



Financial fraud detection using vocal, linguistic and financial cues



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ABSTRACT

Corporate financial fraud has a severe negative impact on investors and the capital market in general. The current resources committed to financial fraud detection (FFD), however, are insufficient to identify all occurrences in a timely fashion. Methods for automating FFD have mainly relied on financial statistics, although some recent research has suggested that linguistic or vocal cues may also be useful indicators of deception. Tools based on financial numbers, linguistic behavior, and non-verbal vocal cues have each demonstrated the potential for detecting financial fraud. However, the performance of these tools continues to be poorer than desired, limiting their use on a stand-alone basis to help identify companies for further investigation. The hypothesis investigated in this study is that an improved tool could be developed if specific attributes from these feature categories were analyzed concurrently. Combining features across categories provided better fraud detection than was achieved by any of the feature categories alone. However, performance improvements were only observed if feature selection was used suggesting that it is important to discard non-informative features.

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1. Introduction

Efficient allocation of capital is critical to stimulate economic growth, the engine that drives improvements in social welfare. The financial world has been rocked by a wave of accounting scandals, from Enron and WorldCom in the early 2000s to the collapse of Lehman Brothers in 2008 leading to a significant degradation of trust in capital markets and concomitant inefficient capital allocation decisions. In order to restore trust in the capital markets, regulators have passed a series of reforms, such as the Sarbanes Oxley Act that impose penalties on those who commit financial misdeeds. However, such penalties will be a helpful deterrent if and only if frauds are detected in a timely fashion. The current resources committed to fraud detection by the Securities and Exchange Commission (the regulatory body that oversees capital markets in the United States) are insufficient to identify all occurrences of frauds in a timely fashion. Moreover, the Center for Audit Quality, which serves the financial auditing profession, recently called for the identification of new ways to better detect financial fraud so as to restore investor confidence [31]. Thus, an automated method for accurate financial fraud detection (FFD) has the potential to deter financial misdeeds and stabilize capital markets.

Most corporate FFD methods documented in accounting and finance research have focused on financial information (see Ngai et al. [1] for a summary of this literature). This type of information includes statistics

describing the company and its stock price, its financial statements, and its operating behavior, e.g. unusual reductions in employee headcount [2]. Numerous measures based on numeric financial information have been developed academically [3] and commercially [4]. Price et al. [4] examined the performance of several of these measures, and the measures all demonstrated the potential for FFD, although the commercial measure consistently outperformed the academic measures.

Very recently, several new categories of information beyond financial information have been considered for FFD. In particular, research has begun to focus on linguistic (e.g. word choices by company executives) and vocal (e.g. voice characteristics of company executives) features to assess deception. These features are based on the premise that information is contained in, and could be extracted from, what people say and how they say it [5]. Some success for FFD through linguistic information was achieved by Humpherys et al. [6] through analysis of the Management's Discussion and Analysis (MD&A) section of Form 10-Ks which public companies must file annually with the Securities and Exchange Commission (SEC). These forms are intended to provide an overview of the companies' financial and business health. By using measures of linguistic characteristics such as lexical diversity and syntactic complexity, Humpherys et al. [6] achieved up to 67% accuracy in detecting fraud. Bloomfield [16] suggested that additional insights might be gleaned from linguistic analysis of spontaneous speech of executives relative to the legally vetted text contained in MD&As. Larcker and Zakolyukina [15] undertook a linguistic text analysis of executives' conversations with financial analysts during quarterly earnings conference calls, and found that linguistic features identified deceptive discussions at better than chance levels.

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Moving beyond linguistics, Mayew and Venkatachalam [7] studied non-verbal vocal characteristics of CEO's during earnings conference calls. They examined whether analysts and investors take into account the CEO's emotional state when they forecast future performance and if the emotional state conveyed meaningful information about future firm prospects. They found vocal based managerial affect measures contained information about a firm's financial future and that investors take this into account when determining stock prices. In a laboratory setting, Murphy [8] found that misreporters experience negative affect. Applying this intuition to corporate CEOs, Hobson et al. [9] documented that negative affect derived from non-verbal vocal features during conference calls predicts both financial fraud and the stock price reaction to the firm's disclosure of the fraud.

Collectively, tools based on financial numbers, linguistic behavior, and non-verbal vocal cues have each demonstrated the potential for detecting financial fraud. However, the performance of these tools continues to be poorer than desired, limiting their use on a stand-alone basis for identifying companies for further investigation. The hypothesis investigated in this study is that an improved FFD tool could be developed if specific attributes from across these three general feature categories were analyzed concurrently. If each of the feature categories provides independent, complementary information regarding financial fraud, then the combination of features across these categories may improve detection performance beyond what can be achieved by each feature category separately.

