Index Fundamentalism Revisited

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Abstract

Is there any justification for investing in managed mutual funds, or are managed funds for suckers, as indexing advocates argue? We answer this question by looking at a long time span of real fund returns (27 years) for one specific company (Vanguard) that is notable for its low fees on managed funds. By creating synthetic portfolios—portfolios based on the assets of Vanguard's mutual funds—we find that whether index funds or managed funds are the superior buy depends on the time span in question, but that managed funds almost always have a lower standard deviation of return than index funds.

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"Two kinds of people I distrust: architects who profess to build cheaply, economists who profess to give simple answers."
Joseph A. Schumpeter, from Swedberg [1991].

"I hardly need tell you that the key to whatever success I may have enjoyed during my long investment career is that the Lord gave me enough common sense to recognize the majesty of simplicity."
John C. Bogle [2002b].

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A debate has played out in the *Journal of Portfolio Management* and elsewhere between advocates of indexing—that is, those who believe that investors would be best served by purchasing an index fund rather than a managed mutual fund—such as Vanguard's John Bogle, *The Wall Street Journal*'s Jonathan Clements, and Princeton's Burton Malkiel, and those such as Wachovia's Dylan Minor who argue that managed funds can be utilized to provide a superior return to index funds. In this paper we focus on the choice between index funds versus managed funds at Vanguard. We focus on Vanguard because it is the only fund family that offers the general public a wide range of low-cost managed and index funds. The only comparable low-cost company is TIAA-CREF, but its asset base is smaller, its mutual funds are younger, and its product selection is far more limited than Vanguard's.

Looking only at the performance of Vanguard funds, we ask three questions. First, would an investor have been best served by:

(a) investing solely in Vanguard's Total Stock Market index fund, Vanguard's broadest U.S. stock index fund,

(b) investing in a portfolio of Vanguard's U.S. index funds, with the size of the investment in each fund proportional to the size of the fund, or

(c) investing in a portfolio of Vanguard's U.S. managed funds, again with the size of the investment proportional to the size of each fund?

Second, we ask what are the optimum portfolio mixes to select from the best points on the risk-return tradeoff, using the above funds and Vanguard's international managed and index funds. Third, using regression analysis and accounting for different Morningstar

styles of mutual funds, we ask whether it is possible to draw conclusions about whether Vanguard's managed or index funds offer superior returns.

SURVEY

Bogle [2002a] looks at a large group of funds over a 10-year span and concludes that index funds do generally outperform both managed funds and the low-cost quartile of managed funds on a risk-adjusted basis when comparing the index funds in each of the nine Morningstar style boxes to the managed funds in the same box.[2] Moreover, without sorting by style he finds the index fund average risk-adjusted return is better than the average risk-adjusted return for both the managed and the low-cost quartile of managed funds. His conclusion remains the same as that of his earlier [1998] study: "An investor who doesn't seriously consider limiting selections to funds in the low-expense groups and eschewing funds in the high-expense group is someone who should take off the blinders—perhaps even a bit of a fool" [1998, p. 38]. He also writes: "[I asked] *why not just buy index funds in each of the style boxes?* I then tested that proposition, and I found the results equally compelling" [2002, p. 32, italics in original]. Inconsistent with this last conclusion, he finds [p. 37] that on average the return of the low-cost managed funds exceeds the return on index funds by 0.12 percent per year, but this figure is not corrected for survivorship bias. Bogle [p. 34] suggests that if, as is likely, survivorship bias is stronger for managed funds, taking this bias into consideration should make index funds

[2] The style boxes have two dimensions. The horizontal is value, blend, and growth, and the vertical is large, medium, and small.

more attractive.[3] Moreover, when comparing risk-adjusted returns the average index fund outperforms the average low cost managed fund by 0.58 percent per year.

Malkiel's [1995] study looks at the returns of mutual funds from 1971 to 1991 and compares them with two benchmarks, the Wilshire 5000 index and the Standard and Poors 500 index. His conclusion is very similar to Bogle's: "Most investors would be considerably better off by purchasing a low expense index fund, than by trying to select an active fund manager who appears to possess a 'hot hand'" (p. 571).[4]

Writing in response to Bogle's 1998 article, which considered fund performance for the five-year period bounded by 1992 and 1996, Minor [2001] analyzes the five-year span from 1990 through 1994. Minor's research "create[s] results that contradict [Bogle's] assertions" (p. 45) simply by moving the time span back by two years. Minor also finds for the roughly 20-year period for January 1978 through June 1998 that both the Morningstar collection of large blend funds and the Vanguard 500 fund underperform indexes that mirror their styles (custom indexes) by roughly half a percent per year with identical risks relative to their benchmarks. But like Bogle [1998; 2002a], he does not correct for selection bias, skewing his results in favor of managed funds.[5]

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[3] Comparing the Sharpe ratios for the index funds with the low-cost managed funds in the nine style boxes, the index funds win four times, tie once, and lose four times, so one needs survivorship bias to conclude that on these grounds index funds are superior to low-cost managed funds. But when comparing the risk-adjusted returns the index funds win six out of nine times.

[4] Specifically, Malkiel finds that hot hands have not worked recently, but have in the past: "While considerable performance persistence existed during the 1970s, there was no consistency in fund returns during the 1980s" (p.549). Wiener [2004] finds "that investors who purchase the prior year's best diversified Vanguard equity fund and hold it for a year will beat the market over time" (4). His data, which ranges from 1981 to 2002, uses the Total Stock Market index (and prior to TSMI's conception, the Wilshire 5000 index) as a proxy for the entire market. Wiener finds that the geometric average annual returns with the hot hand strategy are 19.4 percent versus 13.1 with the Total Stock Market index. We find that this outperformance is significant at the 5 percent level using a two-tailed test. Moreover, the standard deviation of the hot hand strategy is slightly lower (15.6 percent per year versus 16.2).

OVERVIEW OF OUR ANALYSIS

Continuing along the same lines of thought, we wish to further examine whether managed funds outperform index funds. To do this, we look at a group of managed funds that have even lower expenses than the low-expense managed funds examined by Bogle [2002a], specifically those offered by Vanguard (which have an average expense ratio of 0.45 percent per year as opposed to the expense ratio of 0.64 percent in Bogle's lowest-cost quartile). Bogle [2002a] argues that "the substantial costs of financial intermediaries doom active investors as a group to poorer returns" (p. 36).[6] We agree that high costs are likely to doom most managed mutual funds to lower returns, but this conclusion says nothing about whether fund managers with moderately priced services can outperform the market. So rather than comparing index funds with "bad guy" managed funds that charge exorbitant fees, we compare them with "good guy" managed funds with low expense ratios. As Vanguard's management delights in pointing out, Vanguard stands almost alone in being owned by the investors in its mutual funds, which means that Vanguard serves its investing public rather than a group of shareholders whose interests

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[5] More recently, Minor [2003] has found that once one drops the ten percent of funds with the highest expenses from one's sample, expenses explain only a small part of returns. However, Minor reported to us that the median coefficient for the nine Morningstar style groups he considered was –2.1, meaning that if one fund has one-half percent higher expenses than another we would expect it to return roughly one percent less net of expenses. Chalmers, Deepen, and Kale [1999] find that the average fund in the lowest expense-ratio quintile outperforms the funds in each of the other quintiles and that the average fund in the lowest trading-cost quintile outperforms the funds in each of the other quintiles. Minor [2003] goes on to argue that the past performance of mutual funds managers predicts future performance and suggests that investors can exploit this to outperform index funds. For evidence that managers' past performances are guides to future performance, see Chalmers, Deepen, and Kale [1999].

