Do Firms Manage Research and Development Expenses? An Investigation of the Rounding Phenomenon in the Reported R&D Expenses

Daoping He
San Jose State University

Yao Tian
San Jose State University

Prior studies document that firms round up reported earnings and revenues to achieve key reference points. This study examines the rounding phenomenon in the reported research and development (R&D) expenses. Unlike with revenues and earnings, rounding up R&D expenditures will not increase firms' earnings; however, we still find that firms do round up R&D expenditures even when doing so reduces earnings. These findings suggest that firms view R&D expenditure as an investment rather than an expense, and they believe the benefit of rounding up R&D (i.e., sending positive signals to investors about the firms' future prospects) outweigh the costs of doing so (i.e., reducing current period earnings).

INTRODUCTION

Prior studies document that firm managers tend to round their reported earnings upwards to achieve key reference points represented by $N \times 10^k$ (Carlsaw, 1988, and Thomas, 1989). Empirically, this phenomenon is evidenced by an excess of zeros and a lack of the number nines in the second-from-left-most digit of the reported earnings. He, Goo, and Guan (2012) documents that the rounding phenomenon also exists in reported revenues. There are two competing explanations for the rounding phenomenon. The valuation perspective argues that since human beings have only limited amount of memory, they tend to store only the most relevant bits of information about a number (Brenner and Brenner, 1982). Thus, investors perceive reported earnings of $500,000 to be much higher than that of $499,000. As a result, managers have incentives to round up reported earnings and revenues when it is relatively easy to do so (i.e., earnings and revenues are just below the reference points). The contracting perspective, on the other hand, argues that because of uncertainties related to managers' productive efforts, lending and bonus contracts tend to be based on ex-ante estimates and are rounded to rough figures that emphasize the first digit in the contractual number (Carslaw, 1988). These studies are unable to distinguish between these two perspectives, because earnings and revenues are used for both valuation and contracting purposes.

This study examines whether managers round up the reported research and development (R&D) expenditures. Such an examination is important for three reasons. First, the current literature on the rounding phenomenon is restricted to earnings and revenues. Our study extends the literature to other important financial statement items. Second, R&D is a very special item in financial reporting. Although it is reported as an expense for financial reporting purpose after the passage of the Statement of Financial Accounting Standards (SFAS) No. 2 in1971, it is perceived by many investors and financial analysts as

an investment. Examining the rounding phenomenon for R&D expense provides further insights into managers' perspectives regarding R&D expenditures. Third, since R&D is used only for valuation purpose and not for contracting purpose, examining the rounding phenomenon in R&D expense helps to distinguish between these two alternative explanations for the rounding phenomenon.

Our sample includes publically listed U.S. firms for the period from 1950 to 2012. Over the whole sample period, we find that there are significantly more zeros and fewer nines in the second digit of reported R&D expenses, suggesting that managers tend to round up reported R&D expense. To further investigate firms' motives to round up R&D, we divide the sample into two sub-samples, before and after the enforcement of SFAS No. 2 in 1974. We find that firms round up the reported R&D expenditures in both sub-periods, but the degree of rounding manipulation is less severe in the period after 1974 than in the period before 1974. These findings suggest that firm managers view R&D expenditures as an indicator of firms' future performance and they would round up this number to send positive signals to investors about the firms' future prospects. Doing so is less costly prior to 1974, since firms can choose to capitalize R&D expenditure. But after the enforcement of SFAS No. 2, when all R&D expenditures must be expensed, rounding up R&D expenses will actually decrease current period net income. The fact that we still observe the rounding phenomenon after 1974 suggests that managers believe that the benefit associated with rounding up R&D expenses (i.e., sending positive signals to investors about the firms' future prospect) outweigh the cost of doing so (i.e., reporting higher expenses and lower net income).

