A comparison of published betas

Value Line and Merrill Lynch betas do differ, and for important reasons.

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There are two main sources of published betas: *Value Line Investment Survey*, and the Merrill Lynch *Security Risk Evaluation Report*. Do the two services provide similar estimates? If the estimates differ, why do they differ? The analysis presented here will help interested parties decide which service to use and why the selection of estimates is appropriate, as well as understand the implications of the choice.

A study by Meir Statman (1981) provides some significant information on this topic but leaves several important questions unanswered. The Statman study indicates there are differences in the two beta estimates. As the sample covers only 195 stocks, and because almost all portfolios contain a minimum of fifteen to twenty stocks, the analysis of the impact on the differences of forming portfolios was limited to ten stocks. This analysis appears too limited to be useful for most portfolio managers. In addition, Statman was not able to identify why the estimates of beta differed for various individual stocks or portfolios of stocks.

Our study involves a larger sample, which allows us to examine the impact of various portfolio sizes up to forty securities. We increased the sample size to over 1,000 stocks by computing the beta estimates on the basis of the techniques and adjustment equations used by the two services, rather than depending on their published adjusted betas. By examining the different estimation procedures used, we are able to answer the following questions:

1. What is the impact of using different market indicator series, for example, the S&P 500 series versus the NYSE Composite series?
2. What is the impact of the differences in the rate of return interval employed, such as monthly observations versus weekly observations?
3. What is the effect on the beta for a portfolio of different size?
4. What security characteristics influence the size and direction of beta estimates?

We first discuss the alternative procedures for estimating beta and review the literature related to each of the differences. The next section contains a discussion of the tests employed and presents the initial test results. After examining alternative reasons for the interval effect, we discuss implications of the results for those who use published betas or who compute their own.

ALTERNATIVE PROCEDURES FOR ESTIMATING BETA

Both Merrrill Lynch and Value Line employ the same market model to calculate "unadjusted" betas, yet the betas published by the two services differ in four major areas.

Rates of Return. In applying the market model, Merrill Lynch calculates the percentage change in stock prices over time as the rate of return ($R_{i,t}$; $R_{m,t}$), while Value Line uses log price relatives to derive the rates of return. This difference in computed rates of return is small for returns of less than 10 to 15 %, which includes most weekly and monthly returns.

Market Indicator Series. Merrill Lynch uses the S&P 500 Composite Index as the market indicator series, while Value Line uses the NYSE Composite Series. This should not affect beta, because both

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indicator series are value-weighted and employ large samples, and almost all sample stocks are from the NYSE. In line with these similarities, the correlation between daily percentage price changes exceeds 0.90, and this correlation would be higher for longer intervals.[1]

Adjustment Equations. Marshall Blume recognized in 1975 that betas had a "regression tendency": High betas tend to overpredict future betas and low betas tend to underpredict. To avoid large forecasting errors, the two services therefore use the following adjustment equation:

Merrill Lynch: Adj. beta = 0.33743 + 0.66257 (unadj. beta), and

Value Line: Adj. beta = 0.35 + 0.67 (unadj. beta).

In addition, all Value Line betas are rounded to a second decimal place of 0 or 5 — for example, 0.90, 0.95, 1.05, 1.10. Even so, the similar adjustment equations should not have a large impact.

The Interval Effect. Both services consider a total time period of five years, but use different time intervals when computing the rates of return. Merrill Lynch uses monthly returns (60 observations), while Value Line uses weekly returns (260 observations). This difference could have a definite impact on the betas because of non-synchronous trading. Scholes and Williams (1977) showed the problem of estimating betas when there was non-synchronous trading of securities. Dimson (1979) showed that beta estimates are typically biased downward by non-synchronous trading. In turn, the problem of non-synchronous trading is greater for weekly data than with monthly data. Dimson found a downward bias for shorter interval betas, confirmed and analyzed by Roll (1981). Therefore, we expect an interval effect.

Prior Study

Statman chose 195 firms with the highest market value of common stock. He used the reported betas from Value Line (VL) and Merrill Lynch (ML) for the five-year period ending in September 1978. The regression of the adjusted betas generated the following equation:

ML beta = 0.125 + 0.879 VL beta

Assuming no difference in the beta estimates, the intercept would be zero and the slope coefficient 1.00. This intercept was significant, but subsequent portfolio regressions did not have a significant intercept. Notably, the coefficient of determination (R^2) was only 0.55. The results did not improve for portfolios of different sizes. As we pointed out above, Statman considered portfolios of only ten stocks, which is a small size compared with the sizes used in most studies of this type.

