eXtensible Business Reporting Language: A Review and Directions for Future Research

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eXtensible Business Reporting Language: A Review and Directions for Future Research

SUMMARY: The current study reviews and summarizes the fast-growing audit and accounting research on eXtensible Business Reporting Language (XBRL). XBRL is an open standard for reporting structured financial information which enables the efficient gathering of data and automated comparison of financial data over time and across firms. The structured nature of XBRL disclosures facilitates the extraction of rich numeric and textual data that otherwise had to be manually collected. Therefore, XBRL presents unique opportunities for researchers to address new questions that could not be addressed prior to its adoption. The review begins with research examining audit-related XBRL research, the role of XBRL in auditors' work, and XBRL assurance considerations. We continue by summarizing the literature on the voluntary and mandatory XBRL adoption periods and continue with literature on the use of XBRL data, an area that may present the greatest opportunity for future research. The study also provides information about sources from which to obtain XBRL data and concludes with a discussion of future research opportunities.

Keywords: XBRL; eXtensible Business Reporting Language; interactive data; structured data; textual analysis; literature review

I. INTRODUCTION

This study reviews the empirical literature on eXtensible Business Reporting Language (XBRL) in audit and accounting, identifies how to obtain and use XBRL data, and offers directions for future research. XBRL is an open standard reporting language designed to improve the disclosure of financial information. This technology facilitates standardized reporting terminology, comparison across companies and over time, and automated data extraction and usage.[1] The introduction of XBRL is perhaps the most significant advancement in corporate financial reporting since the Securities and Exchange Commission (SEC) required companies to file financial reports electronically via the Electronic Data Gathering, Analysis, and Retrieval (EDGAR) system in 1996. Over a decade has passed since the initial XBRL mandate. According to J. Louis Matherne, Chief of Taxonomy Development for the Financial Accounting Standards Board (FASB), "the SEC XBRL project is a resounding success (Matherne 2019)." The potential for success extends to the academic community; the ease with which XBRL data may be extracted, the richness of the data, and the increase in the number of data sources create abundant opportunities for future research in auditing and accounting.[2]

Our synthesis of the XBRL literature extends a prior review that focuses primarily on the role of XBRL in information systems research in an earlier sample period (Perdana, Robb, and Rhode 2015).[3] We focus on empirical XBRL research relevant to the audit and accounting literature, as identified in 104 working papers and articles published in 16 journals from 2004 through 2019. Over 20 percent of this growing body of literature is focused on assurance of XBRL

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[1] See Part II for more information on what is XBRL.
[2] The richness of XBRL data is achieved via access to data that is often more detailed than the data provided by other datasets.
[3] Other literature reviews referencing XBRL also focused on accounting information systems (Grabski, Leech, and Schmidt 2011; Alles 2018; Hutchison, Daigle, and George 2018; Chiu, Liu, Muehlmann, and Baldwin 2019).

or uses XBRL data to answer audit-related questions. Thus, the first section of this paper examines the audit and assurance literature and related issues. The remainder of the review is structured following the timeline of XBRL adoption, as reported in Figure 1, and resulting use of XBRL data by academics.

[INSERT FIGURE 1 HERE]

We begin our review with a discussion of XBRL in the context of audit and assurance. First, we summarize archival audit-related literature examining XBRL adoption or using XBRL data. This literature examines the association between XBRL adoption and audit outcomes and uses XBRL data to study the association between financial reporting characteristics and disclosures with financial statement auditors. We next introduce a summary of how auditors may use XBRL to streamline risk assessments and analytical procedures. We complete this section with a discussion of assurance of XBRL filings. XBRL was created to provide users with easier access to structured accounting data. Yet, current regulation does not require the assurance of XBRL filings, which has the potential to significantly undermine its usability due to potential quality concerns.

XBRL disclosure quality can be measured along several dimensions. First, whether financial statement preparers select appropriate XBRL tags from the FASB Taxonomy and/or appropriately create custom company-specific extended tags.[4] Second, whether the value (e.g. monetary, percent) and scale (thousands, millions) of the reported data are accurate. Since XBRL presents the opportunity for computer programs to make autonomous decisions, errors and irregularities have the potential to significantly disrupt the market. For example, if firms

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[4] Each accounting concept, e.g., revenue, is represented by an XBRL tag, e.g., <us-gaap:Revenues>. When available, companies are expected to use standard tags that appear in the XBRL U.S. GAAP Taxonomy maintained by the FASB. When companies deem that no appropriate tag is available to represent a unique company-specific accounting concept, they can extend the Taxonomy and create their own tag.

incorporate automated trading rules around company filings based on XBRL data, scale errors (e.g. millions instead of thousands) can prompt erroneous trades. Such trades may subject firms to significant litigation risk. Therefore, to take full advantage of the power of XBRL, regulators should consider requiring the assurance of XBRL filings. This important topic has significant policy implications that are mostly unaddressed in prior literature. However, while early research identifies a consequential amount of errors and misuse of extended tags, recent evidence suggests that the quality of XBRL filings has significantly improved (Debreceny et al. 2011; Du, Vasarhelyi, and Zheng 2013). This increase in quality should motivate an increase in the use of XBRL data by financial statement users and the academic community.

Following our review of audit-related XBRL research, we present other XBRL literature in accounting. First, we examine research related to the voluntary and mandatory adoption of XBRL in the U.S. and abroad. Research on the voluntary adoption period examined the potential reasons for early adoption and the type of firms and governance structures that elected to voluntarily file their financial statements in XBRL format. This research also examined the impact of these filings on the market and the production of the financial reports. The mandatory adoption period, beginning in 2009, introduced an exogenous shock that enabled researchers to assess the impact of XBRL reporting. Several studies attempted to examine the primary objectives of XBRL: to reduce information processing costs and information asymmetry and thereby increase market efficiency. As we describe in Part IV, results vary across studies and often depend on the type of financial statement users.

The next identified research theme focuses on the use of data obtained from XBRL filings in capital markets and audit research. Unlike commercial databases (e.g. Compustat) that disseminate standardized and therefore less granular data, XBRL filings contain the exact details

filed in the company's financial statements. Additionally, XBRL filings include all data in the notes to the financial statements which is often hand-collected by users because it is not available from third-party data providers. For instance, while Compustat includes about 9 fair value (FV)-related items, over 219 items are available from XBRL data (Ahn, Hoitash and Hoitash 2019). This example illustrates the granularity of the data available in XBRL filings and the potential for future research using this data.

We separate the data use theme into studies using metadata and studies using actual XBRL data.[5] To date, most research using XBRL data examines the metadata properties of XBRL filings. Specifically, rather than rely on the actual value (e.g. monetary or textual) reported in XBRL tags, researchers leveraged XBRL tag names to answer their research questions. For example, recent research proposed that the number of distinct tags can be leveraged to measure reporting complexity (Hoitash and Hoitash 2018; Chychyla, Leone, and Minutti-Meza 2019). Research has also taken advantage of the fact that XBRL disclosures mirror firms' financial statement filings to construct measures of financial reporting comparability, which is one of the intended objectives of XBRL (SEC 2009). Here, studies suggest that greater granularity in XBRL data relative to commercial databases may potentially be detrimental to comparability (Hoitash, Hoitash, Kurt and Verdi 2018) and that (XBRL-based measures of) comparability improve analyst forecast accuracy (Caylor, Chambers, and Mutlu 2018; Hoitash et al. 2018). Another stream of metadata literature examined the usage of standard Taxonomy tags as opposed to extended tags that are created by the reporting firm. For example, research examined whether the percent of extended tags used by firms is associated with earnings management (Kim, Kim, and Lim 2019).

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[5] XBRL tags provide metadata, which is data that describes and provides information about other data. For example, the name of the tag as well as other attributes such as scale and period, provide context information on the disclosed value.

In addition to using metadata and the structure of XBRL filings, other studies have started using actual accounting data identified from XBRL filings. These studies further exemplify the richness of XBRL data, using either the detailed monetary data that typically does not appear in Compustat, or textual disclosures in the notes to the financial statements that must be tagged using XBRL. For example, Peterson, Schmardebeck, and Wilks (2015) conduct textual analysis by leveraging XBRL to extract accounting policy footnotes to create a measure of accounting consistency. Using XBRL data to conduct such research is advantageous over other data sources because it provides automatic access to large scale monetary and textual information that otherwise has to be manually collected. The standardization embedded within XBRL further increases the accuracy for cross sectional-comparisons across firms and over time.

One reason XBRL research has proliferated in recent years is the increased availability of XBRL data. To facilitate future research using this data we provide a brief technical introduction to XBRL in Appendix B and identify several XBRL data sources: custom computer programs, SEC datasets, researcher processed data, XBRL US, and other third-party data providers.[6] Each data source requires varying levels of technical skills. XBRL data may be extracted directly from company filings made available in the SEC's EDGAR database. However, using these filings necessitates the knowledge of Python or other scripting language to download and parse the files. The SEC also provides a database comprised of "flat" files. Each file is based on data that was parsed from actual XBRL filings and the files can be linked and combined. Another source of raw granular data is available to members of XBRL US, which provides access to a database of all XBRL-formatted public filings. Researchers have also began to share processed data of aggregated

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[6] All Big 4 audit firms are members of XBRL US. We discuss auditors' use of XBRL data in Section IV.

information which includes the number of tags, number of facts, percent of extensions, etc.[7] Finally, several commercial firms sell access to raw and processed XBRL data.

In the last section, we discuss opportunities for future XBRL research. The significant potential for growth in this field was recognized in a 2019 speech at a National Bureau of Economic Research conference (Kothari 2019), in which S.P. Kothari, the Chief Economist and Director of the Division of Economic and Risk Analysis at the SEC, stated "*structured data will likely drive future research.*" While extant research has addressed various questions proposed in prior literature (e.g. Debreceny et al. 2005), developments in regulations and data quality create ample opportunity for further inquiry to inform auditors, regulators, financial statement users, preparers, and other capital market participants. The increased availability and reliability of XBRL data, as well as the richness and uniqueness in the information it provides that is not available through traditional commercial databases, should motivate further research on XBRL. Studies may use metadata to construct measures that capture different properties of audited financial reports. Furthermore, the growing body of research on textual analysis of corporate filings may benefit from using XBRL data that provides better accuracy in identifying textual disclosures than traditional methods of textual analysis. We encourage researchers to continue investigating the costs and benefits of assurance of XBRL filings and propose potential research questions related to this issue. Finally, future research may examine the impending Inline XBRL (iXBRL) mandate, which requires XBRL to be embedded in the financial statements filed in HTML format.[8]

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[7] For example, access to an XBRL based measure of accounting reporting complexity is available at http://www.xbrlresearch.com/.
[8] iXBRL will be phased in over a three-year period based on filer status beginning with fiscal periods ending on or after June 15, 2019. Regulators believe that this will lead to a reduction in the burden on preparers, greater preparers autonomy over the presentation of XBRL disclosures, enhancement to the usability of XBRL disclosures, and improved quality. More information on iXBRL is discussed in Part IV.

