Vasarhelyi and Mieke Jans

Introduction

- Unlike traditional auditing analytical procedure, process mining of event logs provides a new aspect for auditing in the way that this technique processes the whole population of data instead of using only selected sample from the data.
- Process mining can add value and improve the performance of auditing (Yang and Hwang 2006; Jans et al. 2009, 2013, 2014).
- Previous studies indicated that using process mining of event logs in auditing analytical procedure can successfully detect anomalous transactions which traditional auditing analytical procedure may fail to discover (Jans et al. 2014).
- Moreover, the application of process mining to internal auditing could improve the effectiveness of internal control (Kopp and Donnell 2005; Jans et al. 2011, 2014).
- This paper aims at applying process mining to evaluate internal control effectiveness: (1) Determine the controls required for the business process including the rules for acceptable and unacceptable variants (e.g., the variant is unacceptable if the purchase order has been released without sign). (2) Highlight the weakness of internal control by automatically extracting the unacceptable variants. (3) Conduct two additional analysis: segregation of duty analysis and timestamp examination.

Process Mining of Event Logs

- Process mining refers to the usage of event logs to analyze business processes. There are four characteristics that must be extracted from each event in the system in order to analyze the data:

Characteristics of Event	
(1) Activity	The ***activity*** taking place during the event (e.g. sign)
(2) Process Instance	The ***process instance*** of the event (e.g. invoice)
(3) Originator	The ***originator***, or party responsible for the event (e.g. action owner)
(4) Timestamp	The ***timestamp*** of the event or the date/time of the event (e.g. 2006-11-07T10:00:36)

- Prior studies proposed that when utilizing process mining techniques to analyze the information from event logs, five different types of analysis can be performed in process mining:

Process discovery	Exploring the business process to see if there are any anomalies or unusual transactions
Conformance check	Conducting a confirmation as to whether the process reality matches the expectation or standard
Performance analysis	Measuring business process performance (KPI's)
Social network analysis	Utilizing information contained in the event log to identify which authorized user entered each transaction to detect whether anomalous relationships and/or collusive fraud exist
Decision mining and verification	Focusing on decision points in a discovered process model and using them to test assertions on a case by case basis

Literature Review

- Process mining has been widely applied in computer science, engineering and management research topics (Schimm 2003, Van der Aalst and Weijters 2004, Rozinat et al. 2007, Lijie et al. 2009). However, the application of process mining in auditing and other accounting sub-areas remains in a premature stage.
- Event logs and process mining techniques enable new forms of auditing (Van der Aalst et al. 2010).
- There are two main advantages of using event logs in auditing: (1) it provides the auditor with more data, (2) it provides a human-independent way of recording data (Jans et al. 2010; Bukhsh and Weigand 2012).
- Process mining can provide new audit evidences as the analysis of event logs focuses on the transactional processes rather than the value of transactions and its aggregation (Jans et al. 2014).
- The application of process mining to internal auditing could improve the effectiveness of internal control (Kopp and Donnell 2005; Jans et al. 2011, 2014). Compared with using control objective information, using business process focused information in the internal control framework could improve the effectiveness of internal control evaluation (Kopp and Donnell 2005).

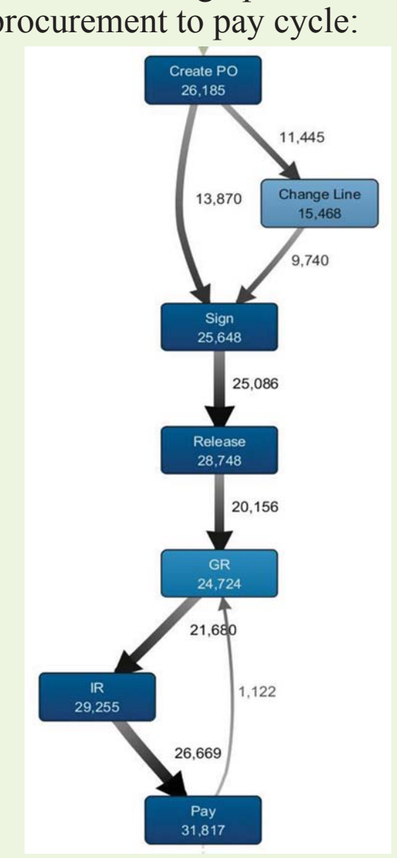
Methodology and Dataset (1/2)

