For What It's Worth: Understanding the Comparative Accuracy and Explanatory Performance of Relative Value Models and Absolute Value Models

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ABSTRACT

Equity asset valuation seeks to estimate the market value of an equity (business ownership) asset. Equity asset valuation models are used by a multitude of individual investors, money managers, securities analysts, and regulators on a daily basis. Relative valuation models estimate value by comparing the market price of an asset to the market prices of similar assets. Absolute valuation models estimate value by estimating the expected future cash flows generated from owning an asset and discounting those cash flows, based on risk, to their present value. The study compares five types of valuation models, two absolute models and three relative models, in terms of accuracy and explanatory power. The study sample is comprised of 107 observations of 36 pharmaceutical firms over a three year period. Findings support that relative valuation models are superior to absolute valuation models which may reflect the high-growth characteristics of the pharmaceutical industry.

I. INTRODUCTION

In the field of finance, the valuation process is employed to estimate the market value of a financial asset or liability. The valuation of equity assets is an area of finance that has received a considerable amount of attention from both the academic and professional worlds (e.g., Copeland, Koller, and Murrin 1994; Eades, Weaver, Carr, and Rodriguez 2003; Lee and Ritter 1999). The two primary classes of valuation models used to estimate equity value are Relative Value models and Absolute Value models. Absolute Value models seek to estimate value by estimating the expected future cash flows generated from owning an asset and discounting those cash flows, based on risk, to their present value. Relative Value models seek to estimate value by comparing the market price of an asset to the market prices of similar assets. These models are used by a multitude of investment bankers, money managers, securities analysts, and regulators on a daily basis to accurately value equity assets. Thus, the accuracy of these methods, in determining the value of an equity asset, is an issue of the utmost importance.

Strikingly, little academic study has explored the comparative accuracy of these two types of models. This paper attempts to fill the gap in the academic literature, by comparing estimated values derived from both discounted cash flow and market comparables models to the market price. This study provides a contrast of the value estimates and the market prices[1] in terms of their accuracy (i.e., the absolute price scaled difference between the value estimate and the current price of the security (Francis, Olsson, and Oswald 2000)) and explanatory power (ability of value estimates to explain cross-sectional variation in current security prices (cf. Francis, Olsson, and Oswald 2000, p. 46)). The value estimates are derived from a compilation of

[1] The semi-strong form efficient market hypothesis (EMH) states that financial markets are "informationally efficient"; thus, prices on traded assets reflect all public information and therefore reflect the collective beliefs of all investors.

historical and forecasted firm fundamentals collected from *Value Line (VL)* annual reports and the Compustat database. The firm sample is comprised of publicly traded firms in the pharmaceutical industry followed by VL during the 2003-2006 time period. By focusing on the pharmaceutical industry, this study differentiates itself from prior studies by focusing on a high growth industry. This study seeks to pragmatically simulate the situation facing financial practitioners as they seek to generate valuation estimates using these models. The methodology applied here is similar to that used by Francis, Olsson, and Oswald (2000) in their comparison of the accuracy and explanatory power of three types of discounted cash flow models. In summary, the primary goal of this study is to understand which of these models is superior in estimating market value within the confines of a high growth industry.

II. LITERATURE REVIEW

Kaplan and Ruback (1995) compare value estimates derived from one form of discounted cash flow, a single-stage free cash flow model, and simple multiple comparison models with the transaction values of 51 highly leveraged transactions. The simple multiple comparison models used in the study were derived with a historical EBITDA[2] value driver. Findings report that the single-stage free cash flow method was more accurate than the simple multiple comparison model, with a higher percentage of valuation error within 15 percent of the transaction price; and the mean error was within 10 percent of the transaction price. When examining the cross-sectional variation between the estimated values and the transaction values, Kaplan and Ruback (1995) found that the comparables method and the discounted cash flow method explained a similar amount of variation.

