The Diversification Puzzle

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The levels of diversification in U.S. investors' equity portfolios present a puzzle. Today's optimal level of diversification, measured by the rules of mean–variance portfolio theory, exceeds 300 stocks, but the average investor holds only 3 or 4 stocks. The diversification puzzle can be solved, however, in the context of behavioral portfolio theory. In behavioral portfolio theory, investors construct their portfolios as layered pyramids in which the bottom layers are designed for downside protection and the top layers are designed for upside potential. Risk aversion gives way to risk seeking at the uppermost layer as the desire to avoid poverty gives way to the desire for riches. But what motivates this behavior is the aspirations of investors, not their attitudes toward risk. Some investors fill the uppermost layer with the few stocks of an undiversified portfolio; others fill it with lottery tickets. Neither lottery buying nor undiversified portfolios are consistent with mean–variance portfolio theory, but both are consistent with behavioral portfolio theory.

The benefits of diversification as measured by the rules of mean–variance portfolio theory have increased in recent years, but the level of diversification in investor portfolios has not. It remains much below the optimal level currently prescribed by mean–variance optimization, which exceeds 300 stocks. I argue that this diversification puzzle can be solved within Shefrin and Statman's (2000) behavioral portfolio theory.

Campbell, Lettau, Malkiel, and Xu (2001) studied U.S. stocks and found

> a clear tendency for correlations among individual stocks to decline over time. Correlations based on five years of monthly data decline from 0.28 in the early 1960s to 0.08 in 1997. . . . (p. 23)

They stated that "[d]eclining correlations among stocks imply that the benefits of portfolio diversification have increased over time" (p. 25). They cited a conventional rule of thumb, supported by the results of Bloomfield, Leftwich, and Long (1977), that a large portion of the total benefits of equity diversification is obtained with a portfolio of 20 stocks.

Despite these findings, actual levels of equity diversification were much lower than 20 stocks in 1977 and remain so today. Goetzmann and Kumar (2001), in a study of more than 40,000 stock accounts at a brokerage firm, found that the mean number of stocks in a portfolio in the 1991–96 period was four and the median number was three. Polkovnichenko (2003) found in a survey of 14 million households in 1998 that they were holding portfolios of one to five stocks. These numbers are little changed from the 3.41 average number of stocks in portfolios reported in 1967 by the Federal Reserve Board (see Blume, Crockett, and Friend 1974).

Large holdings of company (employer) stock in 401(k) accounts add to the diversification puzzle. Benartzi (2001) found that company stock constitutes a large portion of 401(k) portfolios, and Meulbroek (2002) estimated that incomplete diversification because of large allocations to company stock imposes the equivalent of a 42 percent loss of the money invested in such portfolios.

Another piece of the puzzle is the concentration of portfolios in particular styles, such as large-capitalization stock, or locations, such as a bias on the part of U.S. investors for U.S. stocks. Such concentrated portfolios forgo the benefits of broad diversification.

The view of investors in behavioral portfolio theory (Shefrin and Statman; Statman 2002) is different from the view of investors in mean–variance portfolio theory. Whereas “mean–variance investors” consider their portfolios as a whole and are always risk averse, “behavioral investors” do not consider their portfolios as a whole and are not always risk averse. In the simple version of behavioral portfolio theory, investors divide their money into two layers of a portfolio pyramid, a downside-protection layer designed to protect them from poverty and an upside-potential layer designed to make them rich. In the complete version of the theory, investors divide their money into many layers—each of which corresponds to a goal or aspiration.

The view of portfolios as pyramids of assets is part of common investment advice. For example, consider the investment pyramid that the mutual fund company Putnam Investments (available at www.putnam.com) prescribes for its investors presented in Figure 1. In the Putnam pyramid, income funds are placed at the bottom because they are designed to provide a regular stream of income and growth funds are placed at the top of the pyramid because they are intended to help build the value of the investment over time.

