The Beta Mystery--Are Investors Misled?

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Capital Asset Pricing Model beta estimates are one way that an investor can construct a portfolio with a desired systematic risk level. This paper compares the portfolios created using beta values obtained from two sources. While portfolio compositions differ and economic returns differ, the selections do not produce statistically different returns.
Key words: *Asset allocation, Diversification, Individual investors, Investment, Risk*

Introduction

There is a history of debate concerning the relevancy of the Capital Asset Pricing Model (CAPM), notably the Fama and French (1996) CAPM validity challenge.[a] While academics are aware of the controversy, many investment practitioners, especially non-professionals, appear much less well informed. This paper targets those investors who are exposed to CAPM fundamentals and the usefulness of using CAPM betas for portfolio composition, but who are possibly unaware of potential inconsistencies. This paper is based on the assumption that while CAPM beta estimates are useful, there are ramifications when using varying beta estimates in portfolio selection.

What type investor is familiar with the CAPM concept, but not beta estimate inconsistencies? One likely description would be a business college graduate whose academic major is an area other than finance. Such a student completed an introductory corporate finance class, but took no investment or other advanced finance classes. Other possibilities would be finance majors who graduated before Fama and French (1996) challenged beta's validity and general MBA graduates who took only an introductory graduate finance class. A fourth group, unfortunately, are business students who were properly instructed, but for one reason or another, did not retain the lesson. The final group would be individual investors who have no formal investment education, but believe they are adequately trained or sufficiently experienced to select their own portfolios. Members of these groups are unlikely to realize how much beta estimates differ.

An investor who truly believes in CAPM's validity, would not try to pick stocks, but instead would place all investment in some combination of the market portfolio and a risk free asset. An investor desiring more risk would reduce the amount of the risk-free asset or borrow money and leverage the investment in the market portfolio. However, when discussing investing, investors almost always refer to individual stock selection implying that investors, as individuals, do not follow CAPM's tenets.

Given those facts, the natural question is: why would an investor who does not really accept the CAPM use betas to pick an investment portfolio? In truth, that question seems unanswerable. However, many investors, for whatever reason, often seek to increase equity investment's expected returns. Some do so by buying stocks based on tips touting firms with high expected future growth. Others seek guidance from professional advisors. It is clear that some investors use market research information, including betas, as part of the stock selection process. This paper has the narrow focus of identifying the potential difficulties with various beta estimates that individual investors might use.

Literature Review

The considerable literature related to CAPM beta validity can be placed into two general categories: 1) papers specifically examining asset pricing models and 2) papers examining the methodology to estimate CAPM. Dimson and Mussavian (1999) provide an extensive review of the first area by chronicling asset pricing model development from Bernoulli (1738) to modern derivative pricing theories. Among the works cited are Markowitz (1952, 1959) and Sharpe (1963), which provides the CAPM's foundations, Merton's (1973) Intertemporal CAPM and Ross's (1976) Arbitrage Pricing Theory (APT).

The asset pricing model methodology literature is also quite extensive. Black, Jenson, and Scholes (1972) and Fama and McBeth (1973) provide early CAPM tests and point out the basic testing problem that one must regress individual stock returns or portfolio returns on its beta. However, betas are estimates that contain

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error, a violation of the underlying assumptions. Black, Jenson, and Scholes and Fama and McBeth create what is now known as the *two-pass* beta estimation method. Gibbons (1982) introduces a maximum likelihood estimation-based methodology to improve the variable errors problem.

Roll (1977) points out that the market proxy of these tests differs from the true CAPM market portfolio. More importantly, Roll demonstrates that unless one can accurately identify the market portfolio, the CAPM cannot be tested. Thus, researchers present more recent work as tests of market mean-variance efficiency.[b] There is also evidence that CAPM's single risk factor is inadequate. This insight spurred the development of Arbitrage Pricing Theory (APT) and testing additional factors to explain risk and return. Proposed factors include the price/earnings ratio (Basu, 1977), size (Banz, 1981), interest rates (Chan, Chen, and Hsieh, 1985), book/market ratio (Fama and French, 1992), and others.

Researchers continue to examine and trying to improve CAPM beta estimation. Blume (1975) finds that betas estimated using past data alone, *historical* betas, are poor predictors of future stock returns. He shows that betas migrate toward 1.0. Such work led to the replacement of historical betas with *adjusted* betas to better predict future risk. Rosenberg and Guy (1976) present a method to adjust historical betas for risk variables such as leverage. Investment practitioners label these estimates as *fundamental* betas.