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[2] EBITDA is an accounting acronym that refers to earnings before interest, taxed, depreciation, and amortization.

Beyond Kaplan and Ruback (1995), few comparisons of discounted cash flow models and market comparables models have been performed outside of graduate case studies (e.g., Eades, Weaver, and Carr (2003)). While Kaplan and Ruback (1995) is an important piece of the valuation literature, the study is limited to the use of only two forms of valuation models and the use of value estimates for highly leveraged transactions.

Although academic literature comparing the accuracy of discounted cash flow models to the accuracy of market comparable models is sparse, comparisons of various discounted cash flow and multiples models have been studied at length. Francis, Olsson, and Oswald (2000) compared the accuracy and explanatory power of three "theoretically equivalent" discounted cash flow models: the discounted dividend (DIV) model, the discounted free cash flow (FCF) model, and the abnormal earnings (AB) model, otherwise known as the residual income model. The authors used Value Line[3] reports to generate the valuation estimates using the three discounted cash flow models. Francis et al. (2000) conclude that the value estimates derived from the abnormal earnings model "performed significantly better" then the value estimates derived from both the discounted free cash flow model and the discounted dividend model. In terms of accuracy, the discounted free cash flow model was a close second, while the discounted dividend model trailed substantially. The data also support that the abnormal earnings value estimates explained a significantly higher proportion of the variation in the market prices, when compared to the other two discounted cash flow models. The authors attributed the high performance of the abnormal earnings value estimates to the ability of book value, which is part of the residual income equation, to explain a large portion of intrinsic value. Francis et al. (2000) assumed terminal

[3] Value Line Investment Research releases quarterly investment reports that track the performance of 1700 publicly-traded companies. The decision to use Value Line as a source for fundamental forecasts was based on the amount and duration of the company fundamentals they forecast.

growth rates[4] of zero and four percent, finding that the value estimates derived using the four percent terminal growth rate were more accurate than the value estimates derived using a terminal growth rate of zero. While Francis, Olsson, and Oswald (2000) provide an extensive comparison of various discounted cash flow value estimates, they do not address the issues surrounding the accuracy of multiples-based valuation methods.

Multiples valuation methods have been examined in a number of empirical studies. Liu, Nissan, and Thomas (2002, 2007) examined differences in the accuracy of multiples models using various value drivers in both domestic and international markets; the study applied the same metric of accuracy used by Francis et al. (2000) and Kaplan and Ruback (1995). Simple multiple comparison models that use forecasted value drivers to derive value estimates were found to be superior to models that use historical value drivers.[5] The authors also report that simple multiple comparison models that use earnings to derive value estimates have the least absolute error when compared to other value drivers. The superiority of forecasted one and two-year earnings multiple models (FEM_1 and FEM_2) as value predictors was upheld across all the markets examined and across most industries observed.

The current study seeks to replicate and expand upon the research performed by Francis et al. (2000). Specifically, in addition to the FCF and AB models utilized by those authors, I include a comparison of forward multiples valuation methods found to be relevant by Liu et al. (2002, 2007). Each of the preceding studies used a similar method to define valuation accuracy; thus, a side-by-side comparison of the models is appropriate. This study derives all of its forecasted firm data from the same source, Value Line reports; thus, using the same methodology applied previously (e.g., Frances et al. 2000) to compare these five models is appropriate with regards to

[4] The terminal growth rate is the expected inflation rate, plus the real cash flow growth rate.
[5] Likewise, Kim and Ritter (1998) found that the use of earnings forecasts enhances the valuation accuracy of multiples models "substantially".

the underlying assumptions. Based on the above summarized prior research, this study expects that:

H1: The AB estimates will have the least valuation error when compared to the FCF, FEM_1, FEM_2, and FEM_3 estimates.

H2: The AB estimates will explain the most cross-sectional variation in current security prices when compared to the FCF, FEM_1, FEM_2, and FEM_3 estimates.