The pyramid structure of behavioral portfolios is also reflected in the upside-potential and downside-protection layers of “core and satellite” portfolios. Pietranico and Riepe (2002) described Charles Schwab and Company’s version of core and satellite (called “Core and Explore”) as comprising a well-diversified Core to serve as the “foundation” layer of the portfolio and a less-diversified Explore layer to seek “returns that are higher than the overall market, which entails greater risk.”

One might argue that although the portfolios are described as layered pyramids, which is consistent with behavioral portfolio theory, investors actually consider them as a whole, which is consistent with mean–variance portfolio theory. But such an argument is not supported by the evidence. Consider, for example, Question 13 in the Asset Allocation Planner of Fidelity Investments (2003):

> If you could increase you chances of improving your returns by taking more risk, would you:
>
> 1. Be willing to take a *lot* more risk with *all* your money?
> 2. Be willing to take a *lot* more risk with *some* of your money?
> 3. Be willing to take a *little* more risk with *all* your money.
> 4. Be willing to take a *little* more risk with *some* of your money?
> 5. Be unlikely to take much more risk?

Answers 1 and 3 make sense within the mean–variance framework. In that framework, only the risk of the overall portfolio (i.e., *all* the money and changing risk) matters. But Answers 2 and 4 make no sense within the mean–variance framework because they assume a segmentation of the portfolio into layers depending on where investors are willing to take more or less risk with *some* of their money. Mean–variance investors have a single attitude toward risk, not a set of attitudes layer by layer. Behavioral investors have many attitudes toward risk, so they might be willing to take a lot more risk with some of their money.

I argue, consistent with behavioral portfolio theory, that investors consider the individual stocks they hold as part of the upside-potential layer of their portfolios and are willing to forgo the benefits of diversification in an attempt to reach their aspirations. The desire of investors to attain their upside-potential aspirations leads them to take higher risks in these layers than they take in the downside-protection layers. For example, their aspirations lead investors to buy aggressive growth funds, individual stocks, and call options, all of which have positive expected returns accompanying their high risks. Moreover, at the extreme, the desire of investors to reach their aspirations leads them to buy lottery tickets and participate in other gambles that have negative expected returns.

Investors do not gamble because they seek risk. Rather, they gamble because they badly want to reach their aspirations. Some gamblers, thinking that they have positive expected returns, misjudge the odds of their gambles, but other gamblers know the odds and gamble nevertheless because gambles with negative expected returns offer them the only chance to reach their aspirations. In that behavior, they are similar to the Dubins and Savage (1976) investor who is in a casino with $1,000 and desperately aspires to have $10,000 by morning. The “optimal portfolio” for this investor is concentrated in a single gamble, one that offers a chance, however small, of winning $10,000. Investors who diversify their gambles are less likely to succeed than the investor who concentrates them because diversification provides virtually no chance of winning the aspired $10,000.

Mangalindan (2002) related the story of David Callisch, a man with an undiversified portfolio. When Callisch joined Alteon WebSystems in 1997, he asked his wife to give him four years and they would score big. His bet seemed to pay off when Alteon went public. By 2000, Callisch's Alteon shares were worth $10 million. Mangalindan writes,

> He remembers making plans to retire, to go back to school, to spend time with his three sons. His relatives, his colleagues, his broker all told him to diversify his holdings. He didn't. (p. C1)

And by 2002. his shares were worth a small fraction of their 2000 value.

Callisch's aspirations are shared by the many who gamble on individual stocks and lottery tickets. Most lose, but some win. Brenner and Brenner (1990) quoted a lottery winner, a clerk in the New York subway system, as follows:

> I was able to retire from my job after 31 years. My wife was able to quit her job and stay home to raise our daughter. We are able to travel whenever we want to. We were able to buy a co-op, which before we could not afford. (p. 43)

The journey to Shefrin and Statman's (2000) behavioral portfolio theory commenced more than 50 years ago when Friedman and Savage (1948) noted that risk aversion and risk seeking share roles in our behavior; that is, people who buy insurance policies often also buy lottery tickets. Four years after that beginning, Markowitz (1952a, 1952b) wrote two papers, in one of which he extended Friedman and Savage's insurance–lottery framework and in the other, he created the mean–variance framework.

