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How Index Trading Increases Market Vulnerability

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The authors found that the rise in popularity of index trading—assets invested in index funds reached more than $1 trillion at the end of 2010—contributes to higher systematic equity market risk. More equity index trading corresponds to increased cross-sectional trading commonality, which precipitates higher return correlations among stocks. Consistent with the accelerating growth of passive trading, the authors found that equity betas have not only risen but also converged in recent years.

Pointing to a variety of factors, including the rise of systematic market risk (beta) in recent decades, researchers have made the provocative discovery that the U.S. stock market has become more vulnerable over time to unanticipated events (see, e.g., Kamara, Lou, and Sadka 2010). In our study, we examined one possible culprit for the observed increase in market vulnerability: the rising popularity of trading passively managed assets.

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

Index trading in index mutual funds, particularly exchange-traded funds (ETFs), has likewise experienced tremendous growth over the last two decades. Bhattacharya and Galpin (2011) showed that the popularity of value-weighted, or index, portfolios is increasingly global, especially in the category of large, well-covered stocks. This phenomenon is undoubtedly due, in part, to the appeal of index funds, which generally offer low-cost, comprehensive, diversified exposure to various market segments—and in the case of ETFs, the ability to trade those segments on an intraday basis. Their appeal is compounded by the challenges of sourcing skilled active managers, which, of course, is a zero-sum game—or even a negative-sum game—after costs. But the increased popularity of index funds, particularly with respect to the growing importance of ETF trading, comes at the cost of an increase in commonality of stock trading (e.g., basket trading) across the market, a result of the simultaneous buying or selling of the many stocks within the index being traded. Consequently, the entirety of stocks within a given index tend to move together throughout the trading day, which increases correlations—an undesirable effect on markets.

The rising market efficiency of recent decades may also be associated with this commonality in trade behavior. According to Mehrling (2005), Fischer Black once suggested that markets grow increasingly volatile as they become more efficient. Black maintained that higher market efficiency occurs when market participants tend to react in the same manner when unexpected new information becomes available, leading to larger overall swings in market prices. Interestingly, index fund investing—which, in effect, assumes that markets are microefficient—reflects this outcome owing to the common mass trading of the index's constituent stocks with every index fund transaction.

In our study, we sought to enhance understanding of the consequences of this increased trading commonality associated with the proliferation of indices and index trading in recent years. We were also motivated to seek insight into the

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concerning steady increase and convergence of U.S. equity betas across size and style since 1997, as shown in **Figure 1**, which 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 will return to this figure later in the article when we look at how this rise in systematic risk connects with the rise in popularity of passively managed index funds and the increased trading commonality among constituent stocks. Through a battery of tests, we examined the impact on systematic market risk of the trading commonality associated with passive investment trading.

We know so little about the consequences of the growth in index investing—for example, how it affects underlying market liquidity, volatility, and price discovery, especially in light of the relatively new, and rapidly expanding, ETF market, which allows for intraday trading.[2] In a review of the consequences of index investing, Wurgler (2010) suggested that index investing distorts stock prices and risk–return trade-offs, which, in turn, may lead to a host of distortions in other areas, including corporate investment and financing decisions, investor portfolio allocation decisions, and assessments of fund manager skill. These effects could intensify should index-linked investing continue to gain in popularity.

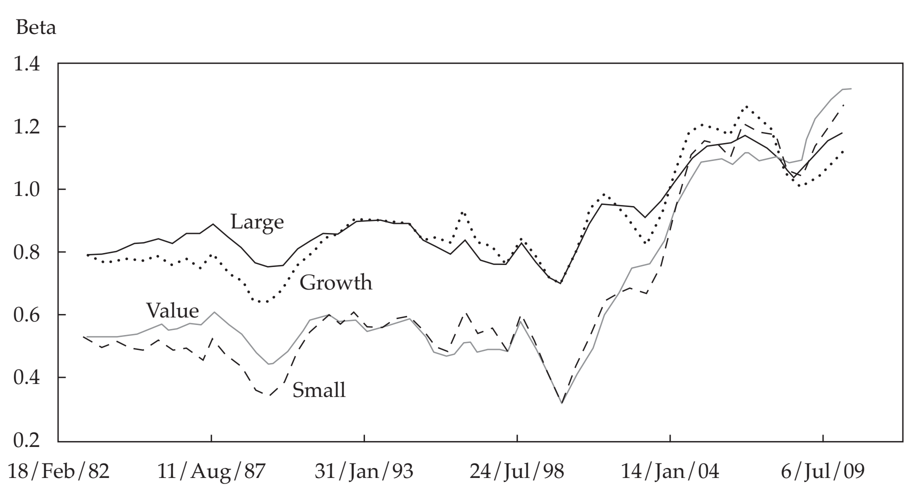
Data

Our dataset consisted of all the stocks on the NYSE, Amex, or NASDAQ that met our criteria over 1 January 1979–1 December 2010. We collected information on daily returns, daily exchange-based trading volumes, monthly market capitalizations, monthly book-to-market ratios, and number of shares outstanding (not adjusted for free float) from the Morningstar Direct database. We included stocks priced between \$2 and \$1,000 and with market caps greater than \$100 million. Consistent with prior research, our limit on market cap excluded most microcap stocks. We also excluded such derivative securities as American Depositary Receipts of foreign stocks. Our dataset contained about 500 stocks in January 1979 and around 2,900 stocks in December 2010.[3] In addition, we used data on all U.S. equity ETFs and U.S. equity mutual funds for our fund asset size estimates, including both live and defunct funds.

Growth in Index Trading

Over the past three decades, the U.S. equity market has seen substantial growth in institutional investing. The average fraction of a company's equity shares held by institutions grew from 24 percent in 1980 to 44 percent in 2000, reaching 70 percent in 2010. The average number of institutions holding the typical company's shares listed on the NYSE grew from 54 in 1980 to 125 in 2000 and to 405 in 2010; institutional trading accounted for more than 70 percent of the total trading volume on the NYSE in 2010.[4] Taken together, these statistics suggest that institutional investing has become more prevalent in recent decades. The influence of institutional investing has been growing steadily and has become a dominant force in today's stock markets.