III. VALUATION MODELS

Discounted Cash Flow Models

Discounted cash flow models attempt to estimate value by estimating the expected future cash flows generated from owning an asset and discounting those cash flows to their present value. The discount rate used in the model is related to the risk associated with those cash flows. Francis et al. (2000) found the AB and FCF models to be far more accurate than and the DIV model. This study analyzes both the AB and FCF models with the required inputs drawn from VL estimates.

The discounted free cash flow model endeavors to discover a firm's value by discounting all of the future cash flows available to be distributed to investors or used to repurchase stock. The same discounted free cash flow model used by Francis et al. (2000) is applied here (which they abstracted from the work of Copeland, Koller, and Murrin (1994)):

$$V_F^{FCF} = \sum_{t=1}^{T} \frac{FCF}{(1+r_{WACC})^t} + ECMS_F - D_F - PS_F$$

$$FCF_t = (SALES_t - OPEXP_t - DEPEXP_t)(1-\tau) + DEPEXP_t - \Delta WC_t - CAPEXP_t$$

$$r_{WACC} = w_D(1-\tau)r_D + w_{PS}r_{PS} + w_E r_E$$

where:

- V_F^{FCF} = market value of equity at time F;
- $SALES_t$ = sales revenues for year t;
- $OPEXP_t$ = operating expenses for year t;
- $DEPEXP_t$ = depreciation expense for year t;
- ΔWC_t = change in working capital in year t;
- $CAPEXP_t$ = capital expenditures in year t;
- $ECMS_t$ = excess cash and marketable securities at time t;[8]
- D_t = market value of debt at time t;
- PS_t = market value of preferred stock at time t;
- r_{WACC} = weighted average cost of capital;
- r_D = cost of debt;
- r_{PS} = cost of preferred stock;
- w_D = proportion of debt in target capital structure;
- w_{PS} = proportion of preferred stock in target capital structure;
- w_E = proportion of equity in target capital structure; and
- τ = corporate tax rate.

The abnormal earnings model seeks to derive a firm's value by adding the firm's current book value and all of the firm's discounted future earnings that exceed the firm's required rate of return on equity. This study utilizes the same abnormal earnings model used by Francis et al. (2000), which they gleamed from Preinreich (1938), Edwards and Bell (1961), and Ohlson (1995):

$$V_F^{AE} = B_F + \sum_{t=1}^{T} \frac{AE_t}{(1+r_E)^t}$$

$$AE_t = X_t - r_E B_{t-1}$$

$$B_t = B_{t-1} + X_t - DIV_t$$

where:
V_t^{AE} = market value of equity at time F;
AE_t = abnormal earnings in year t;
B_t = book value of equity at end of year t; and
X_t = earnings in year t.

Likewise, this study applies a similar methodology as Francis et al. (2000) in that all forecasted data are taken from VL third quarter reports[6]. VL third quarter reports are the first to exhibit VL's five year firm forecasts, which are used to derive the value estimates. As a result, the models must be altered to incorporate the first half year of discounted values.

Altered Discounted Free Cash Flow Model (FCF):

$$V_F^{FCF} = (1+r_{WACC})^{-f}.5FCF_0 + \sum_{t=1}^{5}(1+r_{WACC})^{-(t+f)}FCF_t + (1+r_{WACC})^{-(5+f)}TV^{FCF} + ECMS_0 - D_0 - PS_0.$$

Altered Discounted Abnormal Earnings Model (AB):

$$V_F^{AE} = B_{Q2} + (1+r_E)^{-f}.5(X_0 - r_E \times B_{Q2}) + \sum_{t=1}^{5}(1+r_E)^{-(t+f)}[X_t - r_E \times B_{t-1}] + (1+r_E)^{-(5+f)}TV^{AE}.$$

[6] The study assumes the clean surplus relationship for the calculation for the book value of equity in years 1-3. The year-zero book value is taken from the Compustat Database. The book values for years four and five are taken from the Value Line report.

