Analysis of the Interest Rate Sensitivity of Common Stocks

Empirical equity duration is a useful measure.

Frank K. Reilly, David J. Wright, and Robert R. Johnson

The association between interest rate changes and stock returns has been of enduring interest to investors. Investors, the financial press, and even the popular press frequently look to Federal Reserve policy reflected in interest rate changes. U.S. and global stock and bond markets actually experienced significant changes in response to nuances in the language of Former Fed Chairman Alan Greenspan and other prominent Fed officials.

At the same time, there have been analytical developments related to fixed-income securities that can be used to measure the effect of interest rate changes on stocks. Specifically, an alternative specification of duration, a widely used measure of interest rate sensitivity for bonds, can be applied to common stock.

The notion of duration for fixed-income securities has been around since the seminal work of Macaulay [1938]. Then 30 years later, Fisher and Weil [1971] applied the concept of duration to bond portfolio immunization. Since then Hopewell and Kaufman [1973] derived the relation between modified Macaulay duration and interest rate sensitivity for option-free bonds that has become a major tool in bond portfolio management.

Recent work using effective duration has expanded the measurement of interest rate sensitivity for bonds with embedded options as discussed in Fabozzi, Buetow, and Johnson [2001], Dunetz and Mahoney [1988], and Fabozzi, Pitts, and Dattatreya [1997]. A major requirement for using effective duration is an asset pricing model that can derive an estimate of prices, given a change in interest rates. For many assets whose pricing is influenced by interest rate changes (real estate, mortgage-backed securities, and common stocks), it is not possible to derive a meaningful

FRANK K. REILLY
is the Bernard J. Hank professor in the Mendoza College of Business at the University of Notre Dame in Notre Dame, IN.
Reilly.1@nd.edu

DAVID J. WRIGHT
is a professor of finance in the College of Business and Technology at the University of Wisconsin—Parkside in Kenosha, WI.
Wright@UWP.edu

ROBERT R. JOHNSON
is a managing director of the CFA Institute in Charlottesville, VA.
bob.johnson@cfainstitute.org

mathematical price estimate when interest rates change. It is not possible to estimate price accurately for these assets because other variables beyond interest rates also affect the valuation of these assets.

In the case of common stock, these other variables include earnings growth or the availability of growth options (see Hevert, McLaughlin, and Taggart [1998]). Research has suggested we estimate the interest rate sensitivity of these assets using *empirical duration*, which is based upon the historical relation between asset price changes and interest rate changes. Examples of studies using empirical duration include Leibowitz [1987] and Cornell [2000] for common stock, and Hayre and Chang [1997] for mortgage-backed securities.

We extend the aggregate stock market work of Leibowitz [1986] and expand the analysis of the interest rate sensitivity of common stock by considering alternative sectors of the stock market (e.g., stocks with different firm size; growth and value stocks) and different industries (e.g., financial services, chemicals, technology, precious metals, utilities). Five important results are documented:

1. Dramatic changes over time in the empirical duration for the aggregate U.S. stock market.
2. Substantial differences in the total period average empirical duration for alternative stock sectors and different industries.
3. Significantly different patterns of empirical duration over time for the aggregate stock market, alternative stock sectors, and different industries.
4. A significant and negative relation between market risk and the interest rate risk for alternative industries.
5. Differences in interest rate sensitivity for alternative economic sectors, industries, and investment styles generally consistent with economic expectations.

These results are significant to investment analysts and portfolio managers because they demonstrate the importance of interest rate changes to the valuation of equity securities. The results also indicate how difficult it is to apply the concept of duration to equity securities because the interest rate effect differs between alternative stock sectors and industries, and this effect changes over time. That is, the empirical duration of common stocks (for both the aggregate market and by industry) is shown to be very unstable.

LITERATURE REVIEW

Our literature review focuses on developments and insights related to equity duration. The research helps us understand why we need to use empirical duration, how to compute empirical duration properly, why we should expect differences in duration among sectors and industries, how to interpret differences among industries and sectors, and why there are changes over time in the empirical duration.

A detailed discussion of equity duration in Leibowitz [1986] considers the duration of a total portfolio of both bonds and stocks. Leibowitz, Sorenson, Arnott, and Hanson [1989] provide an insightful discussion of the reason for the great difference between the duration implied by the dividend discount model (DDM) and the duration observed in the market (i.e., the empirical duration). While the DDM assumes a *constant* growth rate of dividends, irrespective of inflation, Leibowitz et al. argue that most companies experience some flow-through of inflation to their pricing that impacts the firm's growth rate of earnings and dividends, which causes a decline in the empirical duration.

Flow-through implies that the amount of the empirical duration *during a period of inflation* will be dictated by a firm's or industry's flow-through of inflation to earnings growth. Specifically, industries with very little inflation flow-through (such as utilities) should have relatively high equity durations compared to industries with fairly strong inflation flow-through (such as natural resources), which should have relatively low equity durations.

Leibowitz et al. [1989] and Leibowitz and Kogelman [1993] analyze equity duration in the context of a franchise factor model and its implication for growth and value stocks because of the difference in flow-through for tangible value (TV) and franchise value (FV). Sweeney and Warga [1986] estimate the specific impact of interest rate changes on stock returns using a two-factor arbitrage pricing theory model that includes the market effect and changes in the yield on long-term government bonds.

Hevert, McLaughlin, and Taggert [1998] examine the equity duration for high-growth and low-growth stocks using a model that considers both the market effect and interest rates. Their results indicate that it is important to consider the market effect and that interest rate sensitivities vary across time periods.

Finally, Cornell [2000] considers the computation of duration for equity portfolios using several forms of the empirical duration model. His results show that the effect of interest rates on stock prices is generally transmitted

through the market factor, but there is also a significant impact of interest rate changes on stocks *after* considering the market effect.

METHODOLOGY AND DATA

To determine the interest rate sensitivity of common stocks, we use two models. Model 1 is a univariate model using the measurement technique employed by Hayre and Chang [1997] as follows:

$$\%\Delta A_{i,t} = \alpha_i + ED_i\,(\Delta Y_t) \qquad (1)$$

where:

$\%\Delta A_{i,t}$ = percentage change in price for asset i during month t;
α_i = constant term;
ED_i = estimate of empirical duration for asset i; and
ΔY_t = change in the Treasury yield during month t.

This model examines the direct relation of the aggregate stock market to changes in interest rates.

When we examine industries and sectors, an important consideration is the differential impact of the aggregate market on alternative industries and sectors. To capture this differential effect and pinpoint the specific interest rate effect, we consider a second model, a multivariate model suggested and supported in Sweeney and Warga [1986], Hevert, McLaughlin, and Taggart [1998], and Cornell [2000]:

$$\%\Delta A_{i,t} = \alpha_1 + \beta_i(R_t) + ED_i\,(\Delta Y_t) \qquad (2)$$

where the new terms are:

β_i = estimate of the industry or sector beta relative to the aggregate market return; and
R_t = stock market return during month t.

This model measures the fact that alternative industries have a differential relation to the aggregate stock market and then provides the marginal impact of interest rates after allowing for the market effect.

We analyze a broad cross-section of industries and sectors to determine the differences among stocks as postulated by Leibowitz et al. [1989]. In addition, we further document the substantial changes over time in equity duration suggested by Leibowitz and Kogelman [1987] and documented by Hevert, McLaughlin, and Taggart [1998] for high- and low-growth stocks. To achieve these dual goals, we use a Treasury bond series to measure yield changes and three common stock data sets.

The yield changes are based on the Lehman Brothers U.S. Treasury bond series, which includes all outstanding U.S. Treasury securities with initial maturities longer than one year. The number of U.S. Treasury issues included in any month ranges from 55 issues (in September 1976) to 181 issues (in April 1993). It is a market value-weighted series that uses the methodology consistent with Merrill Lynch, Ryan Labs, and Salomon Brothers.

An analysis of the aggregate U.S. stock market involves an analysis of both the S&P 500 series and the Dow Jones Wilshire 5000 series. We consider the S&P 500 series because it is widely known and has been used in numerous studies.

The Dow Jones Wilshire 5000 series is considered to be the most complete and diverse common stock series for the U.S. stock market and includes a wide range of stocks in terms of both size and investment style. There are also two different weighting systems available for the Dow Jones Wilshire series: market value-weighted (which is how most series are constructed) and equal-weighted. By definition, the equal-weighted series gives more significance to small-cap stocks as discussed in Reilly and Brown [2006], and will provide some insights on this size effect.

Economic Sectors, Industry Groups, and Industries

The sector-industry series used in this study reflects the new Global Industry Classification Standard (GICS),[SM] which is the exclusive industry classification structure used for Standard & Poor's industry index calculations. It is described in Maitland and Blitzer [2002].

Standard & Poor's developed the GICS in collaboration with Morgan Stanley Capital International (MSCI). GICS currently comprises 10 sectors, 23 industry groups, 59 industries, and 122 subindustries. A company is assigned to a single GICS subindustry according to its principal business activity as determined by Standard & Poor's and MSCI. Revenues are a significant factor in defining an industry's business activity along with earnings analysis and market perception. Most of the new industry series have a starting date of October 1989.

We analyze several sets of S&P data as follows:

1. The ten GICS economic sector indexes for October 1989–November 2003 (170 months).

2. 22 GICS industry groups that combine similar industries such as those in transportation, energy, and retailing. These data are for the period October 1989-November 2003.
3. 46 GICS industries with data for the full period October 1989-November 2003.
4. As Maitland and Blitzer [2002] describe, a number of the new GICS industries had close relationships with the old industries as determined by firm make-up and high correlations of returns during a period of overlapping data. We select 25 of the 46 industries that had return correlations of at least 90% during the overlapping period. Using the linked data from the old series, we are able to examine these 25 industries for the extended period from September 1976 through November 2003 (323 months).

Equity Style Indexes

We examine six different style indexes created by Wilshire Asset Management for the period January 1980-December 2003 (288 months). These indexes include three size categories (large-cap, mid-cap, and small-cap) and two investment styles (growth and value). Stocks included in the large-cap indexes are selected from the largest 750 companies in the Dow Jones Wilshire 5000. The mid-cap indexes include companies ranked 501 to 1,250; the small-cap indexes companies ranked 751 to 2,500; and the micro-cap indexes companies ranked 2,501-5,000. Note that the mid-cap universe overlaps both the large-cap and small-cap universes.

In addition to the pure size indexes, the stocks in each universe are screened quarterly for placement in either the growth or value indexes. Key variables used by Wilshire for the value index screenings include the price-earnings ratio and the price-to-book ratio, while the growth index screenings use sales growth, return on equity, and dividend payout. The result is six Wilshire indexes that combine size and style as follows: Large-Cap Value, Large-Cap Growth, Mid-Cap Value, Mid-Cap Growth, Small-Cap Value, and Small-Cap Growth.

Equity Size Indexes

Because of significant interest in the effect of size on equity duration, we examine a large cross-section of size indexes—from large-cap to micro-cap, as well as several index series within alternative size classes. In most cases, the difference in these size indexes is a broader set of stocks (e.g., going from the largest 750 versus the largest 2,500). In addition, for the small-cap set we consider indexes outside the Wilshire universe—i.e., the Russell 2000 small-cap series and the Ibbotson small-cap index. The intent is to provide confirmation within a size category and strong evidence across size categories (e.g., the difference between large-cap and micro-cap results).

