Feeding the Information Value Chain: Deriving Analytical Ratios from XBRL filings to the SEC[1]

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Abstract

A key public policy driver of XBRL adoption in the USA and elsewhere has been to make information on corporate performance and risks readily available to information consumers. The financial statement data filed with a number of regulators and stock exchanges provide the raw material for one of the most important aspects of peer group analysis, which is the derivation of financial statement ratios. This paper investigates the ability of information consumers to derive ratios from filings in XBRL made to the SEC. In the absence of a financial statement ratios canon, we identify more than 63 ratios drawn from the financial statement analysis professional literature. The accounting concepts embedded in these ratios are matched with the US GAAP taxonomy to identify an element that is best semantic equivalent. We develop and test a methodology to identify elements that can be semantic alternatives to the best choice. We then assess the existence of these elements in filings made by the 1,205 commercial and industrial corporations that filed with the SEC by September 2010. We assess the ability of information consumers to calculate 65 key financial statement ratios. For some of these ratios, the availability of these ratios comes at the cost of potential loss of information quality.

Keywords: Financial statement ratios, investment analysis, XBRL

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1. Introduction

The information embedded in sets of ratios that are based on financial statement data are the lifeblood of intra- and inter-entity performance evaluation. Over time, a variety of ratios have become commonly accepted as measures of key dimensions of the entity including performance, liquidity and survivorship. These ratios are used by management, shareholders and other participants in the information value chain including financial analysts, journalists and policy makers. Entity published financial statements are the raw material for calculation of these financial ratios. A significant change in the way that financial statement data has become available is through XBRL, which allows the individual data points necessary to calculate the various ratios available at an atomic level. Indeed, the primary public policy rationale for the adoption of XBRL has been to make the information value chains more effective and efficient, including feeding the calculation of financial ratios. A number of countries have adopted XBRL with the explicit target of improving the financial reporting value chain. In the USA, for example, all financial reporting by SEC registrants is now migrating to XBRL. The US GAAP implementation represents the most significant adoption of XBRL worldwide.

The research questions addressed in this paper assess how well the SEC interactive data mandate performs in generating data that can be automatically transformed into the information presented in financial statement ratios. Even though there are a number of major XBRL financial reporting implementations around the world, most are constructed around a limited financial reporting template with minimal ability of individual entities to respond to in industry- or entity-specific reporting concepts (e.g. Singapore, Shanghai Stock Exchange). In contrast, the recent SEC interactive data mandate, Rule 32-9002, requires that SEC registrants must furnish financial statement data in XBRL format with allowances for industry- and firm-level variation (SEC 2009c). The match between information consumers' desire for standardized and comparable summary information, primarily via commonly accepted ratios and similar performance metrics, and entity-level and entity-controlled variation from the standard US GAAP taxonomy remains unknown.

In this research, we measure the ability of information consumers to automatically generate standard financial statement ratios. The paper asks three questions. First, does the US GAAP taxonomy incorporate the concepts necessary to calculate the standard financial ratios used in assessment of corporations? Are acceptable substitutes available, when concepts are not supported? Second, where there are appropriate tags, do corporations make filings that allow automatic creation of standard financial ratios. Finally, where automatic creation of ratios from the filings is not feasible, what are the causes? Is this a function of the way corporations report in the financial statements that are the foundation for the XBRL filings or are the roots in the details of the XBRL implementation? This paper addresses important aspects of information quality. While in traditional information value chains, financial analysts would rely on normalised financial data sets (or would conduct such normalization themselves), this paper assesses information quality working on raw data from filings made by corporations to the SEC. This paper regards information quality as a multidimensional concept encompassing critical relationships among multiple attributes, such as timeliness, accuracy and relevancy. Together, these attributes contribute to the validity of the information. Among a number of information quality dimensions (Fisher et al. 2008) this paper focuses on accessibility, completeness, consistent representation and relevance.

To answer these research questions, we identify more than 60 standard ratios for commercial and industrial corporations, commonly seen in the academic and professional literature (e.g., Penman 2010; Robinson et al. 2009, Chapter 7). All accounting concepts in the ratios are identified and redundancy eliminated. The core list of concepts are mapped to the US GAAP taxonomy. For some accounting concepts, there are direct semantic matches of accounting concepts to taxonomy elements. For others, such as Earnings before Interest and Taxation (EBIT), multiple taxonomy elements are required. Merely because a "best" semantic choice is available in the taxonomy does not mean that a filer will employ this element. We develop and test a methodology for identification of alternative elements. The methodology exploits the inherent ontological structure in the US GAAP taxonomy. We then match the list of elements is matched against the filings made to the SEC. From this data, we can determine which ratios can be automatically generated from the current filings. We find considerable variation in the ability of

automatic generation of ratios. For example, cash conversion cycle, current liabilities to net worth, quick ratio and EBITDA margin can all be calculated for more than 95% of filers. Alternatively, the debt to equity and defensive interval ratios can only be calculated for less than 50% of filers.

The issues raised in this study are important for accounting standards setters, securities regulators including notably the SEC, information intermediaries, financial analysts and other information consumers and for the XBRL and semantic Web communities. The remainder of this paper proceeds as follows. The next section provides background on the role played by financial statement ratios in financial statement analysis. The section links this discussion to the perceived benefits of XBRL. The third section sets up the research questions and introduces the method for data collection and analysis. The fourth section provides analysis of all filings made to the SEC by commercial and industrial corporations. The final section provides conclusions and sets out a number of related research questions for future research.

2. Background and Development of Research Questions

Financial statement ratios

Financial statement ratios are relationships between two or more financial facts or financial facts that are related to non-financial facts such as number of employees and units of sales. Ratio analysis represents one of the typologies of corporate financial statement analysis; as opposite to other types of analysis such as horizontal, vertical and trend analysis (Robinson et al. 2009). The purpose of ratio analysis is to transform data from the financial statement into decision-useful information. Ratios make the large amount of information in financial statements more tractable for information consumers, enhance inter-entity comparisons and have desirable statistical properties for econometric analysis of stock returns (Foster 1986; Gallizo and Salvador 2003).

Financial ratio analysis provides a “snapshot” of the main economic variables that characterise a firm as well as a trigger for further, more-in-depth analysis. Ratios are typically grouped under three major categories: investment return; financial strength and management performance. Within each of these categories, it is possible to further

classify ratios according to the specific types of information provided such as capital market, liquidity, solvency, profitability and productivity. Capital market ratios, such as earnings per share and dividends payout ratio, provide information on the return on the investment from an investor's standpoint. Information in respect to the financial strength of a firm can be collected by calculating liquidity (e.g. the quick ratio) and solvency ratios (e.g. fixed charge coverage ratio). Finally, profitability ratios (e.g. return on equity) measure the earning power of the firm and together with asset activity (e.g. inventory turnover) and productivity ratios (e.g. total assets turnover) provide an indirect measurement of management performance.