- This paper proposed 3 perspectives that process mining can be applied to audit. The 3 aspects are as follows: (1) Process Examination, (2) Timestamp Examination, and (3) SOD (Segregation of Duty) Examination.
- Process examination refers to examining the pattern of each process instance, this analysis could assist auditors in understanding whether the client firm's internal control process conforms to its internal control policies. In addition, process examination enable auditor's to focus their work on potential high risk process instances that violate the rules.
- Timestamp examination refers to examining the timestamp of the process instance to find out whether there exist inefficient process or potential high risk processes.
- SOD examination mainly captures the process instances that violate the segregation of duties.
- The data applied in this study is from a large European bank, and the detail information can be found in the table below:

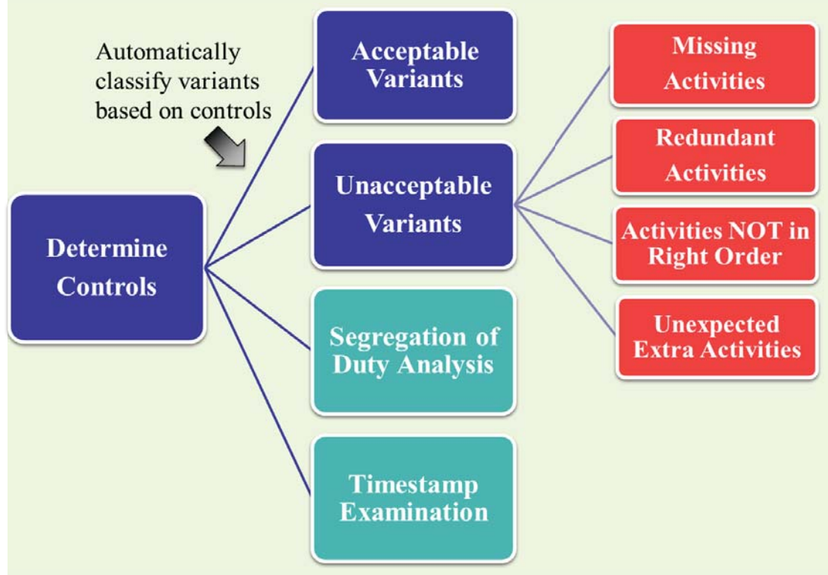
Procurement Process from A Large European Bank	
Events	181,845
Cases	26,185
Activities	7
Activities Detail	Create PO, Sign, Release, GR, IR, Pay, Change Line
Resources (Action Owners)	272
Attributes	27
Variants	980
Mean Case Duration	46.2 Day
Start	01/02/2007
End	01/25/2008

Methodology and Dataset (2/2)

- The data and standard process applied in this paper is displayed below. The graph shows standard process in the procurement to pay cycle:



- Research Method Overview:



Results and Conclusion

Overall Classification Results		
	Variants	Process Instances
Acceptable Variants	49 (5%)	19,198 (73.32%)
Unacceptable Variants	931 (95%)	6,987 (26.68%)

Classification Results		
Categories	Variants	Process Instances
Missing Activities	551 (56.22%)	4,980 (19.02%)
Redundant Activities	831 (84.80%)	2,664 (10.17%)
Activities NOT in Right Order	23 (2.35%)	139 (0.53%)

Segregation of Duty Analysis		
Description	Process Instances	Variants
Same person perform 'Sign' and 'Release'	473	138
Same person perform 'Release' and 'GR'	175	12
Total	648 (2.47%)	150

- This paper provides 3 perspectives of using process mining to evaluate internal control effectiveness automatically.
- The classification results indicates that by classifying variants into different categories, it is possible for process mining to detect potential risks and inefficient internal processes.
- Process mining could be a new audit evidence for auditors as they could use process mining results in their audit work (i.e., auditors could focus more on the cases that have been classified as unacceptable variants, violate segregation of duty or have longest process duration).

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The performance of sentiment features of MD&As for financial misstatement prediction: A comparison of deep learning and text mining approach

Ting Sun, Yue Liu, and Miklos A. Vasarhelyi

Objectives

- Examine the predictive power of sentiment scores of MD&A generated by deep learning and text mining (bag-of-words) approach for future financial misstatements.
- Compare the accuracy of two predictive models with one using the sentiment score provided by deep learning approach and the other using the sentiment score provided by text mining approach.
- Demonstrate that the sentiment features of MD&A provide incremental information for financial misstatement prediction.

Data

- 30,239 10-K MD&A text files associated with 10-Ks from 2006 to 2015.
- 4095 firm-years contain financial misreporting (restatement rate=13.5%).
- 30 Financial and audit-related variables as control variables, following prior research(XXX).

