# The Accuracy of Multiples Used to Estimate the Market Value of Large U.S. Pharmaceutical Companies

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*Many researchers and analysts have shown that expensing R&Ds can distort the profitability measures and market value estimates of R&D intensive firms and treat R&Ds as assets. This paper assesses the valuation accuracy of five goodwill, five enterprise and two price multipliers that can be used to estimate the market values of large U.S. pharmaceutical companies with significant R&D expenditures during the 2010-2022 period. Our results support that goodwill multipliers generally provide the smallest estimation errors of the market values of pharmaceutical firms with significant R&Ds and that gross profit is a superior measure of the profitability of these firms.*

*Keywords: pharmaceutical companies, R&Ds, goodwill multipliers, mean absolute deviation, mean square error*

## INTRODUCTION

In this paper, the accuracy of several multiples for estimating the market value of publicly traded large U.S. pharmaceutical companies is evaluated during the 2010-2022 time period. Since 1975, U.S. Generally Accepted Accounting Principles (GAAP) requires research and development (R&D) costs to be treated as operating expenses in the year they are incurred (Financial Accounting Standards Board, 1974). Researchers and analysts often argued that R&D expenses are more long-term investments in fixed assets (such as plant and equipment) generating long-term (beyond a year) revenues, cash flows and profits at many firms, especially those in the pharmaceutical, software and technology sectors. Therefore, R&D costs are generally adjusted by researchers and analysts by capitalizing them (and amortizing them over their estimated economic life) as assets, not expenses. Many researchers have documented that R&D expensing can distort firms' profitability and market value estimates of R&D intensive firms, including Danielson and Press (2005), Damodaran (1998) and Scherer (1993). Correspondingly, the increases in asset value from capitalizing R&D spending for these companies lead to corresponding increases in their market value of equity (Steward, 1999).

Surprisingly, no academic study has tested the valuation accuracy of goodwill multipliers to estimate the market value of firms with significant R&D costs. Goodwill is not visible (as an intangible asset) but is a real capital asset and can be thought as the value a buyer will be willing to pay for acquiring a firm (its market value) over its accounting (or its book) value. This study seeks to determine which valuation

multiples most accurately estimate the market value of large U.S. pharmaceuticals firms with significant R&D expenditures. This paper will assess the valuation accuracy of five goodwill multiples and seven more traditional multiples that can be used to estimate the market value of large U.S. pharmaceutical companies with the most R&D spending (as a percentage of revenues). Our results support that goodwill multiples generally provide the smallest estimation errors in valuing the market value of large U.S. pharmaceutical firms with the most R&Ds.

## LITERATURE REVIEW

Researchers and analysts find multiples useful in valuing companies, but they do not identify a specific multiple as the best measure of valuation. McManus, Sharma and Tezel (2018) find that, in general, goodwill multiples are superior to enterprise and price multiples to estimate the market values of publicly-traded firms in the automotive dealerships sector. More specifically, goodwill value to earnings before taxes (ebt) provides the smallest estimation error for valuing these firms over the 2010-2016 time period. Using regression methods and financial data of pharmaceutical companies for the period 2005-2010, the results of Shari and Bhardwaj (2011) indicate that price multiples (price to earnings and price to book) and enterprise value to earnings before interests, taxes, depreciation, and amortization (ebitda) outperformed other multiples in valuation. Using financial data from the Compustat database for the 1998 fiscal year, Lie and Lie (2002) find that earnings before interest, taxes, depreciation, and amortization (ebitda) multiples are superior to the earnings before interest and taxes (ebit) multiples. They also report that the market value of equity to book value of equity multiple provides better market value estimates than the earnings multiples. Kim and Ritter (1999) find that the enterprise value to ebitda multiple is the best multiple for the valuation of companies doing an initial public offering (IPO). Kaplan and Ruback (1995) observe that the discounted cash flow (DCF) and multiplier methods are useful for estimating the values of 51 highly levered transactions between 1983 and 1989. Interestingly, they use the median multipliers for companies that are in the same industry. Finally, Alford (1992) investigates how benchmark companies should be selected using the price to earnings multiple.