We then further examine whether the rounding phenomenon exists for both profit and loss firms. For each of the two sub-periods (1950-1974 and 1975-2012), we divide the sample into two groups – profit firms and loss firms - and examine them separately. We find that in the period prior to 1974, both profit and loss firms round up their R&D expenses, but the extent of rounding is more severe for loss firms than for profit firms. This suggests that loss firms have more incentive to take advantage of the option to capitalize R&D expenses to reduce current expenses and avoid reporting a huge loss. In the period after 1974, we find that both profit and loss firms round up their R&D expenses, but the extent of rounding is much smaller than in the period prior to 1974. Comparing profit and loss firms, we find that, contrary to what we observed in the period prior to 1974, loss firms are less likely to round up R&D expenses than profit firm in the period after 1974. This reflects the fact that after 1974, firms can no longer capitalize R&D expenses; thus, rounding up R&D expenses will increase current expenses and reduce earnings. This becomes more costly for loss firms, because doing so will signify their poor earnings performance.

The rest of the paper is organized as follows. Section 2 reviews the literature and develops the hypotheses. Section 3 describes our sample and research methodology. Section 4 presents our findings and section 5 concludes.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Prior studies have examined the rounding phenomenon in reported earnings and revenues in the U.S. and the international contexts. In particular, Carslaw (1988) is the first study to examine the rounding phenomenon. Using New Zealand firms as the sample, this study finds that there are many more zeros and fewer nines in the second digit of the reported earnings, providing evidence that firms round up earnings to achieve key reference points. Thomas (1989) examines the rounding phenomenon in reported earnings for the U.S. firms and finds similar patterns. Guan et al. (2008) analyze the pattern of reported earnings across U.S. industries and find that high-tech firms tend to have the highest occurrences of rounding in their reported earnings. Das and Zhang (2003) extend Thomas (1989) and document that managers exercise discretions to round up earnings by manipulating working capital accruals to meet behavioral thresholds, such as reporting positive earnings, sustaining recent levels of performance and meeting analysts' earnings forecasts. A recent study, He et al. (2012) find that rounding manipulation is also prevalent in reported revenues, and there is an asymmetry in the rounding phenomenon for profit and loss firms. In particular, for profit firms, rounding manipulation is more severe in reported earnings than in reported revenues; for loss firms, rounding manipulation is more severe in reported revenues than in reported earnings. Several studies focus on the rounding phenomenon in reported earnings from the

international perspective. Skousen et al (2004) find that Japanese managers manipulate their earnings by rounding up earnings numbers to achieve key reference points. Kinnunen and Koskela (2003) examine the rounding phenomenon for a sample of 22,000 firms in 18 countries and find that the rounding phenomenon and firms' tendency to exercise cosmetic earnings management is worldwide. However, to the best of our knowledge, studies on the rounding phenomenon are limited to examining only earnings and revenues.

This study extends the rounding phenomenon literature to another important financial statement item—R&D expenditures. R&D expenditure is viewed by many as the most controversial item in financial reporting. Prior to 1974, firms can elect to report it as either an expense on the income statement, or to capitalize it - report it as an asset on the balance sheet. Statement of Financial Accounting Standards (SFAS) No. 2, which became effective in 1974, eliminates firms' options to capitalize R&D and requires firms to expense all R&D costs when incurred. Although R&D is treated as an expense for financial reporting purposes, many researchers, practitioners, and financial analysts argue that it is actually a value-enhancing item, indicative of the firms' future prospects. In particular, Lev and Sougiannis (1996) and Chan et al. (2001) document that the level of R&D investment is positively associated with the firm's subsequent excess stock returns. Penman and Zhang (2002) document that the changes in R&D expenditures are also positively associated with subsequent excess stock returns. Healy et al. (2002) examine the value relevance of capitalized R&D expenditures and suggest that the capital market treats R&D expenditure as an asset. Zhao (2002) finds that in the U.S., R&D expenditures provides additional information about accounting earnings and book values. Thus, we predict that firms have strong incentives to round up R&D expenditures to send positive signals to outsiders about the firms' future prospects. This hypothesis is started formally as follows:

> *H1: When it is easy to do so, firm managers round up the reported R&D expenditures to achieve key reference points.*

