UNDERSTANDING THE LIMITATIONS OF FINANCIAL RATIOS

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ABSTRACT

The purpose of this paper is to provide financial statement users and accounting academics with some useful insights when working with financial ratios. Initially, the uses and benefits of financial ratios and the limitations of using financial ratios are discussed from the financial statement users' and accounting academics' perspectives. Then, practical advice is provided to both financial statement users and accounting academics alike to mitigate the limitations of using financial ratios. Financial statement users and accounting academics will find the issues discussed in this paper useful in their work with financial ratios.

Keywords: Financial ratios, Comparability, Homoscedasticity, Outliers

INTRODUCTION

Financial ratios play an important role in the analysis of financial statements and accounting research. However, the use of financial ratios comes with its hazards. Both accounting academics and financial statements' users need to understand the problems and limitations in working with financial ratios. The purpose of this paper is to address these issues and to provide guidance on how to mitigate the problems surrounding financial ratios. Both accounting academics and financial statement users will find this study useful in their dealings with financial ratios.

The study is organized as follows:

1. Uses and benefits of financial ratios;
2. Limitations of financial ratios;
3. Dealing with the limitations of financial ratios; and
4. Conclusion.

USES AND BENEFITS OF FINANCIAL RATIOS

Financial ratios play an important role in financial reporting. A ratio "expresses the mathematical relationship between one quantity and another," (Kieso et al. 2013, p. 245). A financial ratio consists of a numerator and a denominator, relating two financial amounts. The two financial amounts can be from the balance sheet (e.g. current ratio), or from the income statement (e.g. times interest earned), or from both the balance sheet and the income statement (e.g. return on total assets).

Financial ratios help explain financial statements. For example, financial ratios assist in benchmarking a firm's performance with other firms in the same industry. Further, financial ratios help financial statement users in identifying problem areas with a company's operations, liquidity, debt position, or profitability. From this benchmarking and assessment of a firm's performance, financial ratios help in assessing the firm's overall risk (CICA, 1993). Prior

research supports the use of financial ratios as a means to predict firms' performance, specifically stock returns and return on assets (e.g., Soliman, 2008; Nissim & Penman, 2001; Fairfield & Yohn, 2001).

Financial ratios are frequently used in loan contracts between a firm (borrower) and a financial institution (lender) as a means to limit the firm's activities. A borrower has an incentive to engage in activities that benefit his or her self-interests at the expense of the firm's overall value, resulting in the lender inserting accounting numbers in the debt contract (i.e., debt covenant) to restrict the borrower's value-reducing activities (Watts & Zimmerman, 1986). For example, the loan contract may stipulate that the firm must maintain a current ratio of at least 2:1. In this manner, the firm is encouraged to effectively manage its current assets and current liabilities, for example, by collecting its accounts receivables on a timely basis.

For financial statement users, financial ratios not only provide information about where a firm has been, but also provides guidance about where it is headed in the future. For example, negative trends in financial ratios over time could indicate a firm is in decline and provide insights into predicting corporate failure. The Canadian Institute of Chartered Accountants (CICA, 1993) in their Research Report titled "Using Ratios and Graphics in Financial Reporting," summarizes these and additional benefits of financial ratio analysis (see Appendix 1).

From an academic perspective, financial ratios play an important role in modeling. A variable of interest (dependent variable) is estimated in a linear regression model by key independent variables that are frequently financial ratios. Many bankruptcy prediction models utilize financial ratios (Altman & Hotchkiss, 2006).

In summary, financial ratios provide important information about a firm's past performance, predicting a firm's future performance prospects, assessing management's decision-making, risk assessment, and are a critical tool employed in lending agreements to control a firm's activities. In addition, accounting academics use financial ratios in modeling the key variable of interest in their research studies.

LIMITATIONS OF FINANCIAL RATIOS

Inherent in the use of financial ratios are limitations that if not understood could result in drawing incorrect conclusions from the results. Significant limitations in the use of financial ratios are discussed below.