There are three primary uses of financial ratios: fundamental analysis of corporate performance; credit analysis and intra-entity managerial performance assessment. Ratios have been a key component of fundamental analysis of the performance of equity securities over the last century (Greig 1992; Holthausen and Larcker 1992; Robinson et al. 2009; Subramanyam and Wild 2009). More recent contributions connect the use of financial ratios analysis to the determination of the future potential of a firm by means of different methods, such as systematic fundamental analysis (Nissim and Penman 2001) or under an approach that proposes to provide additional information over financial ratios (Amir and Lev 1996) or, finally, under the approach that proposes to construct a model of the firm based on long-term financial statement information (Laitinen 2006). Ratios are also employed as the foundation for several tests of long-term abnormal market returns (e.g. Ou and Penman 1989a, 1989b).

Financial analysts are a key constituency that both develops and uses financial statement ratios. Research on financial analysts show that they employ a relatively narrow set of financial statement ratios (Ramnath et al. 2008). Research also employs these ratios to predict the accuracy of analysts (Bradshaw 2002, 2004; Ramnath et al. 2008). Ratios play an important role in credit analysis. All major rating agencies analytical criteria base their financial statement analysis on ratios to end up with a credit risk rating, which could be viewed as the expected probability of default (Krämer and Güttler 2008). Altman (1968) showed how ratio analysis could be taken as an effective basis in the context of a broader

Multiple Discriminant Analysis to perform predictions on future defaults. Sets of ratios continue to provide the foundation for failure prediction (Wu et al. 2010).

Intra-entity, financial ratios play an important role in strategic and tactical management and in manager performance evaluation and incentivization (Brüggen and Moers 2007; Van der Stede et al. 2006). While non-financial indicators such as customer satisfaction and product quality have become popular metrics in recent years, particularly as elements of a balanced scorecard (Kaplan and Norton 1992; Otley 1999), the use of traditional financial ratios continue to play an important role in goal setting, attention directing and performance measurement. There are suggestions that such standardized measures will even be elevated in their importance in firm management because of their more parsimonious and comparable approach to performance measurement (Arya et al. 2005; Luft 2009). In essence, financial statement ratio analysis plays a vital role in a range of different aspects of the functioning of the economy.

XBRL and financial statement analysis

The eXtensible Business Reporting Language (XBRL) is an XML-based language for the reporting of business facts, coupled to relevant metadata. A key component of the business case for XBRL over the years, has been the support of the financial statement analysis process in general and of financial analysts in particular (Brown and Willis 2003; Debreceny and Gray 2001). For example, Willis (2003) notes that "users of information from XBRL-enabled corporate reports will be able to extract data instantly and easily, and enter itno their analytical software tools for immediate analysis." Debreceny and Gray (2001) discuss the pivotal role played by financial analysts in the functioning of equity markets. They refer to two major tasks undertaken by analysts: "mechanics" and "analysis." They define mechanics as the "preliminary work the analyst performs locating, collecting, disaggregating, aggregating, and (re)formatting data" (p. 48). Debreceny and Gray (2001) assert that "since the analyst's total time is limited, the more time spent on mechanics, the less time that will be available for analysis" (p. 49) and point to the potential of XBRL to significantly improve the quality of the data acquisition and quality management processes and the efficacy of equity markets. These

broad themes have been continued in a myriad of subsequent publications over the last decade (e.g. DiPiazza and Eccles 2002; DiPiazza et al. 2006; Wagenhofer 2007).

There have been a number of important XBRL adoptions in several countries (Kernan 2008). Some of these adoptions are focused on encoding financial reporting of public companies, including China, South Korea and Japan. In the U.S., Securities and Exchange Commission commenced a multi-year program in 2009 to transition its EDGAR disclosure repository to the XBRL format in what the Commission terms "interactive data." An important factor in the Commission's adoption of XBRL was improving the functioning of the information value chain. In the preamble to the rule, the Commission (SEC 2009c) notes that:

> Interactive data can create new ways for investors, analysts, and others to retrieve and use financial information in documents filed with us. For example, users of financial information will be able to download it directly into spreadsheets, analyze it using commercial off-the-shelf software, or use it within investment models in other software formats. Through interactive data, what is currently static, text-based information can be dynamically searched and analyzed, facilitating the comparison of financial and business performance across companies, reporting periods, and industries.
>
> Interactive data also provide a significant opportunity to automate regulatory filings and business information processing, with the potential to increase the speed, accuracy, and usability of financial disclosure. Such automation could eventually reduce costs. A company that uses a standardized interactive data format at earlier stages of its reporting cycle could reduce the need for repetitive data entry and, therefore, the likelihood of human error. In this way, interactive data may improve the quality of information while reducing its cost.
>
> We believe that requiring issuers to file their financial statements using interactive data format will enable investors, analysts, and the Commission staff to capture and analyze that information more quickly and at less cost than is possible using the same financial information provided in a static format. Any investor with a computer and an internet connection will have the ability to acquire and download interactive financial data that have generally been available only to large institutional users.

Unlike a number of other financial reporting implementations that limit disclosures to a standard format or reporting template (e.g. the taxonomies employed by the Federal

Financial Institutions Examination Council (FFIEC) in the USA for prudential supervision of financial institutions and the taxonomy used by the Accounting and Corporate Regulatory Authority (ACRA) in Singapore for filing financial statements by Singapore companies), the SEC interactive data mandate allows significant flexibility in reporting. The rule, EDGAR Filing Manual (EFM) and the Compliance and Disclosure Interpretations each include details on the requirements for XBRL filing (SEC 2009b; SEC 2009c; SEC 2009d). Collectively, they require that filers ensure that their XBRL instance document must be a complete semantic representation of the filer's financial statements (SEC 2009a, 2009b, 2009c). In the first year of inclusion in the mandate, filers must detail tag the core financial statements and block-tag the notes in XBRL. In the second year, filers must detail tag the information included in the footnotes and additional disclosures in addition to the year one requirements. Supporting this reporting process is a US GAAP taxonomy that is significantly larger, more complex and encompasses greater industry variation than other comparable taxonomies such as the IFRS taxonomy.

The EFM requires that filers develop an extension taxonomy for concepts that are relevant and material for the particular filer but for which there is no corresponding element in the US GAAP taxonomy (SEC 2009b). Further, filers must build their own calculation linkbase rather than incorporate the calculation linkbase included in the US GAAP Discoverable Taxonomy Set (DTS).

XBRL and financial statement analysis

Given the complexity of financial ratios and the considerable variation observed in filings to the SEC, it is an open research question if the promise of XBRL can be fulfilled in the US context. For any given ratio, there are three possible consecutive scenarios, when analyzing the ability of information consumers to extract the data necessary for calculation of financial ratio information. Does the taxonomy incorporate the taxonomy elements necessary to calculate the ratios? What support is there in the US GAAP taxonomy for the calculation of standard financial ratios? The existence of appropriate tags in the taxonomy is a necessary but not sufficient condition for calculation of the ratios – the elements must also exist in the filers' instance documents. Do corporations make filings that include the taxonomy elements necessary for automatic creation of

standard financial ratios. Finally, where automatic creation of ratios from the filings is not feasible, what are the causes? Is this a function of the way corporations report in the financial statements that are the foundation for the XBRL filings? Or are the roots in the details of the XBRL implementation?