Contemporary work recognizes that factors change over time. Howton and Peterson (1999) find support for allowing risk factors to shift. Campbell and Cochrane (2000) and Elyasiani and Nasseh (2000) compare the traditional CAPM with a consumption-based CAPM, but find the better model depends on the conditions.

The above work shows that academics are cognizant that beta estimates can vary based on factors such as the choice of the market portfolio proxy, the time period sampled, and the computation interval. A discussion of these matters can be found in Brigham and Ehrhardt (2002) or almost any other graduate level textbook. However, the problem needs further explanation. Investors should have some concept as to the impact that differing beta estimates can have on portfolio construction for a desired systematic risk level and the subsequent effect on portfolio returns.

Two recent articles along these lines are Groenewold and Fraser (2000) and Los (1999). Groenewold and Fraser consider results from estimating betas using five years of historical, monthly data. They find that the *five year* model performs as well or better than more complicated estimation techniques.

Los (1999) examines the problems of mutual funds that promote their relative systematic market risk (betas) to potential investors. He contends that investors are misinformed because betas generally underestimate the mutual funds' systematic risk. His article concludes that mismeasurement causes too many mutual funds to be advertised as *defensive* and too few to be classified as *aggressive*.

Los addresses this issue in a portfolio setting. It is seems likely that individual stocks might present a greater problem when selections are made using several sources of financial information. Campbell, et al. (2001) reinforce this concern by finding individual stock's volatility to be higher than the market portfolios.

Adding to the confusion is the advent of Internet financial data. Academics often promote individual's use of Internet data sources. *Financial Practice and Education* published "New Technologies in Finance," with papers by Ray (1996), Pettijohn (1996), and Herbst (1996) that examines the growing on-line data opportunities. Grinder (1997) and Woerheide (1999) also promote Internet data use. These papers show that it is increasingly possible for individual investors to obtain financial information that was previously available only to professional analysts from sources such as *smartmoney.com*, *Yahoo!*, *Dow Jones Interactive*, and *marketguide.com*.

However, academics also recognize some possible problems with different financial data sources. Financial analysis employs more accurate secondary data than most other social sciences. Nevertheless, Kahle and Walkling (1996) show that data selection and use can still have great impact. Similarly, Anderson and Lee (1997) find economically important differences between Dow Jones and *Compustat* ownership data by examining data provided by *Compact Disclosure*, *Value Line*, and *Spectrum*. Determining whether differences in beta estimates impact portfolio selection and subsequent return performance is a natural extension of this line of work.

Data and Methodology

There are several methods for CAPM beta calculation. *Value Line* betas utilize five years of weekly returns data and a 1.00 mean reversion adjustment, in keeping with Blume (1975). *Compustat*, in keeping with Groenewold and Fraser (2000), uses monthly returns over five years to calculate historical betas.[c] Each method has both practical and theoretical advantages and disadvantages. The current issue is whether the approach makes an economic difference for those

seeking to construct a portfolio with a given systematic risk level.

The current investigation evaluates beta consistency using *Compustat* and *Value Line* beta estimates for 1995-1998 and *Compustat* stock returns for 1996-1999.[d] The sample begins with all 4,866 companies from *Value Line's* CD ROM. Discarding firms with missing beta estimates leaves 1,177 companies. Removing firms not matching *Compustat's* files for each year leaves 534 observations. Finally, eliminating firms without the needed returns data results in the final sample of 329 companies. Table 1 presents the basic descriptive data. Z-scores are used to test the difference between sample means.

Table 1:
Descriptive Statistics for Capital
Asset Pricing Model Beta Estimates
Reported from *Value Line* and *Compustat*
(N = 329 for each)

Year	Data Source	Mean	Min.	Max.	**z-score**
	Value Line	1.0406	0.30	2.45	
1995	*Compustat*	0.7958	-5.28	4.55	4.21**
	Value Line	1.0131	0.45	2.20	
1996	*Compustat*	0.7499	-3.20	3.38	5.31**
	Value Line	0.9426	0.45	1.95	
1997	*Compustat*	0.6978	-1.58	10.37	5.01**
	Value Line	0.9553	0.40	1.85	
1998	*Compustat*	0.8354	-1.40	6.31	2.97**

*p<.05, **p<.01

Note that *Value Line's* mean beta estimates are larger than *Compustat's* with significance levels of 0.01 or better for each year's data. Given that the market's beta is 1.0 by definition, it is odd that two portfolios with 329 companies would exhibit different mean betas; even if they have differing estimation processes. The table also shows *Compustat* betas are more variable than *Value Line's*. While the more important question is whether the differences are economically material, another is why these numbers differ at all.

