

## PRACTITIONER SUMMARY

# Using Consumer Tweets to Improve Revenue Risk Assessments in Consumer-Oriented Industries

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**SUMMARY:** This article summarizes the study of [Rozario, Vasarhelyi, and Wang \(2022\)](#), which examines the use of consumer tweets in improving the prediction and error detection performance of preliminary analytical procedures for the revenue account for firms that belong to consumer-oriented industries. They find that consumer tweets about product or brand interest increase the prediction and error detection ability of analytical procedures compared to analytical procedures that do not include it. These results suggest that this new source of external nonfinancial information is incrementally informative to auditors in developing assessments for the risk of misstated revenue in the planning stage of the audit. The findings of this study have important implications that may be relevant to the audits of other financial statement accounts.

**Keywords:** twitter information; analytical procedures; audit risk assessment.

## I. INTRODUCTION

Consumer tweets are increasingly being used by companies to increase sales as such information makes it possible for them to better understand their customers ([Deloitte 2019](#)). Relatedly, the audit community has taken interest in the use of new sources of external information and their effect on financial statement audits ([Brown-Liburd and Vasarhelyi 2015](#); [International Auditing and Assurance Standards Board \(IAASB\) 2016](#); [Appelbaum, Kogan, and Vasarhelyi 2017](#); [Public Company Accounting Oversight Board \(PCAOB\) 2017a, 2018](#)). However,

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little is known about whether or how consumer tweets could affect auditing. Auditors are required to perform preliminary analytical procedures for the revenue account to identify unusual account deviations that may require further detailed testing ([Public Company Accounting Oversight Board \(PCAOB\) 2010](#), AS 2110). Since consumer tweets about products or brands may inform auditors' understanding of a company's business and industry, they may improve the risk assessment of improper revenue recognition in the planning stage of the audit. The work of [Rozario et al. \(2022\)](#) explores the use of consumer tweets in preliminary analytical procedures for the revenue account to understand the usefulness of this information. The purpose of this paper is to summarize the [Rozario et al. \(2022\)](#) study.

The logic behind using social media information to assess the risk of misstatement in the revenue account is that consumer expressions on social media may capture consumer behavior—this notion is supported by the “wisdom of crowds” phenomenon, which contends that the combined opinions of a large group of individuals is smarter than the opinions of individual experts ([Surowiecki 2005](#)). As a result, consumer expressions on social media about companies' products/brands may serve as a timely tertiary source of information for auditors to assess the risk of improper revenue recognition. [Rozario et al. \(2022\)](#) finds that Twitter consumer interest, rather than Twitter consumer sentiment, is useful in improving the prediction and error detection ability of analytical procedures for firms that are consumer-oriented, suggesting that this new source of information improves auditors' revenue risk assessments.

## II. EXAMPLES

Twitter interactions have been shown anecdotally to be related to organizations' sales revenues, both positively and negatively, especially for customer facing industries. For instance, the Wendy's Company Twitter account included one of the big memes in 2017. Twitter interactions have helped Wendy's improve its popularity: followers increased from 2.1 million to 2.4 million in six months, there are about 3.9 million followers now. The popularity also converted into an almost 50 percent sales increase to about \$194 million from 2016 to 2017 ([Cheng 2018](#); [Deputy 2018](#)).

Twitter interactions can also affect an organization's sales performance negatively. A United Airlines flight attendant dragged a paying passenger off a plane in 2017. Immediately after the video clip of the incident was circulated on the Internet, the organization received more than 1,000 percent more mentions on social media and 69 percent of the tweets became negative in one night, from which about 91 percent were positive the day before ([Joyce 2017](#); [Ohlheiser 2017](#)). After the incident, the value of United Continental Holdings' shares dropped more than 4 percent, which is about \$1 billion in business value ([BBC 2017](#)). [Garfield \(2017\)](#) suggested that the negative sentiment and the continuing boycott in 2017 might have a negative impact on the airline's sales performance.

It is worth noting that although auditors may have access to other data analytic tools that use internal firm information to assist them with risk assessment, [Rozario et al. \(2022\)](#) suggest that the added value of Twitter information to auditors lies in the wisdom of the crowds that it facilitates. [Rozario et al. \(2022\)](#) contend that Twitter facilitates the wisdom of the crowds phenomenon as any consumer that wants to share an experience or opinion can do so in real time, as long as they have access to a cell phone or computer. Therefore, Twitter offers a unique platform for the dissemination of information by consumers, which may have a real monetary impact. To the extent that auditors have access to high quality firm-specific private information, [Rozario et al. \(2022\)](#)

suggest that Twitter information may still be useful to corroborate auditors' understanding of the firm.