DATA AND EMPIRICAL TESTS

Data

We computed beta coefficients for three non-overlapping subperiods: 1126 securities during 1970–1974, 1210 securities for 1975–1979, and 1165 securities for 1980–1984.

We designed the empirical tests to identify why there may be discrepancies in published betas estimated over the same five-year period. Are these differences due to the return calculation effect, the index effect, the interval effect, or the adjustment equation effect? To this end, we calculated the following eight beta coefficients for each security:

B1 — monthly interval, S&P 500 index, percentage change return,

B2 — monthly interval, NYSE index, percentage change return,

B3 — monthly interval, S&P 500 index, log return,

B4 — monthly interval, NYSE index, log return,

B5 — weekly interval, S&P 500 index, percentage change return,

B6 — weekly interval, NYSE index, percentage change return,

B7 — weekly interval, S&P 500 index, log return, and

B8 — weekly interval, NYSE index, log return.[2]

We calculated eight additional betas by applying the ML adjustment equation to the four monthly betas and the VL technique to the four weekly betas. Hence, sixteen betas were examined for each security.

Table 1 contains descriptive statistics for the unadjusted and adjusted beta estimates from each subperiod. We assembled three categories of paired betas to isolate the return calculation effect, the index effect, and the interval effect. As an example, the index effect can be investigated by analyzing the following set of paired unadjusted betas: (B1, B2), (B3, B4), (B5, B6), and (B7, B8). For each pair of unadjusted betas, the return calculation and the interval are identical in order to determine the effects of different market indexes. In a similar manner, we analyzed the interval effect using the following paired unadjusted betas: (B1, B5), (B2, B6), (B3, B7), and (B4, B8), and then the return calculation effect with the following paired unadjusted betas: (B1, B3), (B2, B4), (B5, B7), and (B6, B8). The classification of paired betas allows us to examine the magnitude of each effect individually by controlling for the other estimation procedures.

TABLE 1

Descriptive Statistics of the Unadjusted and Adjusted Beta Estimates

Beta Estimate	Interval	Index	Return*	1970-1974 Mean	1970-1974 Standard Deviation	1975-1979 Mean	1975-1979 Standard Deviation	1980-1984 Mean	1980-1984 Standard Deviation
Unadjusted Betas									
B1	Monthly	S&P 500	%Δ	1.099	0.382	1.302	0.529	1.040	0.492
B2	Monthly	NYSE	%Δ	1.105	0.382	1.299	0.533	1.028	0.479
B3	Monthly	S&P 500	Log	1.107	0.384	1.254	0.486	1.039	0.486
B4	Monthly	NYSE	Log	1.113	0.384	1.252	0.491	1.026	0.474
B5	Weekly	S&P 500	%Δ	1.017	0.384	1.035	0.428	0.881	0.375
B6	Weekly	NYSE	%Δ	1.041	0.387	1.050	0.430	0.895	0.375
B7	Weekly	S&P 500	Log	1.012	0.379	1.026	0.421	0.877	0.370
B8	Weekly	NYSE	Log	1.033	0.381	1.041	0.423	0.890	0.370
Adjusted Betas									
B1	Monthly	S&P 500	%Δ	1.066	0.253	1.200	0.350	1.026	0.326
B2	Monthly	NYSE	%Δ	1.070	0.253	1.198	0.353	1.019	0.317
B3	Monthly	S&P 500	Log	1.071	0.254	1.168	0.322	1.026	0.322
B4	Monthly	NYSE	Log	1.075	0.254	1.167	0.326	1.017	0.314
B5	Weekly	S&P 500	%Δ	1.032	0.257	1.043	0.287	0.940	0.251
B6	Weekly	NYSE	%Δ	1.047	0.259	1.054	0.288	0.950	0.251
B7	Weekly	S&P 500	Log	1.028	0.254	1.038	0.282	0.937	0.248
B8	Weekly	NYSE	Log	1.042	0.255	1.048	0.283	0.947	0.248

* Security and market portfolio returns were calculated by either a percentage change (%Δ) or a log price relative (log).

The paired betas in Table 1 show that the return calculations and the market index had only a minor influence on the estimated betas. On the other hand, the interval selected for calculating returns produced a significant effect on the distribution of betas. The average weekly betas varied from seven to twenty-four percentage points below the monthly betas. Indeed, while the adjustment resulted in a narrower distribution of betas, the means of the weekly betas were still three to sixteen percentage points less than the monthly betas.[3] Consequently, the choice of interval substantially affects the distribution characteristics of estimated betas.

