Sector Index Returns And The Market: An Examination Of The Pre- And Post-Crash Periods

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Reliance on stock market sector indexes for investment makes it essential to understand how various sectors behave relative to the market. Of particular importance is whether these relationships have changed over time. This paper examines the risk/return characteristics of five S&P sector indexes in pre- and post-1987 stock market crash periods. The results suggest that, relative to the market, the volatility of some sectors may change following major events. Index investing should not be thought of as a totally passive strategy. In light of these changing relationships, financial planners should make sure clients revisit investments, especially following major economic events.
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Introduction

One ingredient to successfully obtaining financial goals is an adequate understanding of the risk/return characteristics of financial instruments comprising a portfolio. In order to achieve retirement or savings goals many investors have turned to various forms of *index investing*[a] The popularity of index fund investing is evident in the amount of attention that the financial media devotes to the tracking of equity indexes. Including an index fund (or group of funds) in one's portfolio may have several advantages over holding only individual stocks. These advantages include a reduction in trading costs and management fees, postponement of taxable gains (i.e., market winners won't be sold as quickly thereby saving on taxes), and obtaining market predictability (i.e., in the sense that you earn what the market or sector does). Whether or not to include in a portfolio financial instruments that track particular sectors of the economy or mirror particular composites, depends on a number of factors[b] including how, and to what extent, the various indexes are related to the market.

While the index approach to investing has generally been thought of as a passive strategy, it may not be prudent to simply invest and "forget about it." Indeed, it may be wise to periodically re-visit the composition of a portfolio comprised of index funds, particularly after major market changes occur (e.g., a stock market crash or correction). This research examines whether or not the fundamental relation between volatility in several major sector indexes and the volatility of the overall market changed following the 1987 stock market crash. Although, this event may be better described as a stock market correction, in keeping with much of the literature (e.g., Bates, 2000; Aggarwal, Inclan & Leal, 1999; Stokes & Neuburger, 1998; Thorbecke, 1997), we use the term crash. By being aware of the potential for certain sectors of the economy to behave differently in relation to the market in pre- and post-stock crash periods, the financial planner can help to properly guide clients to construct portfolio's appropriate for their goals. Given that financial planners and counselors assist individuals in a variety of ways, including providing recommendations and suggestions on how to meet the client's objectives, and that many investors are turning to index based funds as a major part of their portfolio allocation decision, it is imperative that we understand how these indexes behave, especially in relation to the market. This paper seeks to provide information on the subject by looking at how returns in various sectors respond to fluctuations in overall market returns. Specifically, our goal is to examine the behavior of investment betas over time to determine if they are stable or not. Certainly, some sectors are traditionally more volatile than the market and some are less volatile than the market. However, do these responses of certain sectors to changes in market returns remain intact following an event such as a stock market crash? If they do, then one can simply determine their relationships once and forget about them. On the other hand, if these relationships change, then it would be wise to use this information when constructing portfolios geared towards investment objectives.

In order to examine this issue we focus attention on five S&P stock indexes, each representing a major sector of the overall U.S. market, and each proxying for particular types of index funds and index-based investments. The Standard and Poor's indexes are especially important to examine because financial professionals use S&P indexes more than any others to follow movements of industry groups (Mennis, 1999). We compare the pre- and post-crash periods in order to discern whether or not the relationships between these

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S&P sector indexes and the market changed after the 1987 stock market crash.

Risk, Return, and the Meaning of Beta

One method of measuring risk is to use the popular systematic risk measure known as an *investment beta*. Traditionally, investment betas have been estimated for a number of individual stocks and a variety of portfolios and the information is often used by financial market participants for diversification purposes.[c] However, no one has examined the betas for sector indexes like those represented by the S&P. This is surprising given the popularity of index investing and the importance of sector based indexes.[d]

The role of the investment beta has become a mainstay of modern financial economics and has been the subject of much research.[e] The capital asset pricing model (CAPM) has allowed researchers "to quantify risk and the reward for bearing it." (Campbell, Lo & MacKinlay, 1997, p. 181). An underlying assumption of CAPM is that investment betas are constant or stable over time. However, there is some evidence to suggest otherwise (e.g., Fabozzi & Francis, 1978; Sunder, 1980; Stokes & Nueburger, 1998). Does this mean betas are not useful and that they should be ignored? Probably not, especially if we can identify how and why betas change. It may very well be that betas are fairly stable for even some extended periods of time, but that major events (e.g., a stock market crash) may alter the market and thus the beta values. In fact, Emmons and Schmid (2000) found that the recent Asian crisis changed the betas of some of the large firms comprising the S&P 100 index. Exactly how and when betas change, if they do, should be particularly important to investors and financial planners.