PRESENTATION OF RESULTS

The presentation and discussion of results follows the common stock data sets, where results are divided by sample time period and breadth of sample.

Aggregate Bond and Stock Markets: 1976-2003

Exhibit 1 provides the Model 1 results for the Lehman Brothers Treasury Index and the S&P 500 followed by 25 industries ranked by the total-period empirical duration (ED) estimate. There is an estimate of ED based upon a regression for the full period and also an average of the EDs for each month based on the 36-month moving regressions. The reason for the difference in the two ED values is that the 36-month regressions involve overlapping months, so some months are used for only one estimate while others are used for up to 36 estimates.

The empirical duration for the Treasury index was 3.30 during the 327 months with a monthly range from 2.59 to 5.66. While the total-period ED for the S&P 500 was only 1.78, it was substantially more volatile, ranging from −11.78 to 8.67.

Exhibit 2 is a time series plot of the 36-month moving empirical durations for both the Treasury index and the S&P 500 index. The ED of the Treasury index was initially about 2.88. It declined to a low of about 2.59 during 1980, and subsequently experienced an overall increase to a high of about 5.60 at the end of the study period. Overall, the ED series for Treasury bonds experienced a fairly stable upward trend.

To confirm the viability of the empirical duration estimate, Exhibit 3 displays a time series plot of the moving average ED for the Lehman Brothers Treasury Index and the moving average modified-duration series for this index as set in the Lehman Brothers "Global Family of Indices" (annual). The closeness of the two plots indicates a strong similarity between the two duration series, which is what one would expect, as for most of this period Treasury bonds

EXHIBIT 1

Empirical Durations—Model 1 (monthly data: Sept. 1976-Nov. 2003)

	MODEL 1 Estimate for the Entire Period (Sept. 1976 - Nov. 2003)			MODEL 1 36-Month Moving Empirical Durations (Sept. 1979 - Nov. 2003)			
Indexes	Emp. Dur. Estimate	Emp. Dur. t-statistic	Model R-square	Average	Minimum	Maximum	Min.-Max. Range
Lehman Bros. Treasury	3.298	-51.567	0.891	4.13	2.59	5.66	3.08
S&P 500	1.781	-3.519	0.037	2.19	-11.78	8.67	20.45
WIL-5000(MV Wtd.)	1.689	-3.251	0.032	1.83	-11.72	8.42	20.14
WIL-5000(EQUAL Wtd.)	0.928	-1.375	0.006	-0.65	-14.14	7.92	22.07
S&P Industry Stock Indexes (Ranked by the Entire Period Empirical Duration Estimate)							
Electric Utilities	4.134	-8.800	0.192	4.83	-10.69	10.19	20.89
Commercial Banks	3.979	-5.247	0.078	4.09	-9.34	13.31	22.65
Tobacco	3.520	-4.298	0.054	4.63	-1.99	14.97	16.96
Food Products	3.472	-6.466	0.114	4.41	-2.50	12.09	14.59
Healthcare Equip & Suppl	3.432	-5.542	0.086	3.34	-7.74	13.97	21.72
Personal Products	3.129	-4.330	0.055	3.25	-9.72	15.31	25.03
Pharmaceuticals	3.101	-5.038	0.072	4.06	-5.81	12.85	18.66
Household Products	3.045	-5.177	0.076	3.18	-11.42	11.84	23.26
Building Products	2.935	-3.664	0.040	4.57	-8.58	11.28	19.85
Beverages	2.784	-4.542	0.060	1.87	-12.22	11.26	23.47
Multiline Retail	2.741	-3.784	0.042	1.74	-10.23	9.11	19.33
Aerospace & Defense	1.982	-2.614	0.021	1.81	-10.90	7.07	17.97
Chemicals	1.898	-2.809	0.024	1.31	-12.31	7.50	19.81
Commun Equip	1.855	-1.636	0.009	0.58	-23.99	10.15	34.13
Paper & Forest Prod	1.849	-2.358	0.017	1.56	-15.36	8.44	23.79
Software	1.711	-1.699	0.009	2.27	-19.05	13.17	32.22
Road & Rail	1.595	-2.253	0.015	2.82	-7.44	10.43	17.87
Airlines	1.581	-1.517	0.007	1.11	-22.66	7.97	30.64
Auto Components	1.529	-2.151	0.014	1.00	-15.78	7.14	22.91
Computers & Peripheral	1.235	-1.385	0.006	0.84	-21.40	14.40	35.80
Machinery	0.800	-1.061	0.003	0.40	-13.35	7.19	20.54
Oil & Gas	0.780	-1.290	0.005	1.46	-9.04	7.82	16.86
Automobiles	0.777	-0.893	0.002	0.07	-21.11	9.08	30.18
Energy Equip & Svc	0.561	-0.592	0.001	1.45	-9.49	10.40	19.88
Semiconductrs & Semi Eq	-0.236	0.194	0.000	0.00	-30.90	11.77	42.67

1. The signs of all the empirical duration estimates are reversed. The t-statistics have not had their signs reversed.
2. The Software Industry and Commun. Equip. Industry data started in Feb. 1978 and March 1978, respectively.

were option-free. When bonds are option-free, the ED estimate should be similar to the modified duration.

The total period S&P 500 empirical duration (1.78) in Exhibit 1 is lower than the Treasury empirical duration, a striking finding compared to what would be implied by the DDM as noted by Leibowitz et al. [1989]. Our maximum results for the empirical duration of equity (between 8 and 9), are consistent with the Leibowitz et al. [1989] estimates of 7 to 8, but our minimum result is substantially lower—i.e., our minimum ED value is –11.78 versus 2.0 for Leibowitz et al. Overall, however, our results are consistent with the Leibowitz et al. [1989] conclusion that the empirical duration for the equity market is low relative to a DDM estimate (and very volatile).

Stock Market Duration Over Time

The moving average monthly empirical durations are quite volatile, as shown by the time series plots in Exhibits 4 and 5. Exhibit 4 is the correlation between yield changes and stock returns. It is a mirror image of Exhibit 5, which shows the EDs.

EXHIBIT 2

36-Month Moving Empirical Durations—LB Treasury Index and SP500 Index (Sept. 1979-Dec. 2003)

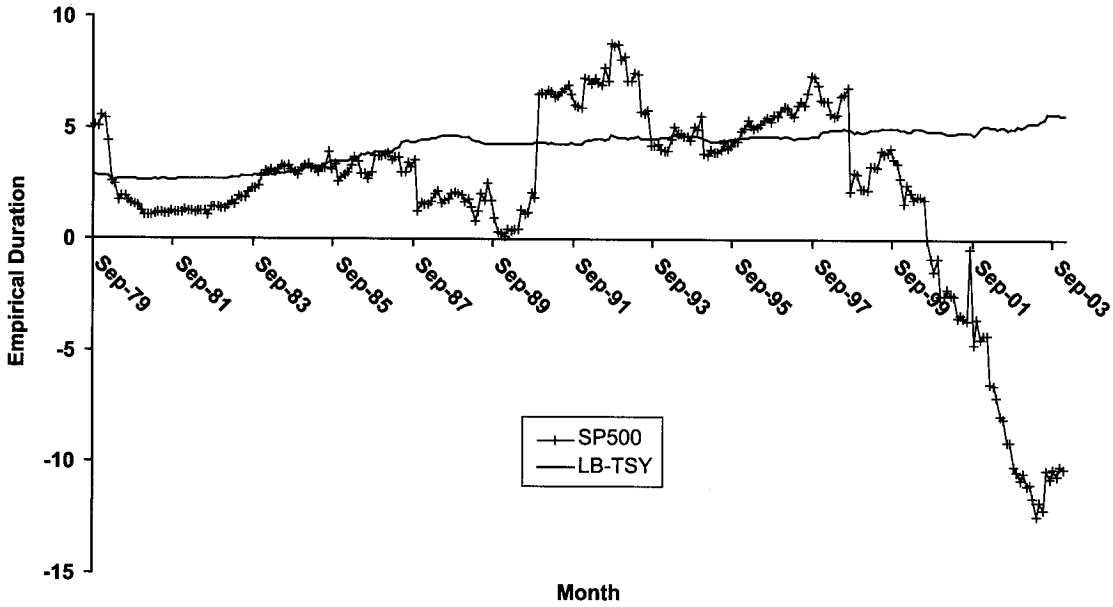


EXHIBIT 3

36-Month Moving Empirical Durations—LB Treasury Index Versus Modified Durations of LB Treasury Index (Dec. 1988-Dec. 2003)

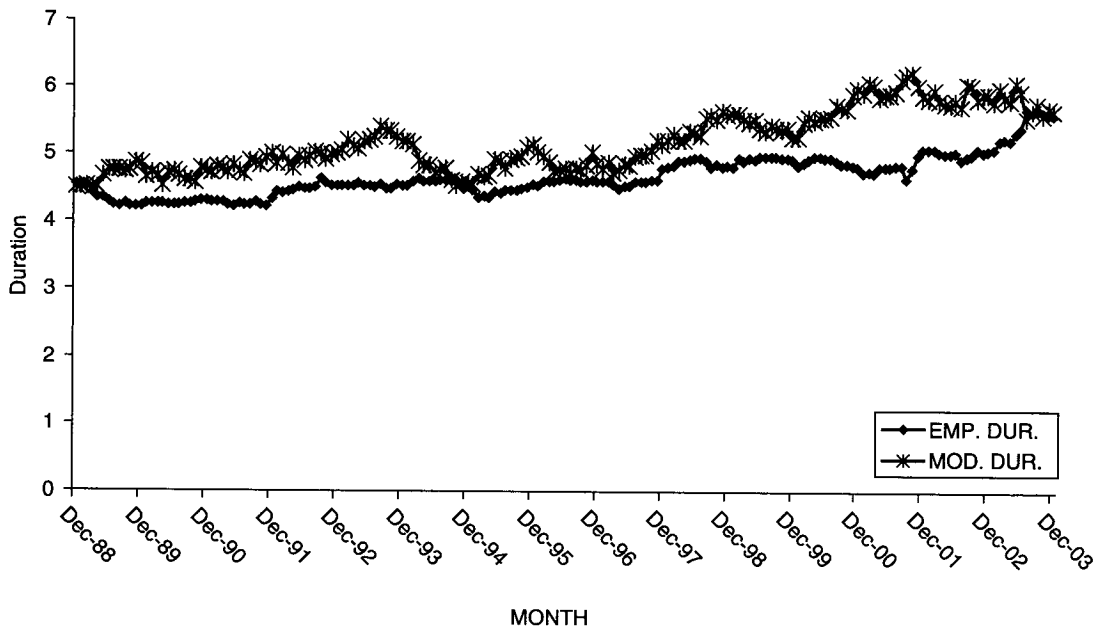


EXHIBIT 4

36-Month Moving Correlation—LB Treasury Yield Change and SP500 Return (Sept. 1979-Dec. 2003)

