How Passive Investing Increases Market Vulnerability

James X. Xiong, CFA
Senior Research Consultant
Morningstar Investment Management
jxiong@ibbotson.com

Rodney N. Sullivan, CFA
Editor, Financial Analysts Journal
CFA Institute
Rodney.Sullivan@cfainstitute.org

August 20, 2011

Abstract

Assets invested in passively managed equity mutual funds and exchange traded funds (ETFs) have grown steadily in recent years, reaching more than one trillion dollars at the end of 2010. We establish that the rise in popularity of index investing contributes to higher systematic market risk. More indexed equity assets corresponds to increased cross-sectional trading commonality, in turn precipitating higher return correlations among stocks. Consistent with the accelerating growth of passive investing, we discover that equity betas have not only risen but converged in recent years.

How Passive Investing Increases Market Vulnerability

Researchers have made the provocative discovery that the U.S. stock market has become more vulnerable over time to unanticipated events (e.g., see Kamara, Lou, and Sadka (2010)). Here, researchers point to a variety of factors, including the rise of systematic risk (beta) in recent decades. In this paper, we pinpoint one possible culprit for the observed increase in market vulnerability; the rising popularity of passively managed assets. In this connection, we offer new insights on the market impact of basket trading associated with the rise of passively managed index funds and ETFs. In particular, we show that the increased commonality of trading constituent stocks associated with index investing is consistent with a more synchronized market and thus rising levels of systematic risk. This, in turn, reduces the benefits of diversification across the equity market.

In U.S. equity markets, institutional investors have played an increasingly important role, especially in recent years. Research has shown how growth in institutional investing and index trading has affected the systematic liquidity and systematic risk of the U.S. equity market [Kamara, Lou, and Sadka (2008)].[1] This research finds that, across all size quintiles, both liquidity betas and return betas have risen alongside the increase in institutional ownership. Alternatively, others [Chordia, Roll, and Subrahmanyan (2011)] have showed that the rise in institutional investing has increased the efficiency of price information and lowered intraday volatility.

Index investing, including index funds and ETFs, has likewise experienced tremendous growth over the last two decades. Bhattacharya and Galpin (2011) show that the popularity of value-weighted portfolio or index portfolio is increasing globally, and it is even more popular in the category of large and well-covered stocks. This phenomenon is undoubtedly due, in part, to the appeal of index funds in that they generally offer low cost, comprehensive diversified exposure to various market segments. Their appeal is compounded by the challenges associated with sourcing skilled active managers, which,

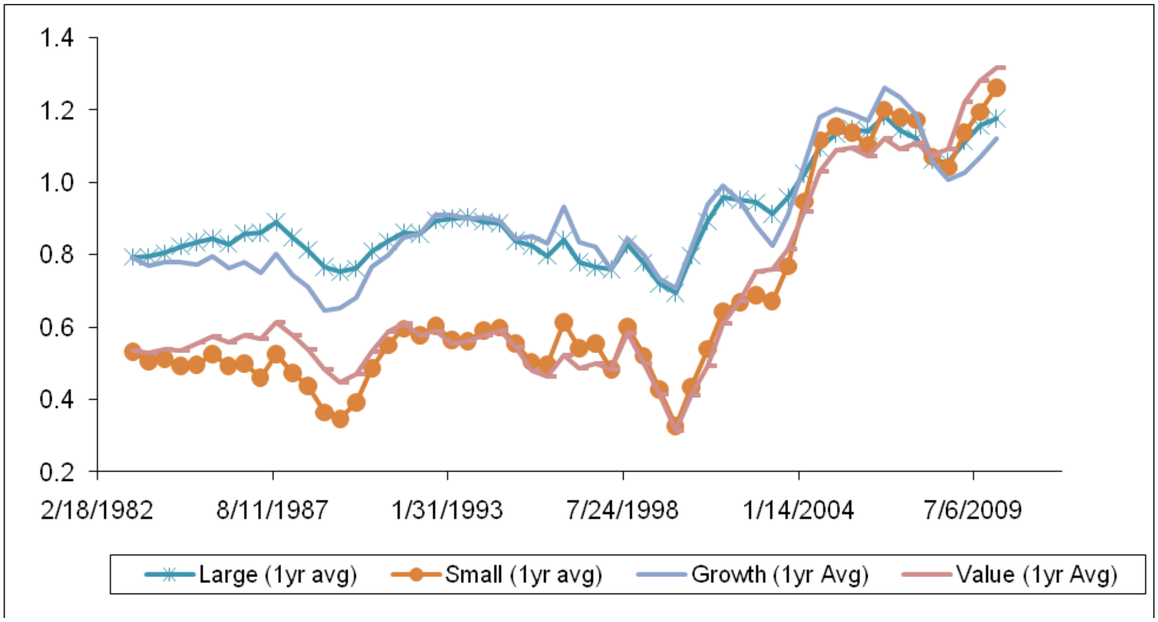
[1] Their daily liquidity measure is based on the Amihud (2002) measure of a company's stock illiquidity, which is calculated as the ratio of the absolute value of daily return to the dollar volume.

of course, is a zero sum game— even negative sum—after costs. However, the increased popularity of index funds and ETFs comes at the cost of increased commonality of trading (e.g., basket trading) across the market resulting from the simultaneous buying or selling of the many stocks within the index being traded. As a consequence, the entirety of stocks within a given index will tend to move together in fashion throughout the trading day.

Consider too how rising market efficiency, as witnessed in recent decades, associates with commonality in trade behavior. Fischer Black, according to Mehrling [2005], once suggested that markets become increasingly volatile as they become more efficient. This occurs because market participants tend to react in the same way when unanticipated new information becomes available, thus leading to larger overall swings in market prices. Interestingly, index fund investing, which in effect assumes markets are micro-efficient, reflects this outcome due to the common mass trading of the constituent stocks within the index associated with every index fund transaction. Our research effort seeks to aid our understanding of the consequences of this increased trading commonality associated with the proliferation of indexes and index trading in recent years.

We are also motivated to seek insight into the concerning steady increase and convergence of U.S. equity betas across size and styles since 1997 as shown in Figure 1. Figure 1 plots the time-series of equally-weighted cross-sectional beta estimates as calculated for the well-known equity size and style groupings for U.S. stocks. We return to this figure in detail later as we study how this seeming rise in systematic risks connects with the rise in popularity of passively managed index funds and associated increased trading commonality among constituent stocks. Through a battery of tests, we examine the impact of trading commonality related to passive investing and the resultant impact on systematic market risk.

Figure 1. Equal Weighted Average Betas for U.S. Stocks by Size and Style



We know so little about the consequences of the growth in index investing; for instance how it affects underlying market liquidity, volatility, and price discovery, especially in light of the relatively new ETF market which allows for intraday trading.[2] In a review of the consequences of index investing, Wurgler (2010) suggests that index investing is distorting stock prices and risk-return tradeoffs. This, in turn, may be leading to a host of distortions including corporate investment and financing decisions, investor portfolio allocation decisions, and assessing fund manager skill. These effects may intensify should index-linked investing continue to gain popularity.

Data

Our dataset consists of all the stocks that meet our criteria on the NYSE/AMEX/NASDAQ from January 1, 1979 through December 1, 2010. Daily returns, daily exchange-based trading volumes , monthly market caps, monthly book-to-market ratios, and number of shares outstanding (not adjusted for free-float) are collected from the Morningstar Direct database. We include stocks with a price between $2 and

[2] Our research effort is intended as a purely positive one directed at a powerful potential impact resulting from the recent surge in popularity of index investing on financial markets. We take no position here on whether index investing is superior or inferior to that of active management.