A financial ratio consists of a numerator and a denominator. If either the numerator or denominator is misstated, then the financial ratio will be in error. Misstatement of either the numerator or denominator could be the result of human error. For example, an error could be made in collecting the firms' financial statement data. Alternatively, the firms could be employing earnings management techniques (e.g., manipulating accruals) that results in the data itself being misstated. Prior accounting research provides evidence that firms' managers manipulate accruals to portray firms' financial results in a more positive manner (e.g., Healy & Wahlen, 1999; McNichols, 2000). In either case, financial statement users and academics would obtain results from their analyses that could lead to erroneous conclusions.

Financial ratios derived from a particular firm's financial statements are based on accounting principles, accounting methods, and accounting classifications chosen by the firm. These choices may not be consistent over time or between firms, thus compromising comparability. Financial statement users and researchers alike need to understand that the availability of accounting choices under generally accepted accounting principles (GAAP) may

provide firms with greater flexibility in financial reporting, but it also can lead to a decline in comparability of a firm's financial results over time and between other firms.

The relation between the numerator and denominator variables in financial ratios poses special problems to accounting researchers. Often, the researcher assumes a relationship or proportionality between the two variables. However, little attention is paid to the distributional properties of ratios (Foster, 1986).

Prior research studies on the distributional properties of financial ratios find that financial ratio data may not be normally distributed, but rather can be severely skewed (Deakin, 1976; Frecka & Hopwood, 1983; Foster, 1986). The implications of non-normality are that the basic assumptions of ordinary least squares (OLS) regression are not valid; that is, the OLS estimators are not the best linear unbiased estimators (Gujarati, 2003). For example, one assumption is that the variance is equal or constant for all observations (homoscedasticity). Skewness causes a breakdown in homoscedasticity resulting in a condition known as heteroscedasticity (unequal variance). The importance of maintaining the validity of OLS assumptions is that these assumptions are necessary to draw inferences about the population under investigation that are statistically valid with hypothesis testing. Otherwise, hypothesis testing becomes more complex (e.g., use of non-parametric methods).

Another cause of heteroscedasticity is the effect of outliers. An outlier is defined as "an observation (or subset of observations) which appears to be inconsistent with the remainder of that set of data" (Barnett & Lewis, 1994, p. 7). Financial ratio data are prone to include outliers. As the denominator of an observation for a particular financial ratio approaches zero, the financial ratio becomes extremely large. Frecka's and Hopwood's Table 1 (Frecka & Hopwood, 1983, p. 117) provides 10 ratio values. With the numerator kept constant with a value of "2.0," the denominator is reduced from a value of "1.0" to "0.10." The ratio value changes from a value of 2.0 (i.e., 2.0 divided by 1.0) to a value of 20 (i.e., 2.0 divided by 0.10). Thus, a decline in value of 0.90 in the denominator has a tenfold effect on the financial ratio. Frecka and Hopwood (1983, pp. 126-127) find that including an outlier with a value of 100 in a sample that has a mean equal to 4 results in weighing that observation 2,304 times more than the average observation. The effect of an outlier on small samples is even more profound. Frecka and Hopwood (1983, p. 127) state that including an observation with a current ratio of 100:1 in an industry of 9 firms that would normally have a mean of 2.0 and a variance of 1.0, changes the sample mean and variance to 12.89 and 1,068, respectively.

Overall, the limitations of financial ratios must be addressed prior to drawing any meaningful conclusions from the results. Methods on how to deal with these limitations are discussed in the next section.

DEALING WITH THE LIMITATIONS OF FINANCIAL RATIOS

The methods on how to deal with the limitations of financial ratios are discussed from two perspectives: (a) financial statement users' perspective; and (b) accounting researchers' perspective.

Financial Statement Users' Perspective

From the perspective of financial statement users, the limitations of financial statement ratios affect the comparability of a firm's financial results. For example, a firm that changes its inventory valuation method from last-in, first-out (LIFO) to first-in, first-out (FIFO) will lack

comparability with other firms that use LIFO. Thus, comparing inventory turnover ratios between firms is compromised. Financial statement users can address this issue by reviewing the accounting principles of the firm with the accounting change. Generally, a summary of the firm's accounting principles is provided in the first or second notes to the financial statements. Further, additional information about the accounting change would be described in a separate note (e.g., inventory valuation note). Comparability is enhanced because the effects of the accounting change on earnings would be explained in the note, allowing the financial statement user to adjust for these effects and compare inventory turnover ratios with other firms in the industry using LIFO. Note that comparing the firm's inventory turnover ratio with its own inventory turnover ratio in the previous year is not compromised because changes in accounting principles are applied retrospectively, meaning the comparative year's amounts are prepared on the same FIFO basis as the current year's amounts. Thus, financial statement users should always review the accounting principles included in the financial statements of firms whose financial amounts are used to calculate and compare financial ratios.