III. VALUATION MODELS

Multiples Comparison Models

Multiples Comparison models seek to estimate value by comparing the market price of an asset to the market prices of similar assets. The simple multiples comparison model seeks to derive a value estimate by multiplying the value driver of a firm by the harmonic average of an industry multiples. Liu et al. (2002, 2007) found that simple multiples comparison models that use one-year and two-year forecasted earnings as the value driver input are more accurate than models that use other types of value drivers. Both models found to be superior by Liu et al. (2002, 2007) are tested here.

One-year Forecasted Earnings Multiple Model (FEM_1):

$$E\hat{V}_{it} = \left(\frac{P}{E_1}\right)_{COMit} \times E_{1it}$$

Two-year Forecasted Earnings Multiple Model (FEM_2):

$$E\hat{V}_{it} = \left(\frac{P}{E_2}\right)_{COMit} \times E_{2it}$$

This study also tests the accuracy of a FEM_3 model that was not featured in Liu et al. (2002, 2007).[7] [The FEM_3 model uses VL's three to five-year earnings forecast as the multiple's value driver.]

Three-year Forecasted Earnings Multiple Model (FEM_3):

$$E\hat{V}_{it} = \left(\frac{P}{E_3}\right)_{COMit} \times E_{3it}$$

[7] FEM3 was used in Yoo (2006) as a piece of a composite multiples valuation model.

IV. DATA AND METHODOLOGY

The basic methodology applied here is similar to that used by Francis et al. (2000) in their comparison of the accuracy and reliability of three types of discounted cash flow models. However, I focus on only two of the three discounted cash flow models examined by the authors: the discounted dividend model is not used due to its' poor performance in the prior research. The value estimates are derived from a compilation of forecasted firm fundamentals collected from *Value Line (VL)* annual reports.[8] Book values and market prices were collected from the Compustat database. The firm sample is comprised of 36 publically traded firms, with fiscal years ending in December, tracked by VL during the 2003-2006 time periods (see Appendix). Market betas were collected from the Value Line reports. The terminal growth rate of four percent was used to compute both the AE and FCF models as it has been deemed more accurate than other terminal growth rates studied previously (cf. Francis et al. 2000; Kaplan and Ruback 1995). The value estimates were assigned according to these criteria, and the absolute price scaled difference between the value estimate and the closing price of the security five days after the Value Line report was released[9] are computed and analyzed. The cross-sectional variation between the estimated value and the closing price of the security five days after the report release date is also explored to determine the explanatory power of the models.

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[8] Value Line provides one-year and three-year forward estimates; the two-year estimate is their arithmetic average.

[9] The five day difference between the VL report's release and the observation of the stock price is given to insure that investors have digested the information from the reports and integrated the information into the market price.

V. RESULTS

The sample is comprised of 107 firm-year observations.[10] Each of the five value estimates are computed using the forward-looking data provided in the VL reports; second quarter book value figures were extracted from the Compustat database. The difference of the value model output and the closing stock price five days after the release of the VL report are computed on both a signed and absolute basis (see Table 1). Analysis of the mean (median) signed error of the estimates reveals a negative bias for all the value estimates, excluding the FCF estimates. The AE estimates produce an average signed prediction error of -43.91% (-47.13%). The FCF estimates exhibit an average signed prediction error of 26.16% (6.81%). The FEM_1 estimates have an average signed prediction error of -24.43% (-6.25%), and the FEM_2 estimates have an average signed prediction error of -7.64% (-6.42%). Finally, the FEM_3 estimates show an average signed prediction error of -0.30% (-5.76%).

[Insert Table 1 about here.]