As stated above, *Value Line* and *Compustat* use different beta estimation techniques. Since both sources use five years of historical returns data and the S&P500 as the market portfolio proxy there are two possible reasons for their different reported betas: (1) *Value Line*'s use of weekly returns versus *Compustat*'s use of monthly returns and (2) *Value Line*'s mean reversion adjustment versus *Compustat's* omission of that technique.

The next step compares the companies with the highest and lowest betas from both datasets for each of the four years by examining the differences when calculating weekly and monthly betas for each company. One can note the difference between calculating the betas with weekly returns versus the reported betas in Value Line to isolate the difference that should be from the mean reversion process. The mean reversion process reduces or eliminates the calculation of a negative beta.

After comparing for the differences in the published betas, the discussion returns to the question of whether the differences are material. That is, will the calculation methods result in selecting different portfolios and, even more importantly, will the performance of those portfolios differ?

Testing the differences requires creating portfolios using various screening rules for the two data sources and then comparing the portfolios' composition and the subsequent year's returns. Based on past research showing unsystematic risk reduction with thirty or more stocks, constructed portfolios consist of thirty stocks. To examine extreme cases, construction includes the formation of a minimum and a maximum mean beta portfolio from each data source. For example, one portfolio consists of the thirty lowest beta stocks using 1995 *Value Line* betas. A comparison between that portfolio and the minimum-beta *Compustat* portfolio follows. Similar comparisons follow for 1996, 1997, and 1998, and then again for all four years with maximum mean beta portfolios. Comparisons consist of noting repeated company names to address composition similarities and means tests to determine returns differences.

Results

Table 2 presents the minimum beta portfolios. The *Compustat* portfolios show more variability while the minimum beta portfolios formed using *Value Line* data have mean betas greater than the *Compustat* data portfolios. The statistical difference is expected given the different beta estimation techniques. Note that the various portfolios share, at most, three of the thirty selections in any given year making it more likely that the subsequent portfolio returns differ and that the data source is a material factor.

Table 2.
Comparison of Minimum Capital Asset Pricing Model Beta Portfolios from *Value Line* and *Compustat* (N = 30 for each)

Year	Data Source	Mean	Min.	Max.	z-score
1995	*Value Line*	0.58	0.30	0.65	7.50**
	Compustat	-0.99	-5.28	-0.18	
Number of firms in common between the two portfolios--1					
1996	*Value Line*	0.59	0.45	0.65	9.39**
	Compustat	-0.77	-3.20	-0.09	
Number of firms in common between the two portfolios--0					
1997	*Value Line*	0.58	0.45	0.65	15.64**
	Compustat	-0.58	-1.58	-0.13	
Number of firms in common between the two portfolios--3					
1998	*Value Line*	0.58	0.40	0.65	9.77**
	Compustat	-0.18	-1.40	0.13	
Number of firms in common between the two portfolios--2					

*p<.05, **p<.01

Table 3 reports the results for the maximum beta portfolios. Again, the *Compustat* portfolios show the more extreme beta measures and the differences between portfolio betas are statistically significant. Also, the compared portfolios again share three or fewer common selections reinforcing the likelihood of subsequent performance differences.

Table 3:
Comparison of Maximum Capital Asset Pricing Model Beta Portfolios from *Value Line* and *Compustat* (N = 30 for each)

Year	Data Source	Mean	Min.	Max.	z-score
1995	*Value Line*	1.69	1.50	2.45	8.52**
	Compustat	2.76	2.08	4.55	
Number of firms in common between the two portfolios--1					
1996	*Value Line*	1.66	1.40	2.20	8.61**
	Compustat	2.42	1.77	3.38	
Number of firms in common between the two portfolios--0					
1997	*Value Line*	1.51	1.30	1.95	2.16*
	Compustat	2.15	1.47	10.37	
Number of firms in common between the two portfolios--2					
1998	*Value Line*	1.49	1.35	1.85	3.73**
	Compustat	2.14	1.66	6.31	
Number of firms in common between the two portfolios--3					

*p<.05, **p<.01

Table 4 presents an unusual observation. Tables 2 and 3 show the number of common selections from the two data sources in any year is three or less for the minimum or maximum beta portfolios. However, comparing the 1995 minimum beta *Value Line* portfolio with the 1995 maximum beta *Compustat* portfolio, reveals three common selections. The same pattern holds for other minimum/maximum portfolio comparisons. In total, Tables 2 and 3 show twelve stocks in common for the portfolios that minimize or maximize both data sources' portfolios, but Table 4 shows a total of twenty stocks in common for the minimum/maximum combinations. This result further supports the expectation that the stock selection process will lead to differing performance returns between the *Value Line* and *Compustat* data groups.