We also examined the published betas, the adjusted B1 beta (the Merrill Lynch beta) and the adjusted B8 beta (the Value Line beta). Notably, the means of the adjusted B8 (VL) betas in Table 1 are 2.4, 15.2, and 7.9 percentage points below the means of the adjusted B1 (ML) betas in each of the three subperiods, respectively. Furthermore, the differences between the means of the published betas were all significant at the 0.01 level.[4]

Factorial Analysis of Variance

We performed a factorial analysis of variance to test the statistical significance of the three different beta estimation procedures. This procedure permits simultaneous testing of the variance of several hypotheses. Specifically, we constructed a three-variable factorial analysis of variance that considered the interval effect, the index effect, and the return calculation effect. A 2 × 2 × 2 factorial design yields eight cells corresponding to the eight different unadjusted betas.[5] This test enabled us to determine the independent and the interactive effects of the three independent variables.

Table 2 presents the factorial analysis of variance results for the three subperiods. The test results for the three main effects reveal that the F-statistics for the interval effect are all exceptionally large and significant. In contrast, the index effect was never statistically significant, and the return calculation effect was significant only during the 1975–1979 period.

In view of the importance of published betas in portfolio management decisions, we worked up a multiple classification analysis on nine portfolio sizes, including one, two, three, five, ten, twenty, thirty, or forty securities in a portfolio.[6] Calculations of eta-squared statistics indicate that the interval effect increased as the portfolio size increased.[7] For example, the interval effect explains between 34% and 72% of the variation among forty-security portfolio betas.

TABLE 2

Factorial Analysis of Variance Results for the Unadjusted Betas

Source of Variation	F-Test 1970-1974 Data F(1, 9000)	F-Test 1975-1979 Data F(1, 9672)	F-Test 1980-1984 Data F(1, 9312)
Interval	99.253**	624.414**	272.530**
Index	3.026	0.454	0.016
Return Calculation	0.006	8.809**	0.115

** Significant at the 0.01 level.

Further, the interval effect that is significant for the individual security betas becomes more prevalent for the portfolio betas.

In sum, the factorial analysis of variance indicated that the interval effect overwhelms the impact of different market indexes and return calculations. Also, on average, weekly betas are lower than monthly betas, which raises several important questions. First, is the direction and the magnitude of the interval effect similar for all individual securities? If not, which individual characteristics explain the direction and magnitude of the interval effect?

ANALYSIS OF THE INTERVAL EFFECT

Why the Interval Effect?

Several articles have suggested alternative hypotheses for the interval effect. Hawawini (1983) suggests that the impact of the interval effect is dependent on the size of the firm: Securities with a smaller than average market value will experience a decline in systematic risk when the interval is shortened; in contrast, firms with large market values will experience an increase in betas when the interval is shortened. This differential impact occurs because of the intertemporal (non-contemporaneous) relationships between the daily returns of individual securities and the market indicator series. Specifically, all stocks do not trade continuously, which means that changes in some stock prices lag behind the market. Dimson (1979) contends that this pattern is most prevalent among small firms. This effect is demonstrated further in Scholes and Williams (1977). Hawawini measures this non-contemporaneous trading effect by comparing the correlation coefficient for contemporaneous trading to the correlation coefficient for non-contemporaneous trading; he then specifies a q-ratio that relates the two correlation coefficients.

It is hypothesized that small firms will have more non-contemporaneous trading and, therefore, larger q-ratios. This is demonstrated in Hawawini. In turn, a higher ratio of non-contemporaneous trading means that the computed betas will decline as the interval is shortened, because the beta calculation is based upon the relationship of contemporaneous returns. The relationship is specified as follows: Betas will decrease faster, the larger the security's q-ratio, and betas will increase faster, the smaller the security's q-ratio.

In summary, there is a strong theoretical relationship between the q-ratio and the impact of the interval on beta and also a good empirical relationship between the q-ratio and the market value of a firm, such that small firms typically have high q-ratios and vice versa. Therefore, betas for small firms, which typically have larger q-ratios, will decline as the interval is shortened.

Alternatively, Levhari and Levy (1977) and Levy (1984) hypothesize that the factor that influences the interval effect is the size of the beta. They contend that stocks with betas close to one are generally invariant to the interval, that stocks with betas less than one increase when the interval is shortened, and that stocks with large betas decline when the interval is shortened.