### III. RESEARCH DESIGN

Rozario et al. (2022) obtained consumer tweets on purchase interest and sentiment from Likefolio, a social media data provider, for 2012–2017 for 76 companies in 20 consumer-oriented industries. The information included tweets relating to companies' products and brands. For example, the tweets "I want to buy an iPhone" and "Apple's customer service is great" reflect consumer purchase interest and sentiment, respectively. Twitter information was subsequently combined with companies' publicly available information for prior period sales and current period accounts receivable, which were obtained from the Compustat database. Finally, Gross Domestic Product (GDP) data was extracted from the Bureau of Economic Analysis (<https://www.bea.gov/>) and merged with Twitter and financial information. The final sample consisted of 1,824 firm-quarter observations that were transformed into 5,472 firm-monthly observations using the cubic splines interpolation method, which is a technique that estimates disaggregated data from aggregated data. Monthly observations were then split into a training set (4,560 observations from 2012 to 2016) and a testing set (912 observations from 2017).<sup>1</sup> The descriptive statistics are reported in Table 1.

Using linear regression as an example of an audit planning analytical procedure, Rozario et al. (2022) incorporated the data described above into models with and without Twitter information and estimate current period revenue account balances.<sup>2</sup> To estimate the error detection ability of the models, the authors conduct a simulated experiment where errors of 2 percent are seeded in the revenue account, thereby overstating revenues by 2 percent. Seeding errors in each firm-year observation allows the authors to measure, in a controlled setting, the number of false positive and false negative errors produced by each model. Rozario et al. (2022) compare the predictive and error detection ability of a baseline model that only includes financial information and GDP information to that of a model that also includes Twitter information of consumer interest or consumer sentiment. The more effective model is deemed as the model that produces more accurate predictions and lower cost of errors.

### IV. RESULTS

The results of Rozario et al. (2022) suggest that an analytical procedure that includes Twitter information helps predict overstatements of revenues. Specifically, considering Twitter information reduces the cost of errors for firms that overstate their revenues by at least 2 percent. Further, Rozario et al.'s (2022) results find that tweets of consumer interest are better predictors of overstated revenues than are tweets of consumer sentiment. Collectively, the evidence from Rozario et al. (2022) suggests that information from social media generated by consumers about companies' products and brands is incrementally useful to auditors' revenue risk assessments of clients that operate in consumer-facing industries. See Table 2.

<sup>1</sup> Rozario et al. (2022) split the data into the aforementioned subsamples to examine the *out-of-sample* predictive power of Twitter information in analytical procedures.

<sup>2</sup> Rozario et al. (2022) used the following regression models:

$$\begin{aligned} Sales_{it} &= \beta_0 + \beta_1 Sales_{it-1} + \beta_2 AR_{it} + \beta_3 GDP_{t-1} + \epsilon, \\ Sales_{it} &= \beta_0 + \beta_1 Sales_{it-1} + \beta_2 AR_{it} + \beta_3 GDP_{t-1} + \beta_4 TCI_{it} + \epsilon \text{ and,} \\ Sales_{it} &= \beta_0 + \beta_1 Sales_{it-1} + \beta_2 AR_{it} + \beta_3 GDP_{t-1} + \beta_4 TCS_{it} + \epsilon. \end{aligned}$$

**TABLE 1**  
**Descriptive Statistics—Financial Information and Twitter Information for Final Sample, from 2012 to 2017**

Two-Digit SIC Code	Industry Name	Number of Firm-Quarter Observations	Average Revenue	Average Accounts Receivable	Average Tweet Consumer Interest	Average Tweet Positive Sentiment	Average Tweet Negative Sentiment
20	Food and kindred products	288	4,120.78	1,951.53	844.53	795.42	305.39
21	Tobacco manufacturing	24	4,616.67	161.38	7.48	22.87	13.17
28	Chemicals and allied products	144	4,539.45	1,592.93	85.12	214.77	89.52
29	Petroleum and coal products	48	29,763.38	10,859.92	3.63	13.27	7.10
30	Rubber/misc. plastic products	24	7,498.13	3,441.46	773.07	1,715.88	789.19
31	Leather and leather products	48	939.78	303.24	35.61	68.98	20.25
36	Electrical equipment and components	96	17,770.89	7,541.23	2,677.05	3,580.18	2,293.22
37	Transportation equipment	168	29,908.22	36,176.99	113.05	368.76	170.54
42	Motor freight transportation	24	14,705.75	6,303.17	52.68	119.44	117.17
45	Transportation by air	192	6,150.74	1,521.82	86.84	150.66	155.65
47	Transportation services	24	1,669.62	1,090.61	43.35	770.62	40.76
53	General merchandise stores	24	28,794.04	1,269.33	238.85	284.32	111.43
55	Automobile dealers and gasoline service stations	48	2,904.34	299.55	2.96	7.49	3.71
58	Eating and drinking places	360	1,401.46	220.35	851.55	1,020.33	473.72
59	Miscellaneous retail	72	22,690.37	5,330.04	95.58	97.85	52.81
60	Depository institutions	24	3,522.33	2,015.75	37.49	33.66	18.24
67	Holding and other investment offices	24	206.97	110.31	8.06	11.01	5.87
70	Hotels, rooming houses, camps and other lodging places	48	2,475.56	800.65	62.60	138.94	22.49
73	Business services	120	8,571.81	5,371.53	4,600.11	5,333.26	2,265.66
75	Automotive repair services and parking	24	772.17	401.16	22.08	19.48	21.92

Source: Rozario et al. (2022). Reprinted with permission.