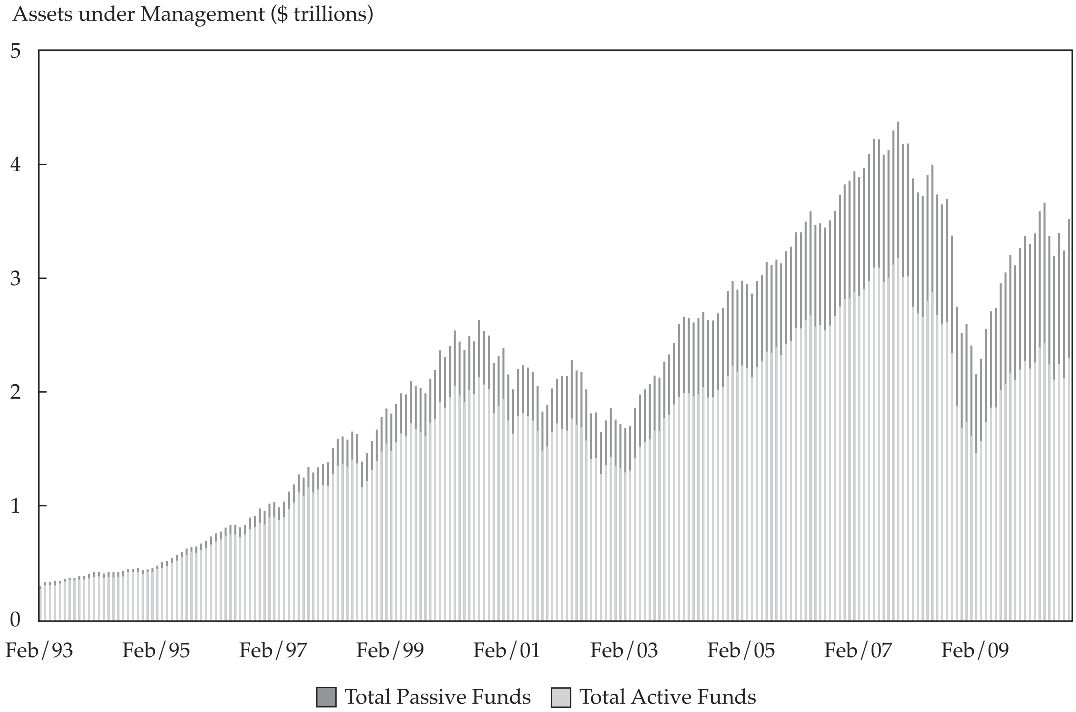
Figure 1. Equal-Weighted 26-Week Average Betas for U.S. Stocks by Size and Style, April 1993–April 2010



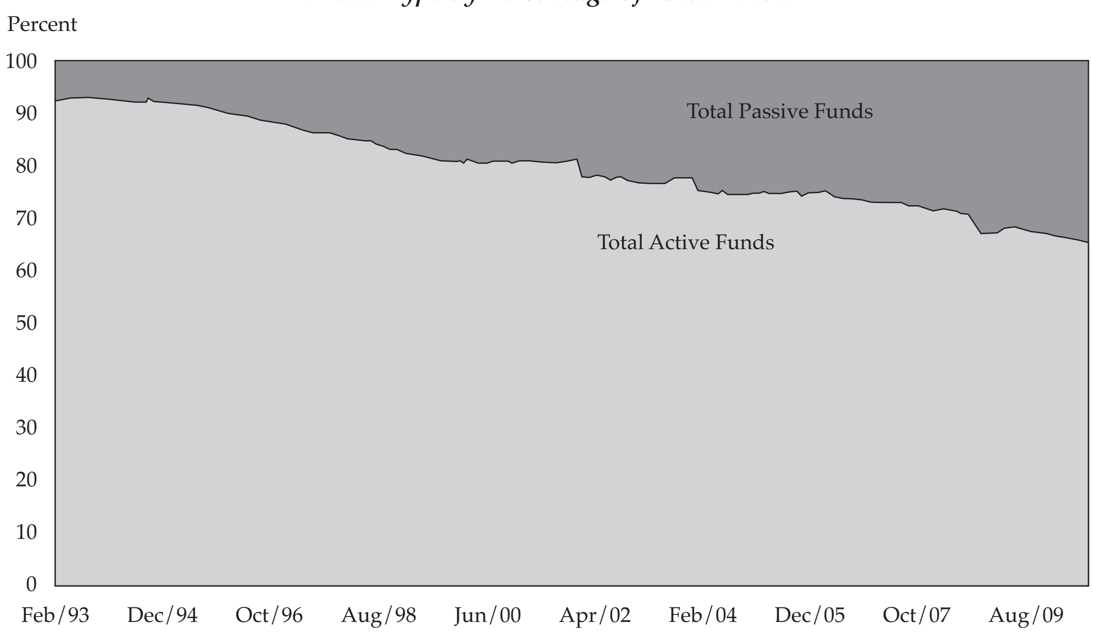
Along with the increasingly prominent role of institutional investors in recent decades, assets invested in index mutual funds and ETFs have risen rapidly. Panel A of **Figure 2** compares total equity assets under management for active mutual funds versus passively managed funds over February 1993–September 2010. We measured passively managed investments as assets invested

Figure 2. Growth in Equity Fund Assets by Type of Fund, February 1993–September 2010

A. Total Dollar Growth



B. Fund Type by Percentage of Total Assets



in index mutual funds and ETFs (all assets were U.S. equity assets).[5] In September 2010, total assets in equity mutual funds and ETFs reached $3.5 trillion. Of that amount, $2.3 trillion was actively managed, with the remaining $1.2 trillion being passively managed. The passively managed assets break down into $619 billion in equity index mutual funds and $605 billion in equity ETFs. As we can see in Figure 2, although passively managed funds 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 percent versus 13 percent). Panel B of Figure 2 shows the relative share of active and passive assets as a percentage of all fund assets; we can see that passive funds have increased their market share against their active fund counterparts over the past two decades.