This research is, then, answers the following research questions:

RQ1 Does the US GAAP taxonomy support calculation of commonly defined financial ratios?

RQ3 What is the semantic match between XBRL filings and commonly defined financial ratios?

RQ4 What are the causes of semantic mis-matches between XBRL filings and commonly defined financial ratios?

3. Method

In this section, we set out the methods employed to identify the availability of ratios in the filings. We describe a canon of ratios and the constituent accounting concepts. We then discuss the match of those concepts to a "best" corresponding element in the US GAAP XBRL taxonomy. These "best" elements may not be in every instance document filed with the SEC. We exploit the structural concept

Standard Ratios, Accounting Concepts and Elements

We identify 63 standard ratios for commercial and industrial corporations, commonly seen in the academic and professional literature. Interestingly, there is no canon of financial statement ratios. Thus, we rely on a variety of sources to generate an inclusive set of ratios and the accounting concepts therein. These sources include professional (Troy 2010) and academic literature (Barnes 1987; Beaver 1966; Bradshaw 2004; Nissim and Penman 2001; Soliman 2008); financial statement analysis textbooks (e.g. Foster 1986; Penman 2009; Stickney et al. 2006; Subramanyam and Wild 2009); Chartered Financial Analyst (CFA) examination and support materials (e.g. Robinson et al. 2009) and Web resources. There is redundancy as accounting concepts appear in multiple ratios.

After removing this redundancy, we develop a canonical list of accounting concepts. Figure 1 shows the ratios that we identify in the professional literature, drawn primarily from the various CFA materials.[i], Where there are differences in the design of ratios, we show the alternatives.

Insert Figure 1 about here

After elimination of the redundancy in the list of accounting concepts in Figure 1, there are 38 accounting concepts found in the 63 ratios. We identify the best choice of semantically equivalent elements in the US GAAP 2009 taxonomy. The match of many accounting concepts to elements was straightforward. For example, there was no judgment required to determine that the semantic equivalent taxonomy for the accounting concept "Current Assets" is the taxonomy element *AssetsCurrent*. For others, the process involved intensive review of the taxonomy by the research team and the exercise of judgment in selection. Figure 2 shows the accounting concepts and the best semantically equivalent in taxonomy elements. Direct semantic matches can be found for 26 accounting concepts, shown in Panel A. Accounting concepts can and do appear in multiple ratios. The third column shows the number of ratios in which a particular accounting concept appears. The Sales concept appears in 26 ratios (40%), total equity in 14 ratios and Net Income in 12 ratios. One third of the accounting concepts appear in three or less ratios.

Not all the accounting concepts in commonly used ratios exist in the US GAAP taxonomy. There are twelve accounting concepts for which there is no direct semantic match in the taxonomy. In each case, these concepts can be substituted by a series of mathematical relationships with a set of elements in the taxonomy. The most elements required to multiple taxonomy elements are required to calculate the concept. The most important of these "missing" concepts are Long-term debt (six ratios) and Earnings before Interest and Taxation (EBIT) (four ratios). There are 34 taxonomy elements required to calculate these accounting concepts. In summary, the 63 ratios involve 38 accounting concepts that match to 60 taxonomy elements.

Insert Figure 2 about here

Alternative Elements

While we identify the "best" semantic match from accounting concept to one or more taxonomy elements, we recognize that not all filers will use the best exact match to the taxonomy. Some will use more generic or more specific elements, or semantically similar but not identical terms. We exploit the ontological structure inherent in the US GAAP taxonomy to identify alternative elements or sets of elements that can substitute for the "best" element, should that element not exist in a given filing. The ontological structure of XBRL taxonomies come through so-called "linkbases." These linkbases wrap metadata around the unique element names that are at the heart of the taxonomy (Debreceny et al. 2009, Chapter 4). These linkbases provide labels, definitions, presentation of the taxonomy to humans and, particularly important for this study, the calculation relationships between elements. The calculation linkbase describes simple mathematical relationships based solely on addition and subtraction. For example, the calculation linkbase prescribes that the elements *AssetsCurrent* and *AssetsNoncurrent* sum to equal the element *Assets*.[ii,iii] Combined together, the presentation and calculation linkbases provides a structure to the taxonomy, somewhat comparable to an object-oriented database (Graham 2001).[iv] This structure is illustrated in simplified form in Figure 3. We first identify a best semantic choice for an accounting concept within the taxonomy. Within the calculation hierarchy in the taxonomy, we see that the best semantic choice, "element of interest," has a parent (or in some cases, multiple parents), siblings and children. These mathematical relationships can be exploited to provide substitute elements for the element of interest.

Insert Figure 3 about here

We identify five patterns in the US GAAP taxonomy, that allow us to substitute individual elements or sets of elements for the "best" semantic matched element. As elements are substituted, there is a potential loss of information quality but a gain in the number of filings brought into the analysis. The first pattern is the required "parent and sibling" relationship, illustrated in Panel A of Figure 4. Here we use the hierarchical structure of the calculation linkbase to derive the value of the missing 'best" element. For example, several ratios require the accounting concept, "Accounts Receivable." The best

semantic choice for this term is the taxonomy element *AccountsReceivableNetCurrent*. The calculation parent of that element *AccountsNotesAndLoansReceivableNetCurrent*. It has just one sibling, *AllowanceForDoubtfulAccountsReceivableCurrent*. As a consequence, if an instance document did not contain the element *AccountsReceivableNetCurrent* but did contain both of the other elements, we can calculate the value of the desired element, by deduction. This substitution should involve no loss of information precision. An important variation on this pattern is the "optional parent and sibling" pattern. Here, when there are multiple siblings, siblings may appear optionally. For example, an element of interest may have a single parent (P) and three siblings (S1, S2 and S3). In the required parent and sibling pattern, P, S1, S2 and S3 would all be required to exist in the instance document. By contrast, in the optional parent and sibling pattern, P would be required to exist in the instance document, as would one or more of S1, S2 and S3. In other words, S1, S2 and S3 would optionally enter the calculation.