Predictive Model

- Decision tree
- Algorithm: CHAID (with boosting)

Sentiment score generated by deep learning approach and sentiment score generated by text mining approach

Table 1 deep learning vs. text miming for sentiment analysis of MD&As

	Sentiment score based on Deep learning approach	Sentiment score based on Text mining
Method	Deep neural network and linguistic analysis	"Bag of words"
Rationale	Understand the tone of the entire text using complex computation	calculate the percentage of positive/negative words
Text preprocessing	No need to preprocess the text	4 steps of preprocessing
Tool	IBM Watson Alchemy language API	Loughran and McDonald's word list (2009)
Is the tool financial-specific	No	Yes (designed for 10-k language)

Table 2 Summary statistics for two sentiment scores

Variable	*Obs.*	*Mean*	*Std. Dev.*	*Min*	*Max*
Sentiment score 1 (deep learning approach)	**30239**	**0.0195**	**0.0783**	**-0.5606**	**0.7487**
Sentiment score 2 ("bag of words" approach)	**30239**	**-0.0047**	**0.0064**	**-0.0721**	**0.0307**

Table 3 Two-sample t test for two sentiment scores

Variable	*Obs.*	*Mean*	*Std.Err.*	*[95% Conf. Interval]*	
Sentiment score 1	**30239**	**0.0195**	**0.0005**	**0.0186**	**0.0203**
Sentiment score 2	**30239**	**-0.0068**	**0.0000**	**-0.0069**	**-0.0067**
Combined	**60478**	**0.0063**	**0.0002**	**0.0059**	**0.0068**
diff	—	**0.0263**	**0.0005**	**0.0254**	**0.0272**
Diff=mean (sentiment score 1)-mean(sentiment score 2)				*t=58.0835*	
H0: diff=0				*degree of freedom=60476*	
Ha: diff>0				*Pr(T>t)=0.0000*	

Table 4 Predictive results

	Model 1 Training set (60%)	*Model 1 Test set (40%)*	*Model 2 Training set (60%)*	*Model 2 Test set (40%)*
Overall accuracy	**76.78%**	**63.64%**	**76.32%**	**64.72%**
Type one error rate	**23.14%**	**36.40%**	**24.38%**	**35.24%**
Type two error rate	**23.40%**	**35.76%**	**22.98%**	**35.82%**
AUC	**0.8480**	**0.7170**	**0.851**	**0.732**
Sample Size	**4814**	**25425**	**4814**	**25425**
Total Sample	**30239**			

Notes: model 1 use sentiment score provided by text mining approach;
model 2 use sentiment score provided by deep learning approach

Conclusions

- The sentiment measures of MD&A of 10-Ks contain incremental information for financial misstatement prediction
- Although not designed for financial-specific text, deep learning approach for textual analysis provides sentiment measures of MD&A with higher level of predictive power

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Blockchain Technology: A Framework and Application to Fraud Detection

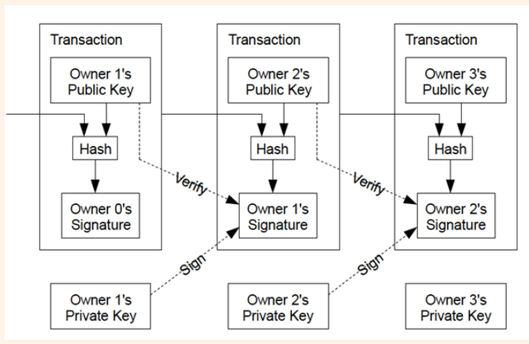
Yunsen Wang and Alexander Kogan

Introduction

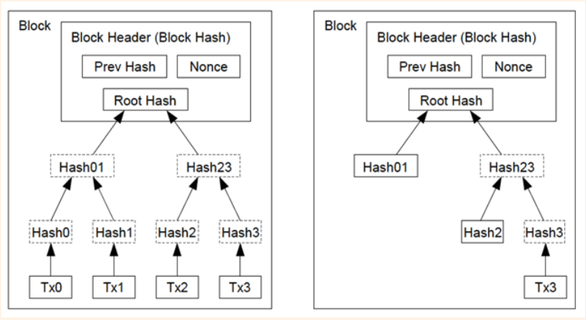
- During recent years, some of the big accounting firms (Deloitte, 2015; PwC, 2015) announced the projects that they would invest in the exploration of an emerging technology, blockchain, to improve audit efficiency and fraud detection effectiveness.
- Blockchain is a decentralized transaction database in cryptographic format distributed along a systematical network. A complete copy of blockchain contains all transactions executed on that network.
- This novel technology has broad applications, the famous one being Bitcoin invented by Nakamoto in 2008. The objective of that invention is to solve the double spending problem of digital currency by using peer-to-peer networks. Bitcoin has become very popular due to its reliance on decentralization.
- To use the blockchain technology for accounting and auditing purpose, the blockchain becomes an unforgeable distributed ledger owned by all business participants based on a common network protocol. A copy of a full chain contains all transactions in the business ecosystem. It is publically distributed, thus it prevents from tampering with transaction data.