[6] For example, Wermers [2000] finds that funds hold stocks that outperform the market by 1.3 percent per year, but their net returns underperform by one percent, with 1.6 percent of the gap due to expenses and transaction costs and 0.7 percent due to underperformance of non-stock holdings.

are at odds with investors. As Eric Haas remarked to us: "Vanguard is one of the few islands of integrity in the sea of self-serving deceit that is the financial services industry."

For those who accept the argument that low-cost funds are best and for those who are curious to know whether markets are efficient, the important question we explore here is not how managed funds with high fees compare to low-cost index funds, but rather whether fund managers add any value to the system, whether *sans* exorbitant fees managers can consistently outperform the market. In other words, the interesting question is not whether high fund fees eat up excess returns (and if the fees are high enough, of course they will eat up any extra returns!), but whether managers working for a company that strives to keep its management fees low can beat the market.

Instead of trying to undertake the colossal task of looking at all mutual funds available through Morningstar in all categories as Bogle did, we focused solely on the funds offered by the Vanguard group, which include extremely large and numerous index funds and well-known low-cost managed funds, such as Explorer, Morgan and Windsor. Thus, instead of having results that are confounded by high management fees, our results minimize the impact high management fees have and get at the important, underlying differences in performance between index and low-cost managed funds.

However, Bogle [2002a] argues that there can be no qualitative, meaningful differences in performance between managed and index funds before expenses and that fees are the only thing that matters: "Active managers as a group will fall short of the index return by the exact amount of the costs the active managers incur. If the data we have available to us do not reflect that self-evident truth—well the data are wrong" [p. 35]. Of course, Bogle is right if we believe there are only two players in the market—

active managers and index funds—but his logical flaw is conflating active mutual fund managers with other investors who try to make active decisions, a point also made by Minor [2003]. Certainly the aggregate non-index players in the market also make the index return before expenses, but this does not mean that managed mutual funds cannot outperform the index since they are not the only other player in the market and thus could systematically over-perform the market if another group (say, individual investors) systematically under-performs.

METHODOLOGY

Rather than simply comparing the returns and standard deviations of individual funds or broad groups of funds (e.g., comparing large-cap growth index funds to large-cap growth managed funds)—which several previous studies have done—we constructed what we call a "synthetic portfolio" of mutual funds, which weights each mutual fund in proportion to its assets. We multiply each fund's return by its weight and then sum up these weighted returns in order to find the return for the entire synthetic portfolio. One can then easily compare the returns of various synthetic portfolios.

Synthetic Portfolios

Since our goal is to get results about what investment strategy would be best for the average Vanguard investor, the logic for using synthetic portfolios is simple. The thought process is this: If each Vanguard investor in U.S. index funds had the same mix of Vanguard's investments, then each investor would hold a portion of his or her assets in each fund equal to the ratio of that fund's assets to the total assets of all Vanguard U.S. index funds. "That is, if 50 percent of the U.S. indexed assets Vanguard manages are in

its S&P 500 index fund, the average Vanguard investor in this class of assets must likewise have 50 percent of his or her money in the S&P 500 index fund." Therefore, the correct way to calculate the return and standard deviation of the portfolio held by our hypothetical average investor is to use a synthetic portfolio. Of course, such an investor may not exist in reality but this is irrelevant: in aggregate, Vanguard investors will receive the return and face the risk calculated by our method, and all Vanguard investors could, by shuffling their portfolios, achieve the same return and risk. In order to analyze the choice between U.S. and international index and managed funds, we create four synthetic portfolios along these lines and compare their performances.[7]

Why is this aggregation method superior to averaging the performance of individual funds without regard to the size of each fund? An important goal of the paper is to guide investors, and we believe investors are more likely to invest larger shares of their assets in larger mutual funds than to spread their assets equally among all mutual funds offered. Moreover, it makes more sense to invest in proportion to the size of each fund, given the point, discussed for example in Bodie and Merton [2000], that if markets are efficient, the best strategy is to invest in all stocks in proportion to their market capitalization. Also, as we argue below, while it makes sense to look at risk-adjusted returns for entire portfolios, it makes no sense to look at risk-adjusted performance for individual components of a portfolio.

The biggest problem in constructing a synthetic portfolio is that mutual fund companies create and kill funds at will. Thus, when a fund has performed poorly, the parent company can simply kill it off and present a rosier picture of the company's

[7] Calculating the return to the synthetic portfolio is also the strategy used by *Barron's* to evaluate mutual fund families.

overall performance. Malkiel argues that this so-called "survivorship bias"—so-called because we end up seeing only the returns from the well-performing funds since the others are eliminated—could be as high as 4 percent per year (p. 553). Generally, survivorship bias affects managed funds to a greater degree than index funds, since companies are blameless for the bad performance of a fund that simply tracks an index and so have less incentive to kill index funds than managed ones.

Fortunately for our study, survivorship bias is not a large problem at Vanguard; in general, the group of funds that Vanguard offers has simply been added to since 1976, and few have been killed. We choose January 1, 1977 as our starting date because Vanguard's first index fund, now called the Vanguard 500 Index Fund, was not born until August 1976. It remained Vanguard's only index fund until the birth of the Extended Market Fund in December 1987. The current year's Morningstar Principia Pro disk only gives information on funds that are still around this year. In order to find funds that had been killed off, we looked in each year's *Wall Street Journal* for a list of all available Vanguard funds. We excluded Admiral and Institutional funds, since they are open only to select investors. Moreover, we were only interested in stock-based mutual funds and therefore excluded any funds that had a median holding of bonds above zero percent during its lifetime. Additionally, we excluded funds that were tax-managed or sector-based, trying to get only those funds whose goal was maximum performance rather than aiming for some other purpose such as limiting an investor's tax liability. Thus, we used funds that held only stock, cash, and trace amounts of bonds (never more than 0.6 percent of the portfolio), where cash is defined as securities with no more than 90-days maturity. After compiling a list of the funds in the *WSJ*, we used CRSP, old Morningstar disks, and

older Morningstar books to determine which funds had been killed off and which had simply changed their names. We were able to get returns and net asset values for almost every fund in the *WSJ*, making our synthetic portfolios close to complete, and the Bogle Financial Research Center's Kevin Laughlin helped us fill in the remaining gaps with data developed by Vanguard.[8]

Once we had all the information, to obtain a return for all the funds in a Vanguard synthetic portfolio, we summed up the net assets as of January 1 to get the value of total assets in that synthetic portfolio each year. Then, we calculated the fraction each fund's holding made up in that synthetic portfolio's assets. Next, we multiplied the return for each fund by its fraction of the synthetic portfolio's assets to get a weighted return. Summing the weighted returns gives us the return for the synthetic portfolio as a whole. Using the CPI, we converted these nominal returns into real values. **Henceforth all of our calculations and discussion are in real terms.** We created four synthetic portfolios using this method: U.S. index portfolio, U.S. managed portfolio, international index portfolio, and international managed portfolio. (Of course, there is some overlap between these groups. For example, most U.S. managed funds hold some foreign assets). Since the average returns on these synthetic portfolios vary based on the specific time span—that is, the average returns over the 27-year span are quite different from those over the 10-

[8] We could not have accurately completed this study without Kevin Laughlin's help. Fifty-two of Morningstar's figures on net asset values were wrong or non-existent, especially for early years of funds. Some were placed in the wrong column in recent Principia Pro disks, although the earlier disks got them right. One was over 30 times the correct figure. Also, Morningstar records the dates of inception of funds, but not dates when they were acquired by Vanguard. The moral is: Do not attempt a study of this sort without data that is better than Morningstar's. One way to improve the available data in this area is to require mutual fund companies to make public this sort of data for their entire fund family going back 30 or more years. Requiring fund companies to provide information about funds that have since been eliminated would obviate the problem of correcting for survivorship bias.

year span—we calculated returns and standard deviations for time spans from 2 years to 27 years, the longest time period that any Vanguard index fund has existed.