## DATA AND VALUATION MULTIPLES

We collect data from Factset for the largest publicly traded U.S. pharmaceutical firms that reported the most R&D costs (as a percentage of revenues) for each year of the 2010-2022 time period. We obtained a sample of seven (7) large U.S. pharmaceutical companies that met our requirements. These seven firms are AbbVie, Astra Zeneca, Bristol-Myers-Squibb, Johnson & Johnson, Merck, Novartis and Pfizer.

We estimate the (year-end) market values of the equity of these seven pharmaceutical companies based on twelve (12) multiples that we group into the following three categories: 1) enterprise multiples, 2) goodwill multiples, and 3) price multiples. While enterprise and price multiples have been extensively studied in the literature, goodwill multiples have not, especially for valuing large pharmaceutical companies with significant R&D expenses. Similarly, in addition to using the earnings before interest, taxes, depreciation, and amortization (ebitda), the earnings before interest and taxes (ebit), and the earnings (e) to assess firm's profitability as suggested in the previous studies, we include earnings before taxes (ebt) and gross profit (gp) measures. Novy-Marx (2012) reports the significance of gross profits in explaining the cross-section of average returns. Gross profits are relatively clean measures of profitability and multiples based on gross profits may be useful in estimating the market value of similar companies in the pharmaceutical sector.

The variable definitions and notation for the twelve (12) valuations multiples studied to estimate the profitability and market values of the largest U.S. pharmaceutical companies with the most R&Ds in our sample are provided in Table 1.

## METHODOLOGY AND EMPIRICAL RESULTS

### Mean and Median Enterprise, Goodwill and Price Multiples

Tables 2A and 2B summarize the mean and median values, respectively, at the end of each year of the 2010-2022 time period of the twelve (12) multiples for all the largest seven (7) U.S. pharmaceutical firms with the most R&D spending. The mean and median multiples for the years 2011, 2012, 2013, 2014, 2016 and 2017 are not reported in Tables 2A and 2B, respectively, to conserve space. Thirteen-year average (from 2010-2022) of the mean and median multipliers are also reported in those tables. Ten-year averages (from 2010-2019) and three-year averages (from 2020-2022) of the mean (median) multipliers are also not reported in Tables 2A and 2B, respectively, as they exhibit similar patterns to the ten-year averages.

**TABLE 1**
**DEFINITIONS AND NOTATIONS OF THE VALUATION MULTIPLES**

Enterprise multiples

1. Total enterprise value to net operating assets: tev/noa
   tev = market value of equity (s) plus interest-bearing debt (d) minus cash and marketable securities (c).
   noa = total assets (ta) minus accounts payables (ap) minus cash and marketable securities
2. Total enterprise value to gross profit: tev/gp
3. Total enterprise value to earnings before interest, taxes, depreciation, and amortization: tev/ebitda
4. Total enterprise value to earnings before interest and taxes: tev/ebit
5. Total enterprise value to earnings before taxes: tev/ebt

Goodwill multiples

6. Goodwill value to gross profit: gv/gp
   gv = market value of equity (s) minus book value of equity (bv)
7. Goodwill value to earnings before interest, taxes, depreciation, and amortization: gv/ebitda
8. Goodwill value to earnings before interest and taxes: gv/ebit
9. Goodwill value to earnings before taxes: gv/ebt
10. Goodwill value to earnings= gv/e
    e = earnings before extraordinary items

Price multiples

11. Price to earnings: s/e
12. Price to book: s/bv

Goodwill multiples are generally smaller than the enterprise and price multiples. For example, the (thirteen-year) average mean and median gross margin goodwill multiples, gv/gp, are 4.71 in Table 2A and 4.45 in Table 2B, respectively while the average mean and median gross margin enterprise multiples, tev/gp, are 6.31 in Table 2A and 6.11 in Table 2B, respectively.