However, not all accounting changes are accounted for retrospectively. A change in accounting estimate is accounted for prospectively, meaning prior period results are not adjusted for the change. The reasoning for this treatment is that a change in accounting estimate is based on new information and should affect only reported results in the current period and going forward. Examples of changes in accounting estimates are changes to the estimate for uncollectible accounts receivable and changes to depreciation expense due to changes in the useful lives or salvage values of property, plant, and equipment assets.

One effect of a change in accounting estimate is to either increase or decrease earnings. For example, a decrease in the rates for uncollectible accounts receivable, an extension to an asset's useful life, and an increase to an asset's salvage value, all have the effect of increasing operating income. Financial statement users should review the firm's notes to its financial statements for additional information provided about any changes to accounting estimates. Further, the changes to accounting estimates should be consistent with the economic substance of transactions affecting the firm. For example, during a recessionary period, a firm's customers have a greater likelihood not to pay accounts receivable, thus one would expect the rate for uncollectible accounts receivable to increase and not decrease.

Financial statement users should be concerned with the direction of accounting estimates (i.e., either income increasing or income decreasing). Generally during the fourth quarter of a firm's annual fiscal period, the firm's managers make decisions concerning accounting estimates that affect the reported results for the annual fiscal period (e.g., determine allowance for doubtful accounts receivable). If the adjusting entries at year-end are predominantly income-increasing, then it is important that these adjustments faithfully represent the underlying economic substance of events affecting the firm. Otherwise, the managerial intent for the adjustments comes into question. For example, accounting managers can make income-increasing accruals sufficient enough to earn income-based bonuses that are stipulated in their employment contracts. Oyer (1998) finds a non-linear relationship between employees' compensation and accounting earnings. That is, employees earn their bonuses once a certain threshold of accounting earnings has been attained, usually occurring during the fourth quarter. Thus, a strong incentive exists for managers to record income-increasing accruals or utilize other income-increasing earnings management techniques in order to obtain higher compensation.

Since financial statement users cannot observe a firm's internal accounting-related decisions, other techniques must be employed to reduce the risk of relying on unreliable

accounting figures that are used in computing financial ratios. First, financial statement users should have a general understanding of how economic and other factors affect a firm's financial results. For example, a home builder's financial results is more likely affected by increasing interest rates than firms in other industries or a firm operating in a highly regulated industry is more likely affected by changes in governmental regulation. Information about these effects can be found in the management discussion section of the firm's annual report for a public company. Second, the compensation agreements of key personnel need to be scrutinized for potential incentives to manage earnings. This information is also provided in the firm's annual report for public companies. Third, key covenants in contracts entered into by the firm that use accounting measures need to be reviewed with particular attention paid to "thresholds" that have been marginally exceeded. Information concerning accounting thresholds used in contracts affecting the financial statements should be disclosed in the firm's financial statement notes. For example, a bank loan covenant may stipulate the firm must maintain a current ratio of 2:1. If the year-end current ratio is 2.05:1 and the firm has reduced its allowance for doubtful accounts receivable, then the risk of earnings management increases.

Overall, the financial statement user needs to take a proactive approach when relying on financial amounts employed in financial ratio analysis.

Accounting Researchers' Perspective

From a researcher's viewpoint, a major limitation in working with financial ratios is the effect of outliers on the statistical results. An outlier represents an observation that is inconsistent with the remainder of the data set (Barnett & Lewis, 1994, p.7). The inclusion of a few outliers could result in the sample's mean and variance and regression's variable coefficients being significantly different from the results that are truly representative of the data set.

In dealing with outliers, Foster (1986) provides five alternatives:

1. Deleting the outlier because it is unrepresentative of the data set;
2. Retaining the outlier because it represents an extreme example of an underlying characteristic of the data set;
3. Making adjustments to the data for the underlying economic and accounting factors that are believed to cause the extreme observation(s); e.g., impute interest payments for "off balance sheet financing" debt;
4. "Winsorizing" the data set's extreme observations; and
5. "Trimming" the data set by deleting a certain percentage or a certain number of the top and bottom observations.