Risk Adjustment

This gave us lists of returns and standard deviations for each portfolio. However, since the standard deviations of returns were different, we needed to risk-adjust. The logic of risk adjustment merits brief explanation. Investors require portfolios with higher levels of risk to have higher expected returns. We eliminate this confounding factor by adjusting for risk. By combining any synthetic portfolio with a risk-free asset (in our case the Vanguard Treasury Money Market fund, since in this study we focus exclusively on Vanguard funds), we can create a corresponding risk-adjusted portfolio for any desired level of risk. Of course, adjusting for risk in this manner changes the returns, so we look at risk-adjusted returns to get a better idea of which portfolios are preferable. An investor should then choose the synthetic portfolio with the highest risk-adjusted return and pick the mix of the risk-free asset and the synthetic portfolio that brings him or her to the ideal point on the risk versus expected return frontier. This is the intuitive idea behind risk-adjustment; those interested in the technical mechanics should see Modigliani and Modigliani [1997].[9]

[9] Bogle [2002, p. 35] calculates average Sharpe ratios—a method of measuring the reward for undertaking risk—and risk-adjusted returns for all index and managed funds. However, this is a misuse of these statistics, since it is these statistics for an entire portfolio that matter, and they should be higher than the corresponding statistics for the individual components of the portfolio. Risk adjustment only makes sense for an entire portfolio, not for its component assets, a point overlooked by Modigliani and Modigliani [1997] in their classic article on risk adjustment. The problem with risk adjustment for individual funds is that if the returns are not perfectly correlated with one another, then when one fund is having a bad year, some other fund likely will be having a good one, meaning that the risk in the aggregate portfolio may be small. For example, if the two funds have returns with a correlation of -1, then while each fund is risky, when they are combined appropriately into a single portfolio all risk disappears. Focusing on only Vanguard funds, we find some—but not uniform—support for Bogle's conclusion that index funds provide better risk adjusted returns (see below).

We refer to the Vanguard Treasury Money Market fund as risk-free rather than low-risk, even though a risk-free asset would have a predictable real rate of return over the entire investment span. Thus, as a practical matter, the risk-free asset is a fiction. The advent of Treasury inflation-protected securities makes it less so, but does not entirely eliminate the problem, since one can't buy a Vanguard TIPS fund in which all securities mature at the same date. When the "risk-free" asset is truly risk-free, the frontier of return versus standard deviation of return for each synthetic portfolio will be a straight line, and the ranking of risk-adjusted returns for a set of synthetic portfolios will be unique, regardless of the degree of risk chosen. That the risk-free asset is a fiction deprives us of that uniqueness; however, this does not concern us excessively, as in reality investors may choose to manipulate risk by combining risky synthetic funds with various alternatives, like long-term, short-term, and high-yield bonds and other asset classes like convertible securities and real estate investment trusts. Thus, our specific way of calculating risk-adjusted returns is only one of many reasonable possibilities.

The specific way we performed our risk adjustment was to use the solver program in Excel to adjust the standard deviations of all the synthetic portfolios to equal the lowest standard deviation among the synthetic portfolios for each period by weighting each synthetic portfolio with our risk-free asset, the Vanguard Treasury Money Market fund. For example, since the international managed portfolio has the lowest standard deviation for the 9-year period, all the other portfolio's standard deviations for that period are adjusted to equal the standard deviation of the international managed portfolio by combining the synthetic portfolios with the risk-free asset. The reason we use this method is to avoid the problem of needing to buy mutual funds on margin or sell mutual funds

short. Since our risk-free asset is another Vanguard fund, we are always able to lower the standard deviation of any portfolio type to any desired level (or, at least, down to the standard deviation of the Vanguard Treasury Money Market fund) by reallocating our portfolio weights within the Vanguard family. And since some investors, such as those under a pension plan, may be allowed to only choose Vanguard funds, this method of risk adjustment also replicates the choices that one group of investors faces.

The Vanguard Treasury Money Market fund warrants some further discussion. The annual real returns of this fund are highly correlated (greater than .95) with the returns on the 90-day Treasury bill, which is commonly used as a risk-free asset. The only problem is that the Vanguard Treasury Money Market began in 1983, meaning that there are no returns for the fund from 1977 when the rest of our data begin until then. But our study needs a risk-free asset for every time period, so we estimated returns of the Vanguard Treasury Money Market for the seven years between 1977 and 1983 by finding the average subsequent excess real return of the 90-day T-bill over that of the Vanguard Treasury Money Market (0.178 % per year) and subtracting this difference from the returns on the 90-day T-bill between 1977 and 1983. We believe this to be a reasonable approximation of what the fund would have returned had it existed. The benefits of using the Vanguard Treasury Money Market rather than the 90-day T-bill or some other risk-free asset outweigh the cost of having to use estimated returns for 7 years.

Restrictions on Short Selling

Open-end mutual funds, like those of Vanguard, cannot be sold short, and intellectual property laws make it difficult for other companies to clone assets with the properties of Vanguard funds and to sell them short. (However, although open-ended

mutual funds cannot be sold short, some closed-end funds can, and electronically traded funds have shares that trade in an open market, meaning they too can be sold short.) Because of these limitations on short selling, Vanguard investors who do not care about risk and care only about expected returns should invest in funds that have the highest average non-risk-adjusted returns.

What would be the impact of permitting companies to clone assets with the same returns as the mutual funds on which these clones are based? Such clones would be derivatives that would exhibit the same *ex post* returns as the corresponding funds, leading to expanded investor choice. Investors would then have a chance to bet against overvalued securities by selling them short. This would enable skeptics to affect the market and help defend against bubbles in classes of stock where well-functioning forward markets do not exist for individual equities. So should firms and individuals be allowed to create and sell short derivatives with properties similar to those of other companies' mutual funds (that is, should the restrictions on use of intellectual property be retrenched for this purpose)? Although a full analysis of this question is beyond the scope of this paper, one result would be the creation of an opportunity for competition in the mutual fund market, forcing high-cost funds to compete with lower cost alternatives by cutting expenses. This would not only serve investors well, but it also likely would have desirable effects on capital formation and economic growth.

RESULTS

We think that looking at the real annual returns for each type of fund before exploring the cumulative returns will help the reader. So, in Exhibit 1 we present annual

real returns from January 1977 to January 2004 for the Vanguard Treasury Money Market fund and the simple indexing strategy of holding Vanguard's Total Stock Market index fund, which mimics the Wilshire 5000 index (a capitalization weighted index of the largest—roughly 7000—U.S. companies).[10] [11] In the Exhibits we refer to this index fund as Wilshire 5000. The other columns present returns for the four types of synthetic portfolios we created—from left to right, U.S. index[12], U.S. managed[13] , international index[14], and international managed[15]. For the U.S. and international portfolios, we indicate the portfolio with the highest return each year in bold. For the international portfolios the longest time span is 21 years and begins in 1983. This span is limited because international managed funds did not exist before 1983 (a 21-year time span) and international index funds did not exist before 1991 (a 13-year time span).