$1000 and a market cap greater than $100 million. Consistent with prior research, the limit on market cap excludes most micro-cap stocks. We also exclude derivative securities like ADRs of foreign Stocks. In our dataset, there are about 500 stocks in January 1979 and about 2900 stocks in December 2010.[3] In addition, we collected all U.S. equity ETF funds and U.S. equity mutual funds for our fund asset size estimates, including both live and defunct funds.

Growth in Index Trading

Key changes in the U.S. equity market over the last three decades include substantial growth in institutional investing. The average fraction of a firm's equity shares held by institutions has grown from 24% in 1980 to 44% in 2000, and now reaching 70% in 2010. The average number of institutions holding the typical firm's shares found on the NYSE has grown from 54 institutions in 1980 to 125 in 2000, and to 405 in 2010.[4] We further estimate that during 2010, institutional related trading accounted for over 70% of the total trading volume on the NYSE. Altogether, these statistics suggest that institutional investing is more prevalent in recent decades. The influence of institutional related investing has been steadily growing and has become a dominate force in today's stock market activity.

Following the increasing role of institutional investors in recent decades, assets invested in index mutual funds and ETFs have also risen rapidly. Figure 2, Panel A, compares total equity assets under management for active mutual funds versus passively managed funds from Feb 1993 to Sep 2010. We measure passively managed investments as assets invested in index mutual funds plus ETFs.[5] All assets are U.S. equity assets. As of October 2010, total assets in equity mutual funds and ETFs reached $3.5 trillion. Of that, $2.3 trillion was actively managed with the remaining $1.2 trillion being passively

---

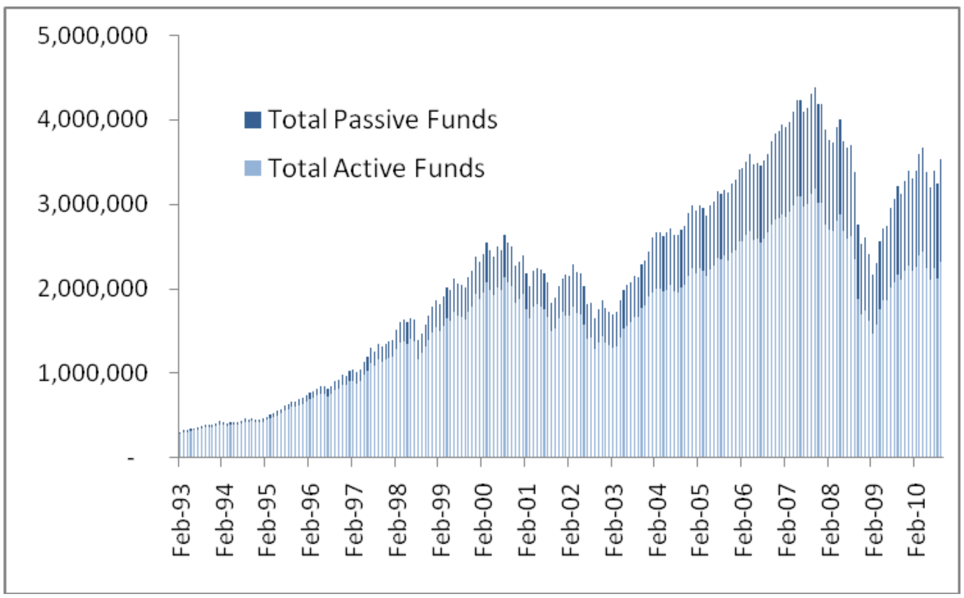
[3] Our stock data are partly subject to survivorship bias from 1979 to 2000. Specifically, Morningstar Direct has less coverage in stocks that were not listed before 2000. Since our analyses depend largely on cross-sectional measures, we expect our results to be unaffected by survivorship bias; our understanding is that excluded stocks were not omitted in any systematic manner.

[4] The numbers in 1980 and 2000 are referred from (Sias, Starks and Titman (2006)). We estimated the 2010 figure from the Morningstar Database.

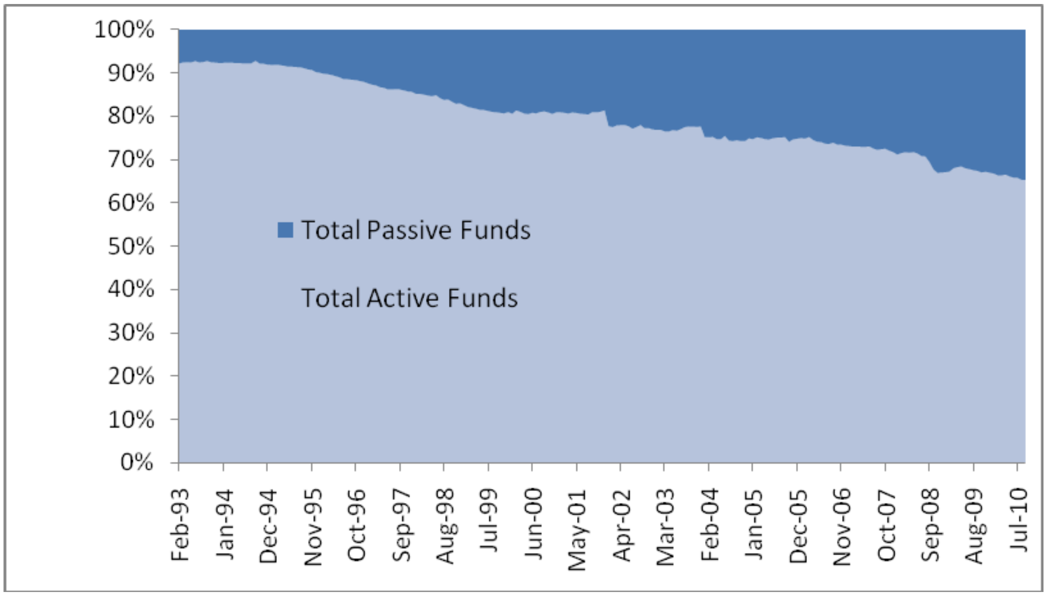
[5] Although not all, most ETFs have passive mandates and track an index, such as the S&P 500 or the Russell 3000.

managed. The passively managed assets break down as $619 billion in equity index mutual funds and $605 billion in equity ETFs. As can be seen from Figure 2, while passively managed funds currently represent only about one-third of all fund assets, the average annual growth rate for passive assets over the past 17 years has been about twice that of actively managed assets (26% per year for passive versus 13% per year for active). Panel B of Figure 2 shows the relative share of active and passive assets as a percentage of all fund assets. From Panel B, one can see that passive funds are clearly increasing market share against their active fund counterparts over the last two decades.

Figure 2. Growth in Equity Fund Assets by Type of Fund
Panel A: Total Dollar Growth



Panel B: Fund Type by Percent of Total Assets



One of the largest index funds, the Vanguard 500 Index (VFIAX) has about $106 billion in assets (as of Feb 2011) and holds about 500 stocks. A typical large-cap stock has a turnover (the fraction of shares exchanged per day) of approximately 0.5%. That is, on average 0.5% of outstanding shares change hands each day. The market cap for a typical large-cap stock runs about $10 billion. It is interesting to note that this particular fund (VFIAX) holds, on average, 2% of the outstanding shares of a typical large stock. Thus, if this fund were to suddenly sell 100% of its holdings of one of these stocks, that sale would represent 400% of the typical daily volume of that stock. Clearly, index funds can impart a significant impact on market prices and trading volume.