The potential for combined features to enhance the early identification of fraud seems plausible given the recent emergence of for-profit entities such as Business Intelligence Advisors (BIA, www.biadvisors.com). BIA hires ex-Central Intelligence Agency officers to generate reports on deception markers observed from corporate communications including earnings conference calls, and sells the reports to hedge funds and other investors interested in profiting from foreknowledge of the revelation of fraud. BIA reports are not available publicly, which prevents the testing of the results from our investigation against feature combinations executed by trained human experts. However, investigation of our hypothesis can result in initial insights on the potential benefits of feature combination via automated methods from publicly available data.

2. Material and methods

2.1. Test material

The set of 1572 public company quarterly earnings conference call audio file samples analyzed in Hobson et al. [9] were used as our sample. Earnings conference calls are ideal for our investigation because they involve corporate executives publicly discussing financial information, thereby simultaneously providing financial, linguistic and vocal cues [33].¹ The audio files contain CEO's speech during the first five minutes of the question and answer portion of the earnings conference call, enabling analysis of spontaneous executive speech in response to financial analyst inquiry. The database spans conference calls that occurred during the calendar year 2007. Uncompressed .wav files were created from an online streaming of publicly broadcast conference calls through ThomsonReuters Streetevents (www.streetevents.com) during the sample period, which were encoded in mono directly onto a computer hard disk, using Total Recorder 7.1 Professional Edition software, at 11.025 kHz sampling rate and 16 bit quantization.

¹ Sample firms are traded in equity markets in the United States and sample selection details are outlined in [9]. Earnings conference calls usually occur at the end of each reporting quarter where top management make presentations to and answer questions from analysts and investors about both their firm's current reported performance as well as their future prospects. These discussions occur usually via telephone or through the internet and are often captured electronically via audio files for replay. The ThomsonReuters StreetEvents database offers restreaming of corporate earnings conference calls for a limited time following the initial broadcast.

To identify conference calls where executives likely deceived their investors, we followed [9] and used the Audit Analytics (www.auditanalytics.com) restatements database to find instances of financial restatements resulting from accounting irregularities. Irregularity restatements occur when financial reports are later found to be incorrect as a result of intentional managerial intervention, not clerical errors. Forty-one conference call speech samples pertain to fiscal quarters that were restated due to an irregularity. We categorized these cases as fraudulent observations and the remaining 1531 observations as non-fraudulent.

We investigate the nature of the fraud underpinning each of the 41 fraudulent observations by reviewing public filings with the SEC, in addition to legal documents and popular press articles. The misrepresented financial topics underpinning each of the frauds, and the percentage of fraudulent firm-quarter observations that pertain to each topic, are depicted in Table 1. The most frequent fraud topic in our sample pertains to revenues and sales, consistent with [3]. Frauds can stem from multiple different causes, such as misrepresentation of both revenues and profit margins, and as such fraud topics are not mutually exclusive. Because the vast majority of frauds in our sample pertain to revenues and sales (75.6%), an analysis of whether different types of frauds are differentially predictable with numeric, linguistic and vocal cues was not possible.

2.2. Features

Our three conceptual feature categories, and the particular features we study within each category, are outlined in Table 2. Accounting risk factors are specific numeric financial features that are likely to create uncertainty for managers when reporting their firms' performance. In particular, we posit based on previous FFD research by Hobson et al. [9] and Dechow et al. [3] that large firms with poor performance, operating in highly volatile settings and higher growth expectations are more susceptible to financial restatements. Specifically, we include proxies for size, using the natural logarithm of market value of equity at the end of the fiscal quarter (lnMVE); performance, using the firm's market adjusted abnormal stock return for the preceding year (RET); operating uncertainty, using the return volatility (VOL) measured as the standard deviation of daily stock returns over the 125 trading days prior to the fiscal quarter end; and growth expectations, using the book-to-market (BM) ratio calculated as the book value of shareholders equity scaled by the market value of equity both measured at the end of the fiscal quarter. Features utilizing financial statement information are

Table 1
Fraud topics for fraudulent sample observations.

Fraud topic	% of Fraud observations pertaining to each topic
Revenue/revenue growth/sales order backlog	75.6%
Product pricing/product mix/product rollout	51.2%
Cost structure/profit margins	48.8%
Expansion/integration of acquisitions	46.3%
Selling, general and administrative	26.8%
Employee incentives/share based compensation expense/management changes	19.5%
Capital spending/production capacity/depreciation/leasing	17.1%
Strategic alliance/competition	17.1%
Inventory	14.6%
Earnings forecast/guidance	14.6%
Consolidation/restructuring/liability estimates	9.8%
Accounts receivable/allowance for doubtful accounts/securitization	9.8%
Raising capital/credit/cost of capital/return on invested capital	9.8%
Branding/advertising	9.8%
Research & development/training	7.3%
Taxes	7.3%

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