II. WHAT IS XBRL

This section discusses relevant XBRL terminology and the reporting structure.[9]

Overview of XBRL

XBRL, eXtensible Business Reporting Language, is an XML-based markup language used to electronically communicate financial and business data. A markup language uses tags to encode documents. Each tag contains metadata properties, such as whether the tag is monetary, percentage, textual or other, the period that the value refers to, whether the value is debit or credit, and much more.[10] The tags in turn enable computers to automatically extract information, sort it, and compare it across firms and over time. Although computers do not independently recognize accounting concepts, they can be programmed to automatically recognize XBRL tags such as <us-gaap:Revenues>, locate this tag in multiple financial reports, and compare the revenue balance across companies and over time.[11]

Taxonomy Tags and Extensions

When filing XBRL reports, financial-statement preparers "tag" each detailed financial concept in Item 8 of the 10-K (and interim 10-Q) filings.[12] This tagging applies to the financial statements, such as the balance sheet and income statement, as well as to the notes to the financial statements. XBRL has two types of tags: *Taxonomy tags* are pre-defined tags representing

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[9] This section is adapted from information available on the xbrl.us website and from Hoitash and Hoitash (2018).

[10] In addition to tag metadata, XBRL files include information about scale of the amount reported, the associated FASB accounting standards codification, and whether the amount is a positive or negative.

[11] Prior to XBRL reporting, two primary barriers prevented this type of streamlined comparison and analysis. First, it was difficult to accurately extract and identify information from HTML (Hyper Text Markup Language) filings, the other financial statement disclosure format, because these filings were designed only for human consumption. Second, firms used different terminologies and syntax to describe their accounting concepts which prevented computers from being able to consistently identify the same accounting concept across different firms. For example, three firms can use the terms "Operating loss," "Loss from operations," and "Income from Operations" to describe the same account concepts and all three firms will use the same XBRL tag <us-gaap:OperatingIncomeLoss> to capture that information.

[12] While XBRL requirements currently apply to the 10-K and 10-Q, proponents of the data have called for a mandate to extend to earnings releases, proxy statements, and management commentary (Singh 2018).

accounting concepts that appear in the XBRL U.S. GAAP Taxonomy. The Taxonomy is a machine-readable "dictionary" that is updated annually and may be downloaded from the FASB website at http://xbrl.fasb.org.[13] Taxonomy tags are indicated by the prefix "us-gaap". For example, <us-gaap:Revenues> is a Taxonomy tag which represents the amount of recognized revenue. Each tag can appear multiple times in the financial document. For example, the Tag <us-gaap:Assets> typically appears several times with different values, representing values for different business units and different time periods. The value of each tag appearance is termed a *fact*.[14] The facts and tags allows for the extraction of more detailed financial information, some of which is not available in traditional commercial databases.

To fully support the objective of XBRL to increase automatic cross-sectional benchmarking, companies are required to use Taxonomy tags if one is available. However, the Taxonomy may not always meet the precise reporting needs of all firms, so companies may extend the Taxonomy and create their own *Extended tags*. These tags are identified by company ticker symbols as a prefix instead of the "us-gaap" prefix.[15] Figure 2 illustrates the average percentage of extended tags from 2012-2018. The data indicates a decline in extension use over the sample period, with high use of extensions in the first year of mandatory adoption, approximately 16 percent, declining to an average of approximately 14 percent in later years.

[INSERT FIGURE 2 HERE]

The decline in extension use may be attributable to a learning curve, in which financial statement preparers are better able to identify the appropriate Taxonomy tags, and to the introduction of new

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[13] Annual updates include the elimination of unnecessary tags and addition of new tags, including those related to changes in accounting standards.

[14] For example, since firms are required to report comparative data over a three-year period, typical 10-K filings include at least three instances of the revenue tag with three different values (i.e., *facts*).

[15] An example of the use of Taxonomy and Extended Tags in an XBRL filing can be found in Appendix A.

Taxonomy tags by the FASB. Importantly, while extended tags allow companies to make decisions about how to best represent their performance, extended tags potentially reduce the efficacy of cross-sectional analysis.

Obtaining and Using XBRL Data in Audit and Accounting Research

Appendix B provides detailed information about how to obtain and use XBRL in audit and accounting research. We have identified and described five sources of XBRL data, including the relative difficulty of using each type of data source: custom computer programs, SEC datasets, researcher processed data, XBRL US, and other third-party XBRL data providers. Table 1 presents the sources of XBRL data identified in papers using XBRL metadata or actual data. The majority of these papers (20) obtain the data via direct download and analysis by researchers. The SEC files are also a popular source of data (eight papers) followed by an XBRL data provider, Calcbench (four papers).

[INSERT TABLE 1 HERE]

III. METHOD

To complete our review of the XBRL research in audit and accounting we rely on the peer-reviewed journals listed in Table 1. Panel A identifies the number of XBRL-related papers identified in each journal. Our journal selection was motivated by identifying those with the greatest impact in accounting literature as well as those that frequently publish XBRL research (Bedard, Deis, Curtis, and Jenkins 2008; Carcello, Hermanson, and Ye 2011; Lennox and Wu 2018).[16] Since XBRL research is experiencing recent growth in academic inquiry, we deemed it appropriate to include working papers in our literature review. Within the identified journals, we conducted our search for articles containing the terms "XBRL," "eXtensible Business Reporting

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[16] Journal rankings were identified from the Australian Business Dean's Council. Available at https://abdc.edu.au/research/abdc-journal-list/

Language," "Interactive Financial Information," "XBRL for Interactive Data" and "Interactive Data" in May and June of 2019.[17]

[INSERT TABLE 2 HERE]

The distribution of identified papers is illustrated in Figure 3 and shows an increasing trend in the number of XBRL papers over the sample period. Table 2 Panel B reports the number of XBRL-related papers by year in the top accounting journals and working papers. The Panel illustrates that papers published in the top accounting journals are concentrated in the last three years, suggesting that XBRL research is gaining traction in its ability to provide opportunities for future publications in accounting journals.

[INSERT FIGURE 3 HERE]

Our review starts with XBRL research in the auditing domain; we discuss the role of assurance in the quality and usability of XBRL filings. Our subsequent presentation of the literature is consistent with the general chronological evolution of XBRL research, starting with studies examining the impact of XBRL adoption, including the voluntary and mandatory filing periods. Next, we consider the use of XBRL data in accounting research, including both metadata and actual-data. A summary of the papers in each category are presented by year in Table 3 Panel A and by journal in Table 3 Panel B. Table 3 Panel C presents a summary of the literature classified into each category.

[INSERT TABLE 3 HERE]

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[17] Our review also includes publicly available papers that the authors know to have used XBRL data but were not identified using these key search terms. For example, the working paper by Czerney, Lisic, Wu, and Zhang (2019) uses XBRL data. However, the paper was not identified via search on SSRN or Google Scholar. It is thus possible that this study may omit working papers using XBRL data due to limitations in identification of keywords by common research search engines.

Auditing and assurance-related studies are common, comprising 21 percent (22 papers) of our sample. We identify mandatory adoption as the most common topic of XBRL research, with 32 papers on this subject published or in process.[18] Studies using metadata are also common, with 24 papers in this category. Studies using metadata are concentrated in the last five years of the sample period, suggesting ample opportunity to further leverage this data. Interestingly, fewer studies (10) have used actual XBRL data, perhaps because using the data is more challenging than using XBRL metadata such as tags.[19] Nevertheless, since XBRL provides access to rich numerical and textual data that is often more detailed than the data provided by other datasets, the advancement of XBRL research using actual XBRL data provides the greatest opportunity for future audit research.

IV. XBRL, AUDIT, AND ASSURANCE

This section discusses audit-related studies examining XBRL adoption and studies leveraging XBRL data to examine audit-related consequences , auditors' use of XBRL data, and XBRL assurance developments.

XBRL Research in Auditing

Studies examining the adoption of XBRL find that companies with Big 4 auditors were more likely to participate in the voluntary filing program (Boritz and Timoshenko 2015). There has been limited research on the association between mandatory XBRL adoption and audit outcomes. Amin, Eshleman, and Feng (2018) test for efficiencies in the audit process generated by XBRL's ability to facilitate streamlined data acquisition and analysis, improve internal controls

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[18] It is important to note that the concentration of papers examining mandatory adoption do not necessarily indicate that this is the most important topic of XBRL research. Rather, when XBRL reporting was initially mandated, researchers identified opportuntities to examine the costs and benefits of the mandate as well as quality considerations.
[19] The number of identified papers using actual XBRL data is likely understated. Some papers may use XBRL data but unknowingly not present the mechanism by which the data is collected.

over financial reporting, and create opportunities for continuous auditing. They find that the XBRL mandate is associated with a decline in audit report lags. The results are concentrated in large accelerated filers in high-tech industries, because these companies have better IT and expertise that facilitate the transition to XBRL, and companies served by Big 4 auditors. They further find that the results hold only for companies with strong internal control systems. They also find evidence of a learning curve in XBRL reporting and a negative association with audit fees, suggesting that both reporting companies and their auditors are more efficient in XBRL reporting over time.

Several studies have used XBRL metadata to examine financial statement characteristics and how these relate to auditors. Hoitash and Hoitash (2018) develop a measure of accounting reporting complexity (ARC) based on the count of XBRL tags in 10-K filings. Since each tag points to an accounting standard, they surmise that more tags captures the complexity of the preparation, reporting, and audit of accounting transactions. Relative to other commonly used measures of complexity, they document that this measure of ARC is more consistently associated with a greater likelihood of misstatements and material weaknesses, longer audit report lag, and higher audit fees. The associations using ARC also have greater explanatory power and economic significance than other proxies for complexity. Likewise, they document an inverse association between the number and percent of extended tags with these audit-related outcomes.[20] Smith, Zhang, and Kipp (2019) measure ARC based on the number, percentage, and ratio of customized XBRL tags and find that the external auditor is less (more) likely to issue a material weakness for firms that (do not) identify cloud-computing as a significant operations risk when ARC is higher. Johnston and Zhang (2018) count the number of items in XBRL filings to develop a measure of

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[20] The association with misstatements applies only to the percentage of extended tags.

financial reporting similarity and find that firms that share the same auditor have more similar accounts reported on the face of the financial statements.

Finally, several studies extract detailed footnote disclosures using XBRL tags and perform textual analysis to make inferences about audit outcomes. Czerney and Sivadasan (2019) use XBRL tags to identify footnote disclosures in the financial statements and find that external auditors, rather than Chief Executive Officers and Chief Financial Officers, have the greatest influence on firms' reporting of textual disclosures. Czerney, Lisic, Wu, and Zhang (2019) use XBRL-identified footnotes and find that the tone of the disclosures is more reflective of bad news for companies using a Big 4 auditor than a non-Big 4 auditor. Using FV-related line items, Ahn et al. (2019) document that firms increase the number of FV tags following receipt of a comment letter from the SEC and that the increase in the number of FV tags is greater among clients with FV expert auditors.