One important component of the capital asset pricing model is the way in which the risk-return tradeoff for portfolios is measured. This measure is called beta. Consider the following equation.

(1) $E(r_j) = r_f + \beta_j[E(r_m) - r_f]$

where r_j denotes the return on asset j (in our case the return on an S&P sector index), r_m is the market return (or the return on the S&P composite index), r_f is the return on the risk-free asset (e.g., the 3-month Treasury bill rate), and $E(\bullet)$ is the expectations operator. The beta of a security is a measure of its systematic or non-diversifiable risk. In the context of our study, β_j is the ratio of the covariance between the return on S&P index j and the market return to the variance of the market return. Thus, beta represents the volatility of index j relative to the overall market.

Portfolios with $\beta > 1$ are relatively more risky, while those with $\beta < 1$ are much less sensitive to market movements. Though a number of studies have estimated beta's for a variety of securities, and others have examined beta stability over time, no study has focused on the investment betas of individual sector S&P indexes. This paper attempts to fill this gap in the literature and to provide the investment professional with useful information about the behavior of sector indexes relative to the market.

Methodology and Data

To determine the sector index investment betas, the following equation is estimated using ordinary least squares regression.

(2) $(r_j - r_f)_t = \alpha + \beta_j(r_m - r_f)_t + \varepsilon_t$

Where $r_j - r_f$ = excess return on index j; α = constant term; β_j = systematic risk of index j; $r_m - r_f$ =excess return on the market; and ε_t =random error term. One major issue of concern is whether or not beta is stable over the time period studied (i.e., $\beta_{jt} = \beta_{jt+k}$, for k = 1, 2, …, n). In our analysis, several tests regarding both *intra*-period and *inter*-period stability are conducted based on the estimation of equation (2). The theoretical CAPM suggests $\alpha=0$; however, following Campbell, Lo, and MacKinlay (1997) the OLS model includes the constant term.

We estimate betas for the returns on the S&P capital goods index, financial index, industrials index, transportation index, and utilities index. For the overall market return we use the S&P composite index. The three-month Treasury bill proxies the risk-free rate. Examination of the sector index betas in the pre- and post-crash periods provides information about the stability of these betas in lieu of major market events.

The data for the study are obtained from the DRI/Citibase data bank and are monthly observations covering the period from January 1970 through July 1997. We define the pre-crash period as 1970:01-1987:09 and the post-crash period as 1988:01-1997:07.[f] The return on each index was constructed by annualizing the monthly growth rate.

Empirical Results

The results from estimating equation (2) for each sector index in both the pre- and post-crash periods are presented in Table 1. Specifically, the third column reports the value of the estimated sector index beta and the fourth column presents the result of a Wald test of parameter restriction (distributed χ^2 with one degree of freedom) to see if the estimated beta is significantly different from one (H_0: $\beta = 1$). A beta value equal to one implies that the index and the market have the same amount of risk and will provide similar returns. If the sector index beta is greater than (less than) one, then a move in the overall market will tend to raise (lower) the index proportionately more (or less) than the market. Thus, volatile sectors are those sectors with betas significantly greater than one, while sectors

that are less volatile than the market have betas significantly less than one.

Focusing on the capital goods index it is found that both the pre- and post-crash period betas are significantly greater than one, with the latter period having the highest value (1.40 versus 1.21). This indicates that the capital goods index is more volatile than the market overall and that this volatility may have increased following the crash. In both cases, the R^2 value is high, suggesting that around 83-85% of the total risk in capital goods index returns is systematic in nature. Thus, only a relatively small proportion of the total risk of capital index returns is diversifiable. One way of checking to see if the estimated beta relationship spelled out in equation (2) is stable *within* the sample period, i.e. testing for intra-period stability, is to conduct the Lagrange multiplier test for the presence of autoregressive conditional heteroscedasticity (ARCH). The null hypothesis of this test assumes that the variance of the estimated residuals is constant. A violation of this assumption is detected if the ARCH statistic is significant and is suggestive of a time-varying variance of the beta model.[g] For capital goods it is found that the variance of the beta equation may indeed have been time-varying during the pre-crash period but no evidence of these ARCH effects are found in the post-crash period. Thus, we can be more confident using the post-crash beta in constructing portfolios.[h]

The financial index is also found to have beta estimates significantly greater than one in both periods studied. Similar to capital goods, the beta value for the financial index is found to be higher in the post-crash period (1.86) than in the pre-crash period (1.13). The volatility of financial index returns relative to the overall market appears to be greater following the stock market crash. The R squared values suggest there has been an increase in the measured amount of total risk that is systematic, i.e., attributable to the market, since the 1987 crash. No evidence of any intra-period instability is found via the test for ARCH effects.