### Mean Absolute Deviation (MAD) and Mean Square Error (MSE) of the Mean and Median Enterprise, Goodwill and Price Multiples

We estimate (year-end) market values based on the average and median multipliers for each of the seven large U.S. companies with significant R&D expenses in the pharmaceutical industry. More specifically, market values of equity are estimated by multiplying the industry's average (or median) multiple by the relevant financial metric for each company at the end of each year of the 2010-2022 period. For enterprise multiples, the market values of equity for each firm are estimated by deducting interest-

bearing debt and adding cash and marketable securities from the estimated total enterprise values. For example, the industry mean value for the enterprise multiple tev/noa is 3.51 at year-end 2022 (see Table 2A). We first estimate each firm total enterprise value (tev) by multiplying net operating assets (noa) at year end 2022 by 3.51. We then subtract each firm interest-bearing debt (d) and add each firm cash and marketable securities (c) to estimate each firm market value of equity (s) at year-end 2022. For goodwill multipliers, market values of equity for each firm are estimated by adding the book values of equity to the estimated goodwill values.

The valuation error is the percentage difference between the estimated market value of equity from the actual market value of equity. Therefore, valuation errors are obtained by calculating the ratio of the estimated market values of equity to the actual market value of equity minus one. The valuation accuracy of each multiple is assessed by calculating the mean absolute deviation (MAD) and the mean square error (MSE) of the valuation errors.

**TABLE 2A**
**LARGE U.S. PHARMACEUTICAL COMPANIES INDUSTRY MEAN MULTIPLES**

| | Mean | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2010 | …2015 | …2018 | 2019 | 2020 | 2021 | 2022 | Average |
| Enterprise multiples | | | | | | | | |
| 1. tev/noa | 1.65 | 2.82 | 3.03 | 2.84 | 2.59 | 3.09 | 3.51 | 2.66 |
| 2. tev/gp | 3.28 | 6.70 | 6.71 | 8.01 | 8.26 | 7.96 | 8.53 | 6.31 |
| 3. tev/ebitda | 7.78 | 19.05 | 16.27 | 16.93 | 22.30 | 15.56 | 17.16 | 14.95 |
| 4. tev/ebit | 17.08 | 26.89 | 22.11 | 22.14 | 20.54 | 21.24 | 23.25 | 20.33 |
| 5. tev/ebt | 22.03 | 29.34 | 24.56 | 24.57 | 29.37 | 23.10 | 25.19 | 23.00 |
| Goodwill multiples | | | | | | | | |
| 6. gv/gp | 1.86 | 5.08 | 5.46 | 5.88 | 6.01 | 6.21 | 6.86 | 4.71 |
| 7. gv/ebitda | 4.33 | 14.85 | 13.41 | 12.56 | 15.80 | 12.51 | 14.16 | 11.32 |
| 8. gv/ebit | 8.79 | 20.68 | 18.16 | 16.31 | 15.99 | 16.79 | 18.92 | 15.22 |
| 9. gv/ebt | 11.15 | 22.51 | 20.18 | 18.04 | 21.84 | 18.18 | 20.43 | 17.05 |
| 10. gv/e | 19.17 | 28.41 | 23.02 | 20.44 | 19.60 | 20.13 | 23.25 | 18.73 |
| Price multiples | | | | | | | | |
| 11. s/e | 36.31 | 35.06 | 26.08 | 24.60 | 21.99 | 23.14 | 26.35 | 24.19 |
| 12. s/bv | 2.55 | 8.15 | 3.22 | 8.97 | 10.79 | 10.68 | 11.54 | 7.79 |