Auditors' Use of XBRL

While the intended beneficiary of mandatory XBRL reporting is investors, other stakeholders, including auditors, may also benefit from the use of XBRL data.[21] In order to opine on the financial statements, auditors must complete a series of audit procedures. The audit process includes risk assessments and analytical procedures, both of which require significant data analysis. The structured nature of XBRL data allows for streamlined acquisition of accounting data (Debreceny and Gray 2010; Gray and Debreceny 2014). Thus, auditors are better able to benchmark and compare audit clients with peer firms and prior year reporting for purposes of identifying anomalies and risks (Gambetta García-Benau, and Zorio-Grima 2016). The easily searchable and comparable data includes numbers presented in the face of the financial statements, as seen in

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[21] We are aware of two Big 6 accounting firms that use the services of Calcbench, a provider of access to structured data. While other Big 6 firms may also subscribe, this information is not publicly available.

Appendix A, or supplementary information contained in the notes to the financials.[22] An additional benefit of XBRL data to auditors is that it is available in real time, as published by public companies. Auditors then have access to peer companies' information immediately, rather than waiting for conventional databases to extract and post it, which may not occur in a timely fashion to assist in audit procedures. Finally, auditors may be able to leverage the structured nature of XBRL data to better enable visualizations of XBRL narratives and disclosures, as, according to Mike Willis, Assistant Director at the SECs' Office of Structured Disclosure, structured disclosures lower the cost of reuse (Willis 2019).

Assurance of XBRL Filings

In this section we identify threats to XBRL data that motivate a potential need for assurance of XBRL filings, challenges of assurance, and additional assurance considerations arising from the introduction of iXBRL.

Quality Threats to XBRL Data

Financial statements are audited by the external auditor and certified by management. Historically, the financial statements were converted to HTML format and this file was provided to the SEC. After the XBRL mandate, firms were required to furnish filings in both HTML and XBRL formats.[23] Although the interactive XBRL filings (financial statements and notes) should theoretically be identical in content to the original financial statements and traditional HTML filings, there is no mandate that these filings receive any form of assurance from the external auditor. As a result, the SEC distributes two sets of filings, one audited (HTML) and one unaudited

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[22] An example of use by auditors may include collection and analysis of the effect of the expected rate of return on pension valuations and net income. XBRL offers streamlined access to data that is otherwise hard to collect.
[23] Many preparers rely on the help of software provided by vendors or fully outsource the conversion process to XBRL.

(XBRL).[24] This approach is concerning because evidence suggests that many XBRL filings are inconsistent with the HTML files or contain errors (Boritz and No 2008, Debreceny, Farewell, Piechocki, Felden, and Gräning 2010; Farewell, Hao, Kashyap, and Pinsker 2018).[25]

The conversion to XBRL creates opportunities for errors in the choice of Taxonomy tags, metaproperties, and file structures. Concern about the reliability of information presented in XBRL files arises from managers' decisions to use Taxonomy or extended tags. The use of an extended tag, or incorrect Taxonomy tag, may reduce the usability, extractability, and comparability of XBRL filings by limiting users' abilities to identify and compare specific line items or footnote disclosures. Other significant threats to XBRL data include errors in metaproperties assigned to the data in the conversion process. For example, recent research finds that the XBRL filings of a significant number of firms contain at least one scale error (Calcbench 2014). Values presented in thousands instead of millions can lead to errors in models, decision making, and trading. Finally, incorrect file structures may negatively impact the usability of XBRL files, such as having the incorrect nesting or presentation that prevents users from linking the value of XBRL tags to their financial statements and notes.

As reflected in the final XBRL adoption (SEC 2009), a major goal of XBRL was to allow automated financial analysis by both humans and machines. The SEC (1) states *"In this format, financial statement information could be downloaded directly into spreadsheets, analyzed in a variety of ways using commercial off-the-shelf software, and used within investment models."* Not auditing the XBRL filings may undermine this goal (PCAOB 2019) via threats to the usability and

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[24] The conversion from the original financial statement file to HTML is a seamless transition; text in the HTML file mirrors text in the Word or PDF file. The HTML conversion thus just changes formatting, while the conversion to XBRL adds metaproperties of the underlying data. Examples of such metaproperties may be found in Appendix B.
[25] Alternatively, some literature on quality during the voluntary filing period does document a decline in errors over the period (Bartley, Chen, and Taylor 2011).

comparability of the data. In addition, the use of automated algorithm-based trading, which has become more prevalent in recent years, may lead to poor performance if these algorithms rely on XBRL data that contains material errors. While recent evidence suggests that the frequency of firms with XBRL errors has significantly declined (Debreceny et al. 2011; Du et al. 2013), the assurance of XBRL filings have the potential to further increase the credibility of XBRL reports.

Assurance Challenges and Opportunities

Threats to the reliability and usability of XBRL data create important opportunities for future research to examine whether assurance should be required and continued analysis of the challenges associated with such assurance. Auditors opine on the financial statements as a whole. However, since the intended usage of XBRL reports is at the individual data-level, rather than the entirety of the financial statements, the assurance of these reports should also be at the data-level (Gunn 2007; Cohen, Debreceny, Farewell, and Roohani 2014). Thus, the audit of identified threats to detailed XBRL data, including the numbers presented in XBRL format, XBRL tags, metaproperties, and file structures, may offer benefits to the capital markets.[26]

Potential assurance of XBRL data is not without challenges. Due to the granularity of the assurance needs, questions arise about appropriate levels of sampling in audits of, for example, XBRL tags (Plumlee and Plumlee 2008; Srivastava and Kogan 2010). Another consideration is the issue of how to determine materiality. For example, whether materiality should be based on the number of incorrect tags rather than the dollar value of the tagged item. Additional audit considerations include control risks, such as whether traditional internal controls over financial reporting are sufficient to ensure the integrity of XBRL filings (Plumlee and Plumlee 2008;

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[26] While the assurance of XBRL should benefit the capital markets, financial statement preparers' perceptions of the benefits of assurance do not always exceed the perceived costs (Daigle and Lampe 2004).

Srivastava and Kogan 2010).[27] Finally, the lack of regulatory penalties for poor quality XBRL filings may contribute to low demand for assurance by filers. While the SEC reviews XBRL filings, we are not aware of any sanctions issued by the SEC for poor quality XBRL-formatted documents.

Absent a regulatory requirement for assurance over XBRL filings, research has considered other factors influencing the supply and demand of such assurance. Survey evidence suggests that auditors are not interested in providing assurance over the XBRL process, likely due to liability concerns (Janvrin and No 2012). Reducing the perceived cost of external assurance may be an important consideration for preparers of XBRL filings (Alles and Gray 2012). Regulators may be particularly concerned with findings that investors appear to value assurance of XBRL-formatted documents, specifically when the standard audit report has explicit inclusion of XBRL (Debreceny, Farewell, and Verkruijsse 2012).

Additional Challenges Presented by Inline XBRL

The SEC continues to adopt advancements to XBRL reporting. In 2018, an amendment was implemented that requires firms to file Inline XBRL (iXBRL) reports in which XBRL is directly embedded into the HTML filings. Thus, instead of submitting two filings (HTML and XBRL), financial statement preparers submit a single set of documents. This change has several objectives, including a reduction of the burden on preparers by eliminating duplication of filings, giving preparers full control over the presentation of XBRL disclosures, enhancing the usability of these disclosures, and improving the quality of filings by making it easier to identify errors (Basoglu and White 2015). The iXBRL requirement will be phased in over a three-year period based on

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[27] Frameworks for how to audit XBRL are proposed by Srivastava and Kogan (2010) and Boritz and No (2016).

accelerated filer status beginning with fiscal years ending on or after June 15, 2019, but some firms have begun voluntarily filing in iXBRL format.

Within the iXBRL filings, financial statement users are able to click on tagged items to see the XBRL data associated with each distinct fact. In essence, the number they see is audited, but the value and metadata information revealed when users click on this amount is not.[28] The embedded filings have thus generated concerns about perceived assurance over XBRL disclosures. EY (2017, 2) states: *"We are concerned that embedding tags in the financial statements and having the SEC provide an iXBRL viewer to highlight them and display aspects of the tag could lead investors to assume that the tagging has been audited or reviewed by the registrant's independent, registered public accounting firm. Investors and other financial statement users also might assume that iXBRL tags were subject to the registrant's internal control over financial reporting (ICFR) on which the auditor issued an attestation report."* The lack of assurance of XBRL filings may expose auditors to additional litigation risk and cause investors to over rely on unaudited XBRL data.

International XBRL Reporting and Assurance

Globally, more than 100 countries have some form of XBRL reporting, be it voluntary or mandatory (Cohn 2017), with a large concentration of participating countries in Asia, Europe, and South America.[29,30] XBRL data can thus be leveraged to conduct international research examining IFRS. Of the countries requiring XBRL-formatted financial statements, we are aware of two that have some form of assurance requirement. In India, an external accountant is required to certify

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[28] An example of the metadata available in iXBRL filings is provided in Appendix C.

[29] Many of these countries, like the United States, make XBRL data publicly available. A list of some countries whose interactive data is made available electronically may be found at https://www.xbrl.org/the-standard/why/ten-countries-with-open-data/.

[30] In addition, foreign private issuers are required to furnish financial statements in XBRL format for fiscal periods ending on or after December 15, 2017, with no phase-in based on filer status.

that the XBRL filings are complete, accurate, and fairly represent the financial statements. However, this certification is not equivalent to a complete audit of the filings (Farewell et al. 2018). As of January 1, 2018, the Netherlands is the first country to require assurance of XBRL filings by the external auditor. In November, 2019, the Committee of European Auditing Oversight Bodies mandated and offered guidance on the audit of iXBRL filings. If XBRL tags are materially misstated, auditors should express a qualified or adverse opinion on XBRL compliance.

In summary, while capital market participants generally recognize the importance of reliable XBRL reporting, audited XBRL information is not mandated in most countries. The arguments we present above should encourage regulators and auditors to consider mandating and implementing XBRL audits.

V. ADDITIONAL EVIDENCE FROM THE LITERATURE

This section reviews extant literature in other areas of accounting that may inform audit research. We review the literature on the voluntary and mandatory adoption of XBRL followed by literature using XBRL metadata and actual-data.