Table 1
Investment Betas for S&P Sector Indexes

	Sample Period	β	H_0: β = 1	R^2	ARCH
Capital goods	Pre-crash	1.2066	34.03*	.85	24.91*
	Post-crash	1.4015	44.69*	.83	1.63
Financial	Pre-crash	1.1257	3.10‡	.54	1.89
	Post-crash	1.8571	70.05*	.74	0.32
Industrial	Pre-crash	1.0283	16.55*	.99	36.24*
	Post-crash	1.0262	3.0703‡	.98	0.00
Transportation	Pre-crash	1.2873	16.73*	.61	0.75
	Post-crash	1.0727	0.66	.56	0.85
Utilities	Pre-crash	0.6854	25.38*	.36	0.00
	Post-crash	0.3991	75.03*	.23	0.37

Notes: The superscripts * and ‡ denote significance at less than the 1% and 10% levels, respectively. ARCH denotes a Lagrange Multiplier test, distributed $\chi^2_{(1)}$, designed to check for the presence of autoregressive heteroscedasticity in the error terms.

Of all the indexes studied, the industrial index most closely resembles the overall market as measured by beta. In fact, while the estimated betas are found to be significantly greater than one in both periods, they are both approximately equal in value and found to be about 1.03. The R^2 values are .99 and .98, suggesting that almost all of the movement in industrial index returns can be explained by movements in the market. Some caution should be used when interpreting the pre-crash beta, however, as evidence of instability in this period is suggested by the presence of ARCH effects.

The beta values for the transportation index in the pre- and post-crash periods were found to be 1.29 and 1.07, respectively. However, only the earlier estimate of beta was found to be significantly greater than one. Thus, the volatility of transportation relative to the

market fell dramatically after the stock market crash. In fact, in the latter period, there appears to be no difference between the transportation beta and the market beta of one. No significant ARCH effects were detected in either period.

The utilities index is by far the least volatile sector examined. In both periods the estimated betas were significantly less than one. However, the post-crash beta (0.40) is much lower than the pre-crash beta (0.69). The relatively low R^2 values suggest that the market explains much less of the movements in utilities returns than it does for the other indexes. Both periods estimates of beta were free of intra-period instability.

The results presented in Table 2 suggest that both capital goods and financials became more reactive to changes in the overall market following the 1987 stock market crash. As measured by their betas, these may be classified as the two most volatile sectors. The industrial index most resembles the market and the estimates of beta in the two periods were not that much different. In contrast, transportation and utilities both became much less volatile relative to the market. In fact, transportation went from being significantly more volatile than the market to having a beta that is not significantly different from one. Utilities is the only sector whose beta is less than one.

The above findings suggest betas may be different in the pre- and post-crash periods, therefore, we turn our attention to examining the issue of *inter*-period instability in beta. Evidence of inter-period instability would suggest that one should not rely on a single beta estimate over periods of time that contain events like the 1987 crash. A test was conducted to examine if there was a significant change in the regression coefficients between the two periods. The results of the Chow breakpoint test are presented in Table 2.[i] In four cases (capital goods, financial, transportation, and utilities) we find evidence of inter-period instability in beta. The Chow test did not detect any instability between the pre- and post-crash regressions for the case of the industrial index.

Table 2 also presents the results of an additional test designed to see if the estimated value of beta in the post-crash period was any different from that of the pre-crash period. The third column of the table shows the findings of a test where the null hypothesis is that the post-crash beta equals the pre-crash beta. Consistent with the findings of the Chow test, we find significant differences between pre- and post-crash sector index betas in all cases except the industrial index. This suggests that estimated sector index betas have changed in value and in this sense suffer from inter-period instability. Thus, while sector index betas may be stable within particular periods, it is important to re-examine their values periodically and especially following a major event like a stock market crash.

Implications for Financial Planners and Counselors

The main contribution of this article is the documentation of changes in sector index betas between the pre- and post-1987 stock market crash periods. The findings are particularly important to professionals in the investment community who often must dispel misconceptions about investing to the public. A key point is that relationships between sectors and the market are not set in stone. These relationships do change. Today's investors need to know that portfolios constructed to provide them with certain expected diversification benefits may not necessarily provide those same benefits in the future.

An important practical implication of this research is the valuable and timely information that the estimated sector index betas provide to investors and financial planners. For instance, if the beta for a particular index is close to one, then those seeking to diversify would not experience the expected benefits from allocating between a market index fund and that index-based investment.