In Exhibit 2, we compare the various portfolios. From left to right, the columns give the first year of the investment, the time span, the geometric average of returns of the Vanguard Treasury Money Market over the time span (the risk-free rate), and the geometric average of returns for the five portfolios. How should Exhibit 2 be interpreted? Take the last row for example. The time span is 27-years, meaning that the series begins

[10] Vanguard's Total Stock Market index fund did not exist for the entire period. We constructed its hypothetical return for the period prior to 1991 by postulating that its return fell short of the Wilshire 5000's return each year by the identical margin that the Vanguard 500 Index fund fell short of the S&P Index in the same year. A similar time-span issue involving the Vanguard Treasury Money Market is explained in the risk-adjustment section above.

[11] The consumer price index is taken from the Bureau of Labor Statistics web page.

[12] The funds included in the U.S. index portfolio are the Vanguard 500, Calvert Social, Extended Market, Growth, Mid Cap, Small Cap, Small Cap Growth, Small Cap Value, Total Stock Market, and Value.

[13] The funds included in the U.S. managed portfolio are Capital Opportunity, Capital Value, Equity Income, Explorer, Growth and Income, Growth Equity, Mid Cap Growth, Morgan Growth, Naess and Thomas, Primecap, Selected Value, Strategic Equity, Trustees Comingled Equity, U.S. Growth, U.S. Value, Windsor, Windsor II, and the domestic component of Ivest.

[14] The funds included in the international index portfolio are Emerging Markets, European Stock, Developed Markets, Pacific Stock, and Total International Stock.

[15]The funds included in the international managed portfolio are Global Equity, International Explorer, International Growth, International Value, and the international component of Ivest.

January 1, 1977 and finishes at the end of 2003. The risk-free asset over that 27-year span has a geometric average return of 2.11 percent, the geometric average of returns on the Wilshire 5000 is 7.83 percent, and so forth. The portfolio with the best return over the 27-year period is the U.S. managed portfolio, with a return of 8.68 percent.

These results are illustrated graphically in Exhibit 3. It shows for each portfolio how much money (in 2004 dollars) was needed to grow to one dollar on January 1, 2004. For all three U.S. portfolios, less than fourteen cents at the beginning of 1977 was needed to grow into one dollar (13.1 cents for the Wilshire, 13.6 cents for the U.S. index, 10.6 cents for the U.S. managed, and 57.0 cents for the money market). Investors who invested in each of the five portfolios prior to the year 2000 peak required six years to break even in January 2004. U.S. managed funds were less caught up in the bubble of 1999 to 2000 than the other two U.S. portfolios, which partially explains the lower standard deviation of the U.S. managed portfolio. As the graph shows, had we compiled our analysis in January 2000 when the market was at its peak, we would have concluded that the U.S. index portfolio beat its managed counterpart for every span except the very longest. Recent stock market developments have eroded some of that margin.

Exhibit 4 presents the standard deviations of returns for the various investments over various periods.[16] In this exhibit, the lowest standard deviations are highlighted for U.S. portfolios and for international portfolios. For example, the standard deviation of the returns over the 27-year span from January 1977 through January 2004 is 16.10 percent for the U.S. index portfolio and 14.31 percent for the U.S. managed portfolio. The synthetic U.S. managed portfolio has a lower standard deviation than its U.S. counterparts for all time spans beginning before the year 2000.

We risk-adjust the portfolios by combining them in an imaginary portfolio along with the Vanguard Treasury Money Market fund. The results (risk-adjusted geometric average annualized returns) are shown in Exhibit 5. Again, we adjust the standard deviation of each synthetic portfolio to equal the lowest standard deviation among the five portfolios. In Exhibit 5, we flag the portfolio with the lowest standard deviation by underlining. For example, for the 27-year period, the lowest standard deviation among the five portfolios is the U.S. managed portfolio, with a standard deviation of 14.31 percent. At the point where the standard deviation of the other two U.S. portfolios equals 14.31 percent, the returns are 7.36 percent for the Vanguard Total Stock Market index, 7.13 percent for the U.S. index fund, and 8.68 percent for the U.S. managed fund. While the returns for the first two portfolios are lower upon risk-adjustment, risk-adjustment does not change the return for the managed portfolio, since it is serving as the baseline. The bold values in Exhibit 5 show which of the five portfolios has the best risk-adjusted returns for each time span. For example, the U.S. managed portfolio outperforms the U.S. index portfolio on a non-risk-adjusted basis for the 27 through 23, 13-11, and 6-3 year spans. When we look at risk-adjusted returns, the U.S. managed portfolio has higher returns for the 27 through 21, 13-8, and 6-2-year spans.[17]

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[16] Each is an estimate of the population standard deviation based on the sample.

[17] For the various holding periods, the amount by which the average expense ratio for the synthetic U.S. index portfolio is less than that for the synthetic U.S. managed portfolio varies between 0.23 and 0.31 percentage points. Thus, the difference in expense ratios for the two portfolis does not vary much and cannot explain the relatively better risk-adjusted performance of the synthetic U.S. managed portoflio for holding periods beginning earlier.

The six-year risk-adjusted return for the Wilshire 5000 exceeds the non-risk-adjusted return over the same period even though risk-adjustment involves diluting the Wilshire 5000 with an asset with a lower geometric average return over the entire period. This seems like a mistake, but it is just an application of the proposition mentioned in Clements [1999] that a diversified portfolio may yield a higher return than either of its component assets. It also exemplifies how risk adjustment may simultaneously reduce risk and raise return.

Exhibit 6 replicates Exhibit 5 in a graphical form. The portfolio with the best risk-adjusted performance over a given period is the portfolio whose curve is highest at that point. The U.S. managed portfolio performs best over the seven longest periods, for start dates between 1991 through 1996, and the four shortest periods. Otherwise, the U.S. index portfolio performs best, except that the Wilshire 5000 is the best six-year performer. Some of the returns for the shortest periods are substantially negative and risk adjustment doesn't mean much for short series. Thus, the short-period risk-adjusted returns are not shown in the graph, although they are included in Exhibit 5. Comparing the international portfolio, the international managed portfolio has higher average returns, whether risk-adjusted or not, for all the time spans beginning between 1991 and 1998.

In Exhibit 7, we break the 27-year period into 15-year spans, and graph the amount, in percent per year, by which the real returns of the Vanguard Total Stock Market index and the U.S. index portfolio exceed the real return of the U.S. managed portfolio. The horizontal axis shows the ending year of each span. We also graph the differential of the risk-adjusted returns. In performing the risk adjustment, we dilute the two index portfolios with the risk-free asset so as to bring their standard deviations of return over the entire 27-year period down to that of the managed portfolio. Thus, each risk-adjusted series is characterized by a constant proportion of the risk-free asset in each of the two index portfolios. We see that for 15-year spans early on, the managed portfolio performs better on both risk-adjusted and non-risk-adjusted bases, whereas later in the period other portfolios do better. We don't understand why. We conjecture as one possibility that the U.S. stock market has become more efficient.[18] Bogle's explanation

[18] Exhibit 7 suggests that the index portfolio has recently improved its performance relative to managed funds. To test this, we regressed the performance differential in favor of the index portfolio on time. The

for this in Merriman [2004] is that prior to 1989 "all the [managed] funds were smaller and more manageable," i.e., that managed funds are now larger and less able to outperform the market.