Voluntary Adoption

The adoption of XBRL was initially voluntary; starting in 2005, the XBRL Voluntary Filing Program (VFP) allowed firms the choice of submitting financial statements in XBRL format (SEC 2005). The VFP was intended to provide participants with the opportunity to practice the XBRL process and to provide the SEC with information that could better inform the mandate that followed the voluntary period. This period spurred research on the characteristics of firms participating in the VFP, the quality of the filings made during this period, and preliminary evidence on the impact of XBRL filings. Overall, XBRL research on the VFP indicates that the

quality of filings made during this time period was low. Nevertheless, there is some evidence to suggest that these disclosures benefited the capital markets.

Characteristics of Participating Firms

Firms participating in the VFP have a higher propensity to voluntarily disclose information, higher profitability (Boritz and Timoshenko 2015), are larger (Premuroso and Bhattacharya 2008; Callaghan and Nehmer 2009) and less financially leveraged (Callaghan and Nehmer 2009). For non-high-tech firms, innovativeness is also an explanatory factor of VFP participation (Boritz and Timoshenko 2015). The literature reports mixed results between analyst following, Big 4 auditors, and high earnings quality and the likelihood of participation in the VFP (Boritz and Timoshenko 2015). Mixed results on the impact of corporate governance on voluntary adoption suggest that firms with either stronger corporate governance (Premuroso and Bhattacharya 2008; Boritz and Timoshenko 2015) or weaker corporate governance (Callaghan and Nehmer 2009) are more likely to voluntary adopt. Additionally, firms in less competitive industries are more likely to voluntarily adopt XBRL due to the increase in proprietary costs related to firms' voluntary disclosures (Chatterjee, Gupta, and Kong 2018). In an international setting, survey evidence suggests that German finance managers have greater pressures to adopt XBRL than IT managers (Pinsker and Felden 2016).[31]

Impact of XBRL Filings

Findings from the literature on the impact of XBRL filings during the voluntary filing period are mixed, perhaps because of limited use of XBRL data by financial statement users. Filings made during the VFP do not appear to reduce information processing costs due to the lack of

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[31] Examining countries with both voluntary and mandatory adoption of XBRL, Abdolmohammadi, DeSimone, Hsieh, and Wang (2017) find that the internal audit function is more likely to be involved in XBRL implementation for large companies in common law countries than for small companies in civil law countries.

requirements about timeliness and reliability of XBRL reports filed during this period (Li, Lin, and Ni 2012; Dong, Li, Lin, and Ni 2016). Other research suggests that only voluntary adopters with strong corporate governance benefit from XBRL reporting (Hsieh and Bedard 2018). However, based on investors' reactions to earnings announcements of firms' participating in the VFP, XBRL filings do appear to offer useful information to the capital markets (Dontoh and Trabelsi 2014). Research on voluntary adoption by Belgian private companies offers evidence on the benefits of voluntary filing; banks charge lower interest rates to voluntary adopters and these adopters have larger loan sizes than nonadopters (Kaya and Pronobis 2016).

Mandatory Adoption

Mandated XBRL reporting for Form 10-K was phased in during 2009, 2010, and 2011 for large accelerated filers with public float of at least $5 billion, all remaining large accelerated filers, and all remaining filers, respectively. In the initial year of compliance, filers were required to tag financial statement footnotes and attached schedules as a single block of text.[32] Beginning in the second year of compliance, filers were required to tag each quantitative disclosure within the footnotes or schedules. Research on the mandatory filing period primarily focused on consequences of adoption for the capital markets. The results inform regulators concerned with the efficacy of the mandate and offer important considerations for users and preparers of financial reports.

The XBRL mandate was intended to reduce information processing costs, lessen the information gap, and reduce information asymmetry. Providing financial information in digital format allows investors to collect and analyze data in a more efficient manner by leveraging automated data collection techniques. In addition to ease of collection, the structure of the XBRL

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[32] See Part VI, Using XBRL Data for Textual Analysis, for further information on different levels of footnote tagging.

Taxonomy facilitates ease of comparison of financial reports across firms and over time. Finally, the ability to access detailed data on the EDGAR system, rather than from third-party providers such as Compustat by Capital IQ, makes data collection and analysis available to a broader set of investors. Much of the XBRL research to date has examined whether the regulation has been successful in these regards.

Studies offer mixed evidence on whether XBRL was successful in mitigating the information gap between large and small investors. Some literature offers support (Bhattacharya, Cho, and Kim 2018; Kim, Li, and Liu 2019) while other research finds an increase in the information gap following the adoption, likely attributable to large investors' superior resources and abilities to process information filed in XBRL (Blankespoor, Miller, and White 2014; Cong, Hao, and Zou 2014; Du and Wu 2018).[33] Offering further juxtaposing conclusions, users of small company filings are able to access XBRL files and prefer them to non-XBRL files (Cong, Du, and Vasarhelyi 2018), [34]

The SEC contended that "*interactive data has the potential to increase the speed, accuracy, and usability of financial disclosures*" (SEC 2009) and thus lower information processing costs. While Dhole, Lobo, Mishra, and Pal (2015) find that financial statement comparability declined after the XBRL mandate, suggesting that this particular goal was not achieve, other literature generally supports this claim. It has been documented that XBRL mitigates information processing costs and thus reduces information asymmetry, as evidenced by reduced analyst forecast accuracy (Liu, Wang, and Yao 2014; Felo, Kim, and Lim 2018), greater stock return synchronicity (Dong

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[33] Examining the SEC's goal of leveling the playing field between investor types, Hodge, Kennedy, and Maines (2004) conduct an experiment and find that many nonprofessional investors fail to utilize XBRL-formatted reports, but that those who do are better able to acquire and integrate information.

[34] This is consistent with the experimental evidence offered by Pinsker and Wheeler (2009), who find that non-professional investors perceive XBRL-formattted documents to be more efficienct and effective than other formats. Arnold, Bedard, Philips, and Sutton (2012) offer evidence that nonprofessional investors' search strategies are improved when narrative disclosures are tagged in XBRL format.

et al. 2016), lower return volatility (Kim, Lim, and No 2012; Huang, Shan, and Yang 2019), lower investor expectations of crash risk (Zhang, Guan, and Kim 2019), lower costs of equity capital (Li, Lin, and Ni 2012), reductions in bank loan spreads (Chen, Kim, Lim, and Zhou 2018) and positive abnormal returns and lower risk for banks (Hao and Kohlbeck 2013). Overall, the mandatory adoption of XBRL was expected to increase shareholder wealth (Chen, Wang, and Zhou 2018). Evidence from the literature also confirms that XBRL met the SEC's goal of improved information accessibility (Janvrin and Mascha 2014; Yen and Wang 2015) and efficiency (Efendi, Park, and Smith 2014; Yang, Liu, and Zhu 2016).[35,36]

Another stream of literature considers how firms respond to the reduction in investors' information processing costs post-XBRL mandate. XBRL reporting, or the change in shareholders' information processing costs, results in changes in tax avoidance strategies (Chen, Hong, Kim, and Ryou 2017) and increases in quantitative footnote disclosures (Blankespoor 2019).

Data Use

XBRL data offers multiple opportunities for use in academic literature. This section reviews the literature using XBRL metadata and XBRL tags to identify tag properties, actual numbers, and text reported in the financial statements. The results discussed in this section offer insights for regulators about the success of XBRL in facilitating the comparability of financial reports. Similarly, the results inform financial statement preparers about their ability to influence the usability of financial reports, such as in the selection of tags and extensions that influence financial

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[35] Confirming these results in a behavioral setting, Janvrin, Pinsker, and Mascha (2013) find that most investors (sixty-six percent) use XBRL based on a perceived increase in task efficiency.

[36] Other literature examines whether improved information processing is evidenced by increased machine coverage. The evidence is conflicting, with Pungaliya and Wang (2018) finding a positive association between machine processing and stock returns post-XBRL mandate, and Allee, DeAngelis, and Moon (2018) failing to find evidence that XBRL is a suitable substitute for other measures based on the amount of information within a disclosure that is machine-readable.

statement comparability. This flexibility in tagging decisions also influences financial statement users' perceptions of the usability and comparability of financial reports.

Metadata

Metadata is data that provides information about another source of data. XBRL tags provide metadata information on the actual monetary or textual values contained in financial reports. To date, studies leveraging the use of metadata in XBRL commonly focus on characteristics of the financial statements such as complexity, comparability, and similarity. Other literature uses metadata to identify the use of extended tags and implications of this use on investors' information processing costs and management's reporting decisions.

Financial Statement and Auditing Characteristics

Hoitash and Hoitash (2018) develop a measure of ARC that is associated with a greater likelihood of misstatements and material weaknesses, longer audit report lag, and higher audit fees. Subsequent literature extends findings using the ARC measure. Brown, Cohen, and Huffman (2019) find that ARC is positively associated with the use of non-GAAP earnings metrics. Leveraging the ability of ARC to capture account-specific complexity, they find that the number of non-GAAP disclosures increases with the reporting complexity of specific accounts such as derivatives and income taxes. Also using a measure of ARC, Smith, Zhang, and Kipp (2019) find that auditors are more likely to issue material weaknesses for firms with high ARC that do not identify cloud-computing as a significant operations risk. Hoitash, Hoitash, and Yezegel (2019) use XBRL to develop measures of account-specific complexity and financial analysts' account-specific expertise. They document that the ARC of information disclosed in the notes to the financials is associated with lower analyst forecast accuracy and higher forecast dispersion, while lower market reactions to recommendation revisions is associated with the complexity of

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information either recognized on the face of the financials or disclosed in the notes. They also use detailed XBRL disclosures to construct analysts' account-specific expertise in fair value, derivatives, and pensions and find that this form of expertise can mitigate the negative effects of complexity associated with these accounts.

Chychyla et al. (2019) also leverage 10-K filings reported in XBRL format and link each XBRL tag to the relevant standard for that line item to measure the length of the accounting standard associated with each tag. Thus, their measure of financial reporting complexity (FRC) captures the complexity of accounting standards in addition to the number of disclosed accounting items. They document a positive association between FRC and the level of accounting expertise on the board and audit committee, and that this expertise can mitigate the relationship between FRC and negative reporting outcomes such as restatements and disclosures of material weaknesses.