**TABLE 2B**
**LARGE U.S. PHARMACEUTICALS COMPANIES INDUSTRY MEDIAN MULTIPLES**

| | Mean | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2010 | …2015 | …2018 | 2019 | 2020 | 2021 | 2022 | Average |
| Enterprise multiples | | | | | | | | |
| 1. tev/noa | 1.75 | 2.87 | 3.22 | 3.17 | 3.42 | 2.37 | 2.92 | 2.54 |
| 2. tev/gp | 3.37 | 6.51 | 6.96 | 7.75 | 8.15 | 7.19 | 7.36 | 6.11 |
| 3. tev/ebitda | 7.79 | 14.25 | 14.62 | 15.57 | 20.59 | 12.56 | 14.06 | 13.31 |
| 4. tev/ebit | 9.10 | 23.74 | 21.63 | 20.89 | 26.14 | 18.31 | 20.80 | 18.68 |
| 5. tev/ebt | 9.35 | 2.79 | 23.78 | 22.69 | 29.52 | 20.06 | 22.84 | 20.31 |
| Goodwill multiples | | | | | | | | |
| 6. gv/gp | 2.03 | 4.70 | 5.44 | 5.66 | 5.99 | 5.58 | 5.85 | 4.45 |
| 7. gv/ebitda | 4.15 | 10.08 | 11.47 | 12.56 | 15.92 | 9.02 | 11.06 | 9.96 |
| 8. gv/ebit | 4.74 | 15.04 | 16.32 | 16.41 | 20.46 | 12.55 | 15.26 | 13.36 |
| 9. gv/ebt | 5.66 | 16.97 | 17.68 | 18.13 | 21.42 | 14.41 | 16.63 | 14.54 |
| 10. gv/e | 8.46 | 21.17 | 21.92 | 21.14 | 24.51 | 16.13 | 20.20 | 19.03 |
| Price multiples | | | | | | | | |
| 11. s/e | 14.60 | 30.84 | 23.34 | 24.42 | 27.42 | 20.14 | 24.06 | 24.48 |
| 12. s/bv | 2.87 | 5.18 | 5.84 | 4.94 | 7.36 | 5.57 | 6.07 | 4.97 |

**TABLE 3A**
**VALUATION ACCURACY: MEAN ABSOLUTE DEVIATION (MAD)USING INDUSTRY MEAN MULTIPLES**

| | Mean Absolute Deviation (MAD) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2010 | …2015 | …2018 | 2019 | 2020 | 2021 | 2022 | Average |
| Enterprise multiples | | | | | | | | |
| 1. tev/noa | 31.7% | 34.4% | 17.5% | 42.8% | 39.9% | 41.9% | 48.1% | 34.7% |
| 2. tev/gp | 19.1% | 11.5% | 10.2% | 16.1% | 5.0% | 22.1% | 32.7% | 15.0% |
| 3. tev/ebitda | 24.1% | 43.8% | 22.5% | 22.6% | 20.8% | 45.5% | 59.0% | 30.0% |
| 4. tev/ebit | 100.3% | 46.1% | 24.0% | 20.9% | 64.5% | 34.4% | 52.5% | 42.2% |
| 5. tev/ebt | 138.0% | 45.9% | 28.2% | 19.2% | 73.2% | 34.2% | 52.8% | 47.2% |
| Goodwill multiples | | | | | | | | |
| 6. gv/gp | 14.1% | 14.1% | 10.2% | 7.3% | 14.1% | 25.5% | 35.1% | 16.1% |
| 7. gv/ebitda | 14.1% | 41.1% | 23.5% | 14.0% | 14.4% | 46.6% | 59.2% | 28.1% |
| 8. gv/ebit | 44.7% | 42.1% | 24.0% | 13.8% | 42.9% | 36.2% | 52.3% | 31.6% |
| 9. gv/ebt | 62.3% | 41.5% | 28.1% | 10.3% | 45.0% | 34.9% | 52.1% | 33.6% |
| 10. gv/e | 86.7% | 40.7% | 26.4% | 23.6% | 53.6% | 35.0% | 50.8% | 40.6% |
| Price multiples | | | | | | | | |
| 11. s/e | 175.3% | 44.8% | 24.2% | 31.7% | 58.9% | 33.1% | 49.5% | 51.2% |
| 12. s/bv | 26.4% | 85.5% | 59.7% | 110.3% | 101.8% | 102.1% | 116.0% | 89.0% |