Background

- Bitcoin was first invented by Nakamoto in 2008 with the purpose of solving the double spending problem of digital currency.
- In Nakamoto's (2008) Bitcoin design, he defined the coin as a chain of digital signatures, which contains a hash of the entire previous transactions.

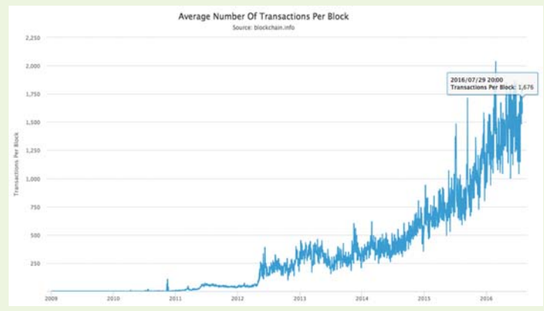


- To timestamp and encrypt the previous transactions, Merkle Tree and timestamp server are applied.

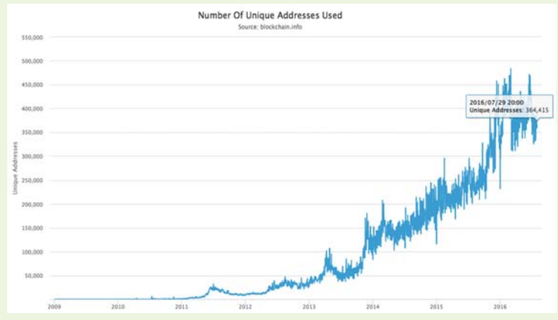


Data Collection and Preprocessing

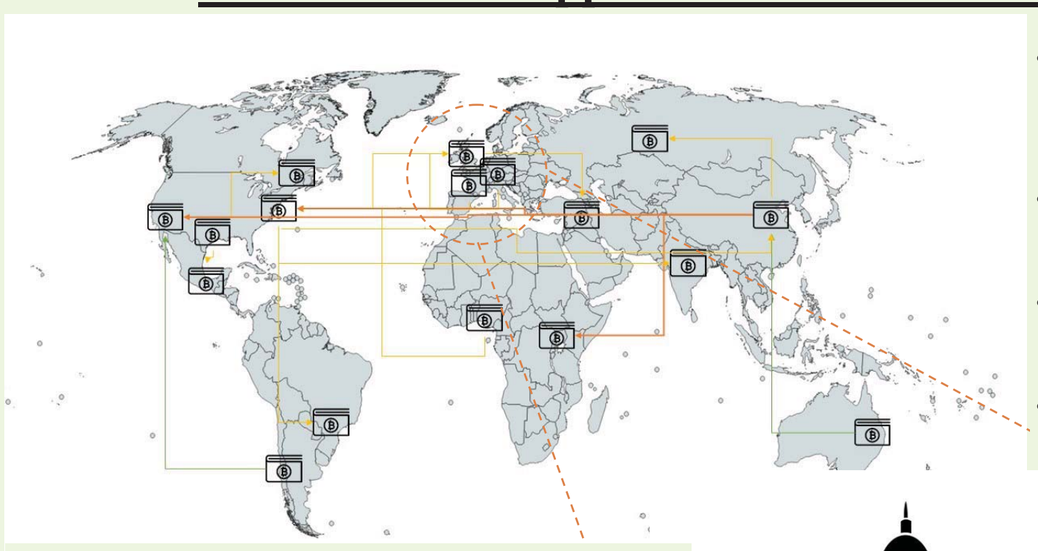
- All the blockchain-based transaction data are collected from blockchain.info using Blockchain Wallet API by Python language.
- The average number of transactions per block shows that from 2009 to 2016 a growing number of transactions were encrypted in the chain of blocks.



- The number of unique addresses used shows that from 2009 to 2016 a increasing number of people have been using blockchain as a channel to transfer funds.