Exhibit 8 asks what portfolio mix achieves the desired tradeoff between return and risk over the period since January 1991, when our first international index fund series begins, through the close of 2003. We use Excel's solver to maximize a function that depends positively on the geometric average rate of return and negatively on its standard deviation. We find that the risk-minimizing allocation is 59 percent U.S. managed and 41 percent international managed. The maximum proportion prescribed in any of our calculations for international funds is 41 percent. As the weight on return becomes larger relative to the weight on standard deviation, U.S. managed funds play a larger role, becoming the whole portfolio for a wide range of relative weights. The other three synthetic portfolios have no role in any optimum portfolio for this particular period. Of course, these numbers are the results of an *ex post* analysis, performed after the entire period is over. If we had performed an *ex ante* rolling optimization using information available at the beginning of each period, we would have obtained different numbers. Thus, these results show only the potential after all time has passed, not what an investor

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performance differential is the annual continuously compounded real rate of return of the index portfolio minus that of the managed portfolio. Our point estimate is that the performance differential has improved by 0.118 percentage points per year, with the index portfolio inferior to the managed fund prior to mid-1996 and superior afterwards. This is a big number, but it is also insignificant, as the t-value is only 0.77. A similar result was obtained for the Vanguard Total Sock Market index fund versus the managed portfolio, with the TSMI being better only after mid-1994. However, the return of the international index fund averages 0.7 percent per year less than the international managed fund with no time trend. Thus, as an empirical matter, a preference for index funds seems to be justified for the U.S. beginning only recently. The results for the U.S. markets are broadly consistent with Bogle [2000], who found for data beginning in 1990 that (p. v): "the Standard and Poor's 500 Stock Index … quickly moved ahead of the average fund manager, and has not only remained there [since 1993] but has—almost unbelievably— steadily accelerated its margin of advantage year after year."

would actually have invested in at the beginning of each period based on the information available at the time of investment. However, this analysis still demonstrates the importance that mixing different types of funds plays in optimal portfolio decisions and demonstrates *ex post* that indexing may not play any role in achieving a desired risk and return trade-off.

In summary, for both of the groups at which we have looked—U.S. and international—Vanguard's managed funds have outperformed its index funds for the longest spans on both risk-adjusted and non-risk adjusted bases. Moreover, the managed funds often have lower risk. Malkiel [1995] finds that "in the aggregate, [mutual] funds have underperformed benchmark portfolios both after management expenses and even gross of expenses" (549). He uses data from 1982 through 1991. We find that for the period from 1982 through 2003, both the synthetic Vanguard U.S. managed portfolio and the synthetic U.S. index portfolio beat the Vanguard Total Stock Market index fund, regardless of whether we risk-adjust the returns. On both risk-adjusted and non-risk-adjusted performance over the entire time span, the U.S. managed portfolio continues to be the winner and the U.S. index portfolio is the worst performer of the three. For the period beginning in 1985, the managed fund loses to the other two regardless of risk adjustment.

These results emphasize the crucial importance that the time span plays in these sorts of analyses, a point also made clear by the differences in the Bogle [1998] and Minor [2001] studies cited in the SURVEY section. Depending on the time span over which a study is performed, the results can vary dramatically. For example, had our analysis begun in 1979 rather than 1977 or ended in January 2000 rather than January

2004, U.S. index funds would look far more attractive compared to the managed funds. However, it is important to emphasize that the time frame chosen for this paper was not arbitrary; we simply used all of the data from the inception of Vanguard's first index fund. But readers should keep in mind the importance of the time frame in determining the results of this study or any other similar study.[19]

One other caveat needs mentioning: all of these results ignore tax implications. The reason for this is that the individual tax situation of individuals differs so greatly that it would be unhelpful and potentially misleading if we were to generalize and estimate the average impact of taxes. Additionally, many individuals will invest in Vanguard through pensions, IRAs, or something similar, effectively eliminating taxes on these investments. However, we do agree with Bogle [2002b] that the higher turnover in

[19] The U.S. managed portfolio outperforms the Wilshire 5000 and U.S. index portfolio over the entire period by an economically important margin. Are those margins statistically significant? A t test shows that the probability that a different sample drawn from the same population would find the Wilshire 5000 to outperform the synthetic U.S. managed portfolio is 26 percent. For the U.S. index portflio to outperform the U.S. managed fund it is 24 percent. When risk-adjusted returns are tested, these numbers fall to 13.9 percent and 11.8 percent respectively. Thus, the superiority of the managed fund over the index funds is not statistically significant at the conventional ten percent level. Had our series begun in January 1989, all of the probabilities would have been over 50%.

Are the index funds significantly more risky? Our criterion is the average absolute value of the annual instantaneous return minus the average annual instantaneous return (similar to the standard deviation of the annualized return). The probability that the Wilshire 5000 has a lower risk than the U.S. managed fund is 2.70 percent. The probability that the U.S. index fund has a lower risk than its managed counterpart is 2.53 percent. The lower risk of the managed fund is statistically significant.

How can we explain the stylized fact that index and managed funds have roughly the same returns with lower risk for managed funds? If we assume that some stocks become overvalued from time to time and managers sell them before they crash, whereas indexers can't, then we would expect higher returns and less risk for managed funds. Once we introduce sufficiently high expenses for managed funds, the return differential disappears, but the risk advantage for managed funds remain.

Here is a numerical example. Suppose the stock market consists of 100 shares each of two stocks, called "Safe" and "Risky". The price of Safe stays constant at $1 per share. The price of Risky oscillates annually between $1 and $1.01. Consequently, the index alternates between annual returns of roughly 0.5 percent and –0.5 percent, averaging zero percent. Managers invest in Risky when it is priced at $1, earning 1% and in Safe when Risky is priced at $1.01, earning zero percent. The index fund has no expenses, so it earns zero percent per year on average with a standard deviation of 0.5 percent. The managed fund earns an average of 0.5 percent per year with a standard deviation of 0.25% per year. Subtract 0.5 percent per year expenses for the managed fund and its return matches the index fund, but its standard deviation stays at only 0.25 percent. In this example the returns of the two kinds of funds are equal with a lower standard

managed funds (or a portfolio of narrowly defined index funds) makes a broad-based index fund more appealing for a non-tax sheltered investor. Individuals should consider their own tax situation when interpreting our results, but since so much investment occurs through tax-free vehicles like pensions, many investors will not need to take taxes into account.[20]

THE CHOICE BETWEEN INDEX AND MANAGED FUNDS: SOME REGRESSIONS

Following the suggestion to us by both William Bernstein and Eric Haas that much of the performance of our different synthetic portfolios is explained by style differences, we examined the Morningstar style boxes for our synthetic portfolios of U.S. index and U.S. managed funds. For the arbitrarily selected years 1994, 2000, and 2002, we found that our synthetic portfolio of index funds had more of a growth orientation than did our synthetic fund of managed funds. An extreme case was 1994, when our synthetic U.S. managed portfolio had 82 percent of its assets in value mutual funds while the synthetic U.S. index portfolio had 98 percent of its assets in blend mutual funds (neither growth nor value). This style difference may account for the larger run up of index funds to January 2000 and the larger subsequent crash of the index fund portfolio.