Measuring Trading Commonality

The accelerating relative growth of passively managed assets places increased demands on index related trading. This index trading activity, in turn, precipitates higher trading commonality in the cross-section of stocks. This is so, because index funds buy or sell groups of stocks via basket orders in response to capital inflows or outflows and following changes to index holdings. These basket orders are sometimes spread over a few days or weeks in an effort to minimize the price impact. Whether spread over a few hours or over a week, index related trading nonetheless creates similar volume changes across the many stocks within the index over the trading period because the trading occurs in the same direction. That is, that basket of stocks is uniformly either a buy or a sell. Additionally, buying (selling) in one period will likely be followed by more buying (selling) in the next period as the index manager attempts to mitigate the market impact by spreading required order flow over time. Furthermore, index funds with a similar, even if technically different, focus nonetheless create similar volume changes for many stocks to the extent that their fund holdings overlap. In sum, it follows that index related trading must, at the margin, reduce the cross-sectional dispersion of changes in trading volume.

To illustrate this, assume that a hypothetical index fund holds 3 stocks, with each stock representing a 33.33% weighting. The market prices are $10, $20, and $25 for the three stocks. The fund is about to purchase $300 dollars to be distributed evenly across each stock. The trade will be split evenly ($150 each day) over the next two days to reduce market impact. Assuming this purchase accounts for all of the market transactions for these two days, the trading volumes will be 5, 2.5 and 2 shares, respectively, for the three stocks each day. The purchased shares are the same for each day for each stock, so there is no change in share volume across the days for each stock. Therefore, the dispersion in volume *change* is zero over the two days (as the standard deviation of volume changes for the three stocks will be zero). However, the dispersion in volume *level* is greater than zero for these days (1.6 = stdev(5,2.5,2)), although it remains the same each day.

From this discussion, it becomes clear that understanding the market impact of index related trading requires a focus on how such trading affects a *change* in the volume of stock trading from period to period, rather than in the absolute *level* of trading volume. We therefore focus attention on examining the impact of cross sectional dispersion of trading volume changes on overall market activity. To accomplish this, we first measure the logarithmic change in trading volume from one period to the next, calculated as:

$$VC_t = \ln\left(\frac{V(t)}{V(t-1)}\right) \qquad (1)$$

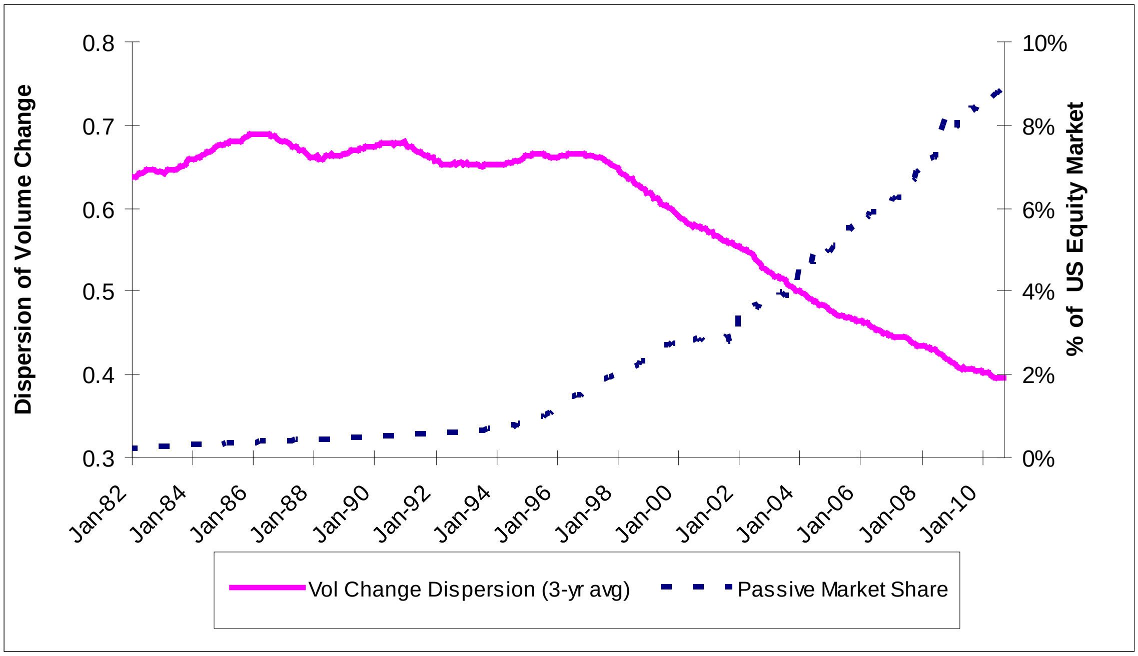
Note that equation 1 is similar to the often used log price return definition. Daily trading volume in equity markets has experienced near exponential growth in recent decades, so using the log of volume changes effectively transforms this exponential volume series into a linear series (see Andersen (1996)). In addition, using the change in volume helps to remove any trend in volume over time that may exist. We then calculate the cross-sectional dispersion of volume change as the standard deviation of VC_t as measured across all stocks for each time period (t).

Figure 3 shows the relationship between the cross-sectional dispersion of trading volume changes and the growth in passive equity fund assets calculated as the percentage of total passive assets relative to the total U.S. stock market capitalization (we refer to this ratio as the "passive market share"). In our measure of the dispersion of volume changes, we follow the formulation discussed above using weekly trading volume, and then smooth with a three-year average. The passive market share is linearly interpolated from 1979 to 1993 by reasonably assuming that the percentage of passive assets was zero percent in 1976.[6,7]

Figure 3. Cross-Sectional Dispersion of Trading Volume Change vs. Growth of Passive Assets *

[6] The Vanguard 500 (VFINX), founded in 1976, was the first index mutual fund.

[7]We include data only from the NYSE/AMEX in Figure 3 and Figure 4.Reported volumes on NASDAQ include inter-dealer trades which result in artificially higher NASDAQ trading volumes versus NYSE and AMEX. In unreported results, we find similar results for NASDAQ.



* Analysis is for U.S. equity market. The volume change dispersion is smoothed by taking a three year average.

Our novel results from Figure 3 show that the dispersion of cross-sectional volume changes has two distinct regimes: a flat regime from 1979 to 1996, and a persistent declining regime from 1997 to 2010. Furthermore, the second regime interestingly declines at an almost constant rate.[8]

Figure 3 further shows that decline in cross-sectional volume change over time nearly a perfect inverse of that shown for the growth in passive assets. Though certainly not a proof of causality, this finding appears highly consistent with our thesis that increased index trading volume drives higher return covariance among constituent stocks. We believe this is in large part due to its association with lower cross-sectional dispersion of trading volume changes. The systematic decrease in changes in stock volume dispersion over time is therefore consistent empirically and intuitively with the aforementioned rise in index trading during the same time period.

[8] In unreported results, we do not observe similar behavior with the dispersion of cross-sectional volume *levels*, suggesting that these two regimes are associated only with volume *changes*.

The rise in index trading is, of course, only one possible contributor to this phenomenon. Though we leave future research to consider other likely sources in more detail, we believe it is important to briefly discuss a few of the possibilities here.

The first possible source is that the observed reduction in dispersion may result from the overall growth in institutional assets, mentioned earlier. Should this be true, we should expect to see the dispersion curve begin to decrease much earlier than 1997 as institutions had already accounted for about 40% of the total U.S. equities in that year; far greater than the current 10% portion of index related assets. So, this explanation seems unlikely although there could be other factors associated with the rise in institutional assets. We discuss some of these possibilities next.