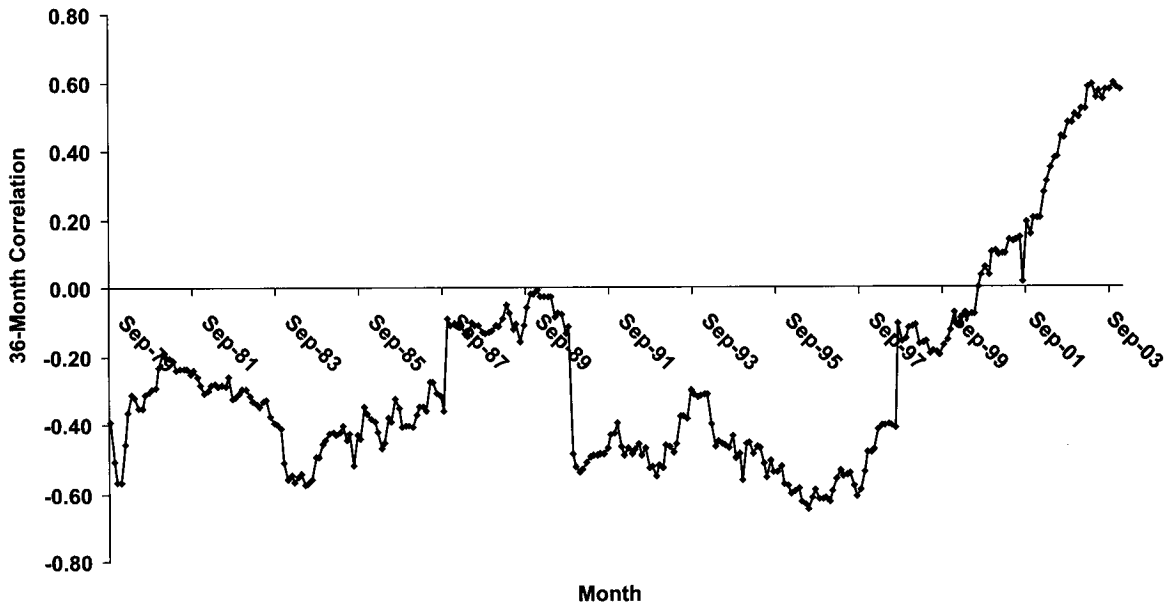
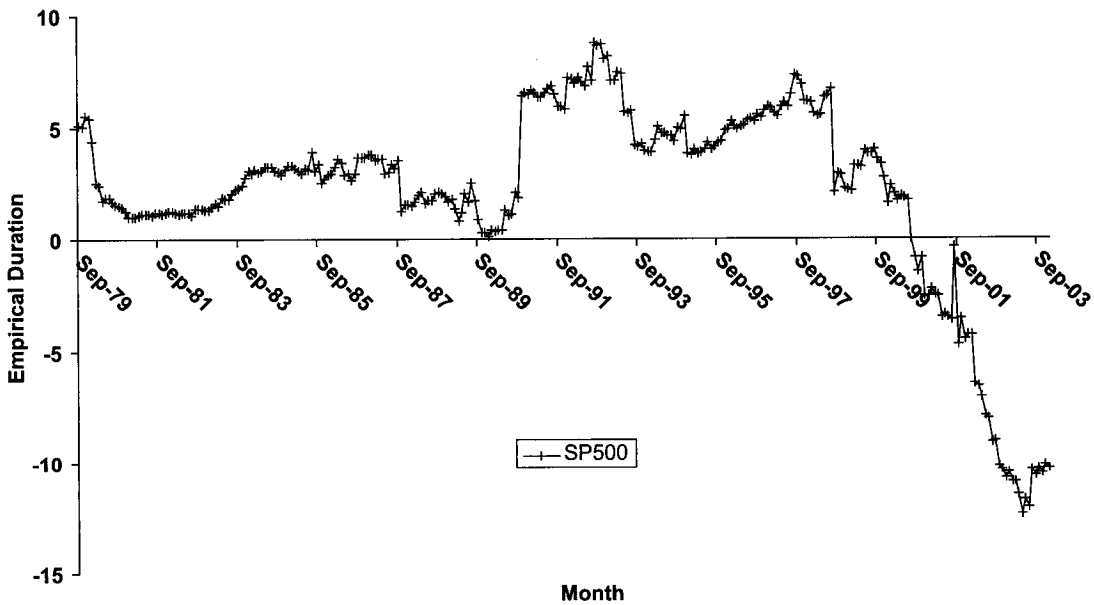


EXHIBIT 5

36-Month Moving Empirical Durations of SP500 Index (Sept. 1979-Dec. 2003)



Initially, it is important to specify that the expected relation (correlation) between yields and stock returns is negative—i.e., when yields increase one would expect, ceteris paribus, that stock returns would decline because the Treasury yield increase implies a higher discount rate for stocks. Given this expectation, the results in Exhibit 4 are striking in two regards.

First, the generally negative correlations pre-2000 are *very volatile*, ranging from almost zero in December 1989 to almost −0.65 in June 1997. As we noted earlier, this supports the contention that there are other factors that impact stock returns beyond changes in bond yields.

The second striking result is that the relation between yield changes and stock returns *becomes positive* in early 2000, and the correlation increases consistently, to about +0.60 as of the end of 2003. This positive relation between changes in Treasury bond yields and stock returns is clearly very inconsistent with expectations, and implies that yield changes are not the only factor affecting stock returns. In fact, they have been minor relative to these other factors since the start of 2000.

Exhibit 5 shows that the stock market ED prior to 2000 was positive and volatile, but since 2000 has become negative. The counter-intuitive result is that stock returns have moved in the same direction as interest rate changes rather than counter to them.

25 Industries: 1976-2003

The total time period results for the 25 industries in Exhibit 1 show an overall average empirical duration of 2.17 and a fairly wide range of EDs from 4.13 to −0.24 using Model 1. Notably, the two high-empirical duration industries (utilities and commercial banks) and the two low-empirical duration industries (semiconductors and energy equipment) are consistent with typical expectations and can be explained in terms of the inflation flow-through argument.

That is, as discussed by Sweeney and Warga [1986], one would envision very low inflation flow-through for regulated utilities (which implies a higher equity duration), in contrast to strong flow-through for energy equipment and for semiconductors, industries with pricing power (which implies a lower equity duration).

The results for the industries in Exhibit 6 for Model 2 show the effect on the EDs of including the market effect and computing industry betas. Notably, the effect on the ED for the aggregate bond market (the Lehman Brothers Treasury index) is trivial since the coefficient for the S&P 500 is very low and insignificant. This implies that, for the period studied, the stock market had virtually no unique month-to-month effect on the bond market that is not explained by interest rates.

All the industry beta coefficients relative to the S&P 500 are positive and statistically significant (t-values from 5 to 19). The betas range from 0.25 to 1.64, with an average of 0.96.

The estimates of the industry EDs after adjusting for the stock market effect are both different from and similar to those obtained for Model 1. The specific ED values are different from the Model 1 results and range from 3.68 to −3.15; there are 12 industries with negative EDs compared to only one in Exhibit 1. The mean ED for the 25 industries is only 0.47 compared to the average ED using Model 1 of 2.17. Recall that a negative duration implies that the industry's rates of return are positively related to yield changes—i.e., the industry experiences higher returns when yields increase.

The results in Exhibits 1 and 6 are very similar, however, in terms of the rank-ordering of the industries, as there are very few rank changes throughout, especially at the extremes.

Four conclusions can be drawn from a comparison of empirical durations derived from the two models. First, wide range of industry betas in Exhibit 6 confirms that adjusting for the market effect on industries is a relevant exercise. Second, adjusting for the market effect clearly has an impact on the specific ED value—there is generally a reduction in the value, and, in fact, a number of the industry duration values move from positive to negative. Third, while the size and signs of the individual EDs change, the rank-ordering of industries based upon their EDs is remarkably stable. Fourth, the size of the industry market beta is inversely correlated with the interest rate sensitivity of the industry. The correlation (−0.824) and rank correlations (−0.785) between an industry's market beta and its ED are significant, which implies that an industry with high market risk generally has lower interest rate sensitivity.

The Model 3 result in computation of a pure industry beta without the interest rate effect show similarity in terms of beta values and rankings. Specifically, the average beta for Model 3 is 0.969 compared to the average from Model 2 of 0.959. The rank correlation between the two series is 1.000.

EXHIBIT 6

Empirical Durations and Market Estimates—Model 2 (monthly data: Sept. 1976-Nov. 2003)

	MODEL 2 Estimate for the Entire Period (Sept. 1976 - Nov. 2003)				
Indexes	Emp. Dur. Estimate	Emp. Dur. t-statistic	SP500 Estimate	SP500 t-statistic	Model R-square
Lehman Bros. Treasury	3.291	-50.451	0.004	0.555	0.891
WIL-5000(MV Wtd.)	-0.114	1.283	1.012	106.296	0.973
WIL-5000(EQUAL Wtd.)	-0.816	1.747	0.979	19.475	0.542
S&P Industry Stock Indexes (Ranked by the Model 2 Empirical Duration Estimate)					
Electric Utilities	3.682	-7.985	0.253	5.110	0.253
Food Products	2.427	-5.316	0.586	11.934	0.385
Tobacco	2.307	-3.043	0.681	8.351	0.221
Commercial Banks	2.180	-3.814	1.010	16.419	0.497
Healthcare Equip & Suppl	2.046	-4.196	0.778	14.833	0.456
Household Products	1.996	-3.858	0.589	10.576	0.313
Pharmaceuticals	1.733	-3.559	0.768	14.670	0.443
Personal Products	1.632	-2.737	0.841	13.112	0.382
Beverages	1.566	-3.033	0.684	12.320	0.360
Building Products	1.066	-1.742	1.049	15.950	0.462
Multiline Retail	1.000	-1.852	0.977	16.822	0.489
Aerospace & Defense	0.213	-0.368	0.993	15.928	0.451
Chemicals	0.155	-0.331	0.978	19.391	0.548
Paper & Forest Prod	-0.031	0.053	1.055	16.748	0.473
Auto Components	-0.132	0.243	0.932	15.979	0.449
Road & Rail	-0.134	0.257	0.970	17.345	0.489
Oil & Gas	-0.509	1.035	0.723	13.690	0.370
Airlines	-0.537	0.619	1.189	12.729	0.338
Software	-0.581	0.784	1.345	16.734	0.483
Commun Equip	-0.802	0.995	1.570	17.976	0.518
Computers & Peripheral	-0.859	1.269	1.175	16.141	0.449
Automobiles	-1.032	1.441	1.016	13.180	0.351
Machinery	-1.059	1.929	1.043	17.668	0.492
Energy Equip & Svc	-1.453	1.888	1.131	13.654	0.366
Semiconductrs & Semi Eq	-3.154	3.496	1.638	16.886	0.468

1. The signs of all the empirical duration estimates are reversed. The t-statistics have not had their signs reversed.
2. The Software Industry and Commun. Equip. Industry data started in Feb. 1978 and March 1978, respectively.

Standard & Poor's Sectors and Industry Groups: 1989-2003

Exhibit 7 presents the results for the ten S&P sectors and 22 industry groups ranked by the empirical duration measure for the shorter period 1989-2003. Because we know it is important to consider industry betas relative to the market and that the more appropriate EDs come from the Model 2 results, going forward we discuss only the results for Model 2.

Given the recent shorter time period, the ED for the bond market increased from 3.29 to 4.88, reflecting an increase in maturity relative to the earlier period.