We also attempted to disentangle the role of style, transactions costs, turnover rates, and the classification of funds as index versus managed. Consequently, we regressed the rate of return for each fund on the rate of return for the Wilshire 5000 index

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deviation of return for the managed fund. An e-mail from James Alfieri's about what managers do inspired this example.

[20] Dylan Minor has pointed out to us "it is important to remember that higher turnover does not necessarily mean more taxes or less tax efficiency. Some managers have very high turnover and are still more tax

and various combinations of dummy variables for Morningstar's index styles, the expense ratio, the turnover rate, and a dummy variable denoting index fund. We used data on Vanguard U.S. equity funds from 1977 through 2002. Our rates of return were continuously compounded nominal annual rates, and our expense ratios were lagged one year to account for the fact that some expense ratios are tied to performance. All of our t values for the expense ratio, the turnover rate, and the index dummy were less than 1.5 in absolute value, and the sign of the coefficient for the index dummy was positive or negative depending on the specification while the signs of the expense ratio and turnover rate were positive in some of the specifications.[21]

Thus, our regression analysis rejects our attempt to rank U.S. index and U.S. managed funds. This regression analysis contributes little to the choice between index and managed funds. Nor does it indicate that the investor should shy away from high expense or high turnover Vanguard funds. It may be that in the case of Vanguard's funds the benefits and costs of active management, high expenses and high turnover, are closely matched, since Vanguard refuses to permit unjustifiably high expenses or turnover rates.

CONCLUSIONS

As the previous section notes, our results in all the other sections reflect the style of the funds that investors choose as well as the efficacy that characterizes these funds' operations. The results from all but the preceding section show that investors in

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efficient than their lower turnover brethren. In this instance, the higher turnover manager is turning over some of the losers to offset winners."

[21] Daniel Wiener remarked to us, "when a Vanguard fund seems to have 'high' expenses it's often because the manager has been paid a performance fee for outperforming his/her benchmark. Hence you'll see that Global Equity had an almost unheard–of expense ratio in fiscal 2002 [1.90%] precisely because of its performance. [It outperformed the S&P 500 index by 16.48%.] I'll take that kind of 'high expense' fund any day. Wouldn't you?"

Vanguard's U.S. index and U.S. managed funds have seen comparable performance. The regressions cited in the previous section provide no evidence that while holding style constant Vanguard index and managed funds have different expected returns.[22]

So does indexing work? Are managed funds something only a sucker would ever buy? Vanguard's managed funds do provide higher returns, especially once we perform the risk adjustment, over the longest time spans, and managed funds also provide lower standard deviations of returns for almost all spans. Internationally, managed funds are superior to index funds in both returns and risk for almost all time spans.

One important conclusion arising from this paper is that managed funds may provide some sort of protection against the type of stock market bubble that characterized many markets at the end of the 1990s. Had our analysis concluded in January 2000, index funds would have looked far better than they do now. Exhibit 3 shows the bubble for U.S. managed funds was far less than the bubble for U.S. index funds. Perhaps managed funds provide some sort of protection against stock-market bubbles that index funds simply cannot provide. If fund managers are more rational or less exuberant than other participants in the market, then it is likely that managed funds would be less susceptible to the splash of market bubbles when they burst, and managed funds would be less susceptible to market troughs. The lower standard deviations of the U.S. managed fund portfolio for almost every time period in the study suggest that managed funds may indeed protect somewhat against market swings.

If one wants to minimize risk or maximize returns, extrapolating our longest data set suggests that managed funds are the way to go. But perhaps the market has become

[22] It is important to remember that we have excluded tax considerations, so our analysis applies only to funds in a retirement plan. The tax implications of the alternatives are an area for future research.

more efficient in over the past decade or two, explaining why the Total Stock Market index fund and our synthetic U.S. index portfolio has outperformed the synthetic managed portfolio over many mid-range time spans with start dates from 1982 through 1997. Regardless, the picture is not nearly as clear as some of Bogle's writings paint it, and we find that he deserves to take more joy in the low cost managed funds that he has shepherded.[23] On the question of indexing versus managed funds, the data provides conflicting results. Indeed, we can see this conflict when we look at the funds owned by Vanguard managers, as given in Wiener [2002]. Of the seven Vanguard directors (one of whom is Professor Malkiel), all seven invest in U.S. managed funds, six in U.S. index funds, four in international index funds and one in international managed funds. In an interview with Paul Merriman [2004], John Bogle says "I have about three quarters of my own equity investments at Vanguard in our index funds." Even they are reluctant to pick the winning class of fund and plunge all of their investments into it. Their behavior reveals that they are neither index nor managed fundamentalists, and our research suggests that perhaps we should not be fundamentalists either.

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[23] Bogle writes [2002b, p.7]: "An all-market index fund is clearly the optimal way to hold the U.S. stock market." He continues (6): "Like Dr. Fama, I believe that *the market portfolio is the most sensible decision.* It takes the need for judgment out of your decision making; it reduces cost; it increases tax-efficiency; it avoids the need to pore over past market data to figure out why the data are what they are." In an October 2003 note to us he writes, "Of course I take joy in Vanguard itself (first [in time]), in low cost managed funds (second), and all-market index funds (third). And while Schumpeter has a point, who dares deny this fundamental truth: 'market return minus intermediation cost equals investor return.' " In February 2004 he added "Of course I 'take joy' from the records of our low-cost active funds. But still 'more joy' from the index funds, because there I'm highly confident (certain!) that the past is prologue." In his Merriman [2004] interview he confidently predicts that index funds will continue to deliver close to the market return, whereas the returns of managed funds are less certain, i.e. for them the past is not prologue.

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EXHIBIT 1
Annual Real Returns (% per year)

Year	Treasury money	Wilshire 5000	U.S. Index	U.S. Mgd.	Int'l Index	Int'l Mgd.
2003	-1.04	28.93	27.84	**32.08**	**38.31**	33.94
2002	-0.85	**-22.80**	-23.49	-24.67	**-16.95**	-18.89
2001	2.40	-12.33	-12.57	**-11.08**	-20.92	**-19.54**
2000	2.33	-13.50	-13.05	**0.36**	-17.91	**-11.26**
1999	1.82	**20.57**	18.93	10.12	**24.82**	22.50
1998	3.34	21.30	**24.15**	13.51	13.44	**15.19**
1997	3.36	28.80	**30.04**	25.42	-0.93	**1.31**
1996	1.71	17.07	18.24	**19.92**	5.54	**10.04**
1995	2.88	32.43	**33.22**	30.93	9.19	**10.69**
1994	1.11	-2.77	**-1.87**	-2.53	**4.13**	-0.48
1993	0.11	7.66	7.61	**11.64**	28.43	**34.83**
1992	0.61	5.70	5.05	**10.04**	-11.02	**-9.88**
1991	2.59	**29.97**	27.48	25.97	**8.68**	4.27
1990	1.72	-11.77	**-9.87**	-17.54		-17.21
1989	4.03	23.13	**25.30**	13.07		19.80
1988	2.64	12.57	11.32	**21.04**		10.88
1987	1.61	-2.51	**0.27**	-3.74		14.52
1986	4.85	14.23	**16.78**	14.55		50.11
1985	3.44	**27.22**	26.43	23.49		37.86
1984	5.63	-0.92	2.17	**6.59**		-4.67
1983	5.07	17.82	16.86	**24.25**		37.84
1982	7.36	13.86	16.51	**18.84**		
1981	5.94	-11.75	-12.97	**2.32**		
1980	-0.01	**18.53**	17.24	10.35		
1979	-2.32	**10.61**	4.20	6.16		
1978	-1.42	-0.25	-2.89	**3.49**		
1977	-1.28	-9.13	-13.63	**-4.36**		