Several studies have used XBRL to develop measures of financial reporting comparability using a broad set of accounting information, as opposed to earnings-based measures of comparability developed in prior literature (e.g. De Franco, Kothari, and Verdi 2011). Hoitash et al. (2018) construct an XBRL-based measure of pairwise financial statement comparability (FSC). This measure suggests that increased comparability improves analyst forecast accuracy and reduces analyst forecast dispersion. Caylor, Chambers, and Mutlu (2018) refer to a similar measure as financial reporting uniformity and find a positive association between uniformity and analyst coverage and forecast accuracy. Also constructing an XBRL-based measure of pairwise similarity, Henry, Liu, Yang, and Zhu (2018) consider the role of financial statement structural comparability in mediating the effects of earnings comparability, finding that earnings comparability increases analyst coverage and analyst forecast accuracy and decreases analyst forecast dispersion through

structural comparability. Considering financial reporting similarity in the audit context, Johnston and Zhang (2018) find that firms' financial statements are more similar to their peers when they share the same auditor.[37]

Extended Tags

Early literature on Taxonomy extensions examined the appropriateness of extension use. A significant number of XBRL extensions were created when an equivalent tag was already provided in the Taxonomy (Boritz and No 2009; Debreceny et al. 2011). Scherr and Ditter (2017) separate necessary from unnecessary extensions. They find that the use of necessary extended tags is associated with the complexity of financial reporting and costs of voluntary disclosure.[38] Unnecessary extension use is most common in firms with less experience in XBRL reporting or less involvement in the XBRL tagging process. Overall, their results suggest that the use of Taxonomy extensions is related to firms' attempts to report accurate financial reporting, rather than management's discretion to hinder information processing. The SEC also examines extended tag use (Cohn 2016; SEC 2019), potentially deterring managers from using them for obfuscation.

XBRL was intended to improve financial statement users' abilities to compare information in financial reports (SEC 2009, 8). However, the use of extensions has been found to mitigate the comparability of these reports (Dhole et al. 2015), and thus generates concerns when companies use extended tags (SEC 2009, 104; Whitehouse 2011; Harris and Morsfield 2012). The literature offers mixed results on the impact of this potential reduction of comparability on investors' information processing. Extended tags have been found to be negatively associated with analyst

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[37] While most studies using XBRL metadata to examine financial reporting comparability to date have leveraged pairwise similarity using the Jaccard coefficient, Yang, Liu, and Zhu (2015) develop a method to identify differences in firm's financial statement reporting structures. They identify trees of data strings using XBRL filings and use a dynamic programming algorithm to calculate distances between trees, which serves as a measure of differences between financial statement reporting structures.

[38] However, Brown et al. (2019) find that the positive association between accounting reporting complexity and non-GAAP disclosures is driven by standard Taxonomy elements rather than firm-specific elements (extended tags).

forecast dispersion, positively associated with forecast accuracy (Johnston 2017; Li and Nwaeze 2018) and positively associated with analyst following (Kirk, Vincent, and Williams 2016; Li and Nwaeze 2018).[39] Other literature suggests alternative consequences, as evidenced by a positive association between extensions and analyst forecast dispersion and a negative association with analyst forecast accuracy (Kirk et al. 2016; Felo et al. 2018; Henry et al. 2018).

If XBRL is successful in mitigating users' information processing costs, capital market participants may be better able to process financial statement information (Hodge et al. 2004) and identify earnings management activities. Standardized tagging of financial statement elements may aid investors in analyzing and comparing financial reports. However, the intention of extended tags is to provide management with discretion in presenting XBRL information in the manner that most accurately reflects the originally prepared financial reports. This discretion may mitigate investors' abilities to monitor earnings management behavior. The evidence on this issue from the extant XBRL literature generally supports the latter hypothesis, documenting a negative association between the use of extended tags and financial reporting quality (Scherr and Ditter 2017; Hoitash and Hoitash 2018; Kim, Kim, and Lim 2019).[40]

Other literature considering the effects of customized extension use on information processing costs finds mixed results on the benefits of extended tags. Allee et al. (2018) fail to find evidence that XBRL quality, measured based on various considerations of extension use, substitutes for their measure of machine readability of financial reports. The use of extended tags increases loan spreads for banks post-XBRL adoption (Chen, Kim, Lim, and Zhou 2018); and

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[39] However, Johnston (2017) documents that these results apply only to extensions of information disclosed in the financial statement footnotes rather than extended tags of information recognized on the face of the financial statements. Li and Nwaeze (2015) find that extensions exacerbate information asymmetry in early years of firms' XBRL adoption, but improve firms' information environments in later years.

[40] Kim, Kim, and Lim (2019) find that the use of standardized XBRL tags constrains earnings management.

increases investors' expectations of crash risk (Zhang et al. 2019). Alternatively, Kim, Li, and Liu (2019) find evidence to support the notion that XBRL, and the use of extended tags, reduces information processing costs, making for a more transparent information environment, and thus firms reporting in XBRL attract more shareholders. In sum, the impact of extended tags on financial reporting quality and subsequent interpretation of financial information by capital market participants is inconclusive. [41]

Other use of Metadata

Several studies use XBRL tags to identify footnotes. Bozanic, Hoopes, Thornock, and Williams (2017) examine how public and private disclosures interact to influence tax regulator enforcement and firm disclosure. They use XBRL data in supplemental analysis to document changes in the number of tax-related tagged numbers. Their findings suggest that when the proprietary costs of disclosure to the IRS are lower, firms disclose more tax-related quantitative information. Ahn et al. (2019) use XBRL data to measure the changes in FV-related tags and find that firms increase the number of FV-related tags following receipt of a comment letter from the SEC. Using XBRL, Ahn et al. (2019) were also able to distinguish Level 3 FV tags from tags capturing FV Levels 1 and 2.

Actual Data

One of the benefits of XBRL is that the data represents information reported directly in the financial statements, rather than data that has been standardized or aggregated by third-party providers (e.g., Compustat). The earliest published literature utilizing detailed XBRL-tagged numbers examined the differences between this data and that reported by data aggregators or redistributors. Boritz and No (2013) find that XBRL data includes more financial statement items

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[41] Additional audit-related outcomes examining extended XBRL tags are presented in Part IV.

than aggregated data (reported by Compustat, Google Finance, and Yahoo Finance), and that the data omitted by the aggregators often exceeds conventional audit materiality thresholds. Chychyla and Kogan (2015) compare line items reported in Compustat with those in 10-K filings reported in XBRL format. They find that Compustat values differ significantly from amounts originally reported in the financial statements. Overall, recent findings suggest benefits in the use of XBRL data relative to data from third-party providers. Improvements in the accuracy of XBRL create further comfort in reliance on this data (Debreceny et al. 2011; Du et al. 2013). The benefits of XBRL further include easy access to and identification of accounting numbers or text from financial reports. An example of leveraging this benefit is provided by Henselmann, Ditter, and Scherr (2015), who use XBRL data to identify firms suspected of engaging in earnings management based on abnormal digit distributions (using the distance to Benford's Law).

Footnote Disclosures

Several studies leverage XBRL-obtained footnote disclosures to examine accounting policy and tax footnotes. Peterson et al. (2015) use XBRL, when available, to identify the accounting policy footnote and create a text-based similarity measure to capture firms' accounting consistency. They document a positive association between accounting consistency and earnings quality and conjecture that using XBRL increases the accuracy in capturing this particular footnote. Inger, Meckfessel, Zhou, and Fan (2014) leverage the efficiency and accuracy enabled by XBRL formatting to extract tax footnotes and calculate the readability of tax disclosures. They document a positive (negative) association between tax avoidance and tax footnote readability for firms with tax avoidance below (above) the median. Bozanic et al. (2017) use XBRL to identify tax footnotes and use the text to examine changes in disclosures as well as the number of uncertain items identified in the tax footnote. Also using XBRL to obtain tax information, Schwab,

Stomberg, and Xiu (2019) use XBRL to identify tax rate reconciliation tables and examine factors contributing to tax avoidance.[42]

VI. DIRECTIONS FOR FUTURE RESEARCH

This section identifies research opportunities about XBRL and using XBRL data. As the disclosure requirements mature and more data sources become available, we encourage researchers to leverage XBRL data and use innovative research designs to answer questions that cannot be answered without this data source. While we have identified some areas for academic inquiry, this is by no means an exhaustive list of the growing potential of XBRL research.

Auditing and Assurance

XBRL is now the standard of financial statement reporting and offers a unique opportunity for academia to guide practice and regulation (Gray, Chiu, Liu, and Li 2014). We thus recommend that researchers continue to examine the costs and benefits of assurance, such as assurance of specific qualities or the overall preparation process (Gunn 2007). Surveys and experiments are particularly suitable to address this question. For example, surveying auditors, other assurance parties, and clients may shed light on the potential costs of assurance. Researchers may consider whether auditors are the appropriate entities to complete the assurance of XBRL-based financial reports (Vasarhelyi, Chan, and Krahel 2012). Under the current reporting standard, behavioral researchers may examine whether jurors hold auditors accountable for errors in XBRL filings absent an assurance requirement.

Other assurance-based research may identify a sample of firms that voluntarily choose to assure their XBRL reports and assess their incremental costs.[43] Within such sample, research may

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[42] Other studies using footnote disclosures in the auditing context are described in Part IV.
[43] While assurance is not required, anecdotal evidence confirms that some companies choose to involve their external auditor in the review of XBRL filings.

also examine quality improvements such as the potential reduction in numerical errors, sign switches, scale errors and the misuse of extended tags. Furthermore, value may be added by research that documents whether such mistakes and inconsistencies are detrimental to investors, particularly to machine processing and automatic algorithmic trading. Finally, future research may consider whether providing greater incentives to maintain the quality of XBRL filings results in higher quality XBRL reports. Combined, results from such studies may be informative to regulators that are currently reluctant to mandate an XBRL audit due to the potential costs and lack of evidence on the potential benefits.

The mandatory adoption literature generally examines if and how investors use XBRL. It remains an empirical question whether and how auditors use XBRL. The structured nature of XBRL data creates opportunity for streamlined risk assessments and analytical procedures, but whether these specific processes improve post-XBRL adoption has not been tested. Similarly, do extended tags impair auditors' abilities to use XBRL for analytical procedures? Finally, other audit-related topics for future research include the impact of iXBRL on audit outcomes. Does this reporting requirement influence the time it takes to complete an audit, as reflected in audit report lags or audit fees?

The use of XBRL metadata and actual data creates opportunities for auditors and researchers alike. Research has used metadata to construct measures of financial statement characteristics like complexity, a measure of company risk. Auditors may be able to leverage similar measures to assist with audit pricing or planning efforts. While auditors may benefit from the use of XBRL data, additional research may consider whether extended tags impair auditors' abilities to use this data for analytical procedures or other audit processes. Further, research identifies inconclusive results about the impact of extended tag use on information processing. The

lack of conclusion regarding this topic is logical, as extended tags currently capture multiple concepts. If extended tags are used correctly, they can capture a company's complexity and unique accounting needs. If used incorrectly, they capture either errors or obfuscation. While some research has attempted to bifurtcate the two, this subject offers additional evidence supporting the need for assurance of XBRL filings. If extended tags are audited for appropriateness, research may be able to identify more reliable evidence on the impact of extended tag use.