Tests of the Interval Impact

To evaluate the Levy hypothesis empirically, we ranked all securities by the B1 beta and then formed deciles for each subperiod. The means of the weekly betas (B5 through B8) for each decile were compared to their corresponding monthly betas (B1 through B4). The Levy hypothesis predicts that the weekly betas would be larger than the monthly betas for the low-beta deciles and smaller for the high-beta deciles.

The beta level decile results in Table 3 show that weekly betas are indeed significantly smaller than the monthly estimates in the high-beta deciles. Although the results also show that the weekly betas are significantly greater for the low-beta deciles during 1980–84, none of the weekly betas is higher during 1975–1979 or during 1970–1974. This implies that the level of systematic risk fails to explain much of the interval effect.[8]

To test the firm size hypothesis, we ranked the stocks by their average monthly market value for each subperiod. The statistics in Table 4 show that the distribution of NYSE security market values is skewed to the right — the average market value is considerably higher than the median value. Although most NYSE firms are less than $0.5 billion in size, a minority

TABLE 3

Monthly Versus Weekly Mean Unadjusted Betas Ranked by Beta Level

Beta Level Decile	1970-1974 Data		1975-1979 Data		1980-1984 Data	
	Monthly	Weekly	Monthly	Weekly	Monthly	Weekly
1 (Highest)	1.813	1.570**	2.311	1.676**	1.926	1.457**
2	1.504	1.349**	1.793	1.406**	1.528	1.207**
3	1.356	1.196**	1.569	1.270**	1.353	1.078**
4	1.237	1.114**	1.393	1.111**	1.208	0.962**
5	1.123	1.045**	1.281	1.061**	1.090	0.932**
6	1.044	0.982	1.164	0.983**	0.957	0.814
7	0.956	0.932	1.053	0.912**	0.832	0.789
8	0.860	0.861	0.916	0.810**	0.699	0.697
9	0.718	0.723	0.757	0.642**	0.506	0.558**
10 (Lowest)	0.505	0.518	0.533	0.514	0.274	0.387**

* The weekly mean beta is significantly different from its corresponding monthly mean beta at the 0.05 level.

** The weekly mean beta is significantly different from its corresponding monthly mean beta at the 0.01 level.

of firms have market values of $1 to $40 billion. This distribution of market values is important, because Hawawini (1980) predicts that the measured beta will increase as the interval is shortened for high market value securities. Table 4 shows that the percentage of firms with market values above the mean is approximately 22% to 24% of the total number.

For each subperiod, deciles were formed based upon the market value ranking of firms. We also formed an additional category of the largest fifty firms. Table 5 lists the average betas for the largest fifty firms, for deciles 1, 5, and 10, and for the entire sample; complete data for all deciles are available from the authors.

The weekly betas for decile one stocks (largest firms) were all greater than their corresponding monthly betas. Most of the weekly betas in the largest fifty firm category were significantly larger. All the below-average sized firms exhibited significantly lower weekly betas, and the strength of the downward bias increases for smaller firms. For decile ten stocks (smallest firms) during 1975–1979, the interval effect causes a remarkable 50 to 60 percentage point difference. *Clearly, the security's market value affects both the size and the direction of the monthly-weekly interval effect.*[9] As betas do not all shift in the same direction or by the same magnitude, the ranking of securities

TABLE 4

Descriptive Statistics for the Distribution of Firm Market Values (Market Values in Millions of Dollars)

Sample Characteristics	1970-1974	1975-1979	1980-1984
Mean	$ 523	$ 593	$ 923
Standard Deviation	1,725	1,961	2,635
Minimum	$ 4	$ 5	$ 6
1st Quartile	54	59	108
Median	143	170	313
3rd Quartile	442	532	872
Maximum	37,918	38,221	50,613
Number of Firms with Market Values Less than the Mean	884 Firms (78.5%)	934 Firms (77.2%)	885 Firms (76.0%)
Number of Firms with Market Values More than the Mean	242 Firms (21.5%)	276 Firms (22.8%)	280 Firms (24.0%)
Total Firms	1,126 Firms	1,210 Firms	1,165 Firms