The second possible source relates to active mutual funds that are managed against an index benchmark. Given that many active funds are managed relative to specific benchmarks, especially the S&P 500, their trading is likely to be concentrated in underlying constituents of the respective index benchmark. As such, these active funds may also contribute to the systematic decrease of dispersion of volume changes. However, for the reasons mentioned above, the contribution is likely to be limited. That is, such activities would have lowered market return dispersion prior to 1997 since the assets of this group already accounted for more than 10% of total U.S. equity assets in 1997.

The third possible source relates to the rise in trading associated with institutional investors, especially those focused on quantitative investing. In particular, institutional investors have been shown to explain the rapid rise in the turnover of stocks since 1993 (Chordia, et al 2011). Among institutional investors, hedge funds, in particular fit this class of investors. Consider hedge fund quantitative strategies, such as statistical arbitrage, and high frequency algorithmic trading, which have trended up sharply since 1997 (Zhang (2010)). Overall growth in hedge fund assets and the rise in turnover rates for the average stock have shown similar growth patterns to that of index fund assets since 1997.

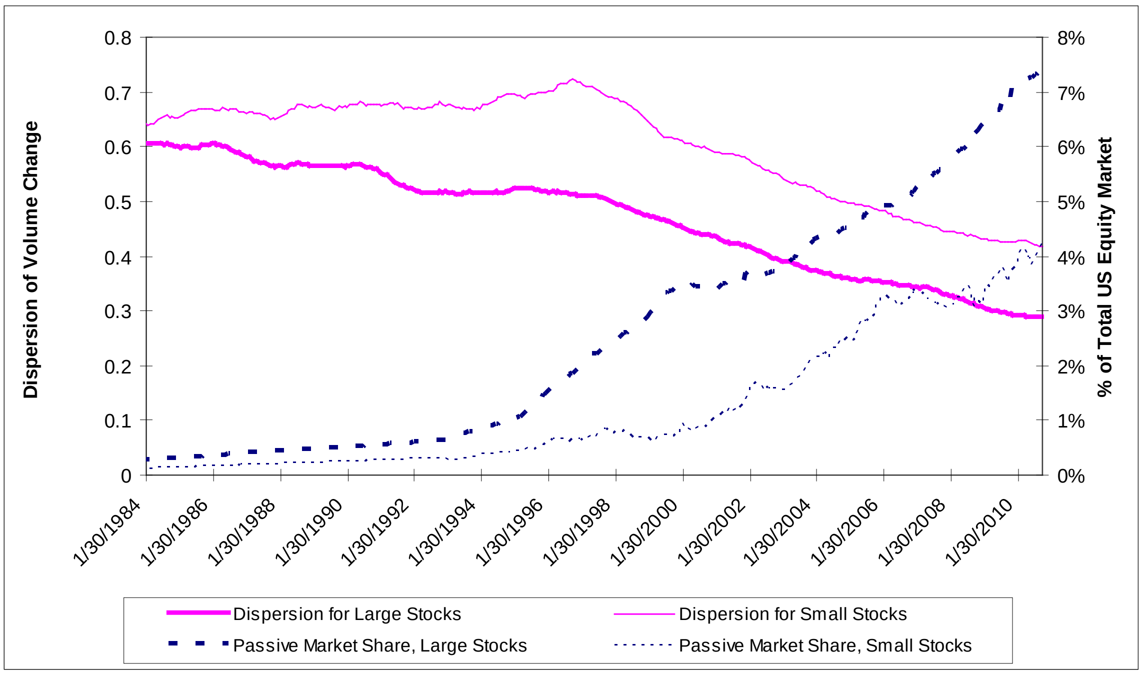
Hedge fund strategies tend to increase the dispersion of volume changes due to the fact that hedge fund traders employ widely different trading strategies. Also supporting this notion, as we will show later, pairwise correlations among stocks since 1997 have dramatically increased, and the increased pairwise correlations are accompanied by the decreased dispersion of volume changes.   Hedge fund trading, however, likely has little impact on average pairwise correlations. For instance, in unreported results, we find that the correlation between the Credit Suisse Tremont long-short equity hedge fund index and the Russell 3000 index is relatively low and stable despite of the growth of hedge fund assets since 1997. Therefore, hedge fund strategies have likely contributed little (if any) to the reduction of the dispersion of volume changes after 1997.

In unreported results, we also explored alternative frequency of volume changes (monthly, quarterly, and semi-annually) and compared results to our earlier findings shown in Figure 4. We found that the change across time becomes less distinct as the frequency is lowered. In particular, at semi-annual frequency, we find almost no change over time. In other words, the regime change in 1997 identified earlier can only be clearly observed in the daily, monthly and to a lesser extent, the quarterly data; perhaps reflecting the high frequency of the cash inflows and outflows frequency of index trading.

In Figure 4, we present the results in a similar manner as those found in Figure 3, but we now separate the universe of stocks into small- and large-cap stocks. Large-cap stocks are measured as the S&P 500 constituents that are traded on the NSYE, while the small-cap stock universe is formed by selecting those stocks in the smallest quintile (the smallest 20 percent) of all NYSE/AMEX stocks.   As shown in Figure 4, the inverse association between cross sectional volume dispersion and passive management is strongly present for both large-cap stocks and small-cap stocks.

From Figure 4, two interesting differences emerge between the large-cap and small-cap segments. First, large-cap stocks exhibit lower trading dispersion than their small-cap counterparts. This indicates that large stocks generally experience heavier index trading and thus higher trading commonality as compared to small stocks. Second, the level of trading dispersion among large stocks began a steep decline about 5 years earlier as compared to small stocks. This suggests that index funds were mainly focused on large stocks in the earlier period with small stocks following the passive investment growth trend later. This is indeed confirmed in Figure 4 by the steep growth trajectory occurring some 5 years earlier for large cap passive assets as compared to their small-cap counterparts. For easy comparison, we multiply by a factor of five the series for small cap passive fund growth as percentage of the total U.S. equity market.

Figure 4. Cross-Sectional Dispersion of Trading Volume Change for Large and Small Stocks*

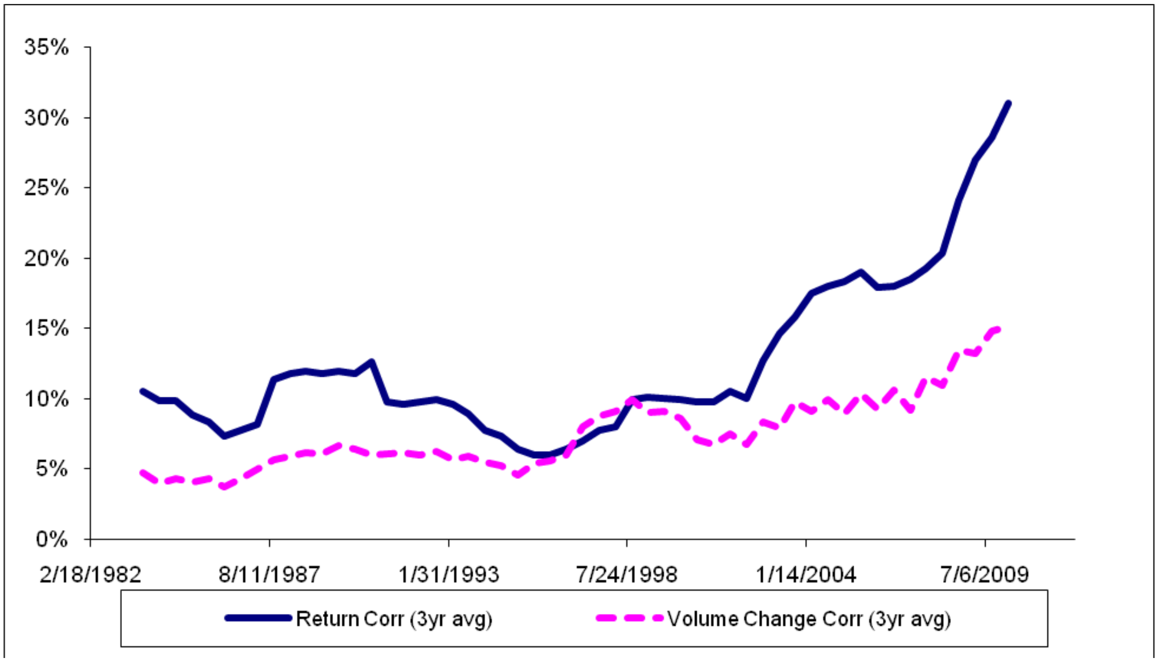


* The percentage of passive funds that hold small stocks are multiplied by 5. The dispersion curves are averaged over three years.