Data Use

Studies using XBRL metadata and actual-data are becoming increasingly prevalent and account for the majority of recent XBRL-related publications in top accounting journals. We believe that access to metadata and granular data that previously had to be hand-collected will continue to fuel future XBRL research in audit and accounting. Future studies may leverage XBRL tags to identify more account-specific contexts, such as debt, leases, or other commitments and contingencies and address more focused context specific questions. Behavioral research in this area may consider how investors respond to the use of extended tags and what factors influence their interpretation of this information (Geerts, Graham, Mauldin, McCarthy, and Richardson 2013). Likewise, as financial statement preparers may not have a sufficient understanding of how their financial statements are used by analysts and investors (Matherne 2019), research may continue to consider how users interpret XBRL-tagged data.

The use of actual numeric or textual data obtained from XBRL reports, particularly data presented in the notes to the financial statements, also presents significant opportunities. This data is often not included in conventional databases and using XBRL can facilitate efficient data gathering that otherwise had to be manually collected and classified. Furthermore, XBRL data reflects information exactly as reported in the financial statements, which presents an opportunity

to examine information that is lost when data is aggregated and standardized by commonly used third-party data providers. Additionally, executing textual analysis to perform natural language processing (NLP) on specific financial statement notes presents an excellent opportunity for future research because XBRL enables the accurate extraction and cross-sectional comparison of text in the footnotes. Thus, via both numeric and textual disclosures, XBRL increases the confidence that cross-sectional comparisons use comparable items.

Researchers may also consider examining how investors access XBRL data. We are not aware of evidence that identifies to what extent each of the common XBRL data sources are used by different types of investors. Future research may examine differences in data quality across XBRL data providers and consequences of these differences on investors' reliance on this data in their decision-making. Finally, actual XBRL data may facilitate a cost-benefit analysis of firms' choices to prepare XBRL filings, be it via in-house capabilities, software packages from service providers, or fully outsourced processes, and the associated quality considerations of each.

Inline XBRL

Regulations about XBRL disclosures continue to evolve, with the most recent change being the shift to iXBRL. The SEC contends that these filings offer multiple benefits to both preparers and users of the filings, including decreased preparation costs and improved data quality (SEC 2016). Future research may examine the voluntary and early adopters of this technology to help inform the SEC on the success of iXBRL in meeting these goals. This research may examine the quality of the filings, characteristics of participating firms such as governance structures and quality, and the impact of iXBRL reports on the capital markets.[44] While research has considered whether investors use XBRL data, future research may further examine whether this and iXBRL data allow

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[44] Additional research examining the adoption of iXBRL may consider the role of individuals responsible for making this decision (Pinkser and Felden 2016).

investors to make better decisions (Vasarhelyi et al. 2012). To inform regulators on the consequences of iXBRL reporting, research may examine whether investors perceive the information presented in iXBRL reports to be assured by the external auditor and the consequences of this perception on users' decision making.

International

International XBRL research allows for the examination of the consequences of XBRL regulation that are not observable in the U.S. market. For example, the examination of XBRL assurance requirements in the Netherlands may help researchers understand how this influences the quality of XBRL filings and investors' reliance on this information. Research may further exploit differences in XBRL reporting requirements by comparing the use of extensions across jurisdictions, including countries that allow extensions and those that do not, to determine the costs and benefits of allowing firms to extend the Taxonomy. Finally, international XBRL data allows for inquiry about differences in reporting between IFRS and U.S. GAAP.

VII. CONCLUSION

This study reviews extant XBRL research, summarize its contributions to the audit and accounting literature, and offers suggestions for future research. The goal of this synthesis is to inform researchers on the potential of XBRL data to answer previously unattainable research questions and to provide insights to stakeholders such as regulators and financial statement users and preparers about the costs and benefits of XBRL. We do so via a comprehensive review of XBRL literature, both peer-reviewed and working papers, from 2004 through 2019. The literature identifies benefits of XBRL reporting to the capital markets as well as potential threats to these benefits due to the lack of assurance requirements for XBRL reports.

XBRL data is inherently technical in nature. To assist accounting researchers in future inquiry using this data we provide information on XBRL data sources, examples of XBRL and iXBRL filings from the SEC, as well as instruction for using XBRL data based on practical experience. We encourage researchers using XBRL to demonstrate a collaborative spirit and share databases and other XBRL resources with the academic community.

AN ILLUSTRATION OF TAXONOMY AND EXTENDED XBRL TAGS

The example below depicts a portion of the 2018 income statement of "USA Truck" filed in XBRL format. The "operating revenue" is captured by the Taxonomy tag <us-gaap:Revenues>. This tag repeats three times in the income statement over three different time periods (fiscal years ended 2016, 2017, and 2018). Each instance of the tag is called a *fact*. To represent the operating expense "Equipment rent" the company uses the extended tag <usak:LeaseAndRentalExpenseEquipment>. The tag is prefixed with the company's ticker as opposed to the standard "us-gaap" prefix. This tag also repeats over time and thus represents three different facts.

Consolidated Statements of Operations and Comprehensive Income (Loss) - USD ($) shares in Thousands, $ in Thousands	12 Months Ended		
	Dec. 31, 2018	Dec. 31, 2017	Dec. 31, 2016
Income Statement [Abstract]			
Operating revenue	$ 534,060	$ 446,533	$ 429,099
Operating Expenses [Abstract]			
Salaries, wages and employee benefits	130,407	122,297	122,408
Fuel and fuel taxes	55,158	45,853	43,179
Depreciation and amortization	28,324	28,463	29,954
Insurance and claims	23,240	25,628	21,154
Equipment rent	10,840	10,173	7,443
Operations and maintenance	33,356	31,001	34,252

Taxonomy Tag and Facts

<us-gaap:Revenues>534060000</us-gaap:Revenues>

<us-gaap:Revenues>446553000</us-gaap:Revenues>

<us-gaap:Revenues>429099000</us-gaap:Revenues>

Extended Tag and Facts

<usak:LeaseAndRentalExpenseEquipment>10840000</usak:LeaseAndRentalExpenseEquipment>

<usak:LeaseAndRentalExpenseEquipment>10173000</usak:LeaseAndRentalExpenseEquipment>

<usak:LeaseAndRentalExpenseEquipment>7443000</usak:LeaseAndRentalExpenseEquipment>

APPENDIX B
OBTAINING AND USING XBRL DATA IN ACADEMIC RESEARCH

This Appendix is designed to aid researchers in the use of XBRL data to answer future empirical questions. We present popular sources for XBRL data as well as an overview of how to use XBRL data for textual analysis. These sources offer detailed data that can easily be extracted and thus create ample opportunity for future research.[45]

XBRL Data Sources

Custom Computer Programs to Obtain Data Directly from Edgar

Financial statements prepared in XBRL format are filed with the SEC on an annual and quarterly basis. Each complete filing is comprised of an instance document that contains the actual monetary facts, such as the reported amount of revenues and the extension schema that includes the extended tags created by the company. Each filing also includes the following five linkbase files, Label, Reference, Calculations, Definitions, and Presentations. Each linkbase has its own purpose, and a combination of the files is needed to fully analyze XBRL reports.[46]

Researchers can opt to write their own code to download XBRL files and parse them into a customized database.[47] Hence, researchers can configure the database to store data about numeric tags as well as large textblocks, enabling textual analysis of financial statement notes and accounting policies. This approach requires significant time commitment and high technical

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[45] We suggest that researchers using XBRL data begin the sample period in 2012, the first year in which all companies were required to tag both the financial statements and accompanying footnotes. Data prior to 2012 is thus biased towards larger companies who were required to fully comply with the XBRL mandate at an earlier stage of the phase-in, or includes companies who were only required to tag the face of the financial statements.

[46] The Label linkbase provides human readable strings for each accounting concept. The Reference linkbase provides reference to authoritative accounting standards (e.g. the FASB codification). The Calculation linkbase presents the mathematical relationships between certain tags. The Presentation linkbase instructs how to present the different concepts and organize them into financial statements and notes. The Definition linkbase associates non-calculation relationships between concepts.

[47] Links to all XBRL filings can be found at https://www.sec.gov/Archives/edgar/xbrlrss.all.xml

knowledge. To help potential XBRL users, the SEC and other data providers, offer more easily accessible data.

Using Custom Computer Programs to Extract XBRL Data for Textual Analysis

XBRL is used to tag the financial statement information at different levels, each enabling researchers to perform textual analysis in varying levels of granularity. First, researchers can extract Level 1 footnote tagging which requires that each footnote is tagged in its entirety as a text block. This can aid researchers identify and extract textual information in each footnote. More importantly, this should help researchers perform cross-sectional comparisons because companies should use the same tag name to depict a particular footnote. For example, the tag "us-gaap:FairValueDisclosuresTextBlock" repeats across 73% of firms that report fair value (Ahn et al. 2019). Level 2 requires the tagging of each significant accounting policy, enabling the examination of accounting policies. For example, Level 2 tagging would enable researchers to extract and examine companies' revenue recognition policy. Level 3 requires that firms separately tag each table or schedule, making it easy to identify and extract tables and their contents such as the tax reconciliation schedule. Level 4 requires firms to tag each individual numerical value that appears in a table, or within a text segment, enabling researchers to accurately separate numeric from textual disclosures. Overall, XBRL enables more accurate textual analysis of disclosures in the notes to the financial statements.

SEC Dataset

The SEC provides datasets of the financial statement and notes that are filed using XBRL. These files are available at https://www.sec.gov/dera/data/financial-statement-and-notes-data-set.html. The SEC provides eight files with various information. The "SUB" file contains information about each filing, which include the company name, unique filing number (accession number), industry

membership and other pertinent information. Other files contain information about each XBRL tag ("TAG"), about the dimension (i.e. other metadata) and additional properties of each tag ("DIM"), and on the value of numeric ("NUM") and textual ("TXT") tags.[48] Other files include information about the rendering process ("REN") which is the process of making XBRL readable by people. The presentation ("PRE") file shows how tags are presented in the primary financial statements and the calculation file ("CAL") provides information on the arithmetical relationships between some tags. Archival researchers should find these files easy to work with as they have already been parsed by the SEC. The SEC compiled the set of eight files for each calendar quarter in a compressed file that also includes a "readme" file with detailed descriptions of the various fields in each file and how files can be linked. Overall, this is a great source of data due to its ease of extraction and interpretation, but it is not without limitations.

Researchers intending to use the SEC files for textual analysis should use caution because the SEC limits the field size to 2,048 bytes. Hence, since most Text Block tags contain larger text, the SEC essentially truncates the data. Therefore, using the SEC provided Text Block tags for textual analysis is not feasible. Another limitation of these XBRL filings is that identifying the exact location of numeric XBRL facts (i.e. in which financial statement, note, or table) is a difficult task because many tags repeat across multiple statements and notes. While it is possible to partially overcome this limitation with extensive programming and the use of heuristics, this is major limitation of current XBRL filings irrespective of the data source. This issue may be resolved with the introduction of iXBRL.

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[48] For example, information on a particular segment typically appears as a dimension.