An important lesson from this research is that viewing index investing as a totally passive strategy may lead to a false sense of security for investors. It is necessary for those who make use of index-based investments to be aware of the potential for changing relationships between sectors and the overall market. By being aware of sector index betas and market events, the financial planner can facilitate the transmission of this valuable information and help clients achieve their financial goals.

Table 2
Tests of Inter-Period Beta Stability

	Chow	H_0: $\beta^{post} = \beta^{pre}$
Capital goods	3.2994†	10.5316*
Financial	14.9619*	51.0117*
Industrial	0.1918	0.0196
Transportation	2.7211‡	5.7302†
Utilities	3.4788†	17.0333*

Notes: The superscripts *, †, ‡ denote significance at less than the 1%, 5%, and 10% levels, respectively. Chow denotes the F-statistic that tests the stability of the regression coefficients. H_0: $\beta^{post} = \beta^{pre}$ is the null hypothesis from a Wald test, distributed $\chi^2_{(1)}$, and is used to check if the estimated value of beta in the post-crash period equals the value of beta from the pre-crash period.

Conclusions

Today's investors are utilizing various forms of index investing to achieve long term financial goals. Proper

financial planning is, of course, essential to the success of any investor's portfolio. The goal of this research was to examine the stability of sector investment betas over time. The results presented in this paper suggest that index investing should not be thought of as being a completely passive strategy. We find that the relative responsiveness of various sectors to the market has changed over time. Specifically, we find that sector investment betas differ between the periods before October 1987 and after October 1987. Given these tendencies for changes in investment betas, financial counselors and planners should make clients aware of the relationships between sector indexes and the market so that appropriate portfolio allocation decisions can be made.[j] In fact, the occurrence of major market changes and other potential shocks to the world economy is inevitable and it is especially important for investor's to revisit their financial positions and perhaps alter their allocation decisions accordingly, regardless of whether or not they are taking an index investing approach. Finally, the results suggest that timing opportunities may exist. Future research should be directed toward determining whether these market changes should or should not trigger a reallocation of the investor's funds

Endnotes

a. *A number of mutual fund companies offer index funds and index-linked products. In fact, more than 50 companies issue S&P 500 index-linked annuities (http://www.spglobal.com/index.html).*

b. *Other factors that investors consider when making their investment decision include their level of risk tolerance, investment horizon, goals, etc. Clearly, for diversification purposes, the decision to include a particular asset in a portfolio may also depend on how that asset behaves relative to other assets and/or the market.*

c. *The early, seminal work in this area was conducted by Markowitz (1959), Sharpe (1964) and Lintner (1965).*

d. *It is interesting to note that S&P now makes available beta estimates for a variety of sectors based on the S&P Depository Receipts (SPDRs). These figures can be obtained free of charge via the S&P Internet website. This provides financial planners with a way to quickly reference these figures and use that information to help their clients construct portfolios.*

e. *The literature is much too large to list all the important papers. For reviews see Campbell, Lo and MacKinlay (1997) and Mills (1999).*

f. *Our choice to begin the post-crash period in January 1988 follows that of Stokes and Neuburger (1998). Similar results to what are reported below were also obtained using post-crash start dates of November and December 1987.*

g. *According to Hildreth and Houck (1968), the effect of a time-varying beta is to alter the properties of the disturbance term in equation (2) so as to become heteroscedastic. In analyzing time series data, heteroscedasticity generally takes the form of what is called autoregressive conditional heteroscedasticity or ARCH effects. A discussion of ARCH and ways to test for its presence is given in Engle (1982).*

h. *In order to examine the issue of ARCH effects further, we re-estimated the pre-crash sample equation recursively backwards, shortening the sample by one month at a time for a total of twelve months. The ARCH statistic was significant for each of the twelve regressions. For capital goods and industrials (discussed below), the results suggest that investment beta regressions in the pre-October 1987 period are not as reliable as those from the post-October 1987 period. One possible explanation for this finding is that these two sectors, which are traditionally more capital-intensive than the other sectors, may now experience less persistent business cycle effects if the events of October 1987 have led to a more efficient economy.*

i. *To conduct the Chow test, one fits the equation separately for both the pre- and post-crash periods and constructs an F-statistic to see whether there are significant differences in the estimated equations. A significant difference indicates a structural change in the relationship.*

j. *In our analyses, the smallest percentage change in beta that was statistically significant was around 16% (Capital goods). A rule of thumb for investors might be that if a sector beta changes by 16% or more (or, say, even 10%), then a more thorough investigation into the possibility of a structural change may be warranted.*

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