People in the mean–variance framework, unlike people in the insurance–lottery framework, never buy lottery tickets; they are always risk averse, never risk seeking. Risk-averse people can be expected to buy insurance policies whereas risk-seeking people can be expected to buy lottery tickets. But why would people buy both? Friedman and Savage theorized that people buy lottery tickets because they aspire to reach the riches of higher social classes whereas they buy insurance as protection against a fall into the poverty of lower social classes.

Markowitz (1952a) clarified the Friedman–Savage framework by noting that people in all sorts of social classes aspire to move up from their current class. So, people with $10,000 might accept lotterylike odds in the hope of winning $1 million, and people with $1 million might accept lotterylike odds in the hope of winning $100 million.

Kahneman and Tversky (1979) extended these ideas into prospect theory. In prospect theory, people accept lotterylike odds when the people are below their levels of aspiration but they reject such odds when they are above their levels of aspiration.

The framework developed by Friedman and Savage, Markowitz (1952a), and Kahneman and Tversky is a keystone in Shefrin and Statman's (2000) behavioral portfolio theory. In this theory, people act as if they are composed of several "doers," each with a different goal and attitude toward risk. In the simple version of the theory, a person is two doers—a downside-protection doer whose goal is to avoid poverty and an upside-potential doer whose goal is a shot at riches. Lottery tickets are best for upside-potential doers with high aspiration levels and little money. Upside-potential doers with lower aspiration levels can meet their needs through call options, and those with even lower aspiration levels can buy stocks.

Mean–Variance Diversification

In mean–variance portfolio theory, the optimal level of diversification is determined by marginal analysis; that is, diversification should be increased as long as its marginal benefits exceed its marginal costs. The benefits of diversification in mean–variance portfolio theory are in the reduction of risk; the costs are transaction and holding costs. Risk is measured by the standard deviation of portfolio returns.

Declining correlations increase the marginal benefits of diversification; Campbell et al. estimated that 50 stocks were required in the 1986–97 period to reduce the excess standard deviation of portfolios to levels achieved by 20 stocks in the 1963–85 period. The questions are: Was a 20-stock portfolio the optimal portfolio in the early periods? And is a 50-stock portfolio optimal today?

In a 1987 paper, I compared the costs and benefits of diversification by using data available in the mid-1980s and concluded that at least 30 stocks were required for an optimally diversified portfolio. Investors could have diversified into 500 stocks by holding a mutual fund, such as the Vanguard 500 Index Fund, at an annual cost (at the time) of 0.49 percent. I calculated the benefit of increasing diversification from 30 to 500 stocks by comparing the expected return of a 30-stock portfolio with the expected return of a 500-stock portfolio that was levered so that its expected standard deviation was equal to the expected standard deviation of the 30-stock portfolio. That benefit is 0.52 percent, so increasing diversification from 30 stocks to 500 stocks is worthwhile because the 0.52 percent benefit exceeds the 0.49 percent cost of the Vanguard Index 500 Fund. The advantage of a levered 500-stock portfolio over a 30-stock portfolio is even greater once the costs of buying and holding a portfolio of individual stocks is considered. For example, more than 100 stocks would be required to exceed the risk reduction benefits of a levered 500-stock portfolio if the annualized cost of buying and holding a portfolio of individual stocks is 0.35 percent.

The expected standard deviation declines as portfolios become increasingly diversified. For example, if the correlation between stocks is 0.08, the standard deviation of a 20-stock portfolio is only 35 percent of the standard deviation of a 1-stock portfolio. Figure 2 shows the decline in standard deviation (as calculated by Equation 2) as the number of stocks in the portfolio increases. Note that a 20-stock portfolio is not necessarily optimal however, even if it attains a large fraction of the total benefits of diversification. The optimal level of diversification depends on expected correlations among individual stocks, the cost of buying and holding stocks and mutual funds, and the expected equity premium. They have all changed.