Measuring Pairwise Correlations

As we mentioned earlier, trading commonality among index funds and ETFs tends to result in the prices and volumes of constituent stocks moving in the same direction during any given period. We would therefore expect to see an increase over time in the average pairwise correlations among both stock prices and trading volumes, especially after the late 1990s, the period associated with rapid growth in passively managed assets. In Figure 5, we inspect this thesis by plotting the average of all stock by stock correlations for the universe of stocks in the NYSE/AMEX/NASDAQ. The figure shows that the equally weighted average pairwise correlation for both daily price return and trading volume changes increases rather dramatically after 1997. The correlation for each stock is measured on 26-weeks of daily returns and the corresponding volume changes, and then averaged across all stocks.

Figure 5 Average Pariwise Correlation for Price Changes and Volume Changes for All Stocks*



*The average pairwise correlation for both returns and volume changes are smoothed by a three-year moving average.

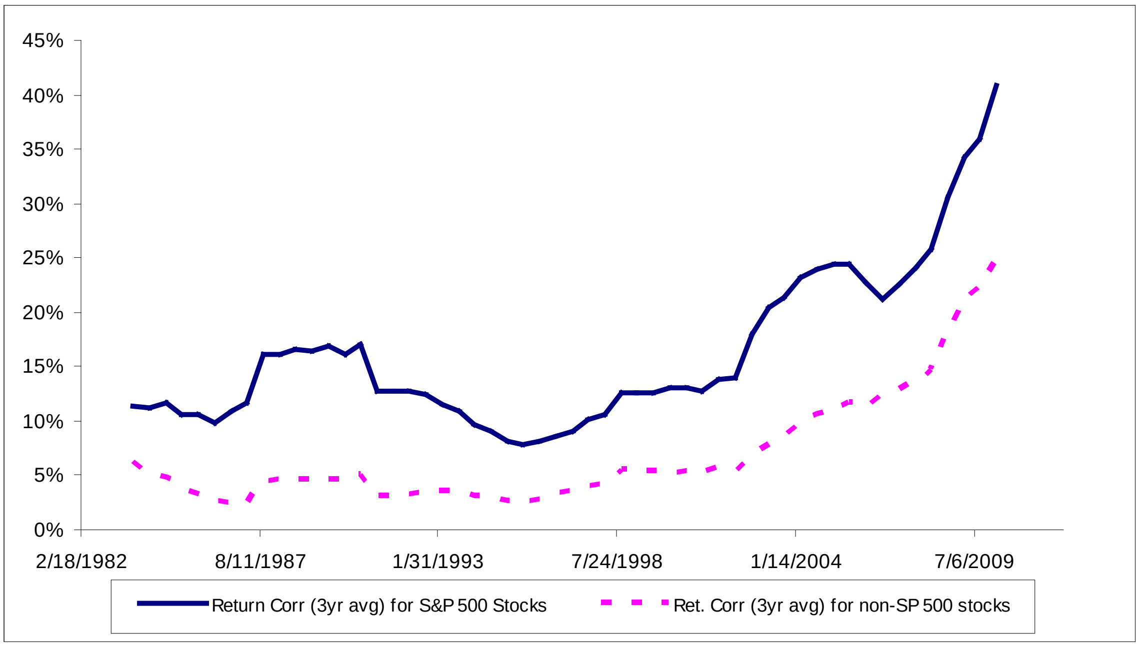
As with Figure 3, Figure 5 also shows that the average pairwise correlations for both price return and change in volume has two distinct regimes: a relatively flat period (from 1980 to 1996), and a positive sloped period (from 1997 to 2010).

Next, Figure 6 shows the pairwise correlations of price changes separately for small-cap and large-cap stocks, as done earlier whereby large-cap stocks are the S&P 500 member stocks and small-caps are represented by non-S&P 500 member stocks.[9] As many passive funds are benchmarked against the popular S&P 500 index, we would expect

[9] Due to data limitations, our database covers 222 stocks that are in the S&P 500 index in 1980, and 440 stocks in 2000.

even higher pairwise correlations among S&P 500 constituents versus their small cap counterparts. Indeed, Figure 6 shows that the S&P 500 member stocks have significantly higher pairwise correlations than those non-S&P 500 member stocks across both sub-periods.[10] In addition, both curves show a relatively flat first sub-period and a positive slope in the second sub-period, consistent with Figures 3 and 5.

Figure 6. Average Pairwise Correlation of Price Changes for S&P 500 Stocks and Non-S&P 500 Stocks



We next explore the impact that the observed rise in passive investing has on markets via explanatory regressions. Specifically, we regress each of our various proxies for the market impact of trading commonality such as the dispersion of volume changes and pairwise correlations for all stocks, against the growth in passive market share, calculated as before (the ratio of the market value of total passive equity assets to the total market value of all equity assets), semi-annually. This permits a direct test of the relationship between the growth in passive investing and each of the market impact variables in question. The results of these regressions are shown in Table 1. For example, the first row provides a direct test of the inverse relationship shown in Figure 3 between the dispersion

[10] This higher pairwise correlation among the S&P 500 members is consistent with the comovement and detachment effects identified in the members of the S&P 500 index (Wurgler (2010)).

of volume changes and the growth of passive assets from 1993 to 2010. Specifically, the results show that the decline in the dispersion of volume changes is highly significant and negatively related to the growth in passive assets over time. To summarize our results, we find that all t-stats for the coefficient estimates on the level of passive assets are statistically significant at the 1% level for each regression. Importantly, this implies the existence of a meaningful relationship between the rise in passive investing and each one of our market impact variables.[11]

Table 1. Regressions on Dispersion of Volume Changes and Pairwise Correlation against the Percent of Passive Assets from 1993 to 2010 (t-statistics in Parentheses)

Dependent Variable	Intercept	Coefficient (Passive Market Share)
Dispersion of Volume Changes	0.67*** (146.8)	-3.73*** (-37.4)
Pairwise Correlation of Price Changes	0.02 (1.62)	3.66*** (11.17)
Pairwise Correlation of Volume Changes	0.05*** (3.28)	1.24*** (3.59)

Note: *** Indicates statistical significance at the 1% level.

In unreported tests, we find that the average pairwise correlation of returns for the first sub-period shown in Figure 5 possesses a negative but insignificant slope when regressed against a simple time trend, a finding consistent with Campbell, Lettau, Malkiel, and Xu (2001). These authors showed that the average pairwise correlation of stock returns, on average, actually decreased from 1962 to 1996. Importantly, however, our results extended through 2010, indicate an important regime shift after 1997. Both changes in prices and volumes each became meaningfully more pairwise correlated after that year. Consistent with our main thesis, we suggest that this regime change was due in large part

[11] Assuming that the breakpoint is in 1997, we repeat the regressions shown in Table 1 for two sub-periods: 1993-1997 and 1998-2010. The coefficients for both periods remain significant for all the dependent variables.

to increased index trading which resulted in a significant increase in average pairwise correlations among stock prices and changes in volume.