After the Statement of Financial Accounting Standard No. 2 came into effect in 1974, rounding up R&D expenses will increase the firm's total expenses and decrease net income in the current period. Thus, we predict that firm managers will have less incentive to round up R&D expense in the period after 1974 than in the period prior to 1974. We state our second hypothesis formally as follows:

> *H2: R&D rounding manipulation is less severe in the period after 1974 than in the period prior to 1974.*

Whether firm managers still round up R&D expenses after 1974 depends on their perceived cost and benefit of doing so. If they believe that the benefit of rounding up R&D expenses (i.e., sending positive signals to the market about the firm's future prospect) outweigh the cost of doing so (i.e., reporting a lower net income in the current period), then we should observe firms still round up their R&D expense in the period after 1974.

SAMPLE AND RESEARCH METHODOLOGY

Our initial sample covers all firms listed on the NYSE, American Stock Exchange, and NASDAQ from 1950 to 2012. We obtain this sample from the Standard & Poor's Research Insight database. Firm-year observations are deleted for missing data on R&D expenditures. The final sample consists of 73,080 firm-year observations. Table 1 reports the sample statistics and descriptive statistics for R&D expenses for the whole sample period (1950-2012), and the statistics for the two sub-periods (1950-1974 and 1975-2012).

TABLE 1
DESCRIPTIVE STATISTICS OF R&D EXPENSES FOR SAMPLE FIRMS
(IN MILLIONS OF DOLLARS)

	Number of Obs.	Mean	Median	Standard Deviation	Min	Max
Sample, prior to 1974	7,072	10.29	1.49	44.35	0.001	1,369
Sample, post 1974	66,008	90.99	3.50	475.51	0.001	12,183
Sample, total	73,080	83.18	6.23	452.75	0.001	12,183

In this study, we apply Benford's law to calculate the expected frequency of occurrence for each number (zero to nine) in the second digit of the reported R&D expense. Benford's law states that the expected distributions of naturally occurring numbers are skewed toward the number zero in the second position of a multi-digit number. Benford (1938) documents that the expected proportions of a number as the first digit in a number series can be approximated using the following equation:

$$proportion\ \ (a\ is\ the\ \ first\ digit) = Log_{10}(a+1) - Log_{10}(a) \tag{1}$$

The expected proportion of the number *b* as the second digit, given number *a* as the first digit, can be calculated as follows:

$$\mathrm{Log}_{10}\left(\mathrm{a}+\frac{\mathrm{b}+1}{10}\right)-\mathrm{Log}_{10}\left(\mathrm{a}+\frac{\mathrm{b}}{10}\right). \tag{2}$$

Thus, the overall expected proportion for *b* as the second digit can be calculated by adding up all possible *a* values for any *b* value as follows:

$$Proportion\ (b\ is\ the\ second\ digit) = \sum\left(\mathrm{Log}_{10}\left(\mathrm{a}+\frac{\mathrm{b}+1}{10}\right)-\mathrm{Log}_{10}\left(\mathrm{a}+\frac{\mathrm{b}}{10}\right)\right). \tag{3}$$

Using these formulas, Benford (1938) developed a table of the expected frequency distribution for each number (0-9) as the second digit of a multi-digit number. Table 2 reports the expected frequency occurrences for each number (0-9) as the second-left-most digit of a multi-digit number. The statistics are taken from Nigrini and Mittermaier (1997). If managers manipulate R&D expenses through rounding, then the observed frequency of occurrence for each number *x* as the second digit of a number will differ from the expected frequency of occurrences.