EXHIBIT 2
Average Annualized Real Returns (% per year)

Year	Span	Treasury Money	Wilshire 5000	U.S. Index	U.S. Mgd.	Int'l Index	Int'l Mgd.
2003	1	-1.04	28.93	27.84	**32.08**	**38.31**	33.94
2002	2	-0.94	**-0.23**	-1.10	-0.25	**7.18**	4.23
2001	3	0.16	-4.44	-5.08	**-4.00**	**-3.15**	-4.39
2000	4	0.70	-6.79	-7.14	**-2.93**	-7.07	**-6.15**
1999	5	0.92	-1.87	-2.43	**-0.45**	-1.42	**-1.02**
1998	6	1.32	1.66	1.57	**1.75**	0.91	**1.52**
1997	7	1.61	5.16	**5.22**	4.84	0.64	**1.49**
1996	8	1.62	6.58	**6.76**	6.62	1.24	**2.52**
1995	9	1.76	9.18	**9.42**	9.08	2.10	**3.40**
1994	10	1.70	7.92	**8.24**	7.86	2.30	**3.00**
1993	11	1.55	7.90	8.18	**8.20**	4.44	**5.55**
1992	12	1.47	7.71	7.92	**8.35**	3.05	**4.17**
1991	13	1.56	9.28	9.31	**9.61**	3.47	**4.18**
1990	14	1.57	7.62	**7.81**	7.41		2.48
1989	15	1.73	8.59	**8.90**	7.77		3.56
1988	16	1.79	8.84	**9.05**	8.56		4.00
1987	17	1.78	8.14	**8.51**	7.79		4.59
1986	18	1.95	8.47	**8.95**	8.16		6.71
1985	19	2.02	9.38	**9.81**	8.92		8.16
1984	20	2.20	8.84	**9.42**	8.80		7.48
1983	21	2.34	9.25	**9.76**	9.49		8.76
1982	22	2.56	9.46	**10.06**	9.90		
1981	23	2.70	8.44	8.94	**9.56**		
1980	24	2.59	8.84	9.27	**9.59**		
1979	25	2.39	8.91	9.07	**9.45**		
1978	26	2.24	8.54	8.58	**9.21**		
1977	27	2.11	7.83	7.66	**8.68**		

EXHIBIT 3
Cumulative Real Value for Alternative Investments

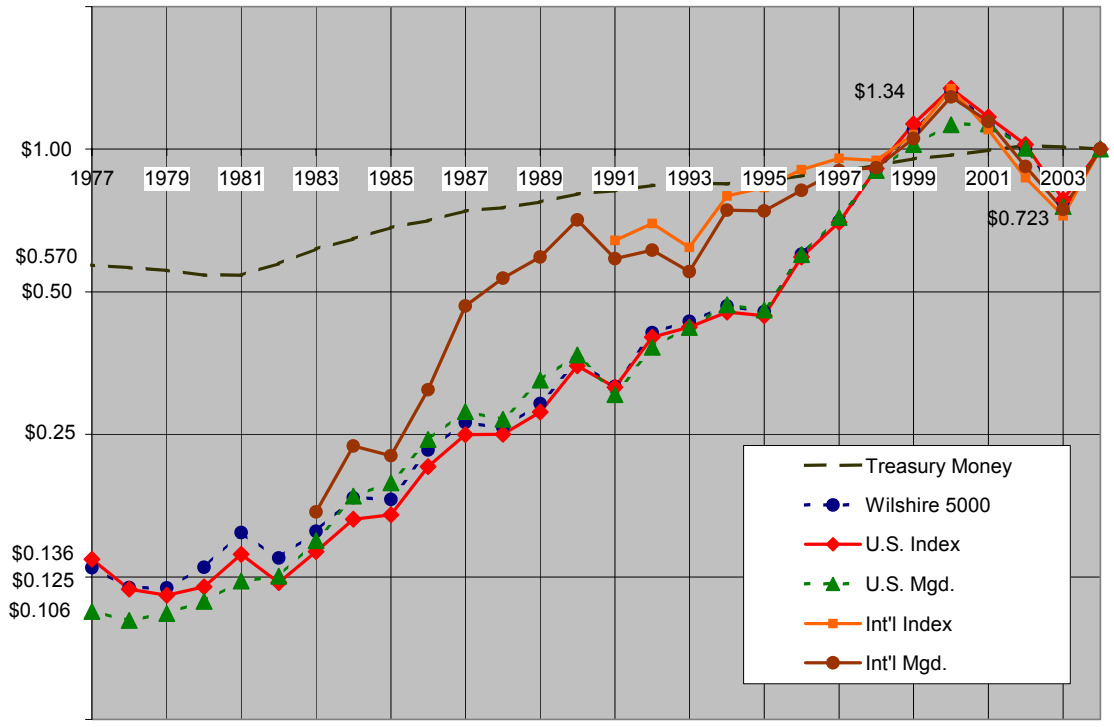

EXHIBIT 4
Standard Deviations of Annual Real Returns (% per year)

Year	Span	Treasury Money	Wilshire 5000	U.S. Index	U.S. Mgd.	Int'l Index	Int'l Mgd.
2002	2	0.13	36.57	**36.29**	40.13	39.07	**37.36**
2001	3	1.94	27.35	**27.04**	29.63	33.11	**30.69**
2000	4	1.91	23.05	**22.67**	24.21	28.50	**25.53**
1999	5	1.73	22.99	22.43	**21.53**	27.92	**25.07**
1998	6	1.83	22.30	22.44	**19.88**	25.45	**23.13**
1997	7	1.84	22.46	22.78	**19.97**	23.29	**21.13**
1996	8	1.70	21.08	21.44	**19.09**	21.58	**19.71**
1995	9	1.65	21.27	21.65	**19.39**	20.29	**18.56**
1994	10	1.57	20.53	20.84	**18.76**	19.13	**17.58**
1993	11	1.56	19.49	19.79	**17.81**	19.60	**19.04**
1992	12	1.51	18.61	18.92	**16.98**	19.33	**18.81**
1991	13	1.48	18.72	18.79	**16.88**	18.54	**18.01**
1990	14	1.43	18.98	18.88	**17.91**		18.35
1989	15	1.51	18.64	18.65	**17.29**		18.15
1988	16	1.48	18.01	18.02	**16.97**		17.59
1987	17	1.43	17.72	17.63	**16.76**		17.18
1986	18	1.57	17.22	17.18	**16.31**		19.65
1985	19	1.56	17.21	17.10	**16.17**		20.26
1984	20	1.72	16.95	16.76	**15.76**		19.99
1983	21	1.79	16.61	16.39	**15.68**		20.46
1982	22	2.04	16.22	16.04	**15.40**		
1981	23	2.12	16.52	16.47	**15.15**		
1980	24	2.14	16.26	16.17	**14.82**		
1979	25	2.32	15.92	15.88	**14.54**		
1978	26	2.39	15.73	15.77	**14.31**		
1977	27	2.44	15.84	16.10	**14.31**		

