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of Financial Ratios in Empirical Analysis

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## ABSTRACT

Despite the theoretical underpinnings for the use of equity and earnings in economic analysis, certain financial ratios are not suited for econometric models. In particular, when reported shareholder's equity and/or earnings are less than zero, an inverse relationship can exist between financial ratios and actual firm performance. Although certain earnings ratios can be corrected when this happens, corrections to other ratios, in particular those involving negative book values for equity would result in severe sample bias, erroneous results, and misleading conclusions.

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Lemmings to the Sea:  
The Inappropriate Use of Financial Ratios in Empirical Analysis

Financial ratios are commonly used to measure firm performance. Public corporations include them in their annual reports to shareholders. Investment analysts provide them for investors who are considering the purchase of a firm's securities. Newspapers report them everyday. Many researchers incorporate these measurements into models of firm performance. In some cases, researchers find it necessary to use certain ratios for no reason other than that it will make their empirical results comparable to earlier studies that used the same financial ratios. The erroneous use of results based on meaningless financial ratios is perpetuated by the need to make comparisons across previous studies on the same subject in order to compare the underlying theoretical issues being tested. This blind following of precedent has led to a situation where important theories of firm performance may be accepted or rejected based on misleading financial ratios.

While many of the most common financial ratios are well suited to statistical modeling, others can lead to disastrous mathematical results. In this short paper, I discuss the implications for econometric modeling and inference that result from the misuse of equity and earnings as measures of firm performance.

Econometric studies of firm performance have generally relied on one of two popular performance measures. One is Return on Assets (ROA), defined as the ratio of earnings to assets. The other is Return on Equity (ROE), defined as the ratio of earnings to equity. Equity itself is defined as the difference between assets and liabilities. Equity

represents the owners' claims against or interests in the assets of the firm. In the case of public corporations, this is equivalent to stockholders' equity. ROE is the more popular measure, primarily because it takes into account a firm's liabilities and pays homage to the dispersed ownership represented by shareholders. In addition, studies using ROE have been more successful in finding statistically significant results. I will argue, however, that negative values for the book value of equity and reported earnings though potentially meaningful for ranking *relative* firm performance, will provide contrary evidence when used for *absolute* rankings.

The reasons can be made obvious in a few sentences. Firms that report very low book values for equity are likely to be over-leveraged, though they can have a high ROE ratio which may not be excluded by any systematic search for outliers. The book value of equity can also be negative when liabilities exceed assets, resulting in a ratio that has no meaning in financial analysis. Eliminating firms with negative equity means eliminating (potentially) the worst performing firms (those whose liabilities exceed their assets), a serious source of sample bias in studies examining firm performance. Finally, when both earnings and equity are negative, these firms will display a "false-positive" ROE, resulting in the most egregious of the errors generated by the inappropriate use of a financial ratio in empirical analysis.

### ***1. Rising ROE with Falling Income***

Return on equity (ROE) provides the clearest example of the potentially disastrous results that are generated by using financial ratios inappropriately in empirical testing. Shareholder's equity is what accountants call a "plugged number", a figure that is calculated rather than measured. Quite simply, equity is the difference between assets

and liabilities. When liabilities exceed assets, the book value of equity is negative. The firm with negative equity is technically bankrupt: they owe more than they own, at least from an accounting perspective. An econometric model using equity as the scaling factor for profitability would necessarily input a negative number for ROE.

Negative return on equity is meaningless as a measure of firm performance. Financial statements and analysts' reports usually note the ratio resulting from negative equity as "not meaningful" and do not report a figure. Unfortunately, available databases (e.g., Compustat's Research Insight) will output a negative number for return on equity when the ratio is requested. In an econometric model, although the figure is not truly meaningful, at least it would rank the technically bankrupt firm as having worse performance than any firm with positive equity. Therefore, although a negative return on equity is meaningless as an *absolute* measure of firm performance, one might consider that it could at least be used as a measure of *relative* firm performance. Unfortunately, this is not actually the case.