TABLE 2
EXPECTED FREQUENCY OCCURRENCES FOR EACH DIGIT IN THE SECOND PLACES OF EARNINGS

Digit	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Second Digit Expected Frequency Percentage	11.97	11.39	10.88	10.43	10.03	9.67	9.34	9.04	8.76	8.5

To test the first hypothesis that managers tend to round up their reported R&D expenses to achieve key reference points, we compare the observed frequency of occurrence for each number *x* in the second digit of the reported R&D expense with the expected frequency of occurrence. We use a normally distributed Z-statistic, as shown in equation (4), to examine the statistical significance of the deviation of the observed frequency from the expected frequency:

$$Z = \frac{|p - p_0| - \frac{1}{2n}}{\sqrt{\frac{p_0(1-p_0)}{n}}} \quad (4)$$

In this formula, p and p_0 are the observed and expected frequencies, respectively. n represents the sample size. The second term in the numerator ($\frac{1}{2n}$) is a correction term, and it will be subtracted only when this term is smaller than $|p - p_0|$ (Thomas, 1989). The Z-statistics will reject the null hypothesis at the ten-, five-, and one-percent levels if their values exceed 1.64, 1.96, and 2.57, respectively.

To compare the rounding phenomenon in the periods before and after 1974, we follow Fleiss (1981) to calculate the Z-statistic to examine the statistical significance of the difference between the two periods. The formula used to calculate this difference is:

$$Z = \frac{|p_i - p_j| - \frac{1}{2}(1/n_i + 1/n_j)}{\sqrt{\bar{p}\bar{q}(1/n_i + 1/n_j)}} \quad (5)$$

where $\bar{q} = 1 - \bar{p}$, $\bar{p} = n_i/(n_i+n_j)$. n_i is the total number of observations in the period prior to 1974, n_j is the total number of observations in the period after 1974, p_i is the proportion of occurrence of the number zero in the second digit for the sample prior to 1974, and p_j is the proportion of occurrence of the number zero in the second digit for the sample after 1974.

EMPIRICAL ANALYSIS

Table 3 presents the distributions of each number (0-9) in the second digit of the reported annual R&D expenses for our entire sample. As shown in the table, 13.24 percent of the observations in the sample report zero in the second digit of the reported R&D expenses, which is higher than 11.97 percent, the expected frequency of occurrence as reported in Table 2. This difference of 1.27 percent is statistically significant at the 1% level (*Z* stats = 10.60). The results also show that there are significantly fewer than expected nines, eights, sevens, and sixes in the second digit of the reported R&D expenses. These

TABLE 3
DISTRIBUTIONS OF SECOND DIGITS IN ANNUAL R&D EXPENDITURE OF ALL SAMPLE FIRMS

	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
R&D Expenses	13.24	10.98	10.82	10.31	9.88	9.90	9.09	8.89	8.66	8.23
Deviation	1.27	-0.41	-0.06	-0.12	-0.15	0.23	-0.25	-0.15	-0.10	-0.27
Z statistics	*10.60*	*3.47*	*0.53*	*1.09*	*1.37*	*2.09*	*2.32*	*1.42*	*0.91*	*2.59*

findings support the first hypothesis that managers view their research and development activities as investments and so they tend to round up the reported R&D expenses to send positive signals to investors and the general public about the firm's future prospects.

The enforcement of SFAS No. 2 in 1974, which requires firms to report all R&D as an expense, makes it more costly for managers to round up R&D expenditures. Thus, firms will have less incentive to do so in the period after 1974 than before 1974. To test this hypothesis, we report in Table 4, the observed frequency distribution of each number (0-9) in the second digit of the reported R&D expenditure for the sub-samples before and after 1974. As shown in the table, 16.70 percent of the observations in the pre-1974 sample report zeros in the second digit of the reported R&D expenditure, while 12.87 percent of the observations in the post-1974 sample report zeros in the second digit. Both distributions significantly deviate from the expected frequency of 11.97 percent. The difference in the deviations between the pre- and post-1974 sample is 3.83 percent and this difference is statistically significant at the 1% level (*z* stats = 9.01). These results support the second hypothesis that rounding manipulations is more sever in the period before 1974 than after 1974.