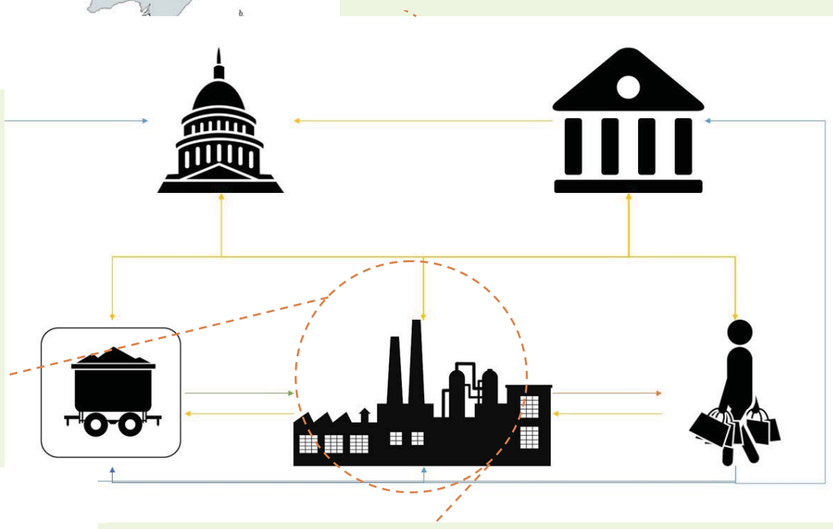


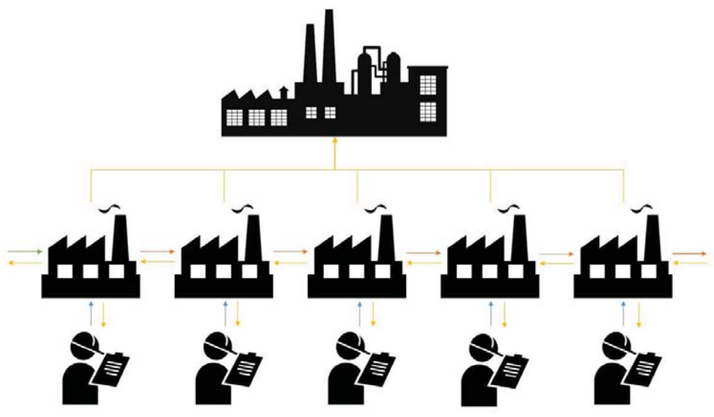
Framework for Applications in Accounting and Auditing



- The framework of infrastructure:
- (1) Private, public and hybrid chains connecting the world economy
- (2) The value creation chain by zooming in and zooming out methods
- (3) Multi-side chain for monetary exchange, product and service exchange

- The blockchain technology has many applications in accounting and auditing:
- (1) Global economy continuous monitoring
- (2) Timely and automatic confirmation
- (3) Fraud detection





- Financial statement fraud detection:
- (1) Inventory misstatement
- (2) Embezzling and misappropriation
- (3) Transactions backdate
- (4) Revenue recognition

Summary and Future Research

- This study proposes a framework and development environment for blockchain technology and applications. It records and shares across a network financial or electronic assets and liabilities through entirely transparent updates of information.
- This new architecture reduces the intentional or unintentional misstatements and errors with very low cost. It delivers the assurance of data security and privacy, which prevents the intruder from stealing or destroying sensitive business databases. As all the transactions are logged on an Internet blockchain, external auditors or even regulators could inspect a corporation's books in real time, and the audit firm can use this architecture to conduct batch auditing.
- In summary, the framework of the infrastructure is able to continuously monitor global economy, automatically conduct confirmation, timely detect the fraudulent transactions. By using this proposed system, auditors do not have to manually exam the audit samples. Instead, if the management committed fraud by tampering with the transaction data, this architecture will provide the auditor a disproof that shows the evidence of fraudulence. As a result, this audit system potentially enables auditors to detect fraud without examining all the transaction records.

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Implementation of Data Analytics on Managerial Accounting Using Balanced Scorecard Framework

Deniz Appelbaum, Zhaokai Yan, Alexander Kogan and Miklos Vasarhelyi

Abstract

The nature of management accountants' responsibility is changing to include organizational performance measurement and providing management with decision related information. The development in corporate information systems such as enterprise resource planning (ERP) systems has granted management accountants both data storage power and computational power. However, research shows that the nature and scope of managerial accounting has barely changed. This paper proposes a Managerial Accounting Data Analytics (MADA) framework based on the balanced scorecard theory in a business intelligence context. With MADA, three types of business analytics (descriptive, predictive, and prescriptive) are implemented into four corporate performance measurement perspectives in an enterprise system environment. Other related issues that affect the successful utilization of business analytics within a corporate-wide business intelligence (BI) system, such as data quality and data integrity, are also discussed.

Big Data and Business Analytics

- Big data and business analytics now influence almost every aspect of major companies' decision making, strategic analysis, and forecasting .
- Big data can originate from traditional transaction systems, or from new unstructured sources such as emails, audio files, internet click streams, social media, news media, sensor recordings, videos, and RFID tags (Zhang, Yang, and Appelbaum 2015).