A brief example should clarify the point. Note that equity generally falls toward zero before going negative. As equity falls, ROE rises. Looking at the data in I, it appears that the Coca-Cola Bottling Companies took on some additional liabilities during 1992. ROE, however, *increased* from 1.4% to a healthy-looking 8.1%. But ROE is deceiving in this case. Net income actually *decreased* by about 30%. Because assets remained about the same, there was a decrease in return on assets (ROA). This problem is exacerbated through the point where reported equity equals zero. Note that although it is unlikely that a firm would report literal zero for equity, the figure may be small enough that data services like Compustat would register \$0 millions before the number is small

enough that it triggers the “T” (insignificant) footnote. (Although I found no examples of zero equity in the sample discussed later, I did recover 1 observation of literal zero from Compustat for Net Income and 4 for Earnings per Share.)

This is not just an example of “earnings management”. This is a serious issue which should call into question the use of ROE to measure firm performance in empirical studies. Indeed, as we take the next logical step in the examination of ROE, you will see that the worst kind of error occurs when the firm with negative equity also has negative net income.

## ***II. Disasters with Negative Equity AND Negative Earnings***

The following example will make this clear. Comcast Corporation reported negative net income every year from 1990 through 1995 (see Table II). In addition, the book value of equity was positive in only one of those six years: 1991. Now, in this example, most simple methods for eliminating outliers would have dropped Comcast in the years 1990-1992 when ROE was +/- 100%. However, despite their dreadful performance in 1993-1995, any econometric model would have identified Comcast as having a healthy, positive return on equity when in reality Comcast 1) was technically bankrupt and 2) had costs that exceeded revenue. The same is true of Continental Airlines in 1991-1992, Eli Lilly in 1992, Dynacore Holdings in 1998-1999, Freeport McMoran in 1993, Interlake Corporation in 1990-1994, etc., etc. In fact, using data from 1990 through 1999 on a sample of firms that were ranked by Fortune magazine among the top 500 for sales, 14.4% of the non-missing observations were for negative net income and 3.8% were for negative equity. The results for return on equity are

disastrous: 2.6% of the non-missing positive ROE observations were calculated over *negative income and negative equity*.

### **III. Deceptions in Significance**

In another example of how ROE is a deceptive measure of firm performance, consider that Coca-Cola Bottling Companies had ROA of around 2% in the years from 1993 to 1997. Compared to other firms who had similar ROA performance in those years, Coca-Cola Bottling had an exceptionally high ROE: 74% versus 13% on average for firms with similar ROA performance. Specifically, Compare Coca-Cola Bottling's performance to that of Cabot Corporation (Table IV) who maintained increasing equity and kept ROA above 2%. The ratio ROE rises as the firm takes on more debt, that is, as equity approaches zero in the denominator of the ratio. ROE has the potential to produce rates of return just large enough avoid elimination as outliers during a time when the firm's performance is worsening. This could in fact be the reason that ROE produces statistically significant results when ROA does not.

### **IV. Sample Bias**

If eliminating outliers is insufficient to prevent this misuse of return on equity as a measure of firm performance, what adjustments are possible? In other contexts, researchers have dropped firms (or observations) on negative equity values. However, if we eliminate all the firms that report negative equity, we are eliminating the worst performers from our sample. This is sample bias at its worst: using a measure of firm performance to eliminate observations from a study of firm performance. As an alternative, eliminating all firms/observations with negative income is just as bad.

The next logical question is: does it matter? As Table V and Table VI show, the answer is a resounding “yes”. The calculated mean ROE figures are statistically significantly different ( $p < 0.001$ ) in all cases except where only the false positives are excluded. Yet even in that case, the p-value for the t-test is 0.11.

There is no mathematical, statistical or econometric adjustment that makes return on equity a useable measure of firm performance. It simply should not be used in large sample econometric models.