TABLE 4
DISTRIBUTIONS OF SECOND DIGITS IN THE ANNUAL R&D EXPENSES
(1950-1974 vs. 1975-2012)

	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Pre-1974 R&D										
Expenses	16.70	9.88	10.38	9.43	9.91	11.31	8.40	9.02	7.79	7.17
Deviation	4.73	-1.51	-0.50	-1.00	-0.12	1.64	-0.94	-0.02	-0.97	-1.33
Z statistics	*12.23*	*3.97*	*1.33*	*2.73*	*0.31*	*4.65*	*2.70*	*0.03*	*2.86*	*3.99*
Post-1974 R&D										
Expenses	12.87	11.10	10.87	10.40	9.87	9.75	9.16	8.87	8.76	8.35
Deviation	0.90	-0.29	-0.01	-0.03	-0.16	0.08	-0.18	-0.17	0.00	-0.15
Z statistics	*7.14*	*2.35*	*0.11*	*0.24*	*1.34*	*0.67*	*1.55*	*1.47*	*0.01*	*1.41*
Pre vs. post 1974	3.83	-1.21	-0.49	-0.97	0.04	1.56	-0.76	0.15	-0.97	-1.18
Z statistics	*9.01*	*3.08*	*1.23*	*2.53*	*0.08*	*4.17*	*2.10*	*0.39*	*2.72*	*3.40*

Next, we further investigate whether this rounding phenomenon is evident in both profit and loss firms and whether there is any difference in the extent of rounding manipulation between profit and loss firms. For each of the sub-periods (1950-1974 and 1975-2012), we divide the sample into two groups, profit and loss firms. We examine the distribution of each number (0-9) in the second digit of the R&D expenses for profit and loss firms separately. We then compare this observed distribution with the expected distribution (as reported in Table 2). The results for the sub-period 1950-1974 are reported in Table 5 and the results for the sub-period 1975-2012 are reported in Table 6.

As shown in Table 5, in the period prior to 1974, for profit firms, the observed frequency of occurrence of the number zero as the second digit of R&D expense is 16.35 percent, which is 4.38 percent higher than the expected frequency of occurrence of 11.97 percent. This difference is statistically significant at 1% level (z stats = 10.86). For loss firms, 20.00 percent of the firms report zero as the second digit of R&D expenses. This is 8.03 percent higher than the expected occurrence of 11.97, and this difference is statistically significant at 1% level (z stats = 5.66). These results suggest that prior to 1974, when firms can choose to capitalize R&D expenses, both profit and loss firms round up R&D expenses. Comparing profit and loss firms, we see that the extent of the R&D expense rounding is more severe for

loss firms than for profit firms (i.e., 20 percent for loss firms vs. 16.35 percent for profit firms), and this difference of 3.65 percent is statistically significant at 1% level (z stats = 2.12). This suggests that, to avoid reporting huge losses, firms that performed poorly (loss firms) have greater incentives to round up R&D in order to reduce the magnitude of the reported losses in the current year.

TABLE 5
DISTRIBUTIONS OF SECOND DIGITS OF THE R&D EXPENSES (1950-1974)

	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Profit firms	16.35	9.86	10.57	9.58	9.94	11.26	8.41	9.09	7.68	7.26
Deviation	4.38	-1.53	-0.31	-0.85	-0.09	1.59	-0.93	0.05	-1.08	-1.24
Z statistics	*10.86*	*3.86*	*0.79*	*2.21*	*0.23*	*4.32*	*2.54*	*0.12*	*3.07*	*3.56*
Loss firms	20.00	10.09	8.41	7.48	9.91	12.34	7.85	8.60	9.53	5.79
Deviation	8.03	-1.30	-2.47	-2.95	-0.12	2.67	-1.49	-0.44	0.77	-2.71
Z statistics	*5.66*	*0.88*	*1.76*	*2.16*	*0.02*	*2.01*	*1.11*	*0.28*	*0.56*	*2.17*
Profit vs. Loss firm										
Difference	-3.65	-0.23	2.16	2.11	0.03	-1.08	0.56	0.49	-1.86	1.47
Z statistics	*2.12*	*0.10*	*1.50*	*1.53*	*-0.05*	*0.68*	*0.37*	*0.30*	*1.48*	*0.87*