The economic sector EDs range from a high of 3.39 (utilities) to a low of −4.00 (information technology). Again, there is an inverse relation between the sector market beta and the ED—e.g., utilities have the lowest market beta (0.41) but the highest ED (3.39), while the information technology sector has the highest market beta (1.59) and the lowest ED (−4.00). This very high interest

EXHIBIT 7

Empirical Durations and Market Beta Estimates for Economic Sectors and Industry Groups—Model 2
(monthly data: Oct. 1989-Nov. 2003)

	MODEL 2 Estimate for the Entire Period (Oct. 1989 - Nov. 2003)				
Indexes	Emp. Dur. Estimate	Emp. Dur. t-statistic	SP500 Estimate	SP500 t-statistic	Model R-square
Lehman Bros. Treasury	4.884	-49.525	0.001	0.171	0.936
WIL-5000(MV Wtd.)	-0.492	2.037	0.999	67.706	0.965
WIL-5000(EQUAL Wtd.)	-3.815	2.855	0.914	11.207	0.441
S&P GICS Economic Sectors (Ranked by the Entire Period Empirical Duration Estimate)					
Utilities	3.390	-2.704	0.407	5.310	0.180
HealthCare	2.449	-2.135	0.716	10.225	0.399
Cons Staples	2.194	-2.163	0.600	9.679	0.374
Financials	1.713	-1.702	1.143	18.594	0.678
Energy	1.381	-1.250	0.610	9.041	0.335
Telecom Svc	0.556	-0.404	0.983	11.693	0.451
Industrials	-0.850	1.300	0.991	24.800	0.786
Materials	-1.792	1.561	0.921	13.138	0.510
Cons Discretion	-2.005	2.760	1.060	23.904	0.775
Info Tech	-4.004	2.638	1.586	17.105	0.640
S&P GICS Industry Groups (Ranked by the Entire Period Empirical Duration Estimate)					
Utilities	3.390	-2.704	0.407	5.310	0.180
House & Pers Prod	3.135	-2.280	0.596	7.099	0.254
Food Bev & Tob	2.668	-2.389	0.604	8.857	0.339
Pharm & Biotech	2.666	-2.083	0.734	9.389	0.360
Insurance	2.252	-1.755	0.960	12.257	0.481
Banks	2.043	-1.466	1.060	12.451	0.487
Divers Finance	1.515	-1.521	1.374	22.583	0.755
Energy	1.350	-1.226	0.610	9.075	0.337
Healthcare Equip & Svc	1.316	-1.121	0.679	9.467	0.355
Telecom Svc	0.556	-0.404	0.983	11.693	0.451
Transportation	0.423	-0.362	0.881	12.328	0.477
Cons Dur & Appar	0.376	-0.359	0.855	13.357	0.517
Food & Staple Ret	-0.460	0.377	0.601	8.062	0.280
Software & Svc	-0.736	0.414	1.567	14.427	0.555
Hotel, Rest, & Leis	-0.740	0.554	0.924	11.330	0.435
Capital Goods	-0.811	1.078	0.999	21.724	0.739
Comm Svc & Sup	-1.521	1.500	0.973	15.715	0.597
Materials	-1.792	1.561	0.921	13.138	0.510
Media	-2.138	2.119	1.172	19.015	0.685
Retailing	-2.377	1.876	1.053	13.607	0.528
Autos & Comp	-3.931	2.528	1.034	10.889	0.424
Tech Hdware & Eq	-4.740	2.803	1.611	15.594	0.598

The signs of all the empirical duration estimates are reversed. The t-statistics have not have their signs reversed.

EXHIBIT 8

36-Month Moving Empirical Durations—SP Utilities Sector (Sept. 1992-Nov. 2003)

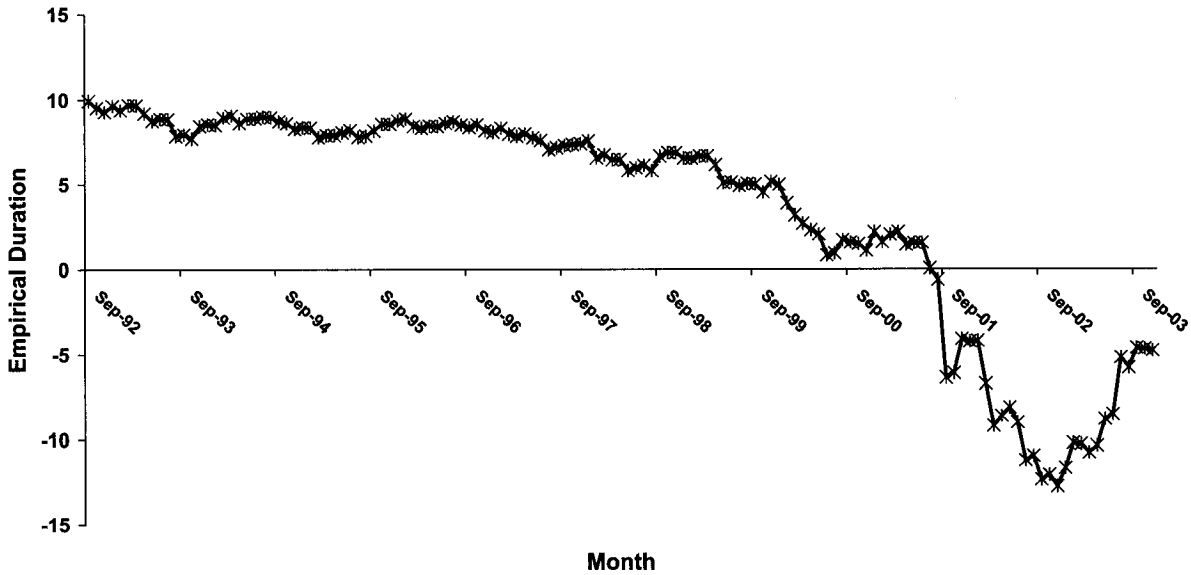
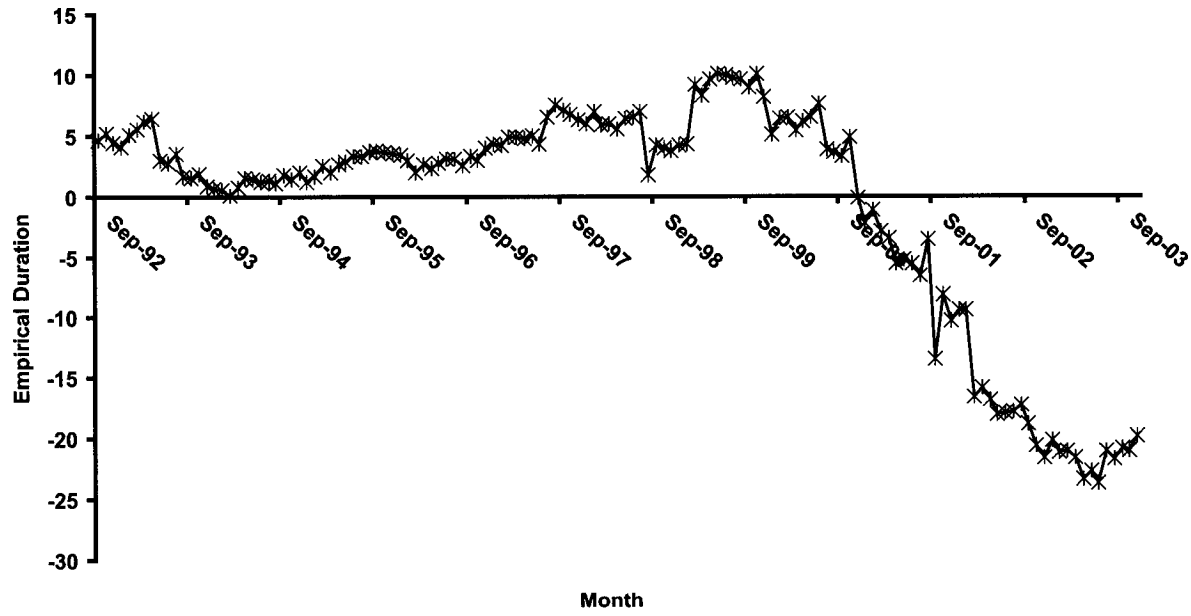


EXHIBIT 9

36-Month Moving Empirical Durations—SP Information Technology Sector (Sept. 1992-Nov. 2003)



rate sensitivity for utilities is illustrated in Exhibit 8, which shows a moving ED that ranges from a peak of about 10.0 to a low of about −12.0.

Exhibit 9 indicates the information technology (IT) industry ED represented generally a low positive value before late 2000, but became very negative to drop to a trough of about −23.00. During the period 1990-2003, interest rates were generally declining. Stock returns for IT were strong pre-2000 but declined sharply after 2000 and moved in the same direction as interest rates. This

implies that during this latter period (2000-2003) when inflation and interest rates declined, securities in the IT industry experienced very poor results.

The industry group results are shown in the second section of Exhibit 7. While there is an increase in terms of specificity—22 industry groups versus 10 economic sectors—many of the general results persist.

The range of empirical durations for the industry groups (from 3.39 to −4.74) is wider than for the economic sectors. The industry groups have an average ED of 0.303, and the market betas for the industry groups range from 0.41 to 1.61. In terms of individual industry groups, the utility results are identical, as that industry continues to have the lowest market beta and the highest ED. Several of the groups with high EDs are financial institutions.

At the low end, there are 10 industry groups with negative EDs; the lowest duration is again the technology sector (Technology Hardware and Equipment). Other industry groups with low EDs tend to have high betas and include materials, media, and retailing—groups that tend to have pricing power and thus high inflation flow-through.

Standard & Poor's GICS Industries: 1989-2003

The results in Exhibit 10 are for the 46 industries across the economy with data for the period 1989-2003. The industry market betas range from a low of 0.266 (electric utilities) to a high of 1.81 (semiconductors and semiconductor equipment), and have an average value of 0.967. As before, this wide range of market betas indicates the importance of adjusting the data for the stock market effect.

The ED estimates are likewise very diverse, and range from 6.15 to −7.56. There are 26 industries with negative EDs. The average ED is −0.488. The high EDs are for tobacco, electric utilities, food products, and a collection of financial institutions including insurance and commercial banks. Again, the low end (negative) EDs are for technology industries that have more pricing power such as electronic equipment and instruments, communications equipment, semiconductors and semi-equipment, and IT services.

Confirming earlier results, there is a strong negative relation between the market beta for an industry and its empirical duration. In general, the industries with low market betas have high EDs, and industries with high market betas have the lowest (large *negative*) EDs.

Exhibit 11 is a time series plot of the 36-month moving average EDs for tobacco (the highest ED of 6.15) and for electronic equipment and instrumentation (the lowest ED of −7.56). It shows the vast range between industries and the significant volatility of the ED for an industry.

Exhibit 12 is a bar graph of the empirical durations for the 46 industries with the Lehman Brothers Treasury and Wilshire indexes. Besides indicating the dramatic differences among industries, this graph shows that only one industry was more interest rate-sensitive than the aggregate Treasury bond market, while 19 industries were more interest rate-sensitive than the aggregate stock market.

Beyond estimates for empirical duration for various industries, a portfolio manager might want to know how different industries relate to the aggregate market in terms of interest rate sensitivity over time. The most straightforward analysis involves the correlations of the 36-month moving empirical durations for each industry versus the moving empirical duration for the S&P 500 as presented in Exhibit 13. The 46 industry correlations range from 0.98 to 0.24. Notably, 21 industries have a correlation of 0.90 and higher, and the median correlation is 0.89.