Insert Figure 4 about here

The third pattern, shown in Panel B of Figure 4, is to allow substitution of the parent for the child, where the child element is the best semantic match for a desired accounting concept. This pattern only applies infrequently as in most cases the loss of information precision is unacceptably large. For example, an acceptable match for the desired element *Cash* is the parent, *CashAndCashEquivalentsAtCarryingValue*. The addition of "cash equivalents" is sufficiently semantically close to the more precise taxonomy element "cash." Conversely, the parent of the taxonomy element *InventoryNet* is the element *AssetsCurrent*. The siblings of *InventoryNet* include elements such as *ReceivablesNetCurrent* and *CashAndCashEquivalentsAtCarryingValue*. These are semantically disparate concepts. *AssetsCurrent* is not an acceptable substitute for the element *InventoryNet.*

The fourth pattern, shown in Panel C of Figure 4 is to allow the substitution of children of the desired element. To continue the inventory theme, the five children of *MarketableSecuritiesCurrent* are *TradingSecuritiesCurrent,*

AvailableForSaleSecuritiesCurrent, HeldToMaturitySecuritiesCurrent *OtherMarketableSecuritiesCurrent* and *InventoryAdjustments*. We allow any combination of these elements as substitutes. Again, there is a clear loss of information precision in this pattern.

The fifth pattern, shown in Panel A of Figure 5, is where there is a direct semantic substitution of the desired element for a semantically equivalent element, elsewhere in the taxonomy. The taxonomy is large and complex, supporting disclosures that equate to the "face" of the financial statements as well as to the notes and additional disclosures. The design of the taxonomy mitigates against redundancy by allowing taxonomy elements can appear in multiple calculation hierarchies. For example, the element *InventoryNet* appears in a calculation hierarchy that corresponds to the traditional "face" of the financial statements and in separate calculation relationships that reflect additional disclosures and notes. Nonetheless, close inspection of the taxonomy revealed a very limited number of occasions where semantically equivalent elements were identified. For example, the value of the element *LiabilitiesAndStockholdersEquity* in an instance document should be identical to the element Assets. These elements are at the top of the two calculation hierarchies that represents the traditional statement of financial position, and are not, therefore, in a calculation relationship.

Insert Figure 5 about here

As noted, the US GAAP taxonomy is large and complex, allowing elements to exist in different calculation hierarchies. Several of these structures display polymorphism (Cardelli and Wegner 1985; Haslhofer and Klas 2010). Polymorphism exists when a thing can have multiple forms and where the appropriate or relevant form depends on the context. In the US GAAP taxonomy, an element can have more than one parent and multiple sets of siblings. We illustrate this in Panel B of Figure 5. For example, the *Cash* element appears in a financial statement disclosure pattern where the parent is *CashAndCashEquivalentsAtCarryingValue* and there is a single sibling, *CashEquivalentsAtCarryingValue*. It also appears in a disclosure structure with a parent, *CashAndDueFromBanks*, and a single sibling. *DueFromBanks*. In turn,

CashAndDueFromBanks has the parent, *CashAndCashEquivalentsAtCarryingValue* and two siblings, *InterestBearingDepositsInBanks* and *CashEquivalentsAtCarryingValue*. In other words, *Cash* "rolls up" to *CashAndCashEquivalentsAtCarryingValue* via two distinct calculation hierarchies in the taxonomy. We observe several similar structures in the taxonomy that impact our analysis, with as many as four sets of parents and sibling structures and three sets of child structures. For the purposes of accepting alternatives, we do not discriminate between these polymorphic structures and treat them identically.

As discussed earlier, as we expand the coverage of possible alternatives, thereby, bringing in additional data points, we lose data quality. We see that there is a clear quality ranking of the patterns discussed in this section.[v] The best choice of element in a given instance document is the semantically equivalent element, shown in Figure 2 (Level 1). The next best alternative is a semantically substitute equivalent element to our best choice element (Level 2). We expect that the values of the "best match" and "semantically equivalent" elements will be identical. The third best alternative is the required "parent and sibling" pattern (Level 3). As we discuss above, information consumers can derive the value of the desired "best" element by deduction. They do so by netting the values of the siblings from the parent of the target element. There should be no loss of information precision. The next best alternative is to take the values of any of the children that exist in an instance document. It would be unrealistic to require the values of all the children as in many cases there will be no entity will disclose all children. For example, there are eight children of *InventoryNet* in a statement of financial position aggregation hierarchy to represent the disclosure alternative, including *InventoryFinishedGoods*, *InventoryOther* and *InventoryLifoReserve*. A filer is extremely unlikely to have all eight of these elements in a given instance document. Given that we allow any one of the children to substitute for a parent, there is a clear potential loss of data quality (Level 4). The next best alternative is to the optional parent and sibling relationship (Level 5). The sixth and final alternative is to accept a parent as a substitute for the desired element. Given that the parent encapsulates other concepts, it has a broader semantic meaning. We accepted the parent as acceptable substitutes for only two elements (Level 6).

Data collection

With the commencement of the mandated filings by XBRL in June 2010, there are now a considerable number of filings in the SEC's EDGAR database. At the date of data collection (December 2010), there are 4,772 filings from 1,519 filers. We eliminate the 307 filers with SIC codes that are in the financial services domain, including banks and insurance companies, leaving 1,202 filers of interest. Data was collected by extracting all filings from the SEC website into a relational database. We then extract all the occurrences of the target or combinations of alternative elements. For the purpose of the study, we do not differentiate in which filing or the number of occurrences of the elements in the filing. As long as the element appeared in at least one filing, we count the element as being present. For each of the target elements we calculate the occurrences at levels one to six, as set out in the subsection above. We do so cumulatively. In other words, if the best choice a given element is in one or more instance documents, the value of that element for each level would be set at available. From this data, we can determine which ratios can be automatically generated from the current filings. We also establish the extent to which calculation of ratios must rely on second and third choices of taxonomy elements. We then go on to identify why ratios cannot be calculated, or which can only be calculated for a relatively small proportion of filers.

4. Results

There are filings from 1,202 distinct "Commercial and Industrial" corporations in the current version of the SEC EDGAR database and in our version of that database as of December 5, 2010. Table 1 shows the elements that go into the principal ratios and their availability at the six different levels of information quality. Panel A shows those elements that appear directly in ratios. Panel B shows those elements which appear indirectly in ratios through, for example, EBIT or "Short Term Borrowings." There are a number of interesting patterns in this data. As might be expected, *Assets* are available in most filings. We find this desired element in effectively all filings. Conversely, the element we observe *Cash* in only a handful of filings. It is only when we come to see the acceptable parent (Level 6), *CashAndCashEquivalents*, that we see an acceptable substitute in 99% of filings.

Insert Table 1 about here

Other elements show interesting patterns, worthy of further investigation in the original filings. For example, *CapitalLeaseObligations* only reaches 10% of filings at the sixth level. Similarly, *PaymentsForOperatingActivities* is only in less than half of the filings. As we discuss earlier in the paper, there are three possible reasons for this outcome. It may be that these concepts are not relevant for the particular corporations. Alternatively, there may be a mismatch between the taxonomy and the way corporations report. Finally, our match from concept to taxonomy element may be incorrect. Additional investigation is necessary.