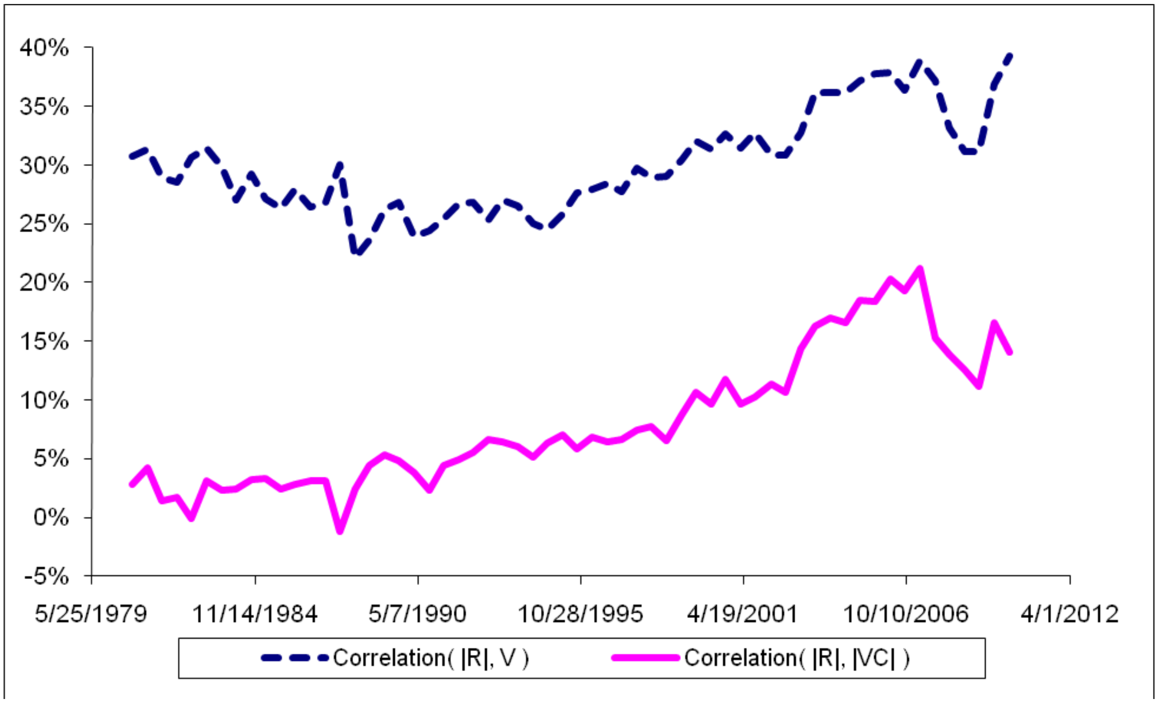
One may argue that the second sub-period experienced unusual market turbulence, namely the 2000 technology, media, and telecommunications crash and the recent 2008 financial crisis, and that these effects might then be responsible for the increased average correlation observed in the latter sub-period. While correlations across securities and across markets indeed tend to increase during crashes (asymmetrical correlation), there are only about four years (2000-2002, 2007-2009) comprising the severe downside markets in this period with the other ten years falling during more normal market conditions. In sum, our findings on the shift in average pairwise correlation suggest a meaningful persistent increase from 1997 to 2010, regardless of the status of the market.

Investigating Cross Correlations

Next, we investigate the cross correlation between price returns and trading volume. Following the prior literature, we study the relationship between absolute returns ($|R|$) and volume level (V). Here, prior research findings generally show that correlations between absolute return and volume have historically been positive (e.g. Karpoff (1987)). As mentioned earlier, this makes intuitive sense as volume changes are the key driver of price changes.

The dashed line in Figure 7 shows the average cross-correlation between ($|R|$) and (V). Here, once again, we see that the latter sub-period demonstrates a significantly steeper slope suggesting much higher cross correlations during that period. As absolute returns are closely related to return volatility, an increase in index trading is thus associated with an increase in the correlation between return volatility and volume levels.

Figure 7. Average Cross Correlations between Trading Volume Levels or Absolute Volume Changes and Absolute Price Returns



As our thesis revolves around index trading, we are more interested in the cross correlation between price returns and volume *changes.* This is because index trading involves synchronized volume changes across many stocks. The solid line in Figure 7 shows the time series of average cross correlation between absolute returns (|*R*|) and absolute volume changes (|*VC*|). Consistent with our earlier findings, the correlation between (|*R*|) and (|*VC*|) significantly increases in the second sub-period.

Following our earlier analysis, we now once again examine the relationship between these cross correlations and the growth in passive assets. In Table 2, regression results between the level of passive investing and each of the two cross correlations (between (|*R*|) and (*V*), and between (|*R*|) and (|*VC*|)) are shown. We find that the t-stats for all the coefficients on the level of passive assets are statistically significant at the 1% level for each regression. This implies the existence of a powerful relationship between passive investing and each of the two cross-correlations. The evidence confirms our previous results shown in Table 1 and Figures 3-7.[12]

[12] In unreported results, we employ the Chow test to determine whether the slope coefficients for the two sub-periods are statistically different from one another for dispersion of volume changes shown in Figure 3, pairwise correlation in Figure 5 and cross correlation in Figure 7. The hypothesis is that there was a

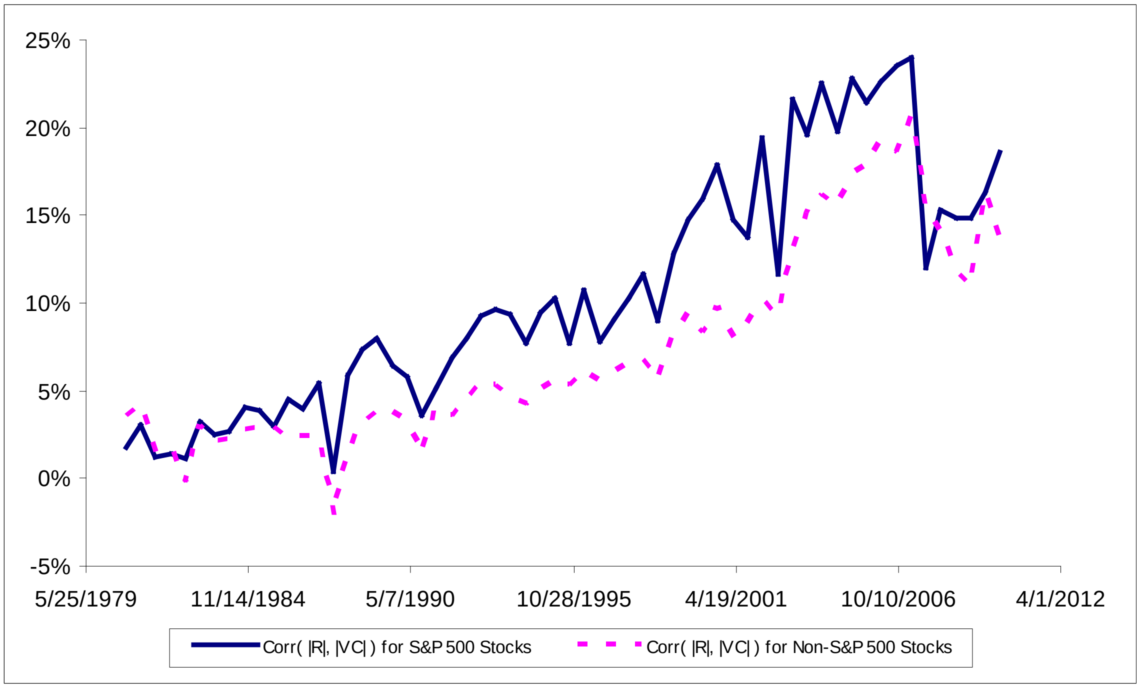
Table 2. Regression on Cross Correlation against the Percent of Passive Assets from 1993 to 2010 (t-statistics in Parentheses)