Accuracy was measured as the absolute price scaled difference of the value estimates and the closing stock price five days after the release of the VL report. An analysis of the median absolute error demonstrates the superior accuracy of the FEM models. The FEM_2 has the lowest median error with a significant value of 26.3% (= 26.3%, p<.05). The FEM_3 is the second most accurate model with a median absolute error of 27.0%. The FEM_1 value estimates yield a median error value of 31.8%, while the AE and FCF value estimates reveal median errors of 47.1% and 43.1%, respectively.

The central tendency of the value estimates is measured as the percentage of value estimates that are within 15% of the closing stock price five days after the release of the VL report (cf.

[10] One firm year was unavailable due to an accounting issue that led to the firm restating their financial statements. As a result, VL did not give forward looking information in the third quarter 2006 report.

Kaplan et al. 1995; Francis et al. 2000). The central tendency data is consistent with the median error data. The FEM_2 has the highest central tendency with 32.71% of estimates falling within 15% of the closing price, and FEM_3 has the second most accurate model with 31.78% of estimates falling within 15% of the closing price. The FEM_1 value estimates have a central tendency value of 23.36%, while the AE and FCF value estimates have central tendencies of 16.82% and 19.63%, respectively.

Using OLS regression analyses, value estimates are analyzed in terms of their ability to explain cross sectional variation in the closing prices of the sample securities five days after the VL reports were released (see Table 2). [Outlier observations were deleted from the sample.[11]] Results of the regressions are in line with the results of the above accuracy tests. The relative value models have a higher explanatory power when compared to absolute value models. The FEM_3 has the highest R^2 value of 0.654, and FEM_2 has the second highest R^2 of 0.627. The FEM_1 value estimates show an R^2 of 0.507, while the AE and FCF value estimates' R^2 values are 0.482 and 0.268, respectively.

[Insert Table 2 about here.]

VI. DISCUSSION

The findings of the current study suggest that relative valuation models are superior, in terms of accuracy and explainability, to absolute valuation models. Thus, hypotheses one and two are not supported by the data. Moreover, the findings of this paper contradict the findings of Kaplan et al. (1995), which along with Francis et al. (2000) served as the theoretical foundation for H1 and H2. The conflicting results can be attributed to multiple factors. First, only two models are used in Kaplan et al. (1995), a one-stage, free cash flow to equity model and a simple

[11] Outlier observations were defined as observations with studentized residuals greater than two.

multiple valuation model with a trailing EBITDA value driver. The models used in the current study are substantially different from those used by Kaplan et al. (1995) in terms of complexity and focus. Second, the sample used in Kaplan et al. (1995) is made up of 51 highly leveraged transaction prices; highly leveraged transaction are also known as leveraged buyouts (LBOs). In general, LBO transaction prices are at premium to their pre-offer market values, thus a direct comparison of the current study and Kaplan et al. (1995) is not appropriate. Third, the current study focused primarily on companies that operate within the pharmaceutical and biotechnology industries. Companies within the pharmaceutical and biotechnology industries exhibit operational characteristics that differ significantly from those of the typical LBO candidates found in Kaplan et al. (1995).

The current study fills some of the gaps left in the equity asset valuation literature. For example, prior studies have compared the value estimates of relative or absolute valuation models to market prices, exclusively. The current study is one of the first to compare value estimates of both absolute and relative valuation models to market prices. According to the data, relative valuation models, specifically forward earnings simple multiple models, are the best way to valuate pharmaceutical companies. The findings serve to reinforce what is common practice in the financial industry: i.e., simple multiple models are regularly used by numerous professionals.

Absolute valuation models rely heavily on assumptions; and discounted cash flow models require forecast cash flows, assumed growth rates, and approximated required rates of return. Simple multiple models require, at most, one assumed input. The “growth” companies that dominate the pharmaceutical industry have very dynamic performance characteristics, and assumptions regarding their future performance are approximations at best. The results of the current study imply that if the future cash flows of a particular company are highly uncertain, then relative valuation models may be more accurate than absolute valuation models. Financial analysts use many methods when valuing companies, and the results reported here imply that forward earnings multiple models should be used when valuing “growth” companies.