We then go on to calculate the availability of the elements that are required to calculate a subset of the ratios set out in Figure 1. We show these 19 ratios in Table 2. For the purposes of this analysis, we calculate two levels. The first version ("tight") requires that all elements be available in order to calculate the ratio. The second version ("loose") loosens this very tight requirement. For example, one of the possible calculations of the Debt/Equity. The strict calculation of debt is to require both the elements *LongTermDebtNoncurrent* and *LongTermDebtCurrent* to appear in the instance document. The less strict version is to allow either of these elements to appear in the instance document. As can be seen from Table 2, loosening this strict requirement increases the availability of the Debt/Equity ratio from 41% to 45%. For some ratios, the effect of loosening the test of element availability dramatically increases the coverage. The pretax margin increases from zero coverage to 70% and interest coverage from zero to 74%. What is also apparent from the table is that eight of the 28 ratios can be calculated for more than 90% of filers.

Insert Table 2 about here

5. Conclusions

A key public policy driver of XBRL adoption in the USA and elsewhere has been to make information on corporate performance and risks. The financial statement data filed with a number of regulators and stock exchanges provide the raw material for one of the

most important aspects of peer group analysis, which are the derivation of financial statement ratios. This paper investigates the ability of information consumers to derive ratios from filings in XBRL made to the SEC. In absence of a financial statement ratios canon, we identify more than 60 ratios drawn from the financial statement analysis professional literature. The accounting concepts embedded in these ratios are matched with the US GAAP taxonomy to identify an element that is best semantic equivalent. We develop and test a methodology to identify elements that can be semantic alternatives to the best choice. We then assess the existence of these elements in filings made by the 1,202 commercial and industrial corporations that filed with the SEC by September 2010. We assess the ability of information consumers to calculate 19 key financial statement ratios. Some eight of these ratios can be calculated for more than 90% of filers. For some of these ratios, the availability of these ratios comes at the cost of potential loss of information quality.

An extensive literature review did not identify any systematic study of the extraction of ratios from SEC or other XBRL filings. The findings are of considerable importance for the SEC, information intermediaries, XBRL US and XBRL International and the research community. Considerable additional research will be necessary. Can we loosen some of the assumptions in this study? For example, must every concept in a given ratio be available? What is the actual loss of information quality as we extend the spread of elements from our Level 1 to Level 6? How does the actual value of the ratio change as we traverse this path? What are the lessons for taxonomy design for the US GAAP taxonomy in particular and for taxonomy design in general? How does the range of ratios we identify compare with the availability of ratios in the common analytical databases? Do the values of the ratios calculated directly from the instance documents differ from the ratios in the analytical databases? Does any difference have potential capital market effects? What are the public policy implications of the availability, or lack thereof, data to calculate key ratios?

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Figure 1: Canonical List of Ratios and Accounting Concepts

#	Ratio	Formula
1	Cash Ratio	(Cash+Marketable Securities)/Current Liabilities
2a	Quick Ratio	(Cash+Accounts Receivable)/Current Liabilities
2b		(Current Assets-Inventory)/Current Liabilities
2c		(Cash+Marketable Securities+Receivables)/Current Liabilities
3	Defensive Interval Ratio	(Cash+Short-Term Marketable Investments+Receivables)/Daily Cash Expenditures
4	Current Ratio	Current Assets/Current Liabilities
5	Cash Conversion Cycle	Receivable Collection Period+Inventory Period-Payables Payment Period
6	Receivable Turnover	Sales/Accounts Receivable
7	Average Collection Period	365/Receivable Turnover
8	Inventory Turnover	COGS/Inventory
9	Average Inventory Processing Period	365/Inventory Turnover
10	Current Liabilities to Net Worth Ratio	Current Liabilities/Current Net Worth
11a	Payables Turnover Ratio	COGS/Accounts Payable
11b		Purchases/Average Accounts Payable
12	Payables Payment Period	365/Payables Turnover Ratio
13	Total Liabilities to Net Worth Ratio	Total Liabilities/Net Worth
14a	Debt to Equity Ratio	Long-Term Debt/Total Equity
14b		(Noncurrent Liabilites+Deferred Taxes+PV of Lease Obligations)/Total Equity
15a	Debt Ratio	Total Debt/Total Assets
15b		(Current Liabilities+Total Long-Term Debt)/(Total Debt+Total Equity)
16	Long-Term Capital Ratio	Long-Term Debt/(Long-Term Debt+Shareholders' Capital)
17	Interest Coverage Ratio	EBIT/Interest Expense
18	Fixed Charge Coverage Ratio	(EBIT+Lease Payments)/(Interest+Lease Payment+(Preferred Dividend/(1-Tax Rate))
20	Cash Flow Coverage of Fixed Financial Costs	(Cash Flows From Operating Activities+Interest Expenses)/Interest Expenses
21	Cash Flow/Long-Term Debt Ratio	Cash Flows From Operation/Book Value of Long-Term Debt
22	Cash Flow/Total Debt Ratio	Cash Flow From Operations/(Total Long-Term Debt+Current Interest Bearing Liabilities)
23	Fixed Assets to Net Worth	Fixed Assets/Net Worth
24	Collection Period Ratio (Days)	Accounts Receivable/Sales x 365 Days
25	Sales to Inventory Ratio	Annual Net Sales/Inventory
26	Assets to Sales Ratio	Total Assets/Net Sales
27	Total Assets Turnover Ratio	Sales/Average Total Assets
28	Fixed Assets Turnover	Revenue/Average Net Fixed Assets
29	Equity Turnover	Net Sales/Average Equity

#	Ratio	Formula
30	Sales to Net Working Capital Ratio	Sales/(Current Assets – Current Liabilities)
31	Accounts Payable to Sales Ratio	Accounts Payable/Net Sales
32	Return On Sales	Net Profit After Taxes/Net Sales
	Net Profit Margin	Net Income/Sales
33	Pretax Margin	EBT/Sales
34	Operating Profit Margin	Operating Profit/Net Sales
35	Operating ROA	Operating Income/Average Total Assets
36	Return On Assets Ratio	Net Profit After Taxes/Total Assets
37a	Return On Total Capital	(Net Income+Gross Interest Expenses)/Total Capital
37b		EBIT/(Short-Term Debt+Long-Term Debt+Equity)
38	Returns On Assets	Net Income/Average Total Assets
39	Return On Net Worth	Net Profit After Taxes/Net Worth
40	Return On Owners' Equity	(Net Income-Preferred Dividend)/Average Common Equity.
	Return On Common Equity	
41	Gross Profit Margin	(Sales-COGS)/Sales
42	Operating Profit Margin	EBIT/Sales
43	Coefficient of Variation	σEBIT/Average EBIT
44	Sales Volatility	σSales/Average Sales
45	Operating Leverage	Fixed Costs/Total Costs
46	Dividend Payout Ratio	Dividend Paid/Net Income
47	Retention Rate	1- Dividend Payout Ratio
48	Sustainable Growth Rate	Retention Rate x ROE
49	EPS	Net Income-Preferred Dividends/Weighted Average Numbers of Shares Outstanding
50	Working Capital Turnover	Revenue/Average Working Capital
51	Financial Leverage	Average Total Assets/Average Total Equity
52	P/E	Price Per Share/Earnings Per Share
53	P/Cf	Price Per Share/Cash Flow Per Share
54	P/S	Price Per Share/Sales Per Share
55	P/Bv	Price Per Share/Book Value Per Share
56	EBITDA Per Share	EBITDA/Average Number of Shares Outstanding
57	Tax Burden	Net Income/Earnings Before Taxes
58	Free Cash Flow to Equity	(Cash Flow From Operating Activities-Investment In Fixed Capital)+Net Borrowing
59	Free Cash Flow to The Firm	Cash Flow From Operating Activities+Interest Expense (1-Tax Rate)-Investment In Fixed Capital
60	Debt to Capital	Totdebt/ Totcapital
61	EBITDA Margin	EBITDA/ Revenue
62	Ev/Ebitda	Enterprise Value/Ebitda
63	Ev/Revenue	Enterprise Value/Revenue