### ***V. Other Problems with Negative Equity***

Similar problems occur with other equity ratios, though none are as damaging as those involving income. For example, the ratio of debt-to-equity will be affected by values of negative equity. Here, again, the question is whether or not the resulting ratio is a *reasonable* measure of firm performance. Putting aside the question of absolute value, a poor performing firm, i.e., one with negative stockholders’ equity, would rank lower than any with positive equity. However, here the relative performance ranks are inverse. In most situations, we consider whether a firm is over- or under-leveraged. Let’s say that 2 firms have the same quantity of long-term debt, \$10 million. Further, the two firms are of comparable size, \$100 million in assets. These firms should rank similarly for leverage. But suppose there is some discrepancy in short-term debt or other liabilities. If one has positive equity of \$10 and the other has negative equity of \$10, the “better” firm (i.e., the one with positive equity) would have a leverage ratio of 1 while the “worse” firm (i.e., the one with negative equity, which is surely over-leveraged) would have a relatively lower leverage ratio of *negative* 1. Again, some of the leverage ratios resulting from negative equity would be eliminated as outliers, for example, where liabilities

exceed assets by some small amount (resulting in an absurdly high absolute value for leverage). A similar inversion of rankings occurs when using the price-earnings ratio over negative income. The danger, as before, is when the difference results in an “econometrically reasonable” figure that is “absolutely unreasonable”.

## ***VI. Recent Usage of Equity***

Nine articles printed in the *Journal of Finance* in 2000 use the book value of equity in measures of firm performance (Chaplinsky and Ramchand; D’Mello and Shroff; Data, Iskandar-Datta, and Patel; Davis, Fama and French; Detragiache, Garella, and Guiso; Haushalter; Kang, Shivdasani, and Yamada, La Porta; Lopez-de-Silanes, Shleifer and Vishny; and Schwert). In this section, I cite several of these papers as examples of research that potentially suffered from the use of “tried and true” financial ratios like return on equity and the price-earnings ratio. This does not in any way imply that only research published in the *Journal of Finance* suffered from this problem. It is more likely that the editorial subject matter more often requires the use of measures for firm performance than articles published in other journals. For example, there were only a few articles published in 2000 in any of the *American Economic Review*, the *Journal of Financial Economics*, the *Journal of Economic Literature* or the *Quarterly Journal of Economics* that measured firm performance. Those that did used profit/revenue or similar measures. Neither return on equity nor the price-earnings ratio was used.

The majority of the *Journal of Finance* papers attempted to make some adjustment to account for the unusual values generated by the use of equity ratios. Schwert eliminates “extreme outliers” with ROE ratios greater than 100. D’Mello and Shroff “excluded ... 10 firms with negative book values [for equity] ...” Davis, Fama

and French “do not use negative BE [book value of equity] firms when calculating the breakpoints for BE/ME [ratio of BE to market value of equity] or when forming the size-BE/ME portfolios.”

However, as demonstrated in this paper, such adjustments are insufficient to correct for the problems that occur with using equity for performance measures in empirical studies. Another example of problems, for example, can be found in Haushalter where firm value is calculated as

$$\text{market value of assets} = (\text{Number of common shares outstanding} * \text{End of year price per share}) + (\text{Book value of total assets} - \text{Book value of equity}).$$

In this case, negative book values for equity would actually have *increased* the value of the firms in this study of oil and gas producers. Finally, Davis, Fama and French report that high BE firms have higher average returns. Because the capital asset pricing model does not explain this pattern, they say “it is typically called an anomaly.” What needs to be revisited is whether or not this “anomaly” is the result of the unusual ranking of firm performance that results when equity is used in financial ratios.

## **VII. Conclusion**

This short paper used net profit return on equity to demonstrate how certain financial ratios can give statistical results that run contrary to logic. In general, I make the point that the book value of equity and reported earnings should be used cautiously if at all in large sample statistical studies because negative values, while potentially meaningful to rank *relative* firm performance, can provide contrary evidence when used for *absolute* rankings.

Adaptations have been made for some financial ratios. For example, the price-earnings ratio can be inverted so that negative values for earnings tend to retain the

relative ranking of firm performance. Scaling factors other than equity can be used to measure leverage with reported values of debt. In the Journal of Finance during 2000, Detraigiache, Garella and Guiso used the ratio of debt to sales; Data, Iskandar-Datta and Patel used debt to assets, as did Haushalter. These papers point the way toward more fruitful and less misleading studies of firm performance. Unfortunately, they are the exception instead of the norm. I suggest it is time to do away with using the book value of equity in econometric studies of firm behavior.