Processed Data

Similar to the mature NLP literature, (e.g. Loughran and McDonald - https://sraf.nd.edu/), some researchers share processed XBRL data. For example, Hoitash and Hoitash (2018) developed a measure of accounting reporting complexity (ARC) based on the count of distinct tags in XBRL filings and found that greater complexity is detrimental to the preparation and audit of the financial reports. Data based on this study is constructed from the SEC database and updated annually. The data can be found at www.xbrlresearch.com. The database includes several permutations of the ARC measure for annual and quarterly filings as well as additional measures, such as the number and percent of extended tags, accelerated status of the filers and the filing date and time.

XBRL US

XBRL US is a non-profit organization with the mission to support the implementation of XBRL business reporting standards. The organization provides a database of public filings for XBRL US members, available at: https://xbrl.us/home/use/filings-database/. The database can be linked to a local database installation and queries can be easily answered.

XBRL Data Providers

Several data vendors offer XBRL based data that is used by public accounting firms, universities, the Department of Treasury, Morgan Stanley, and the SEC. Calcbench is one such data aggregator that extracts data from XBRL and provides varying sets of information. For example, users can download as-reported XBRL data from financial statements and notes. In addition, similar to traditional data aggregators such as Compustat, Calcbench provides its users with standardized data that can be downloaded and analyzed. Calcbench also allows users to access and download detailed data from financial statement notes that otherwise must be hand-collected.[49] Using data

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[49] For example, while in prior years researchers had to manually collect purchase price allocation of M&As, using XBRL data, Calcbench automates the collection of such data.

aggregators such as Calcbench can allow researchers to use XBRL data without the need to create custom computer programs.[50]

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[50] Another popular data vendor used by academic researchers is XBRL Cloud, available at www.xbrlcloud.com.

APPENDIX C: AN ILLUSTRATION OF iXBRL

The example below depicts a portion of the 2018 income statement of "USA Truck" filed in iXBRL format. The resulting HTML document contains embedded XBRL tags that are revealed by clicking on the numeric items within the statement. The underlying information includes attributes such as the tag name, value, scale, etc. For example, after clicking the "Operating revenue" ("Equipment rent") number for the fiscal year ended December 31, 2018, the Revenues (Equipment rent) "Attributes" window appears. The "Attributes" window has four panels, each of which reports additional tag information. While this tag information is also available in traditional XBRL filings, it cannot be accessed directly from the financial statement information presented in the audited HTML report.

USA Truck, Inc.
CONSOLIDATED STATEMENTS OF OPERATIONS AND COMPREHENSIVE INCOME (LOSS)
(in thousands, except per share amounts)

	For the Years Ended December 31,		
	2018	2017	2016
Operating revenue	$ 534,060	$ 446,533	$ 429,099
Salaries, wages and employee benefits	130,407	122,297	122,408
Fuel and fuel taxes	55,158	45,853	43,179
Depreciation and amortization	28,324	28,463	29,954
Insurance and claims	23,240	25,628	21,154
Equipment rent	10,840	10,173	7,443
Operations and maintenance	33,356	31,001	34,252

Attributes

Revenues

Tag	us-gaap:Revenues
Fact	534,060,000
Period	12 months ending 12/31/2018
Measure	USD
Scale	Thousands
Decimals	Thousands
Balance	Credit
Sign	Positive

Attributes

Equipment rent

Tag	usak:LeaseAndRentalExpenseEquipment
Fact	10,840,000
Period	12 months ending 12/31/2018
Measure	USD
Scale	Thousands
Decimals	Thousands
Balance	Debit
Sign	Positive

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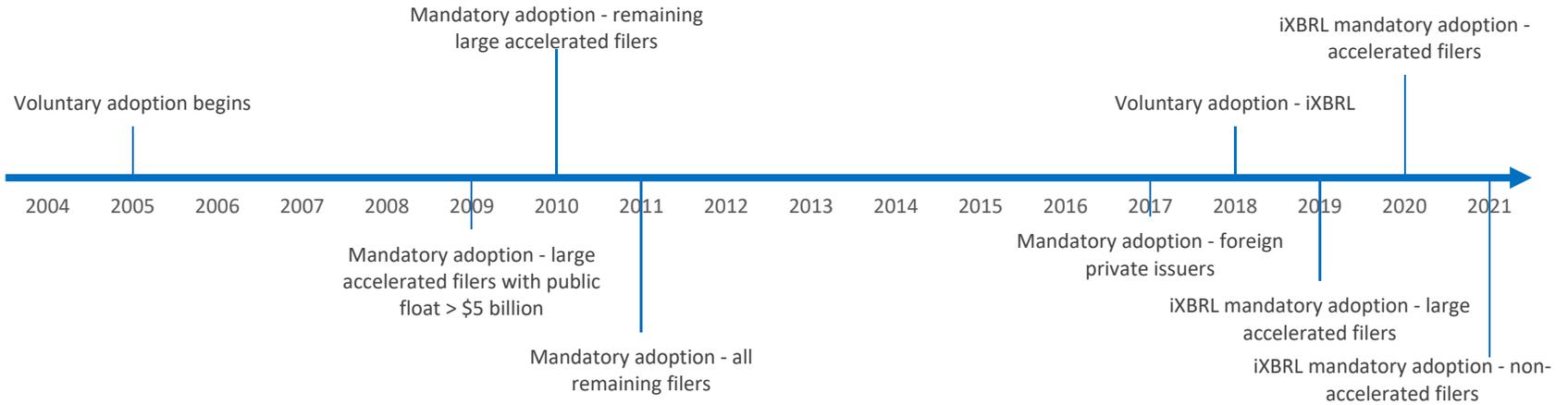
FIGURE 1
XBRL Timeline

Figure 1 reports the timeline of XBRL adoption. This Figure reports the initial voluntary and mandatory adoption years for XBRL and iXBRL The XBRL requirement was phased in over a three-year period based on filers' accelerated status. In the first year of adoption filers were required to tag the financial statement footnotes and attached schedules as a single block of text. Beginning in the second year of compliance, filers were required to tag each quantitative disclosure within the footnotes or schedules. Beginning with fiscal periods ending after Dec. 15, 2017, foreign private issuers were also required to submit their financial statements in XBRL-format, with no phase-in based on filer status. The iXBRL requirement will also be phased in over a three-year period based on filer status, beginning in 2019. IFRS filers are required to file in iXBRL for fiscal periods ending on or after June 15, 2021.

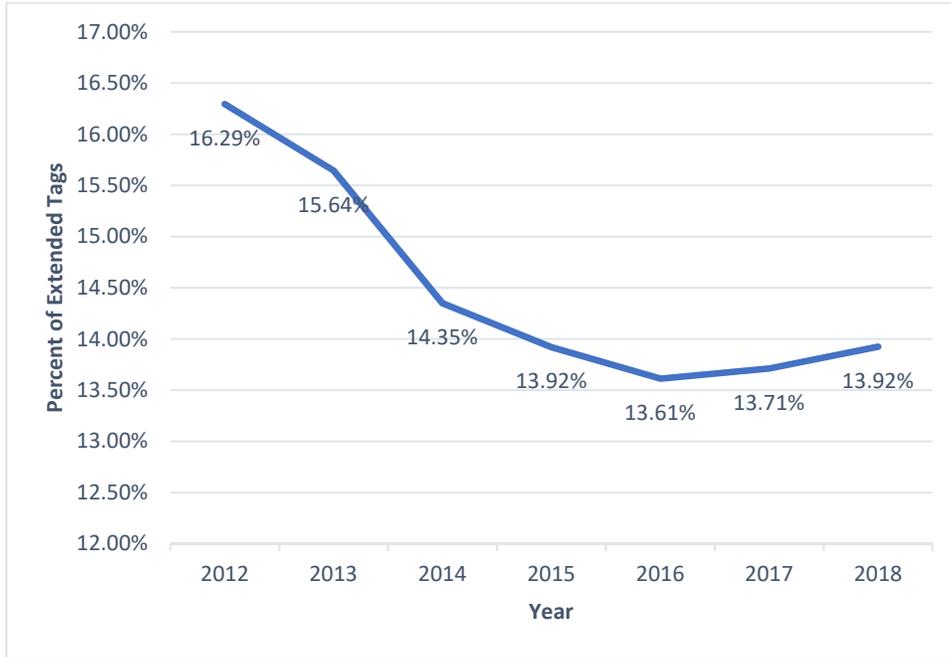**FIGURE 2**
Percent of Extended XBRL Tags by Year

Figure 2 presents the percent of extended XBRL tags by year. The sample begins in 2012 because this was the first year of mandatory detailed tagging of the financial statements and footnotes by all filers. This is based on Compustat firms that match data available at www.xbrlresearch.com
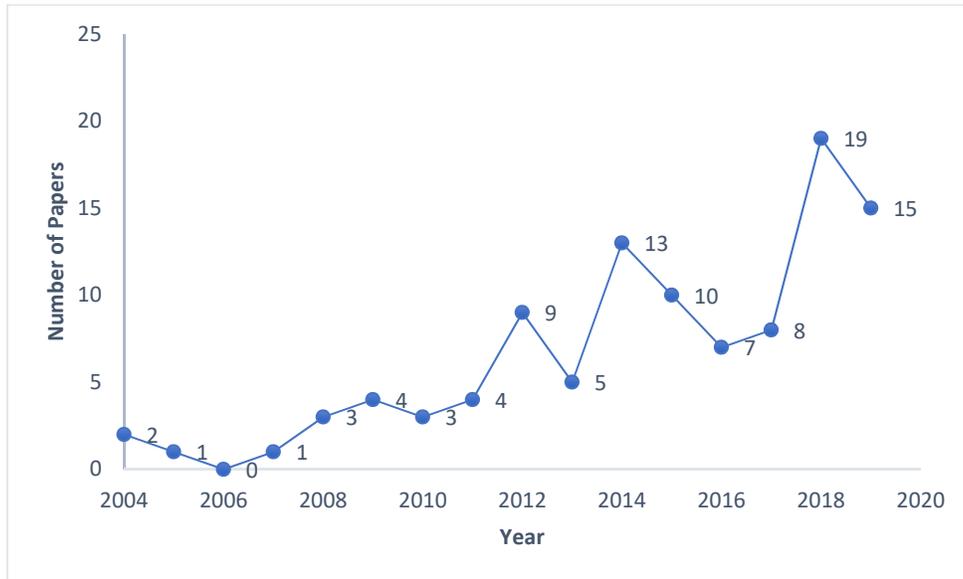
FIGURE 3
Distribution of XBRL Papers by Year

Figure 3 presents the distribution of XBRL-related papers over the sample period covered by this literature review.