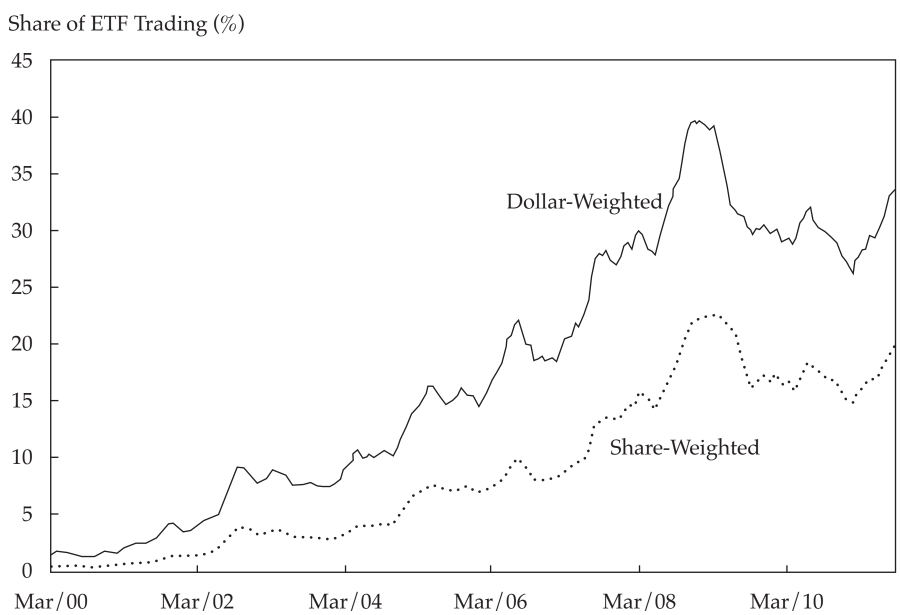
To understand the potential impact of index trading on markets, consider that the Vanguard 500 Index Fund (all share classes), one of the largest index mutual funds, has about $106 billion in assets (as of February 2011) and holds about 500 stocks. A typical large-cap stock has a daily turnover (the fraction of shares exchanged) of approximately 0.5 percent—that is, on average, 0.5 percent of outstanding shares change hands every day. The market cap for a typical large-cap stock runs about $10 billion. Note that the Vanguard 500 Index Fund holds, on average, 2 percent of the outstanding shares of a typical large-cap stock. Thus, if this fund were suddenly to sell 100 percent of its holdings of one of these stocks, that sale would represent 400 percent of the typical daily volume of that stock.

Over the past decade, the growth of ETF trading has been astonishing. ETFs have unambiguously become a powerful influence in the markets. **Figure 3** shows the share of ETF trading volume on U.S. exchanges in recent years. Since 2000, the share of ETF trading has risen dramatically, from close to nil to roughly 35 percent of total dollar trade volume and about 20 percent of total share volume. Clearly exerting a significant impact on overall trade volume and market prices, ETFs have become a key instrument for investors.

Measuring Trading Commonality

As we can clearly see in Figures 2 and 3, the accelerating relative growth of passively managed assets and ETF trading has placed increased demands on index-related trading. This index trading activity, in turn, has precipitated higher trading commonality in the cross section of stocks because index funds (both ETFs and mutual funds) buy or sell groups of stocks via basket orders in response to capital inflows or outflows and following changes to index holdings.[6] These basket orders are

Figure 3. ETF Share of Total U.S. Trade Volume, March 2000–September 2011 (three-month average)



Source: Credit Suisse Portfolio Strategy, Advanced Execution Services.

sometimes spread over a few hours, days, or weeks to minimize the price impact. However spread, index-related trading 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, the basket of stocks is uniformly either a buy or a sell. In addition, 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 similar, even if technically different, focuses create similar volume changes for many stocks to the extent that their fund holdings overlap. In sum, index-related trading must, at the margin, reduce the cross-sectional dispersion of changes in trading volume. And given the substantial rise in ETF trading, the market impact hardly seems to be occurring merely at the margin.

To illustrate this point, let us assume that a hypothetical index fund holds three stocks, with each stock representing a 33.33 percent weighting. The market prices are \$10, \$20, and \$25 for the three stocks. The fund is about to purchase \$300, to be distributed evenly across the three stocks. The trade will be split evenly over the next two days (\$150 each day) to reduce market impact. Assuming that this purchase represents all market transactions for these two days, the daily trading volumes for the three stocks will be 5, 2.5, and 2 shares, respectively. The purchased shares are the same for each day for each stock, and 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 (because the standard deviation of volume changes for the three stocks is zero). The dispersion in volume *level*, however, is greater than zero for the two days (1.6 = stdev[5, 2.5, 2]), although it remains the same each day.

From this discussion, we can see that understanding the market impact of index-related trading requires us to focus on how such trading affects the *change* in the volume of stock trading from period to period rather than the absolute *level* of trading volume. Therefore, we focus our attention on examining the impact on overall market activity of cross-sectional dispersion in trading volume changes. We first measure the logarithmic change in trading volume from one period to the next, calculated as

$$VC_t = \ln\left[\frac{V(t)}{V(t-1)}\right]. \tag{1}$$

Note that Equation 1 is similar to the standard definition of log price return. Because daily trading volume in equity markets has experienced near-exponential growth in recent decades, 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 remove any trend in volume that may exist over time. We can then calculate the cross-sectional dispersion in volume change as the standard deviation of VC_t as measured across all stocks for each time period (t).

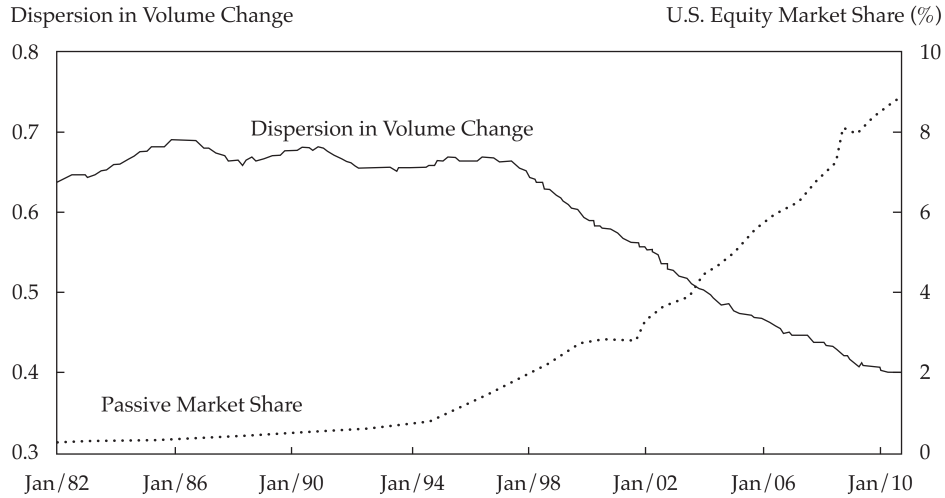
Figure 4 shows the relationship between the cross-sectional dispersion in trading volume changes and the growth in passive equity fund assets, calculated as the percentage of total passive assets relative to the total U.S. stock market capitalization (we refer to this ratio as the *passive market share*). In measuring the dispersion in volume changes, we can follow the formulation discussed earlier, using weekly trading volume, and then smooth with a three-year average. We can interpolate the passive market share linearly over 1979–1993 by reasonably assuming that the percentage of passive assets was 0 percent in 1976.[7]