In addition, data can be transformed to alleviate the harmful effects of outliers. When applying these alternatives in a particular research study, a considerable amount of judgment is required in order to not create results that are unrepresentative of the underlying economic phenomena. Given the effect of a single outlier on the sample's mean and variance, the methodology in handling outliers becomes extremely important.

A first step is to understand the nature of outliers. The nature of an outlier can be classified as either "random" or "deterministic" (Barnett & Lewis, 1994, p. 42). The source of a deterministic outlier is either measurement error or in execution, and the proper response is to correct it or reject it (Barnett & Lewis, 1994, p. 42).

For a random outlier, the response is more complex because its underlying nature is not readily apparent. One response is to accommodate the outlier in the existing research model or to revise the model to incorporate the effects of outliers (Barnett & Lewis, 1994). A logarithmic

data transformation is an example of a model revision. Other responses are to winsorize or trim the data set or to outright reject the outlier.

Winsorizing the data involves assigning the outlier a lesser weight. Ghosh and Vogt (2012, p. 3456) state:

> *A common procedure has been to replace any data value above the ninety-fifth percentile of the sample data by the ninety-fifth percentile and any value below the fifth percentile by the fifth percentile. The assumption seems to be that the outlier does not look right and estimates will be improved if the outlier is made to look like other data.*

Further, Ghosh and Vogt (2012, p. 3456) state the implication of this line of reasoning as "the outlier value must be incorrect" and "the value is replaced by a more plausible value." The fault with this logic occurs when the outlier does truly represent an important characteristic of the sample data and thus, should not be altered.

Another winsorizing procedure is the "skipped Huber method." Under this method, a distance from the median is used as a basis to rein in outliers. Specifically, values that are greater than 5.2 median absolute deviations from the median are adjusted to this threshold value (Connor & Herbert, 1999; Martin & Simin, 2003).

Trimming the data set involves deleting a certain percentage or a certain number of the top and bottom observations. For example, Ettredge et al. (2005) deleted the top 1% and bottom 1% of the observations in their study. Generally, this approach is based on rules of thumb that are particular to the research discipline. Deleting a specifically identifiable outlier implies it does not fit with the pattern of the data set. Thus, its presence in the sample increases the likelihood of non-representative results.

When applying these procedures, it is important that the researcher exercises due care because the procedures in dealing with outliers are not an exact science. Further, the researcher should use a comprehensive approach in dealing with the effects of outliers. A comprehensive approach entails examining the research study's results in raw data form, with the deletion of specifically identifiable outliers, and with the use of data trimming, winsorizing, or transformation. The primary goal of this analysis is to generate a research model and results that provide the researcher with the best linear unbiased estimators.

The researcher must identify the outliers as a first step in order to employ the comprehensive approach. One method of identifying outliers is to generate a series of plots involving the independent and dependent variables, predicted values, and residuals. The residuals are the differences between the observed values and predicted values for the dependent variable. Important plots to study are: dependent versus independent variables; residuals versus independent variables; and residuals versus predicted values.

Plotting the dependent variable versus the independent variables is useful in identifying gaps between a particular observation (i.e., potential outlier) and the primary cluster of observations. Although useful, this analysis does not provide insights into how the observation in isolation or jointly with other potential outliers influences the research model's results (Belsley et al. 1980). Further, the combined effects of more than one independent variable on the dependent variable cannot be separated with this analysis meaning it is only relevant with a simple regression model.

A starting point for checking violations of the model's assumptions, including homoscedasticity, linearity, and existence of outliers, is to plot residuals versus independent variables or residuals versus predicted values (Chatterjee & Price, 1991, p. 24). Plotting residuals

versus the independent variables is of value only with a simple regression model because of the inability to separate the combined effects of the independent variables. The largest residuals, both positive and negative, should be considered as outliers in this analysis. However, in empirical accounting research, simple regression models are rare because most studies involve multiple independent variables.