This table presents the average revenues, accounts receivable, normalized tweets for consumer interest to buy, positive, and negative sentiment broken by the two-digit SIC code. The values for revenues, accounts receivables, tweets for consumer interest to buy, positive, and negative sentiment are presented for the 20 industries for the years 2012–2017.

**TABLE 2**  
**Summary of Results**

**Panel A: Prediction Performance Comparison by Industry Among Benchmark Model (1), TCI Model (2), and TCS Model (3)**

	<b>Smaller MAPE TCI (2) versus Benchmark (1)</b>	<b>Smaller MAPE TCS (3) versus Benchmark (1)</b>
Number of industries	16 of 20	12 of 20

Smaller MAPE indicates whether the difference in mean absolute percentage error between Models (2) and (3) compared to (1) is smaller by industry.

**Panel B: Error Detection Performance Comparison by Industry among Benchmark Model (1), TCI Model (2), and TCS Model (3)**

	<b>Smaller Cost Ratio 1:1 TCI (2) versus Benchmark (1)</b>	<b>Smaller Cost Ratio 1:1 TCS (3) versus Benchmark (1)</b>
Number of industries	13 of 20	9 of 20
	<b>Smaller Cost Ratio 1:2 TCI versus Benchmark</b>	<b>Smaller Cost Ratio 1:2 TCS versus Benchmark</b>
Number of industries	13 of 20	9 of 20

Source: Rozario et al. (2022). Reprinted with permission.

Smaller Cost Ratio 1:1 indicates whether the difference in Cost Ratio 1:1 between Models (2) and (3) compared to (1) is smaller by industry. Smaller Cost Ratio 1:2 indicates whether the difference in Cost Ratio 1:2 between models (2) and (3) compared to (1) is smaller by industry.

Some companies in consumer-facing industries may benefit from the “wisdom of crowds” more than others. For example, companies that are larger in size may be more likely to be diversified and be comprised of different business segments and as a result, the effect of Twitter information in predicting sales may be diluted. Rozario et al. (2022) partition the industries into quartiles, sorting by size, and find that Twitter consumer interest is more effective in improving the prediction and error detection of analytical procedures for industries that are smaller, i.e., those that are in the bottom three quartiles.

The results of Rozario et al. (2022) should be interpreted with caution since auditors would have to consider the extent to which a revenue prediction error in preliminary analytical procedures warrants further investigation given the context of the client’s business and industry. That is, although a revenue prediction error can be used in audit planning to guide the auditor’s attention to areas of high risk of material misstatement, it may not always relate to an audit failure or increased cost in the audit.

## V. IMPLICATIONS

Rozario et al. (2022) show that the inclusion of tweets on purchase interest in preliminary analytical procedures for the revenue account can improve their prediction and error detection ability



for firms that are in consumer-facing industries and that are smaller. Although the analysis is based on estimated monthly firm-observations, one exciting opportunity for practitioners would be to use consumer tweets at the product level to develop more precise expectations for revenues.

In addition, while the purpose of the Rozario et al. (2022) study is not to identify all new sources of external nonfinancial information that may be useful to auditors, it does emphasize consumer tweets as a new source of information that may permeate audits and there are others that should be explored. One consideration for auditors as they seek to apply new sources of information to auditing procedures would be the completeness and accuracy of new types of external data. This is especially important in the big data environment since information is voluminous, produced in real time, and could be unstructured (Zhang, Yang, and Appelbaum 2015). These characteristics of new external data suggest, that while informative, the testing for its completeness and accuracy could prove challenging for auditors (Brown-Liburd and Vasarhelyi 2015; Bartov, Faurel, and Mohanram 2018; Tang 2018). One possible way that auditors may gain comfort over the accuracy and completeness of this information would be to obtain it from a data provider who has appropriate controls in place and issues a System and Organization (SOC) report.

Rozario et al. (2022) echoed the PCAOB's effort in understanding how new forms of data and technology may affect the work performed by auditors by finding evidence that one source of big data, consumer tweets, improves auditors' planning risk assessments for the revenue account (Public Company Accounting Oversight Board (PCAOB) 2017b, 2022). As such, this study may inform the regulator's effort in assessing whether there is a need for guidance or changes to PCAOB standards.

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