Our novel results from Figure 4 show that the dispersion in cross-sectional volume changes has two distinct regimes: a flat regime over 1979–1996 and a persistently declining regime over 1997–2010. Interestingly, the second regime declines at an almost constant rate.[8] We chose 1996 as the breakpoint year for our analysis. Although difficult to pinpoint precisely, as evidenced by Figure 4, it is around this time that index investing meaningfully began its steady rise in popularity, fueled especially by ETF trading.

Figure 4 further shows that the decline in cross-sectional volume change over time is nearly a perfect inverse of the growth in passive assets. Although 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 that this is due, in large part, to its association with the lower cross-sectional dispersion in 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.

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

Figure 4. Cross-Sectional Dispersion in Trading Volume Change vs. Growth of Passive Assets, January 1982–October 2010



Notes: Our analysis is for the U.S. equity market. We smoothed the volume change dispersion by using a three-year average.

The first possible source of the observed reduction in dispersion may be 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 because institutions already accounted for about 40 percent of total U.S. equities in that year—far greater than the current 10 percent portion of index-related assets. So, this explanation seems unlikely, although there could be other factors associated with the rise in institutional assets.

The second possible source is 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 Index, 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 rise in market risk through systematic index-related trading, thus contributing to a decrease in dispersion in volume changes. Indeed, research on active management has shown that the level of closet indexing among active managers began to increase noticeably during the mid-1990s (Cremers and Petajisto 2009).

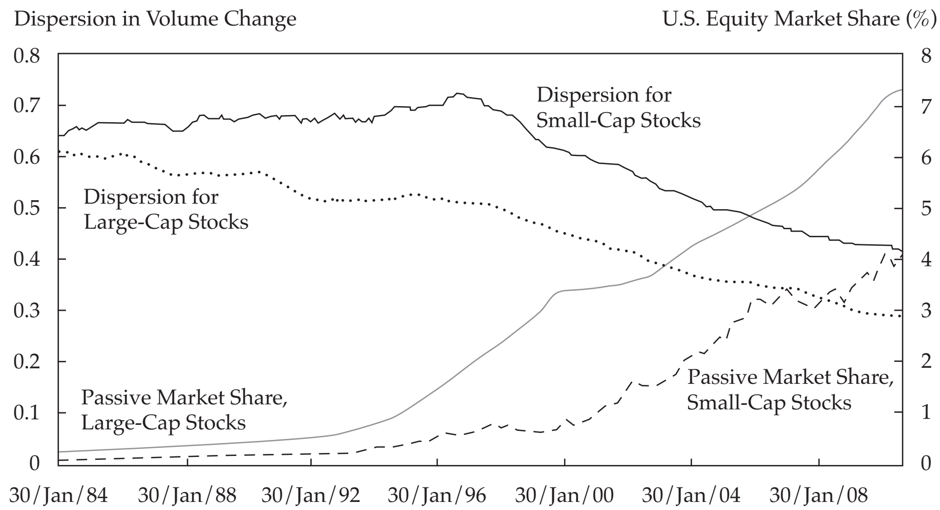
The third possible source is the rise in trading associated with institutional investors, especially those focused on quantitative investing. Specifically, institutional investors have been shown to explain the rapid rise in the turnover of stocks since 1993 (Chordia et al. 2011). Among institutional investors, hedge funds, in particular, fit this class of investors. Consider hedge fund quantitative strategies, such as statistical arbitrage, and high-frequency algorithmic trading (HFT), which have trended up sharply since 1997 (Zhang 2010). Since 1997, overall growth in hedge fund assets and the rise in turnover rates for the average stock have shown growth patterns similar to those of index fund assets. High-frequency traders may, for instance, seek to capture any pricing spread differential between ETFs and index funds.[9]

With respect to the rise in ETF trading, we note that hedge funds and other investors are increasingly pursuing top-down, global, macro-investment strategies. Whatever the drivers behind the observed rise in index-related investing, the result is higher systematic, common trading across a basket of many stocks simultaneously, which means increased overall market risk via higher pairwise stock price correlations and lower dispersion of changes in trading volume.

Hedge fund–related equity trading may also drive high volatility on occasion. As suggested by Khandani and Lo (2007), such activity was likely behind the observed high market volatility in August 2007. Overall, more research is needed to better understand the interaction of institutional trading activities.

We also explored various frequencies of volume changes (monthly, quarterly, and semiannually) and compared our results (unreported) with our earlier findings, shown in **Figure 5**. We found that the change across time becomes less distinct as the frequency is lowered. In particular, at the semiannual frequency, we found almost no

Figure 5. Cross-Sectional Dispersion in Trading Volume Change for Large- and Small-Cap Stocks, January 1984–October 2010



Notes: We multiplied the passive market share for small stocks by 5 in order to make the levels of the market share lines comparable. We averaged the dispersion curves over three years.

change over time. In other words, the regime change in 1997, identified earlier, can be clearly observed only in the daily, monthly, and, to a lesser extent, quarterly data, perhaps reflecting the high frequency of the cash inflows and outflows of index trading.

In Figure 5, we present the results as in Figure 4 except that we 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 NYSE, whereas the small-cap stock universe is formed by selecting those stocks in the smallest quintile (the smallest 20 percent) of all NYSE and Amex stocks. As shown in Figure 5, the inverse association between cross-sectional volume dispersion and passive management is strongly present for both large-cap and small-cap stocks.