Business analytics is 'the use of data, information technology, statistical analysis, quantitative methods, and mathematical or computer- based models to help managers gain improved insight about their operations, and make better, fact-based decisions' (Davenport and Harris, 2007).

⇒ *Descriptive*: Summarize what has happened and also form the basis of continuous monitoring alert systems (Dilla, Janvrin, and Raschke 2010)

⇒ *Predictive*: Use data accumulated over time to make calculations of probable future events

⇒ *Prescriptive*: Answers the question of what should be done given the descriptive and predictive analytics results (Bertsimas and Kallus, 2014)

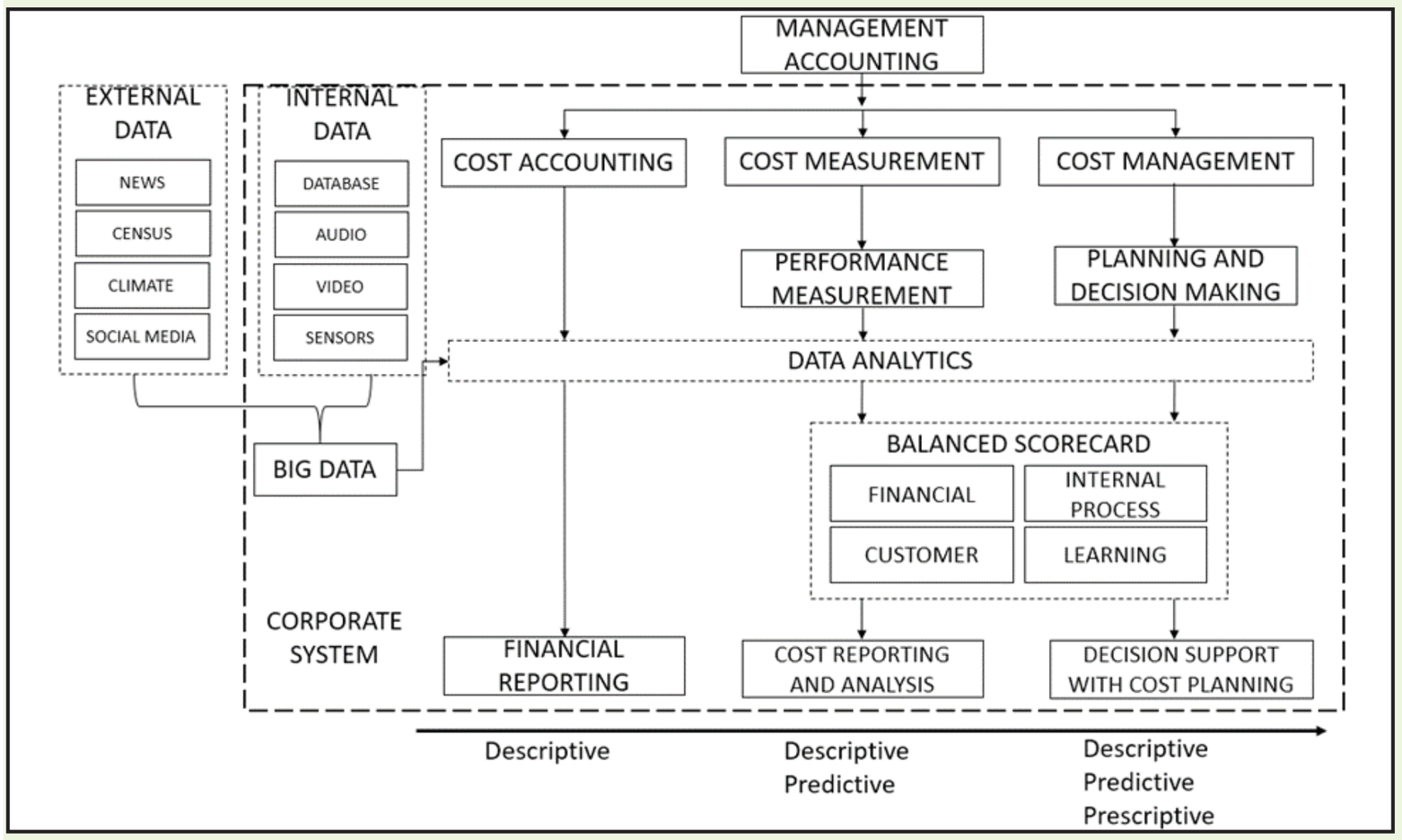
Changing Role of Managerial Accounting

- Management accountants serve the role of participating in strategic cost management for achieving long-term goals; implementing management and operational control for corporate performance measure; planning for internal cost activity; and preparing financial statements (Brands 2015) .
- Management accountants should make predictions including consequences for uncertainty and risk in decisions (Nielsen 2015).
- Management accountants should transgress the boundaries of management accounting and interact with non-accountants to solve the practical problems (Birnberg 2009).