As shown in Table 6, in the period after 1974, for profit firms, the observed frequency of occurrence of the number zero as the second digit of the reported R&D expense is 13.08 percent, which is 1.11 percent higher than the expected frequency of occurrence of 11.97 percent. This deviation is statistically significant (z stats = 7.17). For loss firms, the observed frequency is 12.45 percent, which is 0.48 percent higher than the expected frequency of occurrence of 11.97 percent. This deviation is also statistically significant (z stats = 2.20). These results suggest that after 1974 when firms can no longer capitalize R&D expense, both profit and loss firms still round up R&D expenses, even though doing so reduces current period earnings. These results suggest that both profit and loss firms believe that the benefit of rounding up R&D expenses (i.e., sending positive signals to the market outweigh the cost of doing so (i.e., reporting lower earnings). However, when we compare the extent of rounding for profit and loss firms,

TABLE 6
DISTRIBUTIONS OF SECOND DIGITS OF THE R&D EXPENSES (1975-2012)

	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Profit firms	13.08	10.99	10.78	10.39	9.92	9.75	9.17	8.73	8.75	8.43
Deviation	1.11	-0.40	-0.10	-0.04	-0.11	0.08	-0.17	-0.31	-0.01	-0.07
Z statistics	*7.17*	*2.62*	*0.64*	*0.30*	*0.74*	*0.60*	*1.25*	*2.24*	*0.08*	*0.49*
Loss firms	12.45	11.31	11.03	10.43	9.77	9.73	9.16	9.16	8.78	8.17
Deviation	0.48	-0.08	0.15	0.00	-0.26	0.06	-0.18	0.12	0.02	-0.33
Z statistics	*2.20*	*0.35*	*0.70*	*-0.01*	*1.25*	*0.30*	*0.90*	*0.61*	*0.08*	*1.74*
Profit vs. Loss firm										
Difference	0.63	-0.32	-0.25	-0.05	0.15	0.02	0.01	-0.43	-0.03	0.26
Z statistics	*2.25*	*1.22*	*0.94*	*0.17*	*0.59*	*0.08*	*0.01*	*1.82*	*0.11*	*0.65*

we see that, contrary to what we observed in the period prior to 1974, loss firms are not rounding up as much as profit firms -13.08 percent of profit firms report zeros in the second digit of R&D expenses, while 12.45 percent of loss firms report zeros in the second digit of R&D expenses; this difference of 0.63 is statistically significant at the 1% level (z stats = 2.25). These results reflect the fact that it becomes more costly for loss firms to round up R&D expenses in this period, because doing so will signify their poor earnings performance.

CONCLUSION

This study documents that firm managers tend to round up their reported R&D expenditure and the rounding manipulation is prevalent even after the enforcement of SFAS No. 2 in 1974, which requires all R&D expenditures to be expensed. Our study makes several contributions to the existing literature. First, it extends the existing literature on the rounding phenomenon by providing evidence that rounding manipulation is also evident in financial statement items other than earnings and revenues. Second, we provide evidence on the managers' perceived nature of R&D expenses. In particular, we show that even after R&D is required to be expensed, managers still perceive R&D as an indicator of firms' future performance and are willing to round up this expense item even when doing so decreases current period earnings. Third, findings from our study help distinguish between the two competing explanations for the rounding phenomenon. Since R&D expenditure is used in firm valuation and not in contracting, our finding that the rounding phenomenon exists in reported R&D expenses provides evidence that the valuation perspective could be the main driving force for the rounding phenomenon. Our study also has important implication for accounting standard makers. There are many debates about the potential benefits and costs of R&D capitalization. Recent studies suggest that capitalization of R&D expenditure is associated with more informative stock prices. Our findings suggest that allowing capitalization of R&D costs may increase managers' incentives to deliberately round up their reposted R&D expenditure to mislead investors about the firms' future prospects.

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