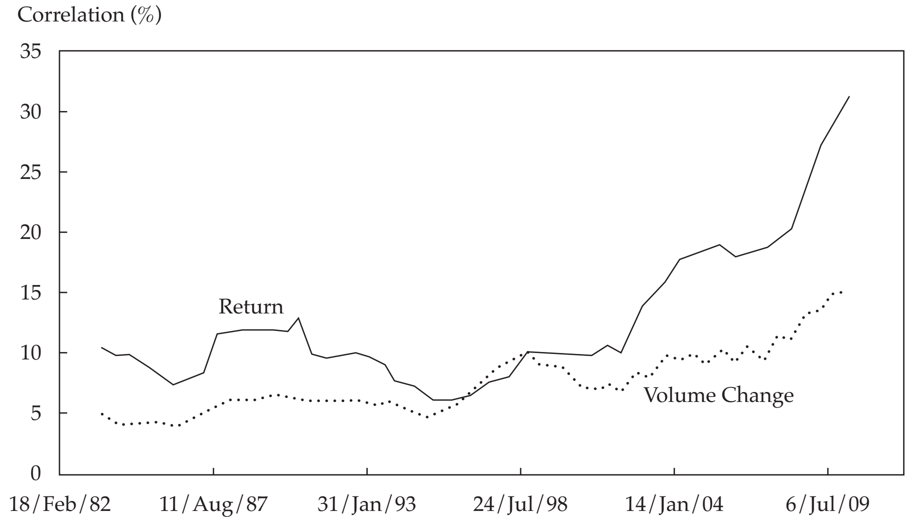
From Figure 5, two interesting differences between the large-cap and small-cap segments emerge. First, large-cap stocks exhibit lower trading dispersion than their small-cap counterparts. This finding indicates that large-cap stocks generally experience heavier index trading and, thus, higher trading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

Measuring Pairwise Correlations

As mentioned earlier, trading commonality among index funds and ETFs drives prices and volumes of constituent stocks in the same direction during any given period. Thus, we would 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 6**, we inspect this thesis by plotting the average of all stock-by-stock correlations for the universe of stocks on the NYSE, Amex, or NASDAQ. The figure shows that the equally weighted average pairwise correlation for both daily price return and trading volume changes increased rather dramatically after 1997. The correlation for each stock is measured on 26 weeks of daily returns and the corresponding volume changes and is then averaged across all stocks.

As with Figure 4, Figure 6 shows that the average pairwise correlations for both price return and change in volume have two distinct regimes: a relatively flat period (1980–1996) and a positive sloped period (1997–2010).

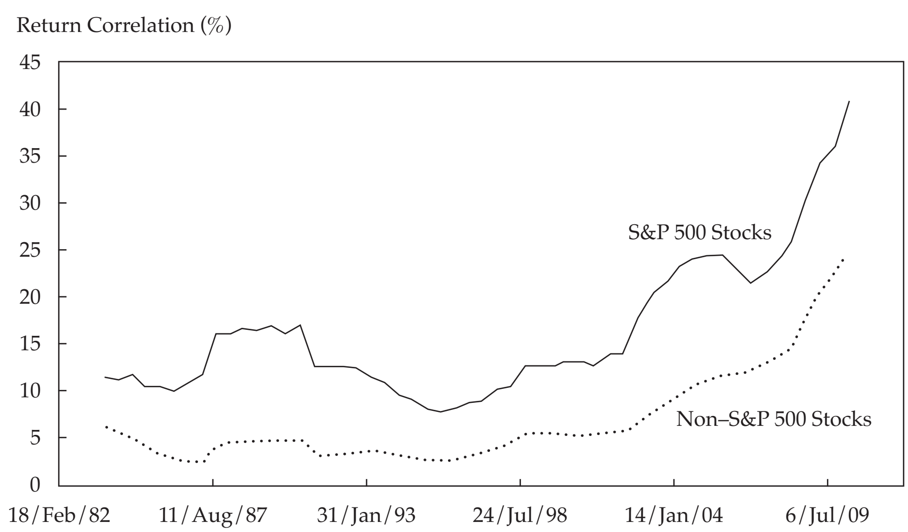
Figure 6. Average Pairwise Correlation for Both Price and Volume Changes for All Stocks, October 1983–April 2010



Note: We smoothed the average pairwise correlation for both returns and volume changes by using a three-year moving average.

Figure 7 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.[10] Because many passive funds are benchmarked against the popular S&P 500 Index, we would expect even higher pairwise correlations among S&P 500 constituents versus their small-cap counterparts. Indeed, Figure 7 shows that the S&P 500 member stocks have significantly higher pairwise correlations than the non–S&P 500 member stocks across both subperiods.[11] In addition, both curves show a relatively flat first subperiod and a positive slope in the second subperiod, consistent with Figures 4 and 6.

Figure 7. Average Pairwise Correlation of Price Changes for Both S&P 500 and Non–S&P 500 Stocks, October 1980–April 2010



Note: We smoothed the average pairwise correlation for returns of both S&P 500 and non–S&P 500 stocks by using a three-year moving average.

Using explanatory regressions, we next explored the impact of the observed rise in passive trading on markets. Specifically, we regressed each of our various proxies for the market impact of trading commonality, such as the dispersion in 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), semiannually. In this case, we treated the growth in passive market share as a proxy for the index trading, which permitted 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 4) between the dispersion in volume changes and the growth of passive assets over 1993–2010. Specifically, the results show that the decline in the dispersion in volume changes is highly significant and negatively related to the growth in passive assets over time. To summarize our results, we found that all *t*-statistics for the coefficient estimates on the level of passive assets are statistically significant at the 1 percent level for each regression. Importantly, this finding implies the existence of a meaningful relationship between the rise in passive investing and each one of our market impact variables.[12]

In unreported tests, we found that the average pairwise correlation of returns for the first subperiod shown in Figure 6 possesses a negative but insignificant slope when regressed against a simple time trend, a finding consistent with Campbell, Lettau, Malkiel, and Xu (2001), who showed that the average pairwise correlation of stock returns, on average, actually decreased over 1962–1996. Importantly, however, our results extended through 2010 indicate a significant regime shift after 1997: Changes in both prices and volumes became meaningfully more pairwise correlated after that year. Consistent with our main thesis, we suggest that this regime change was due, in large part, to increased index trading that resulted in a significant increase in average pairwise correlations among stock prices and changes in volume.