Exhibit 14 graphs a time series plot of the moving empirical durations for the S&P 500 and the leisure industry. The two series tend to move closely together over time, but the leisure industry tends to be more volatile. Exhibit 15 shows a similar plot for the tobacco industry, which has the lowest correlation (0.24).

Size Sectors: 1980-2003

We next examine the empirical durations for different-sized firms and for portfolios with different investment styles to determine whether there are differences both on average and over time. The total-period results by size and by investment style are presented in Exhibit 16. Here we use Model 1, because all of these are essentially market indexes for a segment of the stock market.

Several observations are prompted by the initial section results, which consider only size differences. First, for diversified size-related indexes, all the EDs are lower than that of the Treasury index.

Second, with the exception of the two large-cap indexes, the ED estimates are lower than the empirical duration of the S&P 500. The fact that the large-cap

EXHIBIT 10

Empirical Durations—S&P GICS Industries Ranked by Entire Period Empirical Duration Estimate—Model 2 (monthly data: Oct. 1989-Nov. 2003)

	MODEL 2 Estimate for the Entire Period (Oct. 1989 - Nov. 2003)				
Indexes	Emp. Dur. Estimate	Emp. Dur. t-statistic	SP500 Estimate	SP500 t-statistic	Model R-square
Tobacco	6.145	-2.695	0.564	4.054	0.128
Electric Utilities	4.378	-3.414	0.266	3.402	0.126
Food Products	3.519	-2.989	0.498	6.930	0.259
Household Products	3.295	-2.263	0.531	5.978	0.200
Building Products	3.016	-1.761	1.022	9.770	0.374
Pharmaceuticals	2.795	-2.098	0.726	8.925	0.339
Personal Products	2.692	-1.584	0.811	7.814	0.279
Road & Rail	2.472	-1.923	0.722	9.191	0.349
Insurance	2.252	-1.755	0.960	12.257	0.481
Commercial Banks	1.910	-1.369	1.062	12.463	0.487
Energy Equip & Svc	1.894	-0.924	1.041	8.317	0.297
Diverse Fin Svcs	1.678	-1.662	1.366	22.150	0.748
Gas Utilities	1.546	-1.028	0.652	7.105	0.238
Healthcare Equip & Suppl	1.415	-1.208	0.746	10.435	0.400
Oil & Gas	1.334	-1.228	0.557	8.394	0.304
Household Durables	1.272	-1.037	0.983	13.117	0.511
Health care Provid & Svc	0.882	-0.520	0.620	5.985	0.179
Diverse Telcom Svc	0.842	-0.608	0.936	11.061	0.425
Beverages	0.699	-0.521	0.693	8.451	0.302
Construct & Engineer	0.452	-0.182	0.896	5.906	0.173
Industrial Conglom	-0.215	0.206	1.025	16.046	0.607
Food & Staples Retail	-0.313	0.256	0.599	8.014	0.278
Leisure Equip & Prod	-0.383	0.254	0.659	7.167	0.235
Software	-0.538	0.280	1.560	13.284	0.514
Hotels Rest & Leis	-0.740	0.554	0.924	11.330	0.435
Aerospace & Defen	-0.879	0.642	0.795	9.510	0.352
Textiles & Apparel	-1.155	0.615	0.959	8.362	0.295
Chemicals	-1.508	1.276	0.867	12.014	0.465
Commercl Svc & Sup	-1.521	1.500	0.973	15.715	0.597
Paper & Forest Prod	-1.583	0.971	1.004	10.095	0.380
Multiline Retail	-1.760	1.252	0.982	11.437	0.441
Metals & Mining	-1.839	1.060	1.003	9.459	0.350
Media	-2.138	2.119	1.172	19.015	0.685
Electrical Equip	-2.336	2.180	1.034	15.798	0.602
Auto Components	-2.336	1.630	0.957	10.940	0.421
Machinery	-2.348	1.663	0.972	11.279	0.435
Airlines	-2.355	1.172	1.313	10.696	0.408
Containers & Pckge	-3.085	2.045	0.971	10.535	0.405
Compu & Peripheral	-3.623	1.864	1.424	11.998	0.466
Specialty Retail	-3.675	2.534	1.170	13.207	0.517
Automobiles	-4.567	2.525	1.064	9.626	0.368
Air Frei & Couriers	-4.801	2.205	0.912	6.860	0.234
IT Services	-4.870	2.022	1.200	8.163	0.294
Semiconductrs & Semi Eq	-5.202	2.067	1.806	11.752	0.457
Commun Equip Ind	-5.609	2.794	1.688	13.768	0.539
Elec Equip & Instrum	-7.564	3.628	1.789	14.050	0.554

1. *The signs of all the empirical duration estimates are reversed. The t-statistics have not had their signs reversed.*
2. *Industries not included due to incomplete data are Construction Materials, Trading Companies and Distrib., Biotechnology, Internet Software and Services, Office Electronics, Wireless Telecommunications Services, and Multi-Utilities.*

EXHIBIT 11

36-Month Moving Empirical Durations—SP Tobacco and Electrical Equipment & Instrumentation (Sept. 1992-Nov. 2003)

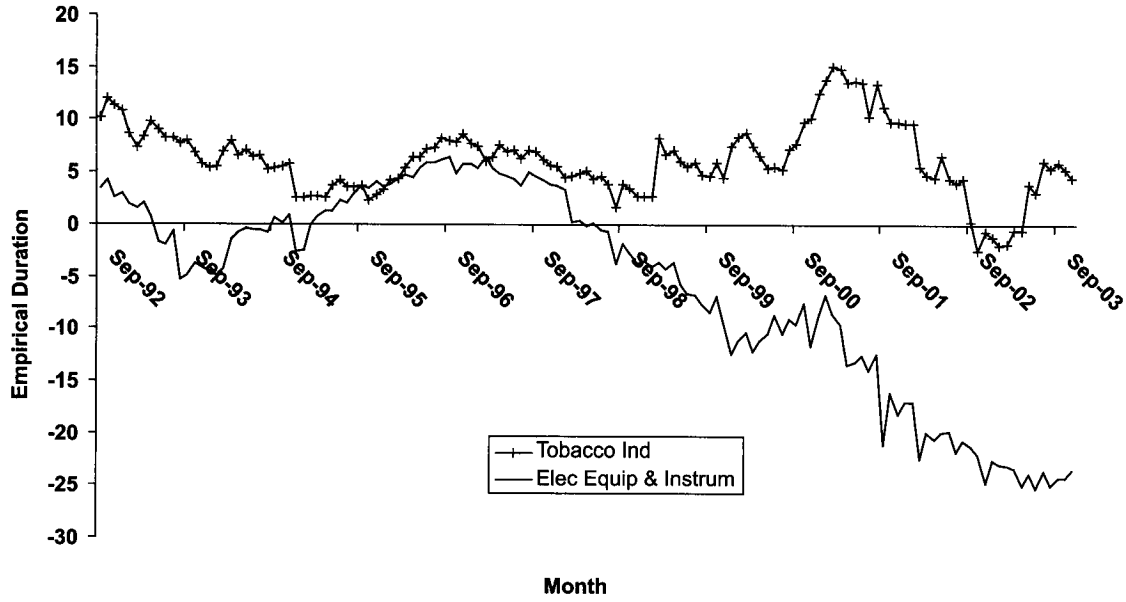


EXHIBIT 12

Model 2 Empirical Durations—Industries and Indexes (Oct. 1989-Nov. 2003)

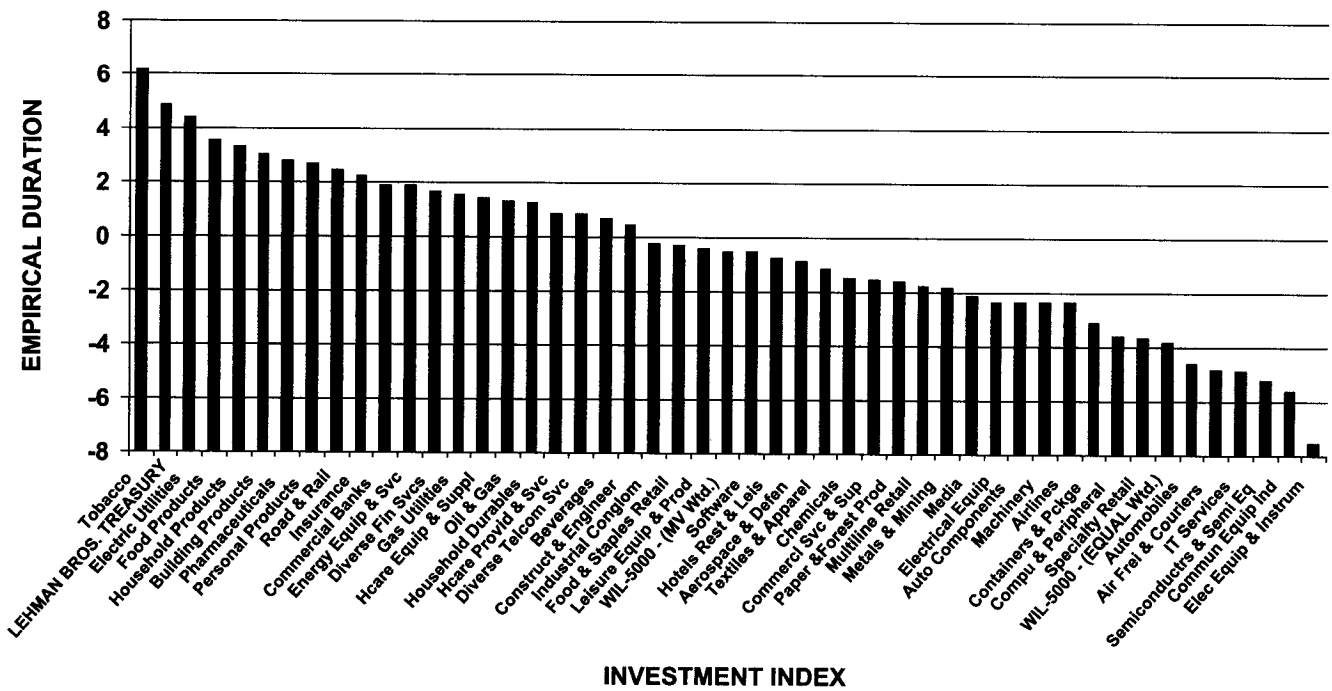


EXHIBIT 13

Correlations of Empirical Durations with S&P Economic Sectors, Industry Groups, and Industries (Sept. 1992-Nov. 2003)

LB-TREASURY INDEX	Correlation
LB-TSY	-0.77

WILSHIRE 5000 INDEXES	Correlation
Market Value Weighted	0.97
Equal Weighted	0.87

SP ECONOMIC SECTORS (Ranked)	Correlation
Industrials	0.99
Cons Discretion	0.97
Telecom Svc	0.97
Materials	0.96
Utilities	0.95
Financials	0.95
Energy	0.93
Info Tech	0.93
Cons Staples	0.84
Health Care	0.83

SP INDUSTRY GROUPS (Ranked)	Correlation
Capital Goods	0.99
Divers Finance	0.98
Media	0.98
Telecom Svc	0.97
Materials	0.96
Transportation	0.96
Utilities	0.95
Comm Svc & Sup	0.95
Tech Hdware & Eq	0.94
Energy	0.93
Autos & Comp	0.91
Hotel, Rest, & Leis	0.90
Insurance	0.90
Banks	0.89
Software & Svc	0.88
Cons Dur & Appar	0.83
Retailing	0.81
Pharm & Biotech	0.79
Food Bev & Tob	0.79
Healthcare Equip & Svc	0.78
House & Pers Prod	0.72
Food & Staple Ret	0.69