ERP systems and Managerial Accounting

- ERP systems integrate all corporate information into one central database and allow information to be retrieved from different organizational sections (Dechow and Mouritsen 2005).
- ERP systems change the role of management accounting by providing management with access to relevant and real-time operational data for the purpose of decision making and management control
- More data storage power and more data computational power.

Managerial Accounting Data Analytics (MADA) Framework



The BSC framework measures corporate performance from four perspectives:

Financial (how do we look to shareholders?); *Customer* (how do customers see us?); *Internal business processes* (What must we excel at?); and *Learning and growth* (can we continue to improve and create value?). (Kaplan and Norton 1992)

	Descriptive	Predictive	Prescriptive
Financial	Ratio Analysis Visualization Descriptive Statistics Spearman Rank correlation Measurements	Support Vector Machines (SVM) Artificial Neural Networks (ANN) Genetic Algorithms Bagging and Boosting models Hypothesis Evaluations Monte Carlo Study/Simulation	Artificial Neural Networks (ANN) Genetic Algorithms Expert Systems/Decision Aids
Customer	Ratio Analysis Clustering Models Text Mining Models Visualization Descriptive Statistics	Bayesian Theory/Bayesian Belief Networks (BBN) Dempster-Shafer Theory Models Probability Theory Models Log Regression Linear Regression	Log Regression Linear Regression Time Series Regression
Internal Process	Clustering Models Text Mining Models Visualization Process Mining: Process discovery models Descriptive Statistics Spearman Rank Correlation Measurements	Dempster-Shafer Theory Models Probability Theory Models Log Regression Linear Regression Time Series Regression Auto Regressive Integrated Moving Average (ARIMA)	Auto Regressive Integrated Moving Average (ARIMA) Univariate and Multivariate Regression Analysis Monte Carlo Study/Simulation
Learning and Growth	Ratio Analysis Clustering Models Text Mining Models Visualization Descriptive Statistics Spearman Rank Correlation Measurements	Univariate and Multivariate Regression Analysis Auto Regressive Integrated Moving Average (ARIMA) Multi-criteria Decision Aid Benford's Law Structural Models Hypothesis Evaluations	Pareto optimal (P-optimal) Goal Programming Branch and bound

Attributes for Successful Implementation

- Management accounting tasks as described in this framework could be regarded as an essential component of Business Intelligence (BI). BI systems may be regarded broadly as the management support systems for gathering, storing, accessing, and analyzing data for decision making (Chaudhuri et al 2011).
- The analytical technique(s) selected by the accountant should not only be appropriate, but the data or big data selected for analysis should possess high quality attributes. In this sense, the data should be relevant, timely, believable, and useful to the end user. Poor quality data could have a substantial and negative economic impact on a business (Haug et al 2010).

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Risk Analysis Based on 10-K Item 1A

Kevin Moffitt and Yue Liu

Introduction to Risk Factor Disclosures

- Beginning in 2005, public firms are required by the Securities and Exchange Commission (SEC) to report "Risk Factors" in order of importance in their 10-K item 1A (SEC.gov/answers). Specifically, risk factors describe where the problem lies and what could go wrong, so they provide important information to stakeholders such as auditors and investors for their decision making (Huang and Li, 2011).
- SEC has provided guidelines for risk categories for risk factors to be filed. For example, the risk categories include lack of an operating history, lack of profitable operations in recent periods, financial position, business or proposed business, and lack of a market for common equity securities or securities convertible into or exercisable for common equity securities, etc. (Mirakur, 2011). However, these are quite broad categories, and firms usually report more detailed risks, which are described in paragraphs and usually with a summary at the beginning of each risk factor. The problem is that there are no formal terms for these reported risks. As a result, similar risks might be expressed differently, making it difficult to compare the risks between firms and do risk analysis.

Related Literature

- Discovering and quantifying various risk types from large amounts of unstructured text is a nontrivial task (Bao and Datta, 2014).
- Table 1 summarizes studies that involve identification of risk categories. Prior studies either manually define risk categories or use predefined risk categories from prior literature for classification. Manual work can be time and labor consuming, and may also be subjective. It may be better to come up with a more objective way of risk taxonomy.
- The current paper aims to develop a method to automatically identify similar risks from individual risk factors to generate risk categories. There is no human judgment involved in discovering risk categories, so the taxonomy might be more comprehensive and accurate. Further, we will evaluate our risk taxonomy and we may develop a risk measure based on our risk taxonomy for risk analysis.