Figure 2: Accounting Concepts and Semantically Equivalent Taxonomy Elements

Panel A – Accounting Concepts with direct matches in US GAAP XBRL Taxonomy

Accounting Concept	US GAAP Taxonomy Element	N
Sales	SalesRevenueNet	20
Total Equity	StockholdersEquityIncludingPortionAttributableToNoncontrollingInterest	14
Net income	ProfitLoss	12
Cost of goods sold	CostOfGoodsAndServicesSold	9
Current liabilities	LiabilitiesCurrent	9
Entity public float	EntityPublicFloat	8
Inventories	InventoryNet	7
Total assets	Assets	7
Accounts receivable	AccountsReceivableNetCurrent	7
Cash flow from operations	NetCashProvidedByUsedInOperatingActivities	6
Cash	Cash	6
Accounts payable	AccountsPayableCurrent	5
Short-term Marketable securities	MarketableSecuritiesCurrent	5
Interest payment	InterestExpense	5
Current assets	AssetsCurrent	4
Preferred dividends	DividendsPreferredStock	4
Short-term debt	ShortTermBorrowings	3
Dividends	PaymentsOfDividends	3
Minority Interest	MinorityInterest	2
Operating income	OperatingIncomeLoss	2
Deferred taxes	DeferredTaxLiabilitiesCurrent	1
Total liabilities	Liabilities	1
Cash expenditures	PaymentsForOperatingActivities	1
Non Current liabilities	LiabilitiesNoncurrent	1
Total Revenues	Revenues	1
Present value of lease obligations	CapitalLeaseObligations	1

Panel B – Accounting Concepts without direct matches in US GAAP XBRL Taxonomy

Accounting Concept	US GAAP Taxonomy elements	N
Long-term debt	LongTermDebtNoncurrent LongTermDebtCurrent	6
Earnings before Interest and Taxation EBIT	ProfitLoss InterestExpense IncomeTaxExpenseBenefit DiscontinuedOperationTaxEffectOfAdjustmentToPriorPeriodGainLossOnDisposal DiscontinuedOperationTaxEffectOfOtherIncomeLossFromDispositionOfDiscontinuedOperation DiscontinuedOperationTaxEffectOfIncomeLossFromDisposalOfDiscontinuedOperation DiscontinuedOperationTaxEffectOfIncomeLossFromDiscontinuedOperationDuringPhaseOutPeriod	4

Accounting Concept	US GAAP Taxonomy elements	N
	DiscontinuedOperationTaxExpenseBenefitFromProvisionForGainLossOnDisposal	
Total Debt	DebtCurrent LongTermDebtAndCapitalLeaseObligations	3
Fixed assets	PropertyPlantAndEquipmentNet AssetsHeldForSalePropertyPlantAndEquipment	3
Earnings before Interest, Taxation, Depreciation and Amortization EBITDA	ProfitLoss InterestExpense IncomeTaxExpenseBenefit IncomeLossFromDiscontinuedOperationsNetOfTax DepreciationAndAmortization CostOfServicesDepreciationAndAmortization CostOfGoodsAndServicesSoldDepreciationAndAmortization CostOfGoodsSoldDepreciationDepletionAndAmortization	3
Earnings before tax, after interest EBTAI	ProfitLoss IncomeTaxExpenseBenefit DiscontinuedOperationTaxEffectOfAdjustmentToPriorPeriodGainLossOnDisposal DiscontinuedOperationTaxEffectOfOtherIncomeLossFromDispositionOfDiscontinuedOperation DiscontinuedOperationTaxEffectOfIncomeLossFromDisposalOfDiscontinuedOperation DiscontinuedOperationTaxEffectOfIncomeLossFromDiscontinuedOperationDuringPhaseOutPeriod DiscontinuedOperationTaxExpenseBenefitFromProvisionForGainLossOnDisposal	3
Preferred shares	PreferredStockValue PreferredStockSharesSubscribedButUnissuedSubscriptionsReceivable	2
Lease payment	LeaseAndRentalExpense InterestExpenseLesseeAssetsUnderCapitalLease	1
Total common equity	StockholdersEquityIncludingPortionAttributableToNoncontrollingInterest PreferredStockValue PreferredStockSharesSubscribedButUnissuedSubscriptionsReceivable AdditionalPaidInCapitalPreferredStock	1
Fixed costs	OperatingExpenses SalesCommissionsAndFees CostOfRevenue CostOfGoodsSoldDirectMaterials CostOfServicesDirectMaterials CostOfServicesDirectLabor CostOfGoodsSoldDirectLabor	1
Total expenses	CostOfRevenue OperatingExpenses	1
Book value	Assets Liabilities	1