SP INDUSTRIES (Ranked)	Correlation
Diverse Fin Svcs	0.98
Media	0.98
Industrial Conglom	0.97
Diverse Telcom Svc	0.97
Electrical Equip	0.97
Chemicals	0.96
Leisure Equip & Prod	0.96
Aerospace & Defen	0.95
Electric Utilities	0.95
Commun Equip Ind	0.95
Commercl Svc & Sup	0.95
Semiconductrs & Semi Eq	0.95
Elec Equip & Instrum	0.94
Oil & Gas	0.93
Airlines	0.93
Auto Components	0.93
Energy Equip & Svc	0.92
Paper & Forest Prod	0.92
IT Services	0.90
Hotels Rest & Leis	0.90
Insurance	0.90
Health care Equip & Suppl	0.89
Automobiles	0.89
Specialty Retail	0.89
Commercial Banks	0.89
Software	0.88
Road & Rail	0.88
Gas Utilities	0.88
Machinery	0.86
Metals & Mining	0.82
Compu & Peripheral	0.81
Construct & Engineer	0.80
Pharmaceuticals	0.78
Building Products	0.78
Containers & Pckge	0.78
Household Durables	0.75
Household Products	0.73
Beverages	0.67
Food Products	0.66
Food & Staples Retail	0.64
Multiline Retail	0.63
Personal Products	0.63
Air Frei & Couriers	0.52
Health care Provid & Svc	0.44
Textiles & Apparel	0.31
Tobacco	0.24

EXHIBIT 14

36-Month Moving Empirical Durations—Leisure Equipment & Products Industry Versus SP500 Index (Sept. 1992-Nov. 2003)

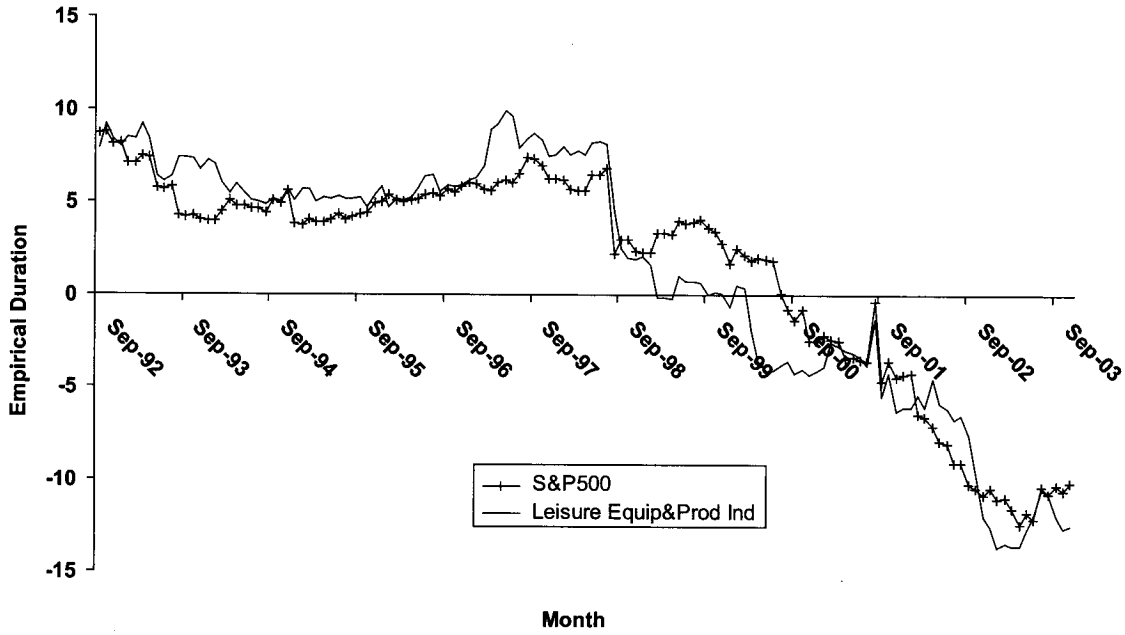


EXHIBIT 15

36-Month Moving Empirical Durations—Tobacco Industry Versus SP500 Index (Sept. 1992-Nov. 2003)

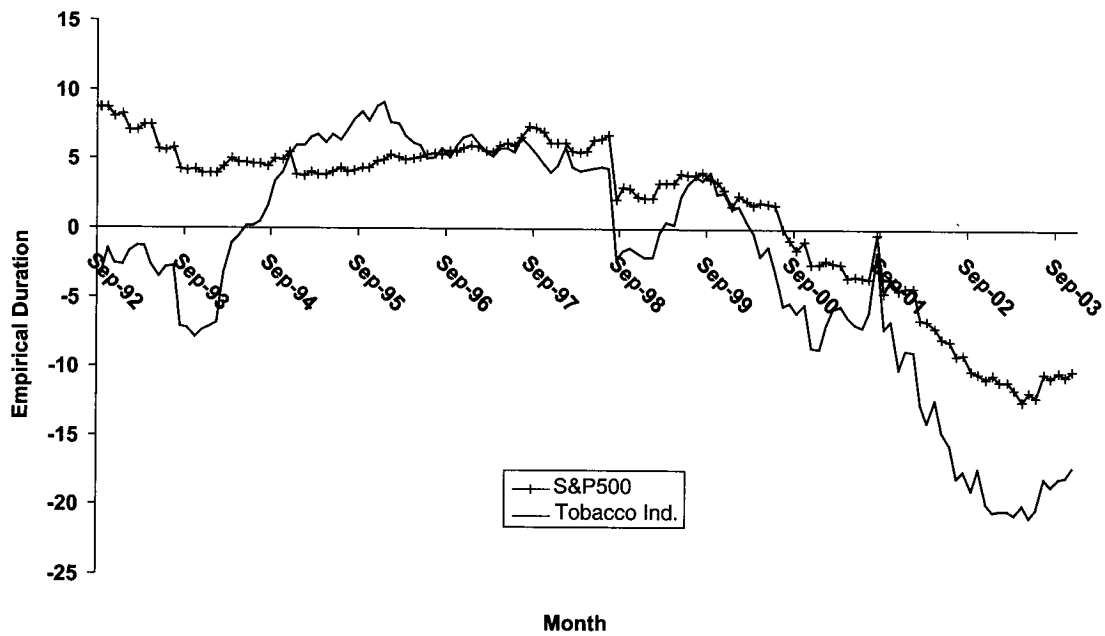


EXHIBIT 16

Empirical Durations—Market Capitalization and Style Stock Indexes—Model 1
(monthly data: Jan. 1980-Dec. 2003)

	Estimate for the Entire Period (Jan. 1980 - Dec. 2003)				*36-Month Moving Empirical Durations (Dec. 1982 - Dec. 2003)*			
Indexes	**Empirical Duration**	**t-statistic**	**R-square**	**F-Statistic**	**Average**	**Minimum**	**Maximum**	**Min.-Max. Range**
LB Treasury	3.347	-47.361	0.887	2243.03*	4.36	2.69	5.66	2.97
S&P 500	1.476	-2.708	0.025	7.33*	2.18	-12.39	8.77	21.16
WIL-5000(MV Wtd.)	1.344	-2.412	0.020	5.82*	1.73	-12.33	8.51	20.84
WIL-5000(EQUAL Wtd.)	0.423	-0.590	0.001	1.602	-1.25	-14.58	4.20	18.79
Alternative Stock Indexes								
Large Cap Indexes								
WIL-LC750	1.506	-2.736	0.026	7.49*	2.09	-12.38	8.86	21.24
WIL-TAR TOP750	1.503	-2.734	0.025	7.47*	2.08	-12.36	8.86	21.22
WIL-TAR TOP2500	1.427	-2.575	0.023	6.63*	1.81	-12.54	8.60	21.13
Mid Cap Indexes								
WIL-MC500	1.312	-2.104	0.015	4.43*	0.84	-12.38	7.94	20.32
WIL-TAR MC750	1.251	-1.979	0.014	3.91*	0.71	-12.84	7.69	20.53
Small Cap Indexes								
WIL-SC1750	0.936	-1.396	0.007	1.949	0.06	-13.89	6.59	20.48
WIL-TAR NEXT1750	0.931	-1.390	0.007	1.931	0.03	-14.16	6.60	20.76
RUS-2000	0.737	-1.060	0.004	1.125	-0.11	-13.64	5.88	19.52
IBB-SC	0.350	-0.498	0.001	0.248	-1.11	-13.00	4.41	17.41
Micro Cap Indexes								
WIL-MICRO	0.002	-0.003	0.000	0.000	-1.34	-13.76	4.20	17.96
Style Indexes								
WIL-LARGE CAP VALUE	1.780	-3.640	0.044	13.25*	2.65	-11.35	8.33	19.68
WIL-LARGE GROWTH	1.481	-2.372	0.019	5.62*	2.24	-12.26	10.36	22.62
WIL-MID CAP VALUE	2.039	-4.020	0.053	16.16*	2.28	-10.81	7.37	18.19
WIL-MID CAP GROWTH	1.237	-1.759	0.011	3.093	0.80	-13.72	10.15	23.87
WIL-SMALL CAP VALUE	1.795	-3.781	0.048	14.30*	1.72	-10.28	5.71	15.99
WIL-SMALL CAP GROWTH	0.970	-1.266	0.006	1.602	0.44	-11.87	9.45	21.31

1. The signs of all the empirical duration estimates are reversed.
*2. * Indicates an F-statistic value that is significant at the 5% level.*

indexes are very similar to the S&P 500 is not surprising, as the S&P 500 index is widely recognized as a representative sample of large-cap stocks.

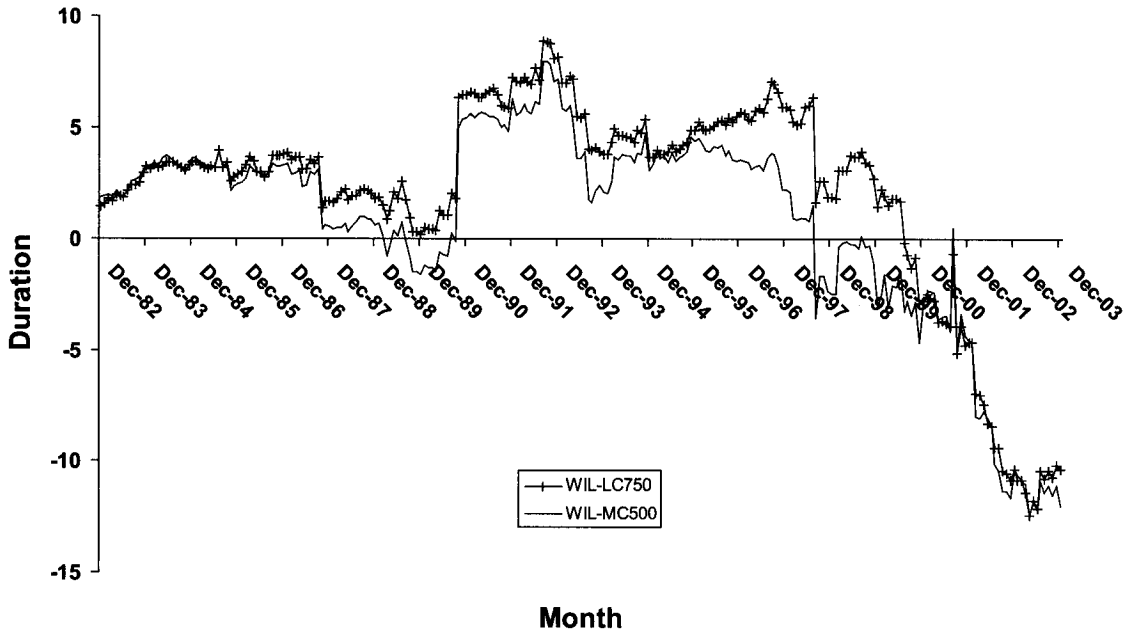
Third and most important, there is a definite clustering and order by size. Specifically, the large-cap stocks have the highest empirical durations (an average of 1.48), followed by the average for the mid-cap stocks (1.28), small-cap stocks (0.74), and finally micro-cap stocks at 0.002.