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**Table I Coca-Cola Bottling Companies: Return on equity rises as income falls**

<i>Date</i>	<i>Income</i>	<i>Assets</i>	<i>Liabilities</i>	<i>Equity</i>	<i>ROE</i>	<i>ROA</i>
Dec-90	0.229	467.972	299.877	168.095	1.4%	0.0%
Dec-91	2.936	785.196	572.49	212.706	1.4%	0.4%
Dec-92	2.083	785.871	760.065	25.806	8.1%	0.3%

**Table II Comcast Corporation, Return on Equity is positive when income is negative**

<i>Date</i>	<i>Income</i>	<i>Equity</i>	<i>ROE</i>	<i>ROA</i>
Dec-90	-178.406	-21.689	822.6%	-7.3%
Dec-91	-155.572	19.48	-798.6%	-5.6%
Dec-92	-217.935	-181.641	120.0%	-5.1%
Dec-93	-98.871	-870.531	11.3%	-2.0%
Dec-94	-75.325	-726.789	10.4%	-1.1%
Dec-95	-37.849	-775.526	4.6%	-0.4%

**Table III Coca-Cola Bottling Companies, Falling income from rising assets**

<i>Date</i>	<i>Income</i>	<i>Assets</i>	<i>Liabilities</i>	<i>Equity</i>	<i>ROE</i>	<i>ROA</i>	<i>Change income</i>	<i>Change assets</i>
Dec-93	14.83	648.45	618.82	29.63	50.1%	2.3%	612.1%	-17.5%
Dec-94	14.15	664.16	630.18	33.98	41.6%	2.1%	-4.6%	2.4%
Dec-95	15.54	676.57	637.60	38.97	39.9%	2.3%	9.8%	1.9%
Dec-96	16.16	702.40	680.13	22.27	72.6%	2.3%	4.0%	3.8%
Dec-97	15.27	778.03	768.76	9.27	164.6%	2.0%	-5.6%	10.8%
Dec-98	14.88	825.23	809.44	15.79	94.2%	1.8%	-2.5%	6.1%
Dec-99	3.24	1110.92	1078.48	32.44	10.0%	0.3%	-78.2%	34.6%

**Table IV Cabot Corporation, Under-performs Coca-Cola Bottling while increasing equity and income**

<i>Date</i>	<i>Income</i>	<i>Assets</i>	<i>Liabilities</i>	<i>Equity</i>	<i>ROE</i>	<i>ROA</i>	<i>Change income</i>	<i>Change assets</i>
Dec-93	37.41	1489.47	1047.20	442.27	9%	3%	-40%	-4%
Dec-94	78.69	1616.76	1054.27	562.49	14%	5%	110%	9%
Dec-95	171.93	1654.33	969.33	685.00	25%	10%	118%	2%
Dec-96	194.06	1857.58	1112.65	744.93	26%	10%	13%	12%
Dec-97	92.75	1823.59	1095.80	727.79	13%	5%	-52%	-2%
Dec-98	121.60	1805.20	1099.70	705.50	18%	7%	31%	-1%
Dec-99	97.00	1842.00	1136.00	706.00	14%	5%	-20%	2%

### Table V Descriptive statistics for Return on Equity

Unadjusted ROE uses all observations. No Negative Equity removes all observations where negative equity is reported. No False Positives removes all observations where both income and equity are negative. Both Corrections removes all observations where negative equity is reported and where both income and equity are negative.

	<i>Unadjusted</i>	<i>No Negative Equity</i>	<i>No False Positives</i>	<i>Both Corrections</i>
Min	-7608.85	0.002	-7608.85	0.002
Median	13.024	14.678	12.867	14.5145
Mean	10.29383	22.85522	6.431102	18.64661
Max	3334.42	3334.42	936.842	936.842
N	4335	3703	4240	3608

**Table VI T-Tests for equality of means with unadjusted value of ROE**

Unadjusted ROE uses all observations. No Negative Equity removes all observations where negative equity is reported. No False Positives removes all observations where both income and equity are negative. Both Corrections removes all observations where negative equity is reported and where both income and equity are negative.

	<i>Unadjusted</i>	<i>No Negative Equity</i>	<i>No False Positives</i>	<i>Both Corrections</i>
Mean	10.29	22.86	6.43	18.65
Observations	4335	3703	4240	3608
Degrees of freedom		8036	8573	7941
t Statistic		-4.56	-1.22	-3.24
P(T <=t)		0.000002	0.11	0.0006