One may argue that the second subperiod experienced unusual market turbulence—namely, the 2000 technology, media, and telecommunications crash and the 2008 financial crisis—and that these effects might be responsible for the increased average correlation observed in the latter subperiod. Although correlations across securities and across markets tend to increase during crashes (asymmetrical correlation), there were only about four years (2000–2002 and 2007–2009) of severe downside markets in this period, with the other 10 years occurring in more normal market conditions. In sum, our findings on the shift in average pairwise correlation suggest a meaningful persistent increase over 1997–2010, regardless of the status of the market.

Investigating Cross-Correlations

We next investigated the cross-correlation between price returns and trading volume. Following the prior literature, we studied the relationship between absolute returns ($|R|$) and volume level (V). Prior research has generally shown that correlations between absolute return and volume have historically been positive (e.g., Karpoff 1987). As mentioned earlier, this finding makes intuitive sense because volume changes are the key driver of price changes.

Table 1. Regressions of Dispersion in Volume Changes and Pairwise Correlation against the Percentage of Passive Assets, 1993–2010
(*t*-statistics in parentheses)

Dependent Variable	Intercept	Coefficient (passive market share)
Dispersion in volume changes	0.67*	–3.73*
	(146.8)	(–37.4)
Pairwise correlation of price changes	0.02	3.66*
	(1.62)	(11.17)
Pairwise correlation of volume changes	0.05*	1.24*
	(3.28)	(3.59)

*Significant at the 1 percent level.

Figure 8 shows the average cross-correlation between (|*R*|) and (*V*). Once again, we can see that the latter subperiod (1997–2010) demonstrates a significantly steeper slope, suggesting much higher cross-correlations during that period. Because absolute returns are closely related to return volatility, an increase in index trading is associated with an increase in the correlation between return volatility and volume levels.

Because our thesis revolved around index trading, we were more interested in the cross-correlation between price returns and volume *changes*—index trading involves synchronized volume changes across many stocks. Figure 8 also shows the time series of average cross-correlations between absolute returns (|*R*|) and absolute volume changes (|*VC*|). Consistent with our earlier findings, the correlation between (|*R*|) and (|*VC*|) significantly increased in the second subperiod.

Following our earlier analysis, we again examined the relationship between these cross-correlations and the growth in passive assets. **Table 2** shows the regression results for the level of passive investing and each of the two cross-correlations (between [|*R*|] and [|*V*|] and between [|*R*|] and [|*VC*|]. We found that the *t*-statistics for all the coefficients on the level of passive assets are statistically significant at the 1 percent level for each regression. This finding suggests 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 4–8.[13]

Figure 9 plots the time series of cross-correlations between absolute volume changes

Figure 8. Average Cross-Correlations between Absolute Trading Volume Levels or Absolute Volume Changes and Absolute Price Returns, October 1980–April 2010

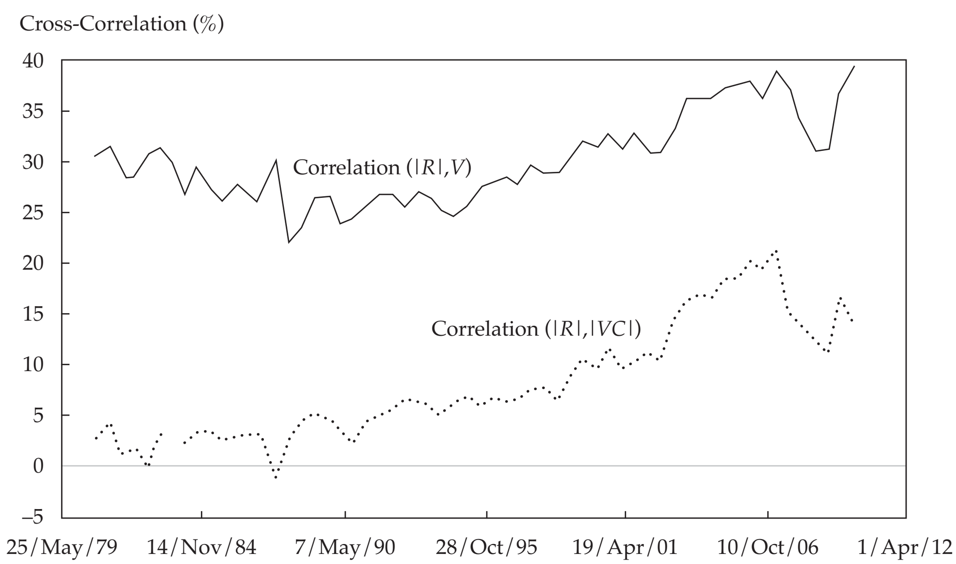
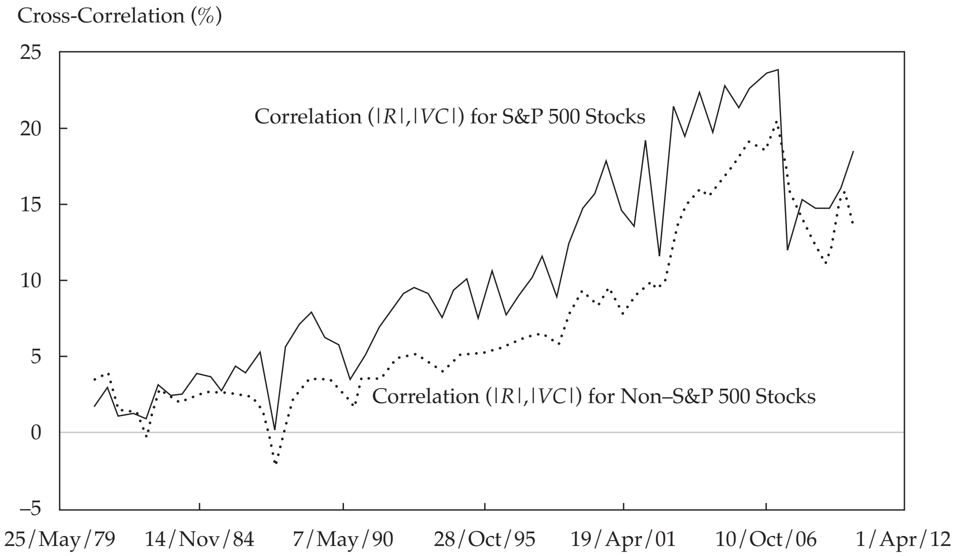


Table 2. Regressions of Cross-Correlations against the Percentage of Passive Assets, 1993–2010
(*t*-statistics in parentheses)

Dependent Variable	Intercept	Coefficient (passive market share)
Cross-correlation between (|*R*|) and (|*V*|)	0.27*	1.41*
	(33.3)	(7.75)
Cross-correlation between (|*R*|) and (|*VC*|)	0.06*	1.53*
	(6.10)	(6.98)

*Significant at the 1 percent level.