Dependent Variable	Intercept	Coefficient (Passive Market Share)
Cross Correlation between (|*R*|) and (|*V*|)	0.27^{***} (33.3)	1.41^{***} (7.75)
Cross Correlation between (|*R*|) and (|*VC*|)	0.06^{***} (6.10)	1.53^{***} (6.98)

Next, Figure 8 plots the time-series cross correlation between absolute volume changes and absolute price changes for S&P 500 stocks and non-S&P 500 stocks, as done earlier in Figure 6. Overall our results are consistent with our earlier findings from Figure 6. That is, the S&P 500 member stocks generally show persistently higher average cross correlations than the non-S&P 500 member stocks from 1980 to 2010 and the cross-correlations for both size groups move higher over time.

Figure 8. Average Cross Correlations between Absolute Volume Changes and Absolute Price Changes for S&P 500 Stocks and Non-S&P 500 Stocks

"structural break" in 1997: the passive assets exceeded $100 billion. The Chow test results confirm that the two sub-periods have significantly different slope coefficients for all the three measurements at the 5% level.



Together, our novel findings suggest that both the correlations between ($|R|$) and ($|VC|$) and between ($|R|$) and (V) significantly increased during the second sub-period years (1997 – 2010), we suggest emanating, to a large extent, from an increased trading commonality. By way of comparison, consider iron fillings under a magnetic field. Without a magnet, the fillings are randomly distributed. Under the force of a magnetic field, the iron fillings line up along the magnetic field lines of the magnet. As such, the outcomes are highly correlated. In this simple analogy, individual stocks are akin to the iron fillings, and index trading acts as the magnetic field. The implications are that for those volatility models incorporating joint volume information (such as those proposed in Andersen (1996)): 1) both volume levels and volume changes should be considered, and 2) increased trading commonality should play a larger role in estimating potential outcomes.

Impact on Systematic Risk and Portfolio Diversification

As mentioned earlier, we seek to understand the steady increase and convergence of U.S. equity betas across size and style in the years following 1997, as shown in Figure 1. We suggest that the answer to our quest lies, in part, to links to trading commonality driven by passively managed index funds.

Earlier, in Figure 5, we showed that average pairwise correlations among stocks have increased since 1997. From this, we can reasonably infer that this rise in correlations has simultaneously yielded a rise in average betas for the universe of stocks.[13]

To estimate our betas for Figure 1, we used 26-weeks of equally weighted daily returns and then sorted the stocks on size or book-to-market ratio (for our two style groups). The equally weighted average beta for small stocks is then measured as the average beta for those stocks whose market cap is below the 50th percentile of the universe. Likewise, the equally weighted average beta for growth stocks is the average beta for those stocks whose book-to-market ratio is below the 50-th percentile of the universe.

In unreported results, we regress each of our four size and style betas against a time variable (as shown in Figure 1). Our results show that the slope coefficients of the beta estimates for the second sub-period are all positive and significant at the 1% level while those from the first sub-period are all close to zero, indicating average beta for all equity segments over the 1997-2010 period shifted meaningfully higher.

We note that the equally-weighted average beta for each of the size and style categories shown in Figure 1 is always less than one in the first sub-period (1979 – 1996).[14] Even more interesting is the fact that during this period, average beta estimates are consistently lower for small stocks than large stocks, a finding consistent with Kamara, Lou and

---

[13] This is so because in the single-factor market model, the beta of a stock (β_i) is proportional to the correlation (ρ) between the stock and the market. More specifically, $\beta_i = \rho \frac{\sigma_i}{\sigma_M}$ where σ_i and σ_M are the volatility of the stock (i) and market, respectively. In unreported analysis, we find that, σ_i and σ_M tend to move in the same direction, thus there is no apparent linear relationship between the average beta and the average of $\frac{\sigma_i}{\sigma_M}$. Therefore, as correlations rise, so too does beta.

[14] By definition, only the value-weighted average beta is equal to one, we use equally-weighted average beta, which will not necessary be equal to one. Lower equally-weighted average beta for small stocks indicates a lower return correlation between the small stocks and the market.

Sadka (2010). This means that small stocks, on average, were less sensitive to overall market risk than large stocks during the first sub-period. Similarly, average betas for value stocks are unsurprisingly lower than for growth stocks.

Strikingly, however, the observed differences in betas have dramatically narrowed over the last ten years, as betas for all size and style categories have converged. This convergence comes from the rise of small- and value- stock betas to the same level of large and growth stocks during the first half of the decade beginning in the year 2000. During the second half of the decade, the average betas across all four size and style categories all together began a steady rise, exceeded one, and have remained elevated ever since, a result of great importance to investors.

This increase and convergence of betas importantly suggests that diversification benefits during the second sub-period (1997-2010) were reduced for all types of portfolios (small, large, growth, or value), a situation which remained (at least) through the end of our study period. This unambiguously means increased investment risk for investors to unanticipated events in the recent decade.

We next examine the possible contributors to the rise in equity betas by separately regressing each of our four beta series against the dollar value of total passive assets, as similar to Table 1. The results are shown in Table 3. We find that the t-stats for all the coefficients on the level of passive assets are all statistically significant at the 1% level for each regression. Our results support the existence of a meaningful relationship between passive investing and a rise in equity market risk as proxied by various market betas.

Table 3. Regression on the Four Beta Estimates against the Percent of Passive Assets from 1993 to 2010 (t-statistics in Parentheses)

Beta (Dependent Variable)	Intercept	Coefficient (Passive Market Share)
Large	0.76***	5.33***

	(22.39)	(6.98)
Small	0.39*** (6.71)	11.09*** (8.70)
Growth	0.79*** (17.26)	4.68*** (4.50)
Value	0.34*** (7.12)	11.75*** (10.84)

To further demonstrate the reduced diversification benefits since 1997 for both large-cap and small-cap stocks, we examine the excess return volatility for portfolios of large- and small-cap stocks while varying the number of stocks in the respective portfolios. Specifically, for the largest- and smallest- cap stock quintiles, we construct for each 26-week period, equally weighted portfolios containing a different number (5-50) of randomly selected stocks (without replication), similar to the empirical methodology of Campbell, Lettau, Malkiel, and Xu (2001) and Kamara, Lou and Sadka (2010). Using daily returns, we calculate the annual excess return volatility of each portfolio relative to the market, defined as the difference between the standard deviation of return of the portfolio and the standard deviation of return of a value-weighted portfolio of all the stocks in the sample. To examine changes over time, we again sub-divide our sample into two sub-periods, 1979-1996 and 1997-2010. For each sub-period, we calculate the average annual excess volatility for each portfolio.