When examining residuals a form of standardization is recommended to provide greater comparability of residuals. The studentized residuals are the most common form of standardized residuals (Hair Jr. et al., 1998, p. 172). Examining studentized residuals versus predicted values is the preferable plotting technique to identify outliers in a multiple regression study. The "ideal" plot for the researcher is a "null plot." As Hair Jr. et al. (1998, p. 173) state:

> *The null plot shows the residuals falling randomly, with relatively equal dispersion about zero and no strong tendency to be either greater or less than zero.*

A "pattern" in the plot indicates the violation of the constant variance of the error terms assumption (homoscedasticity). The violation of this assumption is called heteroscedasticity and results in a lack of statistically valid hypothesis testing. Two common patterns of heteroscedasticity are diamond-shaped or triangle-shaped patterns (Hair Jr. et al., 1998, p.175). A diamond-shaped pattern indicates more variation exists in the mid-range of the sample than at the tails. A triangle-shaped pattern indicates the residuals increase or decrease with increases in the predicted values. In both cases, the constant variance assumption is violated and the researcher should question the validity of hypothesis tests.

As is the case with most accounting research studies, sample sizes can be quite large with the number of observations in the thousands. Thus, visually identifying outliers can be difficult through an analysis of plots. Three statistical tests provided by most statistical packages are the Levene's Test, Mahalanobis Distance, and Cook's Distance.

The Levene's Test is a test for homoscedasticity for groups of data. The null hypothesis for this test is that the variances are equal across the groups. Field (2005, p. 98) explains:

> *Therefore, if Levene's test is significant at $\rho \leq .05$ then we can conclude that the null hypothesis is incorrect and that the variances are significantly different — therefore, the assumption of homogeneity of variances has been violated. If, however, Levene's test is non-significant (i.e. $\rho > .05$) then we must accept the null hypothesis that the difference between the variances is zero — the variances are roughly equal and the assumption is tenable.*

A breakdown of the homoscedasticity assumption (i.e., heteroscedasticity) could be caused by the effects of outliers. Thus, a significant Levene's Test indicates the existence of heteroscedasticity and increases the likelihood of finding outliers in the sample.

In some cases, the effect of a single outlier can strongly influence the results of the researcher's multiple regression model. This observation is called an influential observation and it is important that the researcher identifies it. The Mahalanobis Distance statistic can be used to detect the outliers that are considered influential observations. The Mahalanobis Distances "measure the distance of cases from the mean(s) of the predictor variable(s)," (Field, 2005, p. 165). Also, Mahalanobis Distances possess the statistical properties for statistical testing. Hair Jr. et al. (1998, p. 66) recommend a conservative .001 significance level as a threshold to identify these influential cases.

The Cook's Distance is a statistic that measures the effect of a single observation on the research model. Specifically, it measures the influence of a single observation "based on the total

changes in all other residuals when the case is deleted from the estimation process," (Hair et al. 1998, p. 218). Hair Jr. et al. (1998, p. 225) prescribe a rule of thumb of greater than 4 / (n – k – 1), (where "k" is the number of independent variables and "n" is the sample size), as a threshold to identify influential observations for small or large sample sizes. Other researchers use as a rule of thumb a Cook's Distance of ≥ 1.0 as an indicator of an influential observation (Field, 2005, p. 165).

After identifying the outliers by the procedures indicated above, the researcher can apply the following techniques in dealing with the outliers' effects on financial ratio data:

1. If the financial ratios used as independent variables in the research model exhibit skewness, then the researcher should consider a data transformation. Foster (1986, p. 103) and Frecka and Hopwood (1983, p. 122) find logarithmic transformations reduce skewness for certain financial ratios. However, Frecka and Hopwood (1983, p. 117) find the maintenance of OLS normality assumptions are best achieved by deleting the outliers.
2. A comparison of the statistical results using the raw data, transformed data, raw data with specific outliers deleted, and trimmed data or winsorized data needs to be conducted. The researcher needs to carefully analyze the results to find the best fitting research model.

Lien and Balakrishnan (2005) conduct a simulation exercise of a simple regression model and provide results for the raw data, trimmed data, and winsorized data. On the one hand, they find that the trimmed data results show little change in the value of the independent variable's co-efficient from that of the raw data's results, but there is a substantial reduction in the explanatory power of the model (i.e., lower R^2). On the other hand, the winsorized data results show a higher value for the independent variable's co-efficient, when compared to the raw data's and trimmed data's results. However, the explanatory power of the winsorized data model is maintained (i.e., higher R^2 than trimmed data model). Overall, these results indicate that the researcher needs to exercise judgment and make trade-offs when deciding on how to deal with the effect of outliers in financial ratio data.