Figure 9. Average Cross-Correlations between Absolute Volume Changes and Absolute Price Changes for Both S&P 500 and Non–S&P 500 Stocks, October 1980–April 2010



and absolute price changes for S&P 500 stocks and non–S&P 500 stocks, as done earlier in Figure 7. Overall, our results are consistent with our earlier findings from Figure 7—that is, the S&P 500 stocks generally exhibited persistently higher average cross-correlations than the non–S&P 500 stocks over 1980–2010 and the cross-correlations for both size groups moved higher over time.

Taken together, our novel findings imply that the correlations between (|*R*|) and (|*VC*|) and between (|*R*|) and (|*V*|) significantly increased during the second subperiod (1997–2010), emanating largely, we believe, from an increased trading commonality. By way of comparison, consider iron filings under a magnetic field. Without a magnet, the filings are randomly distributed. Under the force of a magnetic field, the filings 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 filings and index trading acts as the magnetic field. The implications are that for those volatility models that incorporate 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, in our study we were seeking 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, in links to trading commonality driven by passively managed index trading.

Figure 6 shows that average pairwise correlations among stocks have increased since 1997. From that finding, we can reasonably infer that this rise in correlations has simultaneously yielded a rise in average betas for the universe of stocks.[14]

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). We then measured the equally weighted average beta for small-cap stocks 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 50th percentile of the universe.

In unreported results, we regressed 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 subperiod are all positive and significant at the 1 percent level, whereas those for the first subperiod are all close to zero, which indicates that the average beta for all equity segments over 1997–2010 shifted meaningfully higher.

Note that the equally weighted average beta for each of the size and style categories shown in Figure 1 was always less than 1 in the first subperiod (1979–1996).[15] Even more interesting is the fact that during this period, average beta estimates were consistently lower for small-cap stocks than for large-cap stocks (consistent with Kamara, Lou, and Sadka 2010), which means that small-cap stocks, on average, were less sensitive to overall market risk than were large-cap stocks during the first subperiod. Similarly, average betas for value stocks were unsurprisingly lower than those for growth stocks.

Strikingly, however, the observed differences in betas have dramatically narrowed over the last 10 years, as betas for all size and style categories have converged. This convergence comes from the rise of small-cap and value stock betas to the level of large-cap and growth stock betas during the first half of the decade beginning in 2000. During the second half of that decade, the average betas across all four size and style categories began a steady rise, exceeded 1, and have remained elevated ever since, a result of great importance to investors.

Importantly, this increase/convergence of betas suggests that diversification benefits during the second subperiod (1997–2010) were reduced for all types of portfolios (small-cap, large-cap, growth, and value), a situation that remained (at least) through the end of our study period. This finding unambiguously means increased investment risk for investors with respect to unanticipated events in the past decade.

We next examined 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, similar to Table 1. The results are shown in **Table 3**. We found that the *t*-statistics for all the coefficients on the level of passive assets are statistically significant at the 1 percent 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.

To further demonstrate the reduced diversification benefits since 1997 for both large-cap and small-cap stocks, we examined the excess return volatility for portfolios of large- and small-cap stocks while varying the number of stocks in the portfolios. Specifically, for the largest- and smallest-cap stock quintiles, we constructed, 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 calculated the annual excess return volatility of each portfolio relative to the market, defined as the difference between the portfolio's standard deviation of return 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 subdivided our sample into two subperiods: 1979–1996 and 1997–2010. For each subperiod, we calculated the average annual excess volatility for each portfolio.

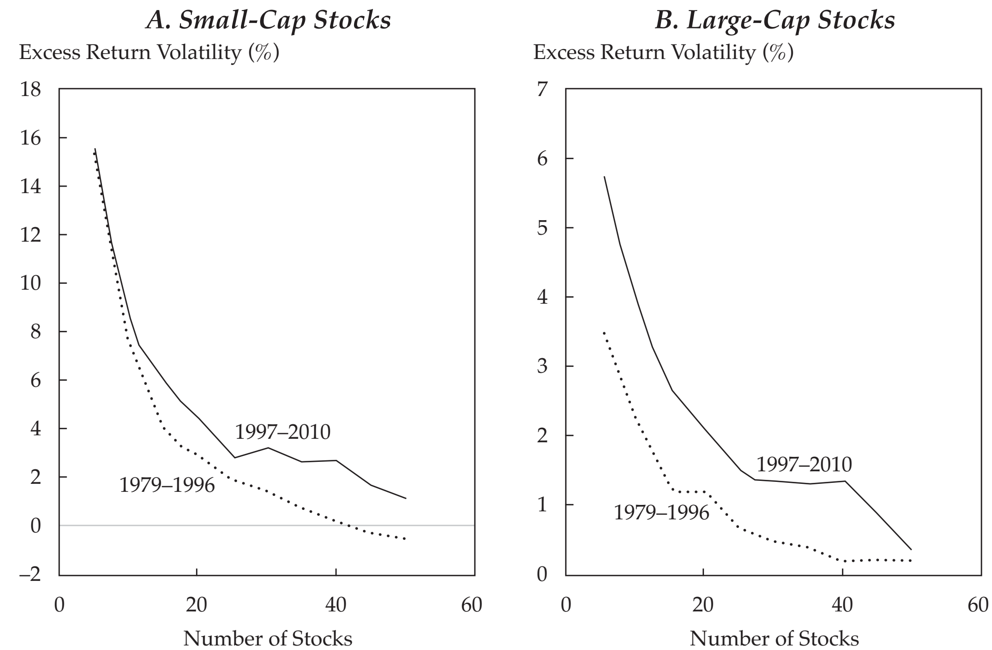
Figure 10 presents the results and shows that for both large- and small-cap portfolios, the diversification benefits diminished dramatically in the second subperiod (1997–2010). In other words, to maintain the same excess return volatility level after 1997, investors would need to meaningfully increase the number of stocks in their portfolios, both large- and small-cap stocks. In fact, even a small-cap portfolio of 50 stocks would no longer attain diversification benefits below a level of 1 percent excess return volatility, whereas before 1997 investors could do so with as few as 30 stocks. Furthermore, investors would need to more than double the number of large-cap stocks to more than 40 to reach a target of 1 percent excess volatility within their large-cap portfolios. Altogether, these results plainly suggest a decrease in the ability of investors to diversify risk in recent decades.