EXHIBIT 5
Risk Adjusted Average Annualized Real Returns (% per year)

Year	Span	Wilshire 5000	U.S. Index	U.S. Mgd	Int'l Index	Int'l Mgd
2002	2	-0.21	-1.10	**0.02**	**6.82**	4.17
2001	3	-4.36	-5.08	**-3.42**	**-2.08**	-3.56
2000	4	-6.64	-7.14	**-2.58**	**-5.12**	-5.20
1999	5	-1.57	-2.22	**-0.45**	**-0.39**	-0.46
1998	6	**1.82**	1.747	1.754	1.43	**1.75**
1997	7	4.96	**5.00**	4.84	1.05	**1.85**
1996	8	6.27	6.38	**6.62**	1.48	**2.54**
1995	9	8.43	8.55	**8.82**	2.21	**3.40**
1994	10	7.23	7.43	**7.55**	2.37	**3.00**
1993	11	7.47	7.65	**8.20**	4.32	**5.39**
1992	12	7.27	7.38	**8.35**	3.04	**4.05**
1991	13	8.63	8.64	**9.61**	3.43	**4.10**
1990	14	7.36	**7.56**	7.41		2.50
1989	15	8.18	**8.46**	7.77		3.53
1988	16	8.49	**8.69**	8.56		3.97
1987	17	7.85	**8.23**	7.79		4.55
1986	18	8.17	**8.65**	8.16		6.11
1985	19	9.00	**9.44**	8.92		7.16
1984	20	8.44	**9.04**	8.80		6.62
1983	21	8.92	9.47	**9.49**		7.52
1982	22	9.15	9.79	**9.90**		
1981	23	8.05	8.52	**9.56**		
1980	24	8.38	8.80	**9.59**		
1979	25	8.43	8.58	**9.45**		
1978	26	8.05	8.07	**9.21**		
1977	27	7.36	7.13	**8.68**		

EXHIBIT 6
Risk Adjusted Average Annualized Rates of Return: Graph (% per year)

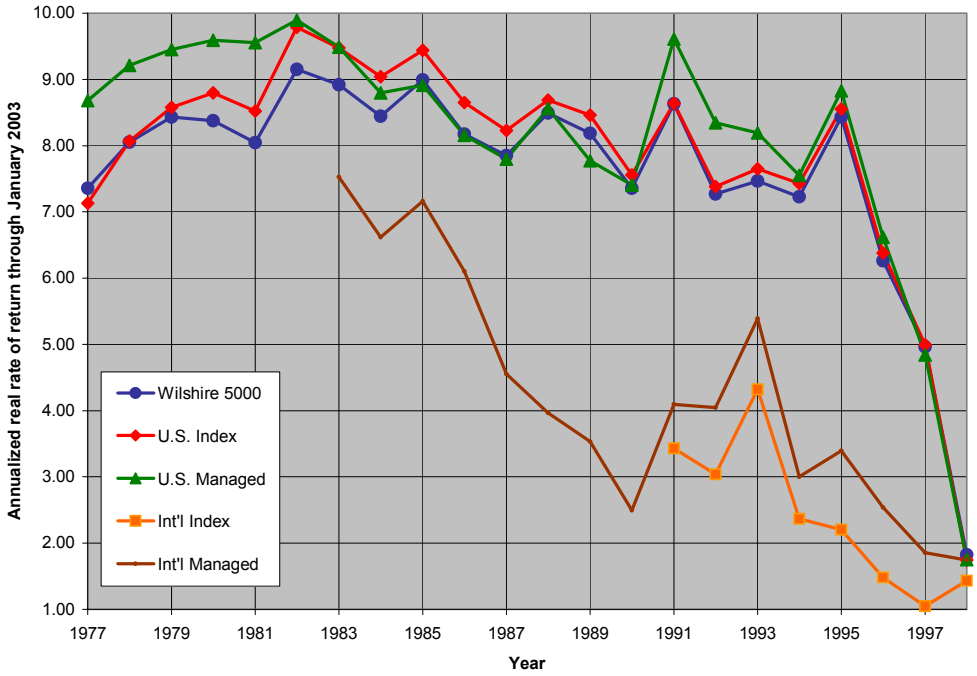

EXHIBIT 7
Fifteen-Year Average Annualized Real Return Above U.S. Managed (% per year)
(Above Zero Means Wilshire 5000 or U.S. Index is Better than U.S. Managed)

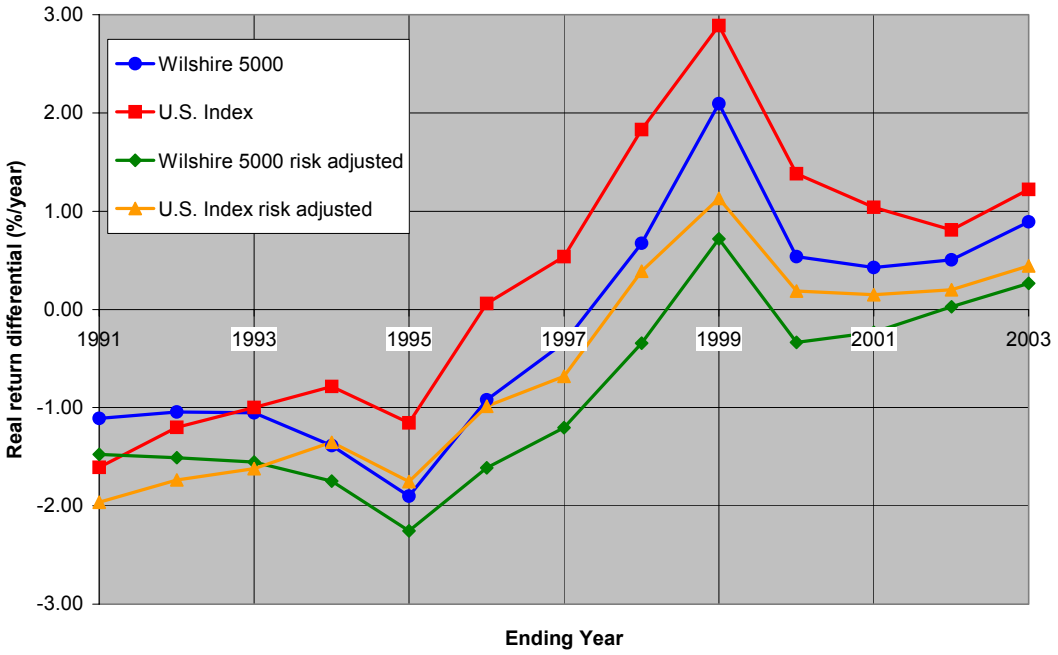

EXHIBIT 8
Portfolio Mix to Achieve Desired Tradeoff Between Return and Risk

Fraction of assets in each portfolio					*To Maximize*
Wilshire 5000	*U.S. Index*	*U.S. Mgd*	*Int'l Index*	*Int'l Mgd*	
0	0	0.59	0	0.41	Minus standard deviation of return
0	0	0.78	0	0.22	Return minus 2* standard deviation of return
0	0	0.96	0	0.04	Return minus 1*standard deviation of return
0	0	1.00	0	0.00	Return minus 0.9*standard deviation of return
0	0	1.00	0	0.00	Return