Figure 3: Simplified Calculation Structure of the US GAAP Taxonomy

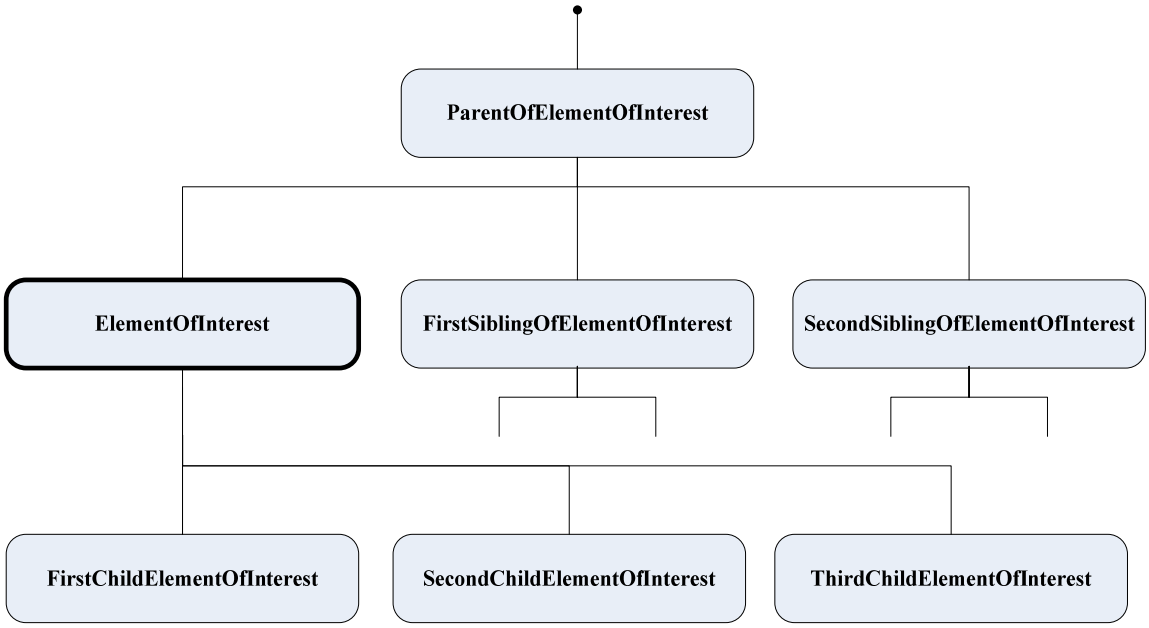

Figure 4: Patterns of Alternative Elements (1)

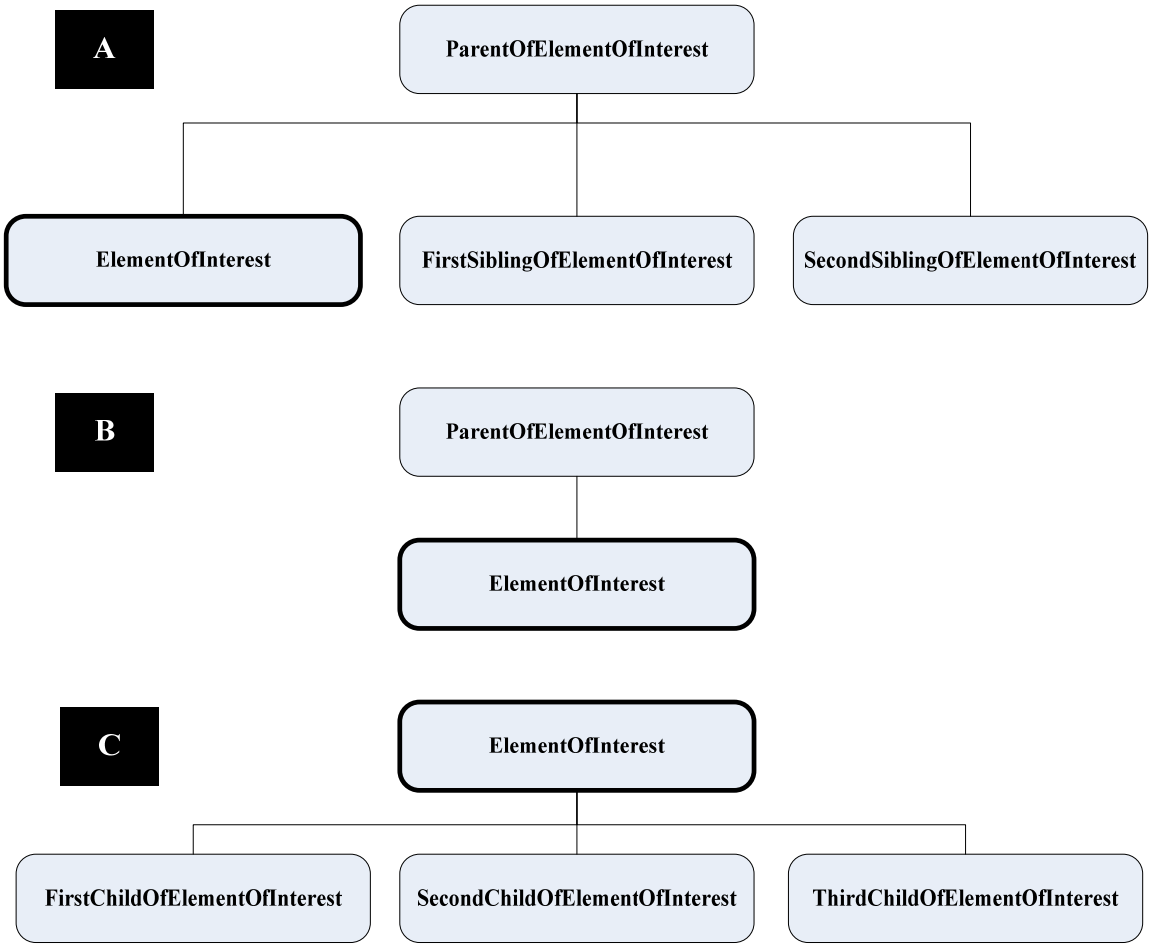

Figure 5: Patterns of Alternative Elements (2)