Table 3. Regressions of the Four Beta Estimates against the Percentage of Passive Assets, 1993–2010
(*t*-statistics in parentheses)

Beta (dependent variable)	Intercept	Coefficient (passive market share)
Large-cap	0.76*	5.33*
	(22.39)	(6.98)
Small-cap	0.39*	11.09*
	(6.71)	(8.70)
Growth	0.79*	4.68*
	(17.26)	(4.50)
Value	0.34*	11.75*
	(7.12)	(10.84)

*Significant at the 1 percent level.

Figure 10. Excess Return Volatility against Number of Stocks



Robustness Test and Future Research

The number of stocks in our analysis rises over the study period, from 500 in 1979 to 2,900 in 2010. Some may suggest that the cross-sectional distribution of company characteristics may have changed over the sample period. To address this concern, we performed a robustness test by examining a smaller sample subset in which we randomly selected 500 stocks from the universe of all NYSE/Amex/NASDAQ stocks. We selected these stocks from each period to ensure that the stock universe was meaningfully different across periods. In unreported results, we found that the randomly selected 500 stocks yielded results consistent with those shown in our figures, which suggests that our findings are empirically robust.

Our research effort offers a glimpse into how the proliferation of index trading affects systematic market risk. More work is needed to understand fully how the trading behavior of investors (especially institutional investors) affects markets. Given the wide array of passive funds, the trading commonality of passive index trades will not be universal. We showed that S&P 500 stocks have higher return commonality and correlations than do 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 those markets could prove informative.

Conclusion

Passively managed index funds and ETFs have experienced accelerating growth in recent decades. The level of passively managed assets now reaches more than half the level of assets in actively managed mutual funds. ETF trading now accounts for roughly one-third of all trading in the United States. This 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 trading commonality then gives way to a rise in systematic fluctuations in overall demand, which, in turn, leads to a fundamental impact on the overall market and investors' portfolios. In short, the growth in trading of passively managed equity indices corresponds to a rise in systematic market risk.

From this finding, we can infer that the ability of investors to diversify risk by holding an otherwise well-diversified U.S. equity portfolio has markedly decreased in recent decades. As our research has demonstrated, U.S. equity portfolios have become less diversified in recent years; returns for all subsets have become more correlated, leaving no areas for investors to improve diversification and thus mitigate risk. Put another way, investors' equity portfolios are increasingly moving in lockstep with swings in the overall market. All equity investing, indexed or otherwise, is thus plainly a more risky prospect for investors.

We suggest that the observed rise in systematic risk emanates, in part, from growth in passive index trading, especially ETFs, owing to increased trading commonality over time and across stocks. Although perhaps not the only explanation for the persistent rise in systematic risk, our results provide compelling evidence that the observed increase in trading commonality since 1997 has indeed led to lower cross-sectional dispersion in volume changes and, therefore, greater market risk since then. That is, an increase in cross-sectional trading commonality associated with the rise in passive trading meaningfully corresponds to a decrease in the ability of investors to diversify risk in recent decades.

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

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This article qualifies for 1 CE credit.

Notes

1. Kamara, Lou, and Sadka (2008) based their measure of daily liquidity "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" (p. 41).
2. The focus of our research was the recent surge in popularity of index trading and its potentially powerful impact on financial markets. We take no position here on whether index investing is superior or inferior to actively managed investing.
3. Our stock data are partly subject to survivorship bias over 1979–2000. Specifically, Morningstar Direct provides less coverage for those stocks listed before 2000. Because our analyses depended largely on cross-sectional measures, however, we believe that our results are unaffected by survivorship bias; our understanding is that excluded stocks were not omitted systematically.
4. The numbers for 1980 and 2000 are from Sias, Starks, and Titman (2006). We estimated the 2010 numbers from the Morningstar Direct database.
5. Most ETFs, though not all, have passive mandates and track an index, such as the S&P 500 Index or the Russell 3000 Index.
6. Of course, index-related trading extends beyond mutual funds and ETFs to include futures, swaps, and derivatives. In our study, we restricted our analysis to mutual funds and ETFs.
7. Founded in 1976, the Vanguard 500 Index Fund was the first index mutual fund. We included data from only the NYSE and Amex in Figures 3 and 4. Reported volumes on NASDAQ include interdealer trades, which results in artificially higher NASDAQ trading volumes versus the NYSE and Amex. We found similar results (unreported) for NASDAQ.
8. In unreported results, we did not observe similar behavior with the dispersion in cross-sectional volume *levels*, which suggests that these two regimes are associated with volume *changes* only.
9. To the extent that HFT activity provides liquidity to other index traders, however, such activities would lead to a reduction in return volatility. More research is needed to better understand the interaction of such trading activities.
10. Owing to data limitations, our database covered 222 stocks that were in the S&P 500 in 1980 and 440 stocks that were in the S&P 500 in 2000.
11. This higher pairwise correlation among the S&P 500 members is consistent with the co-movement and detachment effects identified in the members of the S&P 500 (Wurgler 2010).
12. Assuming that the breakpoint is in 1997, we repeated the regressions shown in Table 1 for two subperiods: 1993–1997 and 1998–2010. The coefficients for both subperiods remain significant for all the dependent variables.
13. In unreported results, we used the Chow test to determine whether the slope coefficients for the two subperiods are statistically different from one another for dispersion in volume changes (Figure 4), pairwise correlation (Figure 6), and cross-correlation (Figure 8). The hypothesis is that there was a "structural break" in 1997, when the passive assets exceeded $100 billion. The Chow test results confirm that the two subperiods have significantly different slope coefficients for all three measurements at the 5 percent level.
14. 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, $\beta_i = \rho(\sigma_i / \sigma_M)$, where σ_i and σ_M are the volatility of the stock (i) and the market, respectively. In unreported analysis, we found 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 σ_i/σ_M. Therefore, as correlations rise, so too does beta.
15. By definition, only the value-weighted average beta is equal to 1; we used the equally weighted average beta, which will not necessarily be equal to 1. The lower equally weighted average beta for small-cap stocks indicates a lower return correlation between the small-cap stocks and the market.

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