These results are consistent with the implications of the franchise factor model as discussed in Leibowitz and Kogelman [1993], who contend that the ED for the tangible value (TV) segment is expected to be quite high because of the relatively low flow-through for established businesses. The ED for the franchise value (FV) component should be much lower (possibly zero) because the expected inflation flow-through from new investments should be much higher.

Therefore, if we assume that a relatively large component of the total value of large-cap stocks will come from TV and a relatively smaller component from FV, large-cap would have a higher ED than small-cap firms, which have a lower proportion of value from TV and more

EXHIBIT 17

36-Month Moving Empirical Durations—Wilshire Large-Cap 750 Versus Wilshire Mid-Cap 500 (Dec. 1982-Dec. 2003)



from FV. Finally, micro-cap firms will have virtually all their total value from FV and thus have the lowest ED.*

This pattern of differences in empirical duration due to size is quite consistent over time in the three time series plots of moving empirical durations. In the comparison of large-cap to mid-cap in Exhibit 17, it is shown that the mid-cap empirical duration is almost always lower than the large-cap empirical duration. They tend to move together, and during many periods are identical. In Exhibit 18 (large-cap versus small-cap), the pattern is the same, but the difference in EDs is a little greater, including a substantial spread at period end. Finally, in Exhibit 19 (large-cap versus micro-cap), there is a substantial difference. The micro-cap is almost always smaller, including several periods when the EDs for the micro-cap stocks are negative, while the EDs for the large-cap stocks are nearly always positive.

Size-Adjusted Investment Style Sectors: 1980-2003

Finally, we consider empirical durations for alternative investment styles (growth versus value stocks). According to the franchise factor model (Leibowitz and Kogelman [1993]) and the growth option concept (Hevert, McLaughlin, and Taggart [1998]), growth stocks should have lower EDs than value stocks because more of their total value is due to their future growth component than their current value component.

The results in the last section of Exhibit 16 show Wilshire index results for: 1) large-cap value and growth, 2) mid-cap value and growth, and 3) small-cap value and growth. These indexes allow a pure comparison of growth and value without a size impact.

The EDs in the comparisons support the expectation that growth stocks will have lower empirical durations. Specifically, the large-cap value versus large-cap growth comparison shows empirical durations of 1.78 versus 1.48; the mid-cap difference is 2.04 versus 1.24; and the small-cap is 1.80 versus 0.97. Therefore, the empirical durations for the value stocks are always higher than the empirical durations for the growth stocks.

The comparative time series plots of the moving empirical durations in Exhibits 20, 21, and 22 provide mixed results, however. There are some periods when the EDs for the two style series are very similar (1982-1986), but when they diverge there are substantial differences. Value stocks are typically higher, except during the early 1991 to early 1993 period when the EDs for the growth

EXHIBIT 18

36-Month Moving Empirical Durations—Wilshire Large-Cap 750 Versus Wilshire Small-Cap 1750 (Dec. 1982-Dec. 2003)

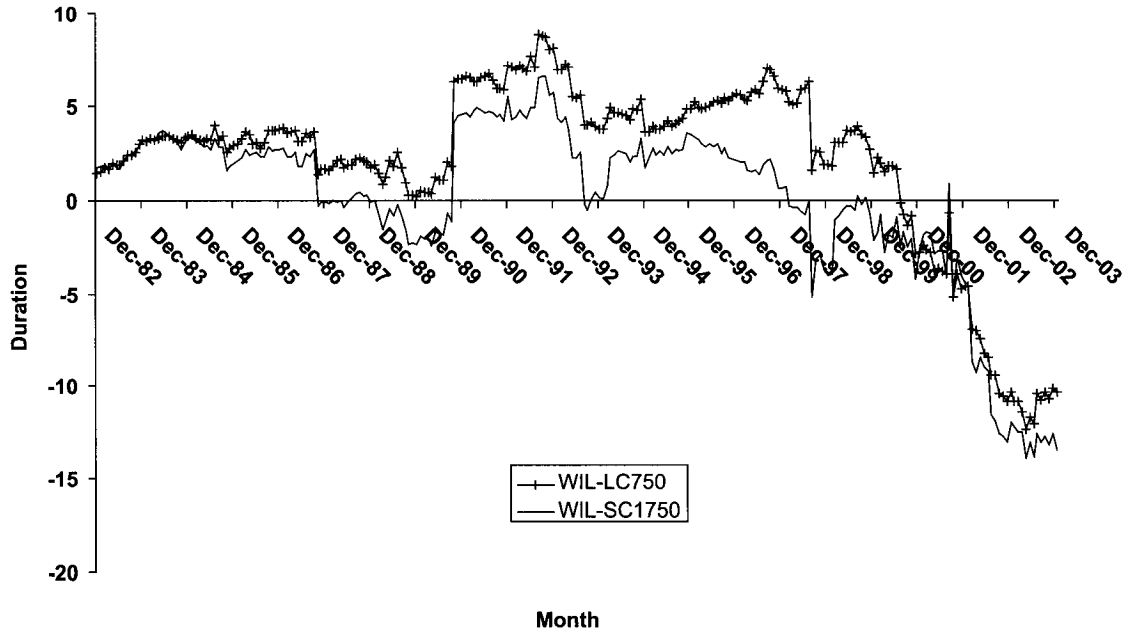


EXHIBIT 19

36-Month Moving Empirical Durations—Wilshire Large-Cap 750 Versus Wilshire Micro-Cap (Dec. 1982-Dec. 2003)

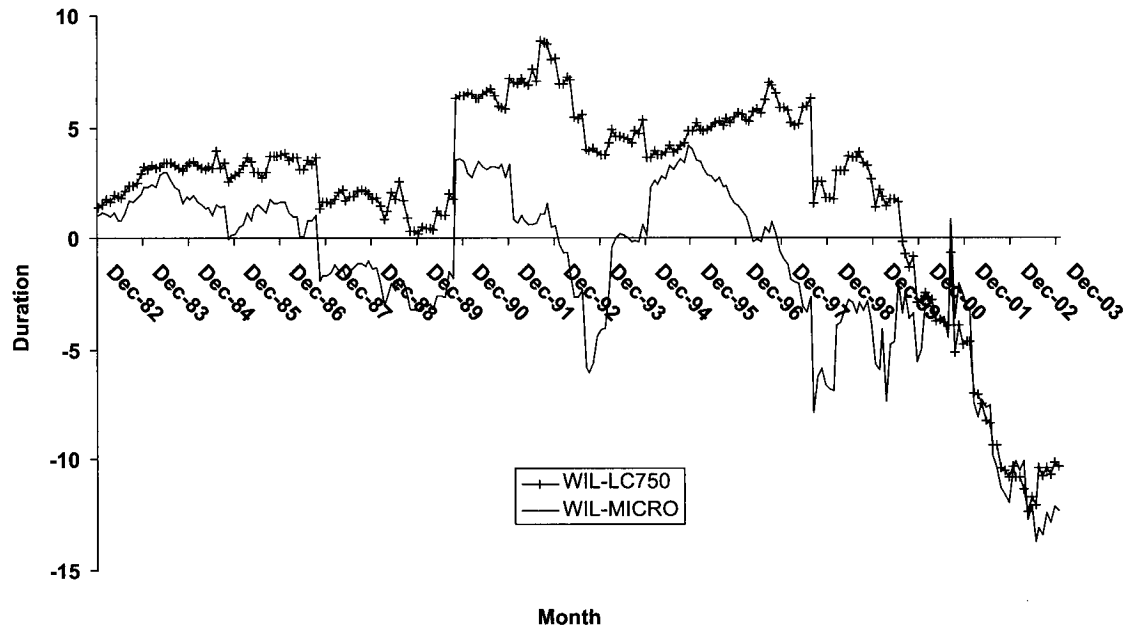


EXHIBIT 20

36-Month Moving Empirical Durations—Wilshire Large-Cap Value Versus Wilshire Large-Cap Growth (Dec. 1982-Dec. 2003)

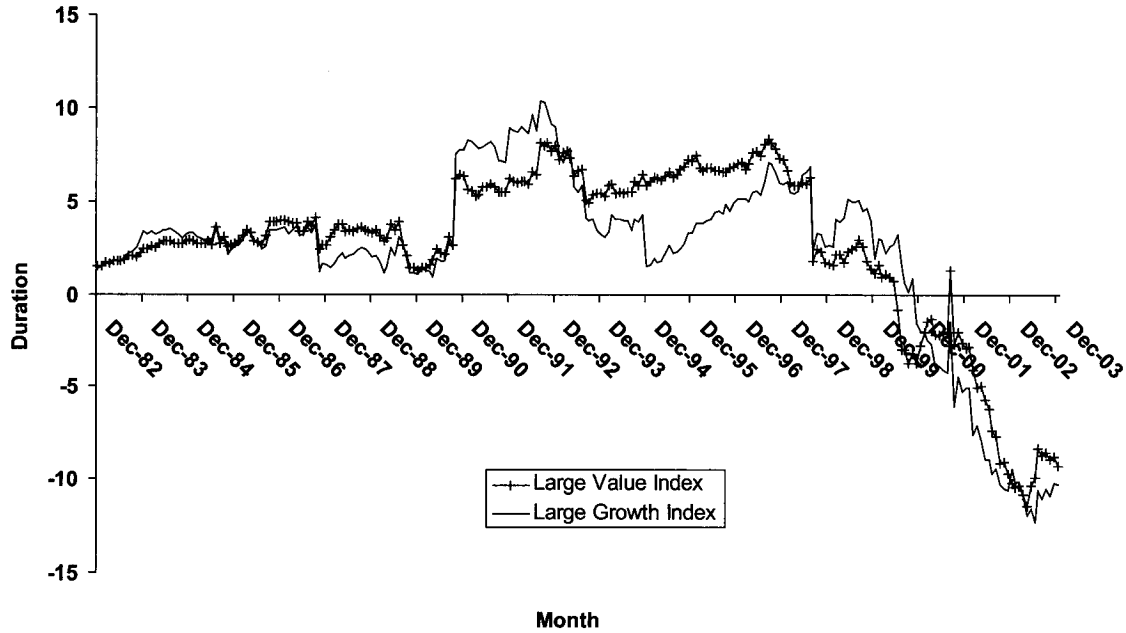


EXHIBIT 21

36-Month Moving Empirical Durations—Wilshire Mid-Cap Value Versus Wilshire Mid-Cap Growth (Dec. 1982-Dec. 2003)