Table 4.
Minimum Portfolio Selections in Common with Maximum Portfolio Selections

Year	Minimum Portfolio Data Source	Maximum Portfolio Data Source	Number of companies in common
1995	*Value Line*	*Compustat*	3
	Compustat	*Value Line*	2
1996	*Value Line*	*Compustat*	4
	Compustat	*Value Line*	2
1997	*Value Line*	*Compustat*	4
	Compustat	*Value Line*	2
1998	*Value Line*	*Compustat*	1
	Compustat	*Value Line*	2

Table 5 compares the subsequent year's stock returns for the portfolios in Tables 2 and 3. Panel A reports minimum beta portfolios and Panel B for maximum beta portfolios. In three of the four cases in Panel A, the *Value Line* portfolio's return is nominally higher while Panel B reports that three of four Compustat portfolios show nominally higher returns. The compared returns in the two panels are not statistically different, but investors should observe that portfolios constructed following the same general guidelines produce returns differing by a factor of four to five times.

Table 5:
Comparison of Stock Returns from Capital Asset Pricing Model Beta Portfolios from *Value Line* and *Compustat* (N= 30 for each)

Year	Data Source	Mean	Min.	Max.	z-score
Panel A: Minimum Beta Portfolio Stock Returns (in %)					
1995	*Value Line*	16.59	-80.79	275.20	1.01
	Compustat	64.57	-50.04	1390.21	
1996	*Value Line*	28.78	-80.04	280.44	0.82
	Compustat	15.19	-67.82	170.79	
1997	*Value Line*	2.92	-78.05	150.00	0.18
	Compustat	0.54	-86.25	109.16	
1998	*Value Line*	68.62	-78.56	1447.37	1.01
	Compustat	11.20	-90.40	757.52	
Panel B: Maximum Beta Portfolio Stock Returns (in %)					
1995	*Value Line*	6.03	-73.99	186.84	1.34
	Compustat	25.69	-57.14	275.20	
1996	*Value Line*	13.16	-64.96	184.00	0.26
	Compustat	17.11	-74.67	280.44	
1997	*Value Line*	3.63	-87.90	299.14	0.45
	Compustat	-3.48	-90.80	120.69	
1998	*Value Line*	26.48	-99.83	484.26	1.30
	Compustat	125.47	-69.07	1580.00	

*p<.05, **p<.01

One possible reason that the returns data are not statistically different could be the sample size. Thirty stocks may still allow enough diversification to reduce unsystematic risk. Repeating the above tests using portfolio sizes of twenty, ten, and five stocks results in twenty-two of twenty-four cases having significantly different betas from the two data sources. Three of the twenty-four cases have significantly different returns, but at only a marginal level of significance supporting the argument that the three cases were found by chance. These results do *not* support the premise that portfolio size impacts the results.

Interestingly, tests do not indicate that either data source, *Value Line* nor *Compustat*, can be considered better predictors of future performance. In six of the eight cases under the thirty stock portfolios, the portfolio that should earn the higher return -- based on mean beta -- does so. That pattern continues for the smaller portfolio groupings; therefore, whether the betas are adjusted (*Value Line*) or historical (*Compustat*) is not a determining factor. One explanation is that the CAPM is invalid as its many critics contend. Another explanation is that CAPM should use *ex ante* betas and not historical betas unless the historical betas are not expected to change.

Conclusion

This study compares beta estimates from two sources. The fundamental issue is portfolio selection and performance. If portfolio compositions based on the data from the sources are the same, then the data source is irrelevant. If the portfolios differ, then the return performance must be compared to determine if one source produces superior portfolios. The results of this comparison of *Value Line* and *Compustat* indicate that there is a difference in their beta estimates leading to differing portfolio selections. However, there is no significant difference in the portfolios' subsequent returns performance although the returns would presumably be economically interesting to investors. Based on this analysis, when selecting portfolios-- whether of thirty, twenty, ten, or even as few as five stocks-- the data source for beta estimates does not matter.

Endnotes

[a] *Fama and French (1996) wrote one of several papers examining pricing models. Ross (1976) develops the arbitrage pricing theory (APT), Haugen (1999) questions both CAPM and APT implications, as does Elton (1999) in his presidential address to the American Finance Association.*

[b] *Grauer (1999) uses theoretical data to test CAPM implications. His results lead him to conclude "it does not bode well for those seeking to design an unambiguous test of the model" (p789).*

[c] Compustat will calculate beta using as few as two years of data if no more are available.

[d] *It is often difficult to recover historical betas from the indicated websites. However, investors can estimate the beta for any interval using historical price data.*

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