**TABLE 3B**
**VALUATION ACCURACY: MEAN ABSOLUTE DEVIATION (MAD) USING INDUSTRY MEDIAN MULTIPLES**

| | Mean Absolute Deviation (MAD) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2010 | …2015 | …2018 | 2019 | 2020 | 2021 | 2022 | Average |
| Enterprise multiples | | | | | | | | |
| 1. tev/noa | 21.0% | 23.3% | 8.0% | 45.9% | 15.0% | 10.5% | 17.7% | 17.8% |
| 2. tev/gp | 7.4% | 2.1% | 2.3% | 3.7% | 0.4% | 5.3% | 10.6% | 4.2% |
| 3. tev/ebitda | 10.1% | 10.7% | 5.1% | 5.4% | 5.8% | 15.3% | 28.9% | 11.0% |
| 4. tev/ebit | 25.0% | 21.4% | 9.1% | 6.3% | 94.6% | 9.7% | 46.8% | 23.2% |
| 5. tev/ebt | 28.5% | 25.6% | 12.5% | 4.7% | 138.4% | 11.0% | 55.5% | 28.8% |
| Goodwill multiples | | | | | | | | |
| 6. gv/gp | 3.4% | 2.9% | 1.4% | 0.8% | 2.6% | 7.6% | 12.9% | 3.9% |
| 7. gv/ebitda | 2.2% | 9.4% | 5.5% | 4.1% | 2.8% | 15.0% | 28.4% | 9.6% |
| 8. gv/ebit | 4.2% | 10.2% | 6.5% | 3.2% | 41.6% | 9.3% | 33.4% | 12.8% |
| 9. gv/ebt | 5.1% | 11.0% | 8.4% | 2.1% | 59.4% | 9.7% | 37.6% | 14.7% |
| 10. gv/e | 7.1% | 10.5% | 7.7% | 14.5% | 94.1% | 10.2% | 46.3% | 32.8% |
| Price multiples | | | | | | | | |
| 11. s/e | 30.5% | 21.3% | 6.1% | 18.2% | 129.5% | 9.7% | 50.3% | 45.7% |
| 12. s/bv | 16.3% | 27.8% | 40.3% | 59.6% | 57.3% | 23.3% | 36.0% | 30.6% |

**TABLE 4A**
**VALUATION ACCURACY: MEAN SQUARE ERROR (MSE) USING INDUSTRY MEAN MULTIPLES**

| | Mean Square Error (MSE) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2010 | …2015 | …2018 | 2019 | 2020 | 2021 | 2022 | Average |
| Enterprise multiples | | | | | | | | |
| 1. tev/noa | 16.7% | 21.6% | 6.2% | 30.8% | 19.7% | 22.9% | 34.0% | 20.0% |
| 2. tev/gp | 6.7% | 2.3% | 1.9% | 4.0% | 0.4% | 7.2% | 16.9% | 4.7% |
| 3. tev/ebitda | 10.0% | 21.7% | 5.8% | 6.4% | 6.5% | 31.6% | 56.6% | 17.9% |
| 4. tev/ebit | 132.8% | 32.3% | 9.7% | 7.4% | 86.1% | 16.0% | 65.4% | 36.1% |
| 5. tev/ebt | 256.2% | 34.6% | 13.9% | 5.4% | 137.8% | 17.0% | 73.7% | 52.3% |
| Goodwill multiples | | | | | | | | |
| 6. gv/gp | 2.6% | 3.1% | 1.4% | 0.8% | 2.6% | 9.9% | 19.4% | 4.6% |
| 7. gv/ebitda | 2.4% | 18.9% | 6.1% | 4.1% | 2.8% | 33.1% | 56.0% | 16.1% |
| 8. gv/ebit | 23.9% | 21.8% | 8.0% | 3.1% | 37.2% | 16.9% | 57.6% | 19.5% |
| 9. gv/ebt | 48.1% | 22.6% | 10.7% | 2.0% | 60.4% | 16.6% | 62.7% | 24.6% |
| 10. gv/e | 95.8% | 22.2% | 8.7% | 13.0% | 72.5% | 17.2% | 66.0% | 33.0% |
| Price multiples | | | | | | | | |
| 11. s/e | 403.0% | 32.3% | 7.9% | 18.6% | 103.9% | 15.4% | 65.5% | 63.2% |
| 12. s/bv | 10.0% | 108.6% | 45.7% | 180.8% | 168.9% | 130.9% | 201.0% | 137.1% |