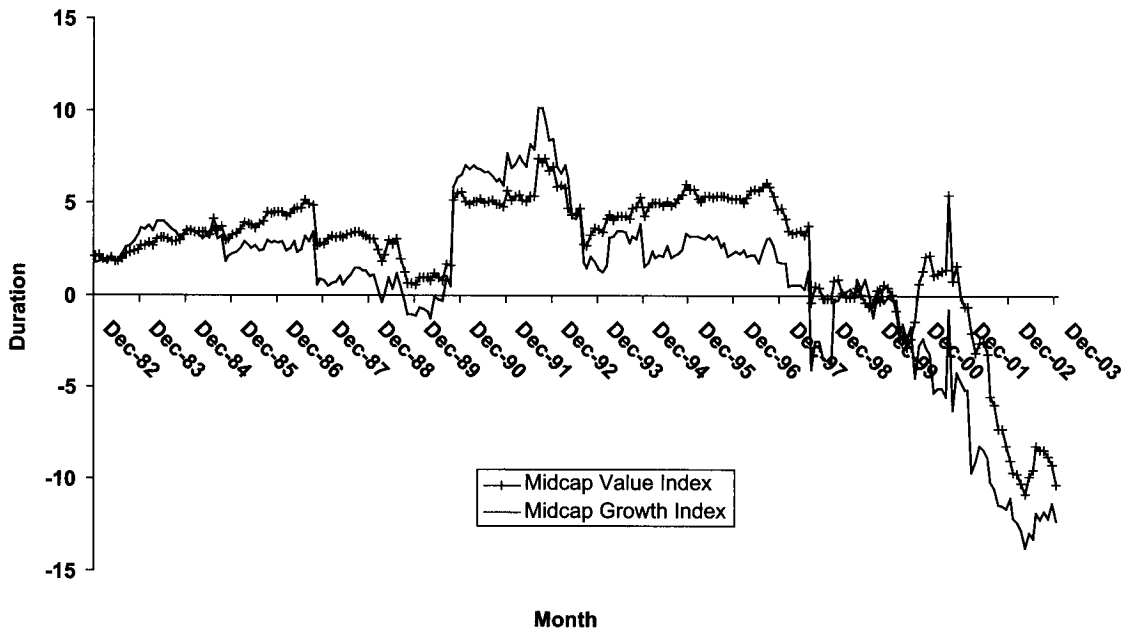
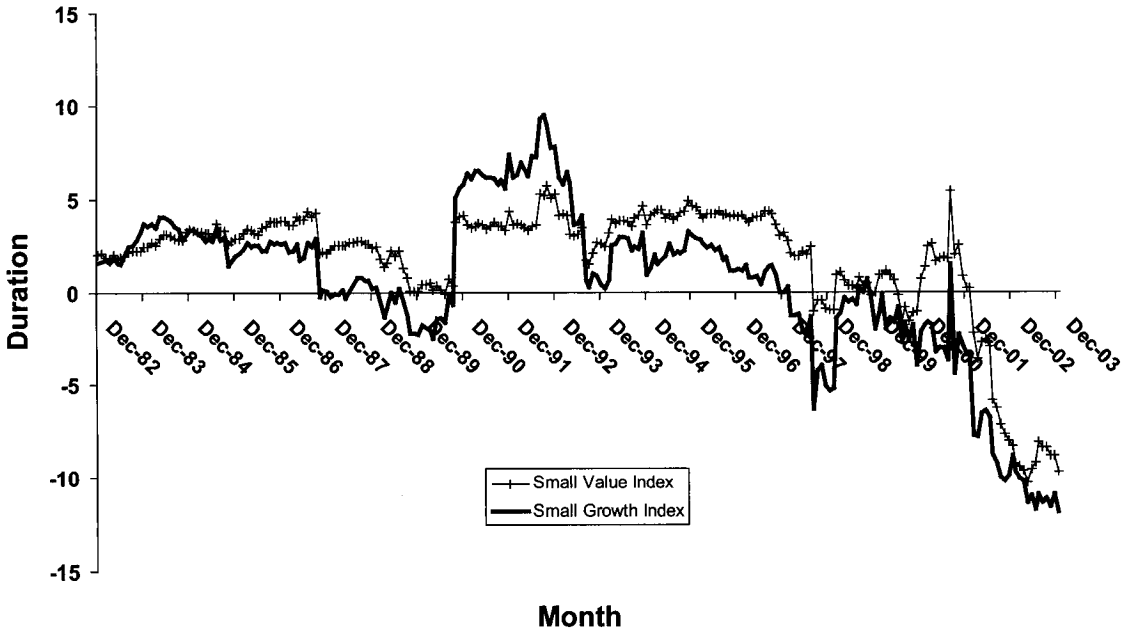


EXHIBIT 22

36-Month Moving Empirical Durations—Wilshire Small-Cap Value Versus Wilshire Small-Cap Growth (Dec. 1982-Dec. 2003)



stocks were consistently higher, irrespective of size. These unique results followed the 1990-1991 recession, and this economic environment would have impacted these 36-month moving regressions. Assuming the recession resulted in an overall reduction in corporate growth expectations, these lower growth expectations would have affected growth firms more than value firms.

SUMMARY AND CONCLUSIONS

Investors and portfolio managers have always been concerned with the interest rate sensitivity of aggregate stocks and industries. Investors have sometimes become obsessed with Federal Reserve interest rate changes. Although several other authors have proposed measures of equity duration to quantify this sensitivity, they have not measured consistent equity duration for a large cross-section of industries and sectors over time.

We attempt to fill this gap by measuring the empirical duration (ED) for the aggregate stock market, various economic sectors, and a large cross-section of industries, as well as for stock indexes by size and investment style. The analysis considers total period EDs after adjusting for the market effect and time series patterns for the market and industries.

The Treasury bond market empirical duration ranges from about 4.0 to 6.0, and is very similar to the measured modified duration. The ED for the aggregate stock market averages less than 3.0 and ranges from −12.00 to 8.67, which is much lower than the equity duration implied by the dividend discount model, but is generally consistent with the Leibowitz [1986] results. The results for the cross-section of industries indicate a wide range of EDs that are consistent with traditional expectations—i.e., utilities and financial services industries are generally at the high end, and energy and other industries with pricing power are at the low end. These results are quite consistent with the inflation flow-through hypothesis in Leibowitz et al. [1989] and Leibowitz and Kogelman [1993], who demonstrate that, as inflation flow-through increases, empirical duration should decline.

Another consistent result is the significant negative relation between the market beta for industries and the industry ED—industries with low market betas have high EDs, while industries with high market betas have low

(negative) EDs. Industries with high (low) market risk tend to have low (high) interest rate risk.

The results for the differential-size company samples also show clear and consistent differences as the EDs range from large-caps at about 1.50, mid-caps at about 1.30, small-caps at about 1.0, and micro-cap stocks at zero. The time series plots of the moving EDs show that these differences in EDs for different-size stocks are stable over time and consistent with the Leibowitz and Kogelman [1993] expectations.

The analysis of investment style indexes also provides consistent ED results. It has been hypothesized that growth companies should have lower EDs because more of their value is derived from their franchise (growth options) value, which should imply a lower ED because of higher inflation flow-through. The empirical duration coefficients support this expectation, as the value stock indexes have higher EDs than the growth stock indexes for all three size categories.

Our results overall indicate that empirical equity duration is a very useful technique to measure the interest rate sensitivity of the aggregate stock market and to differentiate the interest rate sensitivity of alternative economic sectors and industries. The results are generally consistent with economic expectations and company performance during periods of inflation. While the total-period results help us identify the long-term characteristics of an industry or sector, it is important to recognize that empirical durations have been quite volatile over time for the aggregate stock market, alternative industries, and different investment styles.

ENDNOTES

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*A very similar argument is made in terms of the presence of growth options by Sweeney and Warga [1986] and Hevert, McLaughlin, and Taggart [1998].

REFERENCES

Cornell, Bradford. "Equity Duration, Growth Options, and Asset Pricing." *The Journal of Portfolio Management*, 26, no. 3 (Spring 2000), pp. 105-111.

Dunetz, Mark L., and James M. Mahoney. "Using Duration and Convexity in the Analysis of Callable Bonds." *Financial Analysts Journal*, 44, no. 3 (May/June 1988), pp. 53-73.

Fabozzi, Frank J., Gerald W. Buetow, Jr., and Robert R. Johnson. "Measuring Interest Rate Risk." In Frank J. Fabozzi, ed., *The Handbook of Fixed-Income Securities*, 6th ed. New York: McGraw-Hill, 2001.

Fabozzi, Frank J., Mark Pitts, and Ravi E. Dattatreya. "Price Volatility Characteristics of Fixed-Income Securities." In Frank J. Fabozzi, ed., *The Handbook of Fixed Income Securities*, 5th ed. Chicago: Irwin Professional Publishing, 1997.

Fisher, Lawrence, and Roman L. Weil. "Coping with the Risk of Interest-Rate Fluctuations: Returns to Bondholders from Naive and Optimal Strategies." *Journal of Business,* 44, no. 4 (October 1971), pp. 408-431.

"The Global Family of Indices." Lehman Brothers Fixed Income Research, annual.

Hayre, Lakhbir, and Hubert Chang. "Effective and Empirical Duration of Mortgage Securities." *The Journal of Fixed Income,* 6, no. 4 (March 1997), pp. 17-33.

Hevert, Kathleen T., Robyn M. McLaughlin, and Robert A. Taggart. "Growth Options and Equity Duration." *The Journal of Portfolio Management*, 25, no. 1 (Fall 1998), pp. 43-50.

Hopewell, Michael H., and George Kaufman. "Bond Price Volatility and Term to Maturity: A Generalized Respecification." *American Economic Review,* 63, no. 4 (September 1973), pp. 749-753.

Leibowitz, Martin L. *New Perspectives on Asset Allocation.* Charlottesville, VA: The Research Foundation of the Institute of Chartered Financial Analysts, 1987.

————. "Total Portfolio Duration: A New Perspective on Asset Allocation." *Financial Analysts Journal,* 42, no. 5 (September-October 1986):

Leibowitz, Martin L., and Stanley Kogelman. "Resolving the Equity Duration Paradox." *Financial Analysts Journal,* 49, no. 1 (January/February 1993), pp. 51-64.

Leibowitz, Martin L., Eric Sorenson, Robert D. Arnott, and H. Nicholson Hanson. "A Total Differential Approach to Equity Duration." *Financial Analysts Journal*, 45, no. 5 (September/October 1989), pp. 30-38.

Macaulay, Frederick R. *Some Theoretical Problems Suggested by the Movements of Interest Rates, Bond Yields and Stock Prices in the United States since 1856.* New York: National Bureau of Economic Research, 1938.

Maitland, Maureen, and David M. Blitzer. "A GICS Overview for Standard & Poor's U.S. Indices." Standard & Poor's Quantitative Services, July 22, 2002.

Reilly, Frank K., and Keith C. Brown. *Investment Analysis and Portfolio Management*, 8th ed. Mason, OH: South-Western, 2006.

Sweeney, Richard J., and Arthur D. Warga. "The Pricing of Interest-Rate Risk: Evidence from the Stock Market." *Journal of Finance*, 41, no. 2 (June 1986), pp. 393-410.

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