Figure 9. Excess Return Volatility against Number of Stocks

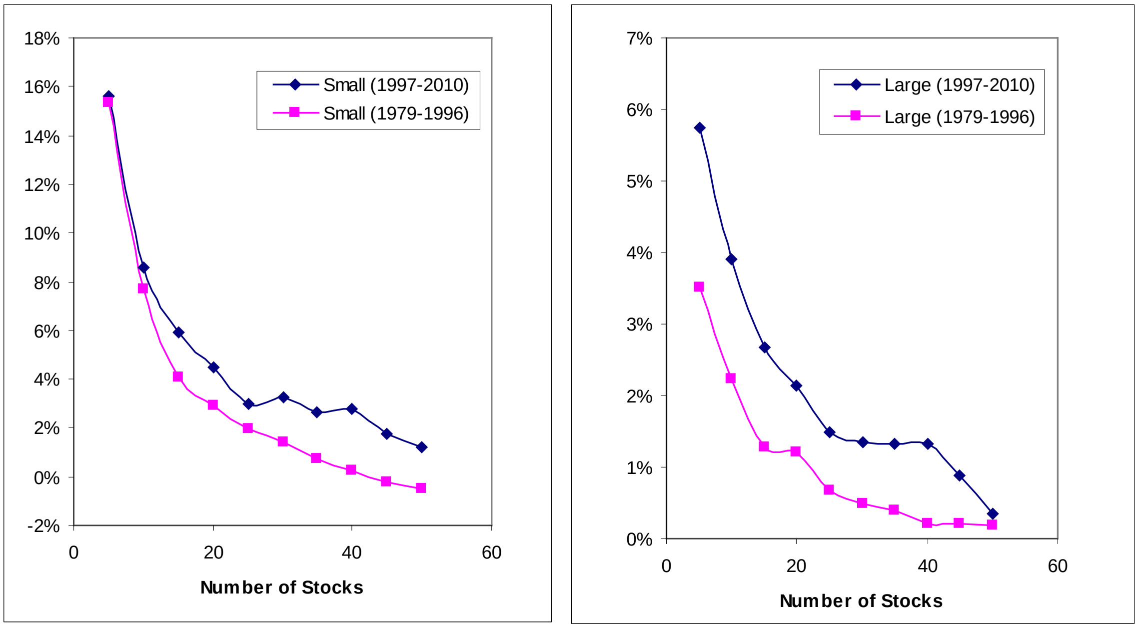


Figure 9 presents the results. It shows that for both large and small portfolios, the diversification benefits are dramatically diminished in the second sub-period (1997-2010). In other words, an investor who wishes to maintain the same excess return volatility level after 1997 would need to meaningfully increase the number of stocks in her portfolio, for both large and small cap stocks. In fact, she can no longer attain diversification benefits below a level of 1% excess return volatility for her small cap portfolio, whereas prior to 1997 she could do so with as few as 30 stocks. Furthermore, she must now more than double her holdings of large cap stocks to over 40 stocks to obtain a target of 1% excess volatility within her large-cap portfolio. Altogether, these results plainly suggest a decrease in the ability of investors to diversify risk in recent decades.

Robustness Tests and Future Research

The number of stocks included in our analysis rises over the study period, from 500 in 1979 to 2900 in 2010. Some may suggest that the cross-sectional distribution of firm characteristics may have changed over the sample period. To address this concern, we performed a robustness check whereby we examine a smaller sample subset in which we randomly select 500 stocks from the universe of all NYSE/AMEX/NASDAQ stocks. These stocks were selected in each period to ensure that the stock universe is meaningfully different across periods. In unreported results, we find that the randomly selected 500 stocks yield very consistent results to those shown in earlier figures offering support that our findings are empirically robust.

Our research effort offers a glimpse into how the proliferation of index investing impacts systematic market risk. More work is required to fully understand how the trading behavior of investors (especially institutional) impacts markets. Given the wide array of passive funds, the trading commonality of passive index trades will not be universal. We showed that those stocks within the S&P 500 have higher return commonality and correlations than non-S&P 500 stocks. Further research on different benchmarks may reveal additional insights. For example, passive investing has shown strong growth in international markets. So, extending our analysis across these markets could prove informative.

Conclusions

Passively managed index funds and exchange traded funds (ETFs) have experienced accelerating growth in recent decades. The level of passively managed assets now reaches more than half of the level of assets within actively managed mutual funds. The increased level of trading associated with passive investing, however, comes with important consequences. It means an increased trading commonality among index constituents through the interactions of market participants. Such trade commonality then gives way to a rise in systematic fluctuations in overall demand. This, in turn, leads to a fundamental impact on the overall market and investors' portfolios. In short, we find that growth in passively managed equity assets corresponds with a rise in systematic market risk. Importantly, from this we can infer that the ability of investors to diversify risk by holding an otherwise well-diversified portfolio has markedly decreased in recent decades.

We suggest that the rise in systematic risk emanates, in part, from an increase in trading commonality across time and across stocks associated with growth in passive investing. Though perhaps not the only explanation for rising systematic risk, our results provide strong evidence that the observed increase in trading commonality since 1997 has indeed led to lower cross-sectional dispersion of volume changes and thus greater systematic risk since then. That is, an increase in cross-sectional trading commonality associated with the rise in passive investing meaningfully corresponds to a decrease in the ability of investors to diversify risk in recent decades.

As evidence, we report that both pairwise and cross correlations between return volatility and volume volatility has significantly increased since 1997. Furthermore, we show that the diversification benefits of equity investing have decreased for all styles of stock portfolios (small, large, growth, or value). The decline in diversification benefits can couple with increased market volatility and firm-specific volatility. These changes have introduced additional challenges to risk management in equity portfolio construction. Altogether, our results suggest that the fragility of the U.S. equity market has risen over recent decades. Investors should therefore incorporate the impact of increased trading commonality into their volatility modeling framework.

References

Amihud, Yakov. 2002. “Illiquidity and Stock Returns: Cross-Section and Time-Series Effects.” Journal of Financial Markets, vol. 5, no. 1 (January):31–56.

Anderson T. 1996. Return Volatility and Trading Volume: An Information Flow Interpretation of Stochastic Volatility. Journal of Finance, 51, 169-204.

Bhattacharya, Utpal, and Neal Galpin. 2011. “The Global Rise of the Value-Weighted Portfolio”. Journal of Financial and Quantitative Analysis, Vol. 46, No. 3: 737-756

Campbell, John Y., Martin Lettau, Burton G. Malkiel, and Yexiao Xu. 2001. “Have Individual Stocks Become More Volatile? An Empirical Exploration of Idiosyncratic Risk.” Journal of Finance, vol. 56, no. 1 (February):1–43.

Chordia, Tarun, Richard Roll, and Avanidhar Subrahmanyan. 2011. “Recent Trends in Trading Activity and Market Quality.” *Journal of Financial Economics*, vol. 101 (2011):243-263.

Kamara, Avraham, Xiaoxia Lou, and Ronnie Sadka. 2008. “The Divergence of Liquidity Commonality in the Cross-Section of Stocks.” *Journal of Financial Economics*, vol. 89, no. 3 (September): 444–466.

______ . 2010. “Has the U.S. Stock Market Become More Vulnerable Over Time?” *Financial Analysts Journal*, Vol. 66, No. 1: 41-52.

Karpoff, J. M. (1987), “A Relation between Price Changes and Trading Volume: A Survey”, Journal of Financial and Quantitative Analysis, Vol. 22, pp. 109-126.

Mehrling, Perry. Fischer Black and the Revolutionary Idea of Finance. New Jersey: John Wiley & Sons, 2005.

Sias, R. W., L. Starks, and S. Titman. 2006. “Changes in institutional ownership and stock returns: Assessment and methodology.” Journal of Business, Vol. 79, No. 6: 2869-2910.

Wurgler, Jeffrey. 2010. “On the Economic Consequences of Index-Linked Investing.” Forthcoming in Challenges to Business in the Twenty-First Century: The Way Forward W.T. Allen, R. Khurana, J. Lorsch, G. Rosenfeld, Eds. American Academy of Arts and Sciences.

Zhang, X. Frank. 2010. “The Effect of High-Frequency Trading on Stock Volatility and Price Discovery.” Working Paper.