**TABLE 4B**
**VALUATION ACCURACY: MEAN SQUARE ERROR (MSE) USING INDUSTRY MEDIAN MULTIPLES**

| | Mean Square Error (MSE) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2010 | …2015 | …2018 | 2019 | 2020 | 2021 | 2022 | Average |
| Enterprise multiples | | | | | | | | |
| 1. tev/noa | 32.7% | 35.3% | 18.4% | 45.6% | 36.7% | 22.0% | 33.7% | 31.2% |
| 2. tev/gp | 19.0% | 9.8% | 10.6% | 15.3% | 4.9% | 16.8% | 22.3% | 13.3% |
| 3. tev/ebitda | 24.1% | 23.8% | 18.6% | 18.0% | 18.5% | 27.6% | 39.4% | 23.1% |
| 4. tev/ebit | 41.6% | 39.8% | 23.6% | 18.9% | 57.0% | 24.1% | 41.1% | 32.5% |
| 5. tev/ebt | 44.3% | 41.7% | 27.5% | 15.0% | 73.3% | 25.6% | 45.9% | 35.6% |
| Goodwill multiples | | | | | | | | |
| 6. gv/gp | 14.1% | 13.5% | 10.2% | 7.3% | 14.0% | 19.9% | 20.0% | 14.1% |
| 7. gv/ebitda | 13.0% | 23.3% | 18.9% | 14.0% | 14.5% | 27.4% | 39.1% | 22.1% |
| 8. gv/ebit | 14.0% | 26.9% | 22.2% | 13.8% | 36.7% | 24.1% | 38.3% | 23.3% |
| 9. gv/ebt | 17.2% | 28.1% | 24.9% | 10.4% | 44.3% | 25.5% | 39.7% | 24.8% |
| 10. gv/e | 20.2% | 26.4% | 25.5% | 24.0% | 52.5% | 26.1% | 42.6% | 32.6% |
| Price multiples | | | | | | | | |
| 11. s/e | 40.2% | 37.7% | 19.2% | 31.4% | 57.8% | 23.5% | 41.9% | 39.4% |
| 12. s/bv | 27.2% | 48.2% | 44.1% | 68.5% | 62.2% | 40.1% | 45.5% | 42.6% |

The valuation accuracy for the seven largest U.S. firms with significant R&D expenses in the pharmaceutical industry mean and median multiples are reported in Tables 3A and 3B (MAD) and Tables 4A and 4B (MSE), respectively. The results for MAD and MSE are very similar and only the results in Tables 3b and 4b using the industry median multiples will be discussed.

The gross margin goodwill and enterprise multiples, gv/gp and fv/gp, are the most accurate at valuing the market values of large U.S. pharmaceutical firms with significant R&Ds expenses as they provide the smallest valuation errors for both MAD (3.9% and 4.2%, respectively in Table 3B) and MSE (14.1% and 13.3%, respectively in Table 4B) over the 2010-2022 time period. Generally, the goodwill multipliers using ebitda, ebit, and ebt are superior or more accurate than the enterprise multipliers using ebitda, ebit and ebt. The MAD of those goodwill multiples range from 9.6% to 14.7% and their MSE range from 22.1% to 24.8%. However, the goodwill multiple using earnings, gv/e, is inferior to the other goodwill multiples. Finally, the price multiples are the least accurate in valuing the market values of the largest U.S. pharmaceutical firms with significant R&Ds costs as they provided the largest valuation errors. Overall, goodwill multiplies are generally superior to estimate the market value of these pharmaceutical firms to enterprise. Price multiples and gross profits are clearly a superior measure of profitability for these firms.

## CONCLUSION

Researchers and analysts should use gross margin multiples for valuing the largest publicly-traded U.S. pharmaceutical firms with the most R&D expenses as they provide the smallest estimation errors in valuing these firms' market values of equity. Our results support that goodwill multiples are very useful to value those pharmaceutical companies and that valuation using multiples is easy to implement and is not sensitive to the assumptions necessary for the discounted cash flow (DCF) methods.

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