Although the current study significantly contributes to the literature by offering insight into the accuracy of various forms of equity asset valuation models, it does have limitations. The study is limited in regards to the scope of the companies used in the sample, which only include companies that operate within the pharmaceutical and biotechnology industries. The literature would be well served by an examination that includes a broad multi-industry sample. The data reported here is also limited in regards to the time period in which the observations occurred: i.e., years 2003-2006. Future research that makes similar observations over multiple time periods would contribute greatly to the literature.

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TABLE 1
Accuracy - Pooled Sample Prediction Errors

Panel A: Signed Prediction Error (Bias)

	Mean	Mean % Difference	α-Level Difference = 0	Median	Median % Difference
Current Share Price	35.975	--	--	34.540	--
Value Estimate					
AE	20.342	-43.913%	0.000	16.460	-47.134%
FCF	39.730	26.162%	0.006	37.930	6.814%
FEM_1	30.919	-24.430%	0.020	28.740	-6.250%
FEM_2	32.841	-7.642%	0.120	29.770	-6.416%
FEM_3	32.687	-0.304%	0.927	29.350	-5.755%

Panel B: Absolute Prediction Error (Accuracy)

Value Estimate	Median	Versus FCF	Versus FEM_1	Versus FEM_2	Versus FEM_3	Central Tendency
AE	0.471	0.908	0.082	0.000	0.000	16.82%
FCF	0.431	--	0.049	0.000	0.000	19.63%
FEM_1	0.318	--	--	0.000	0.000	23.36%
FEM_2	0.263	--	--	--	0.014	32.71%
FEM_3	0.270	--	--	--	--	31.78%

TABLE 2
Explainablity - Results of Regressions of Stock Prices on Value Estimates

Univariate Regressions of Stock Price on Value Estimate

	AE	FCF	FEM_1	FEM_2	FEM_3
OLS Standardized Coefficient	0.694	0.518	0.712	0.792	0.809
OLS Unstandardized Coefficient	0.788	0.343	0.527	0.745	0.898
t -Statistic	9.697	6.057	10.133	12.974	13.759
OLS *R*-squared	0.482	0.268	0.507	0.627	0.654
F - Model	94.029	36.689	102.671	168.315	189.304
Dfs	(1,101)	(1,100)	(1,100)	(1,100)	(1,100)

APPENDIX

Sampled Companies

ADRX	ANDRX CORP
AGN	ALLERGAN INC
BIIB	BIOGEN IDEC INC
BMY	BRISTOL-MYERS SQUIBB CO
BRL	BARR PHARMACEUTICALS INC
BVF	BIOVAIL CORP
CELG	CELGENE CORP
CEPH	CEPHALON INC
CVD	COVANCE INC
ENZN	ENZON PHARMACEUTICALS INC
FRX	FOREST LABORATORIES
GILD	GILEAD SCIENCES INC
GSK	GLAXOSMITHKLINE PLC
IMCL	IMCLONE SYSTEMS INC
LLY	LILLY (ELI) & CO
MEDX	MEDAREX INC
MRK	MERCK & CO
MRX	MEDICIS PHARMACEUTICAL
MYL	MYLAN INC
NBIX	NEUROCRINE BIOSCIENCES INC
NKTR	NEKTAR THERAPEUTICS
NVO	NOVO NORDISK A/S
PFE	PFIZER INC
PPDI	PHARMACEUTICAL PROD DEV INC
PRGO	PERRIGO CO
PRX	PAR PHARMACEUTICAL COS INC
PRXL	PAREXEL INTERNATIONAL CORP
SEPR	SEPRACOR INC
SGP	SCHERING-PLOUGH
VRX	VALEANT PHARMACEUTICALS INTL
WPI	WATSON PHARMACEUTICALS INC
WYE	WYETH