TABLE 5

Unadjusted Mean Betas by Market Value Categories

Market Value Categories (Range of Market Values in $ Millions)	MONTHLY BETAS				WEEKLY BETAS			
	B1	B2	B3	B4	B5	B6	B7	B8
1970-1974 Data:								
Largest 50 Firms (1,782-37,918)	1.039	0.987	1.031	0.979	1.070	1.039*	1.068	1.034*
Deciles								
1 (1,029-37,918)	1.045	1.006	1.035	0.995	1.046	1.022	1.043	1.017
5 (145-222)	1.123	1.131	1.130	1.139	1.034**	1.053**	1.030**	1.045**
10 (0-27)	1.107	1.141	1.121	1.153	0.985**	1.043**	0.977**	1.032**
Entire Sample	1.099	1.105	1.107	1.113	1.017**	1.041**	1.012**	1.033**
1975-1979 Data:								
Largest 50 Firms (2,317-38,222)	0.974	0.925	0.962	0.913	1.036*	1.011**	1.031*	1.006**
Deciles								
1 (1,120-38,222)	1.015	0.972	1.002	0.959	1.029	1.011	1.023	1.005*
5 (170-260)	1.281	1.273	1.238	1.232	1.043**	1.055**	1.035**	1.047**
10 (0-28)	1.682	1.725	1.566	1.614	1.080**	1.135**	1.064**	1.116**
Entire Sample	1.302	1.299	1.254	1.252	1.035**	1.050**	1.026**	1.041**
1980-1984 Data:								
Largest 50 Firms (3,473-50,613)	0.997	0.956	0.984	0.942	1.033	1.021*	1.027	1.014*
Deciles								
1 (1,970-50,613)	0.998	0.966	0.979	0.946	1.020	1.013*	1.014	1.006*
5 (315-456)	1.038	1.025	1.033	1.019	0.874**	0.885**	0.869**	0.880**
10 (0-49)	0.962	0.968	0.985	0.990	0.709**	0.736**	0.704**	0.731**
Entire Sample	1.040	1.028	1.039	1.026	0.881**	0.895**	0.877**	0.890**

* The weekly mean beta is significantly different from its corresponding paired mean beta at the 0.05 level.
** The weekly mean beta is significantly different from its corresponding paired mean beta at the 0.01 level.

by a particular computed beta will differ depending upon the return interval used. This feature explains why the previous tests between published betas consistently experienced low correlation statistics.

CONCLUSION AND IMPLICATIONS

Considering that substantial variation exists between the two most widely used beta estimates, it is important to identify why published betas differ. The selection of an index or a rate of return calculation does not affect the estimated betas. Our results demonstrate that the major reason for observed variation between published betas is the interval effect. Furthermore, the security's market value is a significant predictor of the direction and magnitude of the difference.

Consequently, practitioners and academicians should be aware of the interval used in computing systematic risk. Shorter intervals can lead to overvaluation of small-sized firms and also to overestimation of the risk-adjusted performance of a portfolio of small-sized firms, relative to measurements based on the longer interval in such an analysis. In contrast, using a shorter interval would cause analysts to underestimate the value and risk-adjusted performance for a portfolio of large-size firms. In short, analysts must be certain about the interval used to estimate beta as well as the size characteristics of the stocks involved.

[1] For a discussion of these price indicator series and a correlation matrix among the series for daily intervals, see Reilly (1986, Chapter 5).

[2] Monthly returns were calculated from the last trading day of each month. Following Value Line's procedure, weekly returns were based upon Wednesday closing prices. On Wednesdays when the NYSE was closed, the return was based upon the Tuesday closing price.

[3] Both adjustment equations yield adjusted betas that are typically closer to one. Holding all other factors constant, the difference between the two adjustment equations produces a VL beta that is greater than the ML beta by an amount equal to $0.01257 + 0.00743 \times$ Unadjusted Beta. Because the impact generated by the adjustment equations is simply a linear expression, the empirical analysis focuses on the other three differences between published betas.

[4] The t-statistics for the differences between the published betas were 4.64, 25.03, and 14.49 for each of the subperiods, respectively.

[5] Eight different betas were computed for each firm. Hence, the number of estimated betas employed in the factorial tests amounted to eight times the number of securities.

[6] Securities were randomly selected on a non-replacement basis and formed into portfolios assuming an equal investment in each security.

[7] The eta-squared statistic measures the proportion of the total sum of squares explainable by each factor. The statistic was computed for each of the nine portfolio sizes in every subperiod to indicate the strength of each factor as a predictor. The interval effect was significant at the 0.01 level for all portfolio sizes in every subperiod. See Andrews, Morgan, Sonquist, and Klem (1973).

[8] Schwartz and Whitcomb (1977) note that the Levy hypothesis may apply to very lengthy intervals (exceeding six months), but not to shorter intervals.

[9] Although previous studies investigated the relationship between systematic risk measurements and trading frequency, they did not empirically test the monthly-weekly interval effect across a large number of NYSE securities.

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