CONCLUSION

Financial statement users and accounting researchers need to understand the problems and limitations in working with financial ratios. The purpose of this study is to recognize these issues and to provide both financial statement users and accounting researchers with useful hints when working with financial ratios.

From the financial statement users' perspective, financial ratios provide important information about a firm's past performance, predicting a firm's future performance prospects, assessing management's decision-making, risk assessment, and are a critical tool employed in lending agreements to control a firm's activities. All of these uses are dependent on the comparability of a firm's financial ratios with itself and between firms over time. Comparability is enhanced when financial statement users take a proactive approach in their work with financial ratios. A proactive approach involves scrutinizing firms' financial statement notes for the consistent application of accounting principles and estimates. Changes to either accounting principles or accounting estimates should be properly disclosed and be supported by the underlying economic substance of events affecting the firm. Special attention should be directed at the relation between income increasing accruals and managers' performance contracts based on earnings.

From the accounting researchers' perspective, a major limitation in working with financial ratios is the effect of outliers on the statistical results. The inclusion of a few outliers could result in the sample's mean and variance and regression's variable co-efficients being significantly different from the results that are truly representative of the data set. Specifically, the effect of outliers is to invalidate the constant variance assumption (homoscedasticity) of OLS regression. This condition is known as heteroscedasticity. The importance of maintaining the validity of OLS assumptions is that these assumptions are necessary to draw inferences about the population under investigation that are statistically valid with hypothesis testing.

The accounting researcher needs to develop a methodology to first identify the outliers. Plotting studentized residuals versus predicted values is a first step to identify outliers in a multiple regression study. Hair Jr. et al (1998) provide guidance in this area. For large sample sizes, statistical techniques such as Levene's Test, Mahalanobis Distance, and Cook's Distance are available with most statistical packages. Field (2005) and Hair Jr. et al. (1998) provide guidance on the use of these techniques.

Next, after identifying the outliers, a comprehensive approach is required in dealing with the effect of outliers. A comprehensive approach entails examining the research study's results in raw data form, with the deletion of specifically identifiable outliers, and with the use of data trimming, winsorizing, or transformation. The primary goal of this analysis is to generate a research model and results that provide the researcher with the best unbiased estimators. Overall, the accounting researcher needs to exercise considerable professional judgment and due care throughout this process.

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Appendix 1

BENEFITS OF USING FINANCIAL RATIOS

1. Ratios can provide a greater awareness of the interrelationship of individual financial statements and a greater understanding of the financial statements themselves by summarizing data in a form that is more easily understood, interpreted and compared.

2. Ratios can facilitate comparisons with external measurements, such as industry-wide norms, and help identify an entity's strengths and weaknesses.

3. Ratios can facilitate comparisons over time, such as changes in long-term trends of financial position, operations and cash flows.

4. Ratios can provide an informed basis for making investment-related decisions by comparing an entity's financial performance in relation to another entity in the same industry and the industry as a whole.

5. Because they are determined by dividing one financial variable by another, ratios downplay the impact of size and allow evaluation over time or across companies without undue concern for the effect of size differences.

6. Ratios can identify the stability of relationships within an entity over time and common relationships among entities within a given industry.

7. Ratios can be used to support the viability of extending credit. For example, a small closely-held entity may ask a supplier for trade credit or approach a bank for a loan. In such cases, credit managers and bank loan officers may be able to use ratio analysis on the financial statements to gain insights into the past, present, and future prospects of the individual applicants. These insights may help potential creditors predict the future cash flows of prospective borrowers and make credit decisions on a more rational basis.

8. Ratios can serve as benchmarks against which the financial strength of an entity is measured; for example, debt covenants often specify limits in terms of financial ratios.

9. Ratios can be used as an initial indicator to determine if there are specific problems that need to be investigated further, such as aging of accounts receivable and inventory turnover.

10. Ratios can assist auditors and other users in evaluating the reasonableness of the amounts shown in the financial statements. Analytical review procedures can help the auditor in gaining an understanding of the client's business, plan the engagement, identify unexpected relationships among accounting data and provide substantive audit evidence.

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