TABLE 1 Panel A: Sources of XBRL Metadata

Study	Data Obtained	Source
Ahn et al. (2019)	Fair value-related tags	Custom Computer Program
Allee et al. (2018)	Number of XBRL tags	Custom Computer Program
Allee et al. (2018)	Tag quality	www.xbrlcloud.com
Bozanic et al. (2017)	Tax-related tags	Custom Computer Program
Brown et al. (2019)	Number of XBRL tags	https://www.sec.gov/dera/data/financial-statement-and-notes-data-set.html
Caylor et al. (2018)	XBRL tags	www.calcbench.com
Chen, Kim, Lim, and Zhou (2018)	Standard and extended tags	https://www.sec.gov/structureddata/rss-feeds-submitted-filings
Chychyla et al. (2019)	XBRL tags	Custom Computer Program
Dhole et al. (2015)	Standard and extended tags	www.calcbench.com
Felo et al. (2018)	Standard and extended tags	Custom Computer Program
Henry et al. (2018)	Standard and extended tags	Custom Computer Program
Hoitash and Hoitash (2018)	Standard and extended tags	www.calcbench.com
Hoitash et al. (2018)	XBRL tags	https://www.sec.gov/dera/data/financial-statement-and-notes-data-set.html
Hoitash et al. (2019)	XBRL tags	Custom Computer Program
Johnston (2017)	Standard and extended tags	https://www.sec.gov/dera/data/financial-statement-and-notes-data-set.html
Johnston and Zhang (2018)	XBRL tags	https://www.sec.gov/dera/data/financial-statement-and-notes-data-set.html
Kim, Kim, and Lim (2019)	Standard and extended tags	Custom Computer Program
Kim, Li, and Liu (2019)	Standard and extended tags	Custom Computer Program
Kirk et al. (2016)	Standard and extended tags	Custom Computer Program
Li and Nwaeze (2015)	Standard tags	Custom Computer Program
Li and Nwaeze (2015)	Extended tags	www.xbrlcloud.com
Li and Nwaeze (2018)	Standard and extended tags	Custom Computer Program
Scherr and Ditter (2017)	XBRL filings	Custom Computer Program
Scherr and Ditter (2017)	Extended tags	www.xbrlcloud.com
Smith et al. (2019)	Extended tags	https://www.sec.gov/dera/data/financial-statement-and-notes-data-set.html
Yang et al. (2015)	Structure of XBRL filings	Custom Computer Program
Zhang et al. (2019)	Standard and extended tags	www.xbrlcloud.com

Table 1 Panel A presents XBRL data sources from studies using XBRL metadata. The authors of this study used judgment in identifying data extraction techniques that were not specifically mentioned by authors of the cited papers. For example, if a researcher refers to the SEC's RSS feed, we assume that the authors downloaded and parsed the files using a custom program.

TABLE 1 Panel B: Sources of Actual XBRL Data

Study	Data Obtained	Source
Ahn et al. (2019)	Fair value footnotes	Custom Computer Program
Boritz and No (2013)	Financial data	SEC's Interactive Data Viewer (IDV)
Bozanic et al. (2017)	Tax footnotes	Custom Computer Program
Chychyla and Kogan (2015)	Financial data	Custom Computer Program
Czerney et al. (2019)	Footnotes	Custom Computer Program
Czerney and Sivadasan (2019)	Footnotes	https://www.sec.gov/dera/data/financial-statement-data-sets.html
Henselmann et al. (2015)	Financial data	Custom Computer Program
Inger et al. (2014)	Tax footnotes	Custom Computer Program
Peterson et al. (2015)	Accounting policies in footnotes	Custom Computer Program
Schwab et al. (2019)	Tax rate reconciliation	www.calcbench.com

Table 1 Panel B presents XBRL data sources from studies using actual XBRL data. The authors of this study used judgment in identifying data extraction techniques that were not specifically mentioned by authors of the cited papers. For example, if a researcher refers to the SEC's RSS feed, we assume that the authors downloaded and parsed the files using a custom program.

TABLE 2 PANEL A: Articles by Journal

Journal	n
The Accounting Review	5
Journal of Accounting Research	3
Contemporary Accounting Research	2
Journal of Accounting and Economics	1
Review of Accounting Studies	1
Journal of Information Systems	24
Working Papers	23
International Journal of Accounting Information Systems	17
Accounting Horizons	6
Journal of Emerging Technology in Accounting	7
Journal of Accounting and Public Policy	4
Journal of Business Research	3
International Journal of Disclosure and Governance	2
Current Issues in Auditing	2
Decision Support Services	2
Journal of Financial and Quantitative Analysis	1
The Journal of the American Taxation Association	1
Total	104

Table 2 Panel A presents the number of publications in each journal included in our review. We first list publications in the top accounting journals and subsequently order journals by the number of publications.

TABLE 2 PANEL B: Articles by Journal and Year

Year	TAR	JAR	CAR	JAE	RAST	JIS	Working Papers	Other	Total
2004	1	0	0	0	0	0	0	1	2
2005	0	0	0	0	0	1	0	0	1
2006	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	1	1
2008	0	0	0	0	0	0	0	3	3
2009	0	0	0	0	0	1	0	3	4
2010	0	0	0	0	0	0	0	3	3
2011	0	0	0	0	0	1	0	3	4
2012	0	0	0	0	0	4	3	2	9
2013	0	0	0	0	0	2	1	2	5
2014	0	0	0	0	1	2	2	8	13
2015	1	0	0	0	0	5	1	3	10
2016	0	0	0	0	0	0	2	5	7
2017	0	1	0	0	0	3	2	2	8
2018	2	1	0	0	0	3	6	7	19
2019	1	1	2	1	0	2	6	2	15
Total	5	3	2	1	1	24	23	45	104

Table 2 Panel B presents the number of publications by year in the top accounting journals, Journal of Information Systems, and working papers.

TABLE 3 PANEL A: Articles by Theme and Year

Year	Audit & Assurance	Adoption: Voluntary	Adoption: Mandatory	Data Use: Meta	Data Use: Actual
2004	1	0	0	0	0
2005	0	0	0	0	0
2006	0	0	0	0	0
2007	1	0	0	0	0
2008	2	2	0	0	0
2009	1	1	0	0	0
2010	2	0	0	0	0
2011	0	1	1	0	0
2012	3	1	2	0	0
2013	0	0	1	0	0
2014	2	1	6	0	2
2015	1	1	2	3	3
2016	1	3	2	1	0
2017	1	0	3	3	1
2018	3	2	10	9	0
2019	4	0	5	8	4
Total	22	12	32	24	10

Table 3 Panel A presents the number of publications by year in the identified research categories. As some papers are included in multiple categories and some are reported in footnotes or other sections not tabulated here, the sum of papers reported in this Table will not agree to the total reported in Table 2 Panels A and B.

TABLE 3 PANEL B: Articles by Theme and Journal

Journal	Audit & Assurance	Adoption: Voluntary	Adoption: Mandatory	Data Use: Meta	Data Use: Actual
The Accounting Review	2	0	1	2	2
Journal of Accounting and Economics	0	0	0	1	0
Journal of Accounting Research	0	0	2	2	1
Contemporary Accounting Research	0	0	2	2	0
Review of Accounting Studies	0	0	1	0	0
Working Papers	4	3	6	9	4
Journal of Information Systems	5	1	8	4	1
Other	11	8	12	4	2
Total	22	12	32	24	10

Table 3 Panel B presents the number of publications by journal in the identified research categores. As some papers are included in multiple categories and some are reported in footnotes or other sections not tabulated here, the sum of papers reported in this Table will not agree to the total reported in Table 2 Panels A and B.

TABLE 3 Panel C: Summary of XBRL Literature

Theme	Papers
Audit & Assurance	
Audit Outcomes	Debreceny and Gray (2010); Gray and Debreceney (2014); Amin et al. (2018); Hoitash and Hoitash (2018); Johnston and Zhang (2018); Ahn et al. (2019); Czerney and Sivadasan (2019); Czerney et al. (2019); Smith et al. (2019)
Assurance	Daigle and Lampe (2004); Gunn (2007); Boritz and No (2008); Plumlee and Plumlee (2008); Boritz and No (2009); Srivastava and Kogan (2010); Alles and Gray (2012); Debreceny et al. (2012); Janvrin and No (2012); Cohen et al. (2014); Basoglu and White (2015); Boritz and No (2016); Farewell et al. (2018)
Voluntary Adoption	
Characteristics of Participants	Premuroso and Bhattacharya (2008); Callaghan and Nehmer (2009); Boritz and Timoshenko (2015); Pinsker and Felden (2016); Chatterjee et al. (2018)
Impact of XBRL Filings	Li et al. (2012); Dontoh and Trabelsi (2014); Dong et al. (2016); Kaya and Pronobis (2016); Hsieh and Bedard (2018)
Mandatory Adoption	Yoon et al. (2011); Kim et al. (2012); Li et al. (2012); Hao and Kohlbeck (2013); Blankespoor et al. (2014); Cong et al. (2014); Efendi et al. (2014); Liu et al. (2014); Wang and Seng (2014); Dhole et al. (2015); Yen and Wang (2015); Dong et al. (2016); Yang et al. (2016); Chen et al. (2017); Liu et al. (2017); Allee et al. (2018); Amin et al. (2018); Bhattacharya et al. (2018); Chatterjee et al. (2018); Chen, Kim, Lim, and Zhou (2018); Chen, Wang, and Zhou (2018); Cong et al. (2018); Du and Wu (2018); Felo et al. (2018); Pungaliya and Wang (2018); Blankespoor (2019); Huang et al. (2019); Kim et al. (2019a); Kim et al. (2019b); Zhang et al. (2019)
Data Use	
Metadata: Financial Statement and Auditing Characteristics	Yang et al. (2015); Caylor et al. (2018); Henry et al. (2018); Hoitash and Hoitash (2018); Hoitash et al. (2018); Johnston and Zhang (2018); Brown et al. (2019); Chychyla et al. (2019); Hoitash et al. (2019); Smith et al. (2019)
Metadata: Extended Tags	Dhole et al. (2015); Li and Nwaeze (2015); Kirk et al. (2016); Johnston (2017); Scherr and Ditter (2017); Allee et al. (2018); Chen et al. (2018); Felo et al. (2018); Henry et al. (2018); Hoitash and Hoitash (2018); Li and Nwaeze (2018); Brown et al. (2019); Kim et al. (2019a); Kim et al. (2019b); Smith et al. (2019); Zhang et al. (2019)
Metadata: Other	Bozanic et al. (2017); Ahn et al. (2019)
Actual Data	Boritz and No (2013); Inger et al. (2014); Chychyla and Kogan (2015); Henselmann et al. (2015); Peterson et al. (2015); Bozanic et al. (2017); Ahn et al. (2019); Czerney and Sivadasan (2019); Czerney et al. (2019); Schwab et al. (2019)

Table 3 Panel C presents the papers discussed in each of the identified research categories. As some papers are included in multiple categories and some are reported in footnotes or other sections not tabulated here, the sum of papers reported in this Table will not agree to the total reported in Table 2 Panels A and B.