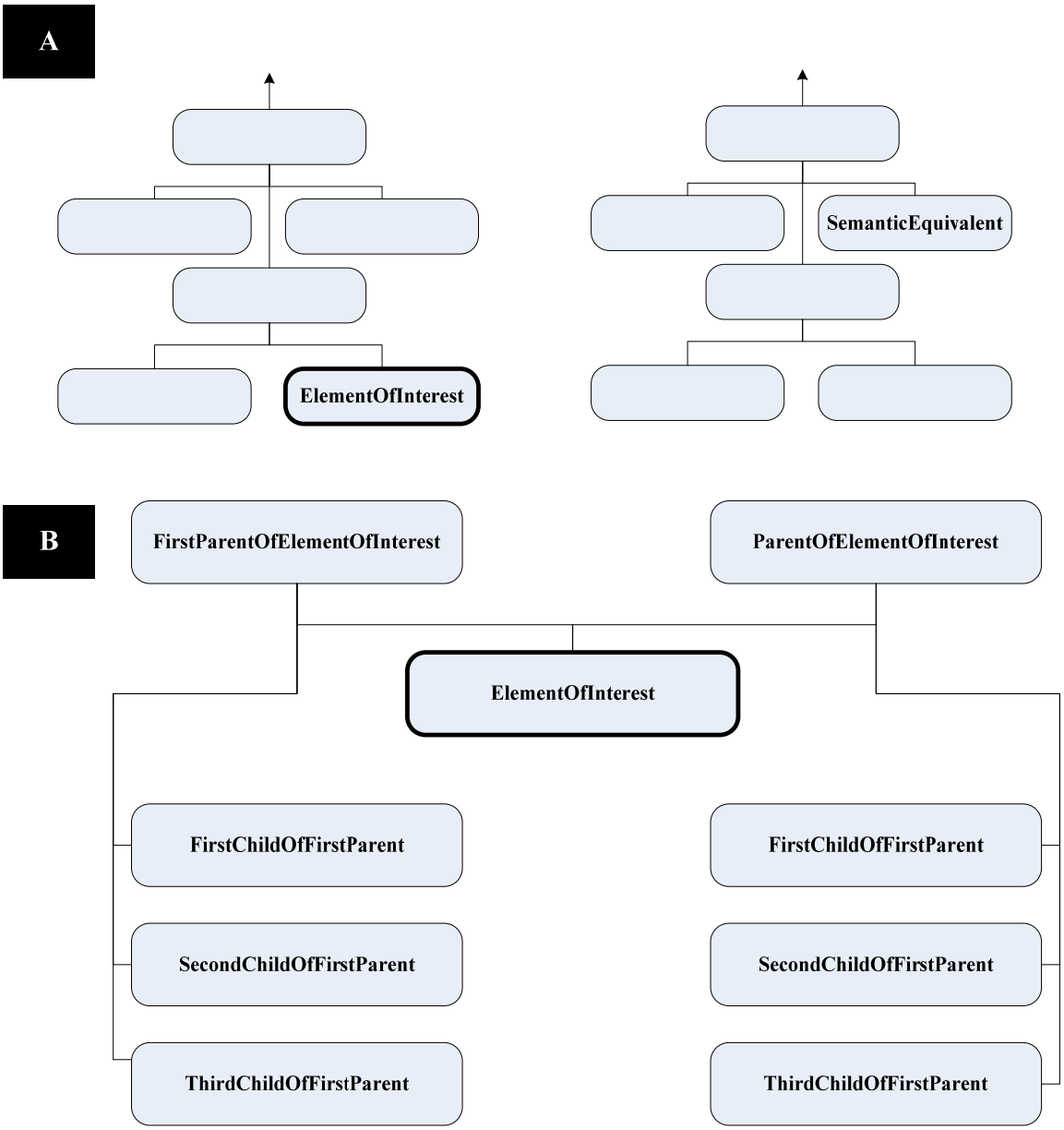

Table 1: Availability of Elements in Filings

Panel A – Concepts appearing directly in ratios

N	Element	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
20	SalesRevNet	42%	42%	43%	76%	76%	95%
14	StockHolEquityWithNCI	56%	56%	58%	98%	98%	98%
12	ProfitLoss	54%	54%	56%	57%	57%	100%
9	COGSS	22%	22%	22%	63%	63%	63%
9	LiabCurr	98%	98%	98%	98%	98%	98%
8	PublicFloat	64%	64%	64%	64%	64%	64%
7	AccountsRecNetCurr	67%	69%	69%	69%	69%	69%
7	Assets	100%	100%	100%	100%	100%	100%
7	InvNet	69%	69%	69%	70%	70%	70%
6	Cash	2%	2%	4%	4%	4%	99%
6	NetCashOperAct	95%	95%	96%	100%	100%	100%
5	AccountsPayCurr	78%	78%	78%	83%	86%	86%
5	IntExp	70%	70%	70%	74%	74%	74%
5	MtblSecCurr	10%	10%	10%	18%	18%	18%
4	AsseCurr	98%	98%	98%	98%	98%	98%
3	PayDiv	22%	22%	22%	22%	22%	24%
1	DefTaxLiabCurr	16%	16%	17%	17%	17%	17%
1	Liabilities	57%	57%	70%	70%	87%	87%
1	LiabNonCurr	17%	17%	67%	96%	96%	96%
1	PayForOperAct	0%	0%	0%	47%	47%	47%

Panel B – Concepts appearing indirectly in ratios

Element	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
AddPaidInCapPrefStock	0%	0%	0%	0%	0%	0%
AssetsHeldForSalePPE	1%	1%	1%	1%	1%	1%
CapitalLeaseObl	2%	2%	2%	10%	10%	10%
COGSDeprDeplAmort	0%	0%	0%	1%	1%	1%
COGSSDeprAmort	0%	0%	0%	1%	1%	1%
COSDeprAmort	1%	1%	1%	2%	2%	2%
CostOfRev	19%	19%	24%	45%	45%	45%
DebtCurr	16%	16%	16%	44%	75%	75%
DeprAndAmort	38%	38%	38%	40%	40%	40%
DiscOperTaxDiscontOper	2%	2%	3%	3%	3%	3%
DiscOperTaxEffAdjDisp	0%	0%	0%	0%	1%	1%
DiscOperTaxExpBenDisp	0%	0%	0%	0%	0%	0%
DiscOperTaxOtherDisp	0%	0%	0%	0%	1%	1%
DiscOperTaxPhaseOut	2%	2%	2%	2%	4%	4%
DivPrefStock	2%	2%	2%	4%	4%	4%
IncLossDiscOperNetTax	22%	22%	22%	23%	27%	27%
IncomeTaxExpBen	97%	97%	97%	98%	98%	98%

Element	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
IntExpLesseeAssCapLease	0%	0%	0%	74%	74%	74%
LeaseAndRentExp	5%	5%	5%	5%	5%	5%
LTDebtCapitalLeaseObl	22%	22%	22%	75%	75%	75%
LTDebtCurrent	37%	37%	39%	45%	45%	45%
LTDebtNonCurrent	54%	54%	55%	62%	62%	62%
OperExpense	28%	28%	28%	84%	87%	87%
OperIncomeLoss	87%	87%	87%	87%	89%	89%
PrefStockUnissued	0%	0%	0%	0%	0%	0%
PrefStockValue	47%	47%	47%	47%	47%	47%
ProceeedsRepayDebt	3%	3%	3%	28%	28%	28%
PropPlanEquipNet	96%	96%	96%	96%	96%	96%
STBorrowings	19%	19%	20%	27%	27%	27%

Table 2: Availability of Ratios in Filings

Ratio	Tight	Loose
Cash conversion cycle	31%	99%
Cash ratio	18%	97%
Cash flow coverage	74%	74%
Cash flow/Total debt ratio	15%	72%
Current ratio	98%	98%
Current Liabilities to Net Worth	96%	96%
Debt to equity ratio	41%	45%
Long-term capital ratio	62%	87%
Defensive interval ratio	6%	47%
EBITDA Margin	0%	95%
Fixed charge coverage	0%	76%
Free cash flow to equity	23%	86%
Gross Profit margin	62%	62%
Interest coverage	0%	74%
Operating ROA	89%	89%
Pretax margin	0%	70%
Payables turnover	56%	56%
Quick ratio (Version 1)	68%	97%
Receivable Turnover	66%	66%

[i] Provenance of each ratio is available from the contact author.

[ii] Each of these elements are of the monetary datatype. There are many other datatypes available within XBRL, including text and shares.

[iii] The US GAAP taxonomy provides a number of "entry points" which provide views or templates of the taxonomy, fined tuned for different types of entities. In this paper, we refer exclusively to corporations that are typically termed "commercial and industrial." These corporations normally report their statement of financial position in a classified manner. There are alternative ontological structures that provide templates for financial services.

[iv] Details of the formal ontological structure of XBRL taxonomies are beyond the scope of this paper (Lampathaki et al. 2009; Piechocki et al. 2009; Spies 2010, Forthcoming).

[v] For the sake of minimizing the length of this paper, we do not display how the patterns apply to each of the elements in the study. This list is available from the contact author.