Related Literature

Table 1. Studies involving risk categorization

Author-year	Unit of analysis	# of risk categories	Method of defining risk categories
Campbell et al. (2014)	item 1A	5	subjectively define risk categories
Huang and Li (2011)	individual risk factors	25	manually identify risk categories by reading 10-Ks
Mirakur (2011)	individual risk factors	29	manually identify risk categories by reading 10-Ks
Miihkinen (2013)	risk disclosures in Finland	5	manually identify risk categories
Bao and Datta (2014)	individual risk factors	25	predefined risk categories from Huang and Li (2011)

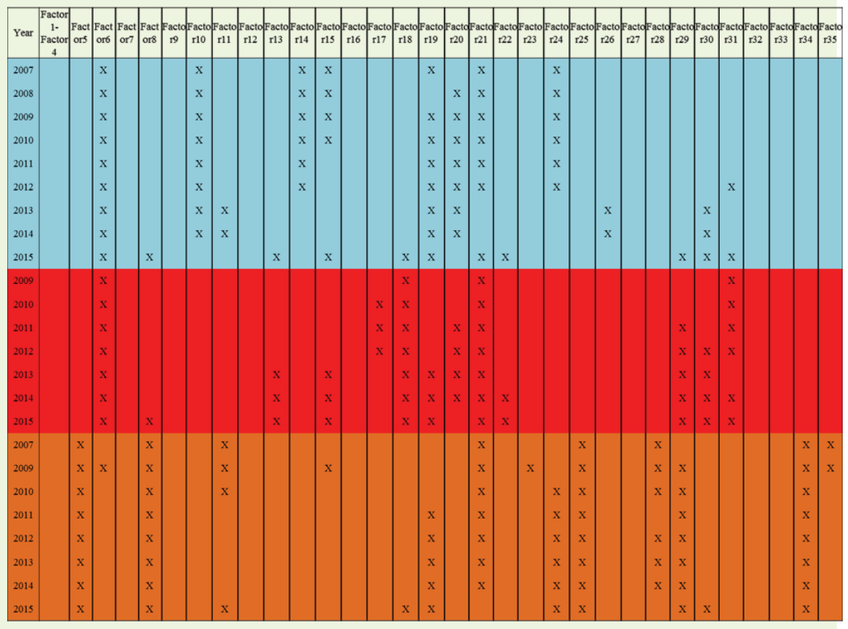
Sample Selection and Research Method

- This paper focuses on the retailing industry, which include firms with sic code starting with 52-59. For now we only use files of Walmart, Target, and Home Depot for a pilot study.
- **Approach 1:** based the Financial Times Lexicon (FT-lexicon), which contains 12,629 unique terms with definitions. A similarity score for each pair of risk factors and term definitions is calculated and recorded in a csv file. A similarity matrix is obtained. For the similarity matrix, terms with low similarity scores (smaller than 0.1) for all risk factors are deleted, and 4,387 terms remain in the final matrix. A factor analysis is conducted on the final matrix to identify similar risks.
- **Approach 2:** based on Microsoft Bing Search API. For each risk factor, all the noun phrases in the form of NBAR: {<NN.*|JJ>*<NN.*>}, or <NBAR><IN><NBAR>) are extracted from the summary sentences of risk factors using part-of-speech technique. The tf-idf score for each phrase (ignoring stop words) is calculated and for each file the top two phrases with highest tf-idf scores are recognized as important phrases. In order to group similar risk phrases together, Bing Search API is used to get the top 100 hit for each important phrase, and the phrases with same hit will be grouped together.

Preliminary Result

Table 2. Result for approach 1

Note: blue area stands for Walmart, red for Target, and orange for Home Depot.



Future Work

- Refine the two approaches to generate more meaningful and accurate risk categories.
- Apply the method to the whole industry
- Evaluate the method

Preliminary Result

Table 3. Result for approach 1-Walmart

	# of similar risk terms from previous year	# of new risk terms	list of new risk terms
2008	15	5	computer systems consumer trends market share products transactions
2009	20	0	
2010	20	0	
2011	20	0	
2012	20	0	
2013	20	5	on-going FCPA matter other adverse consequences impediments expansion changes in climate
2014	24	1	retail offerings
2015	22	4	digital retail benefit cost increases in wage foreign exchange rates

Note: this is the result based on the original risk terms extracted, and Bing Search API is not applied yet.

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