The expected correlation I used (Statman 1987), which was implied in the data of Elton and Gruber (1984 p.35) was 0.15. The more recent figure, according to Campbell et al., is 0.08.

The current expense ratio of the Vanguard Total Stock Market Index Fund (Total Market Fund), a fund that did not exist in the mid-1980s, is 0.20 percent, lower than the mid-1980s expense ratio of the Vanguard Index 500 Fund.[1] Yet, the Vanguard Total Market Fund contained 3,444 stocks in March 2002, many more than the 500 stocks of the Vanguard Index 500 Fund.

The equity premium in the mid-1980s based on realized returns for 1926–1984 was estimated to be 8.2 percent. The equity premium based on realized returns for the 1926–2001 period was 8.79 percent. Today, there is little agreement that 8.79 percent is a fair estimate of the *expected* equity premium. Fama and French (2002) estimated the expected equity premium based on P/Es and based on dividend yield. The average of the two is 3.44 percent.

To estimate the optimal level of diversification in mean–variance terms one begins with the equation for the standard deviation of a portfolio of n stocks:

$$\sigma_n = \sqrt{\sum_{j=1}^{n}\sum_{i=1}^{n} w_i w_j cov(r_i, r_j)} \tag{1}$$

[1]The actual mean annual cost of the Vanguard Total Stock Market Index Fund was lower than 0.20 percent in the 1997–2001 period. Indeed, the mean annual return of the fund was higher by 0.06 percent than the mean annual return of the Wilshire 500 Index, which it tracks. Such

where w_i and w_j are the weights of stocks i and j in the portfolio and $\mathrm{cov}(r_i,r_j)$ is the covariance between the returns of stocks i and j.

Consider, for simplicity, the case in which the standard deviation, σ, of each of the n stocks is identical; where all correlations, ρ, between pairs of stocks are identical; and where the weight of each of the n stocks is the same. In this case,

$$\begin{aligned}\sigma_n &= \sqrt{n(1/n)^2\sigma^2 + \left(n^2 - n\right)(1/n)^2\sigma^2\rho} \\ &= \sigma\sqrt{(1/n) + [(n-1)/n]\rho}.\end{aligned} \tag{2}$$

Now assume that all the stocks have the same expected return, R, which is equal to the sum of the risk-free rate, R_f, plus the equity premium, EP, and investors can borrow and lend at the risk-free rate. Compare a portfolio of n stocks with a portfolio with a larger number of stocks, m. Set m to be 3,444, the number of stocks in the Vanguard Total Market Fund. Assume that investors borrow at the risk-free rate to lever the m-stock "Total Market" portfolio on the Total Market line in Figure 3. [Please note that much of the text on Figure 3 has been moved to the notes. You will receive a redrawn figure, but please check the notes.] The expected standard deviation of the levered m-stock portfolio is equal to σ_n, the expected standard deviation of an n-stock portfolio. Thus, the expected return of the levered m-stock portfolio is

$$R_{nm} = R_f + \frac{\sigma_n}{\sigma_m}EP, \tag{3}$$

where σ_m is the expected standard deviation of the m-stock portfolio.

The difference between the expected return of the n-stock portfolio, R, and the expected return of its corresponding levered m-stock portfolio, R_{nm}, is

good fortune is not guaranteed, however, to continue. I assumed that the expected annual cost of this Vanguard fund is 0.20 percent.

the benefit of increased diversification from n to m stocks, B_{nm}, expressed in units of expected return as

$$\begin{aligned} B_{nm} &= R_{nm} - R \\ &= \left(R_f + \frac{\sigma_n}{\sigma_m} EP \right) - \left(R_f + EF \right) \\ &= \left(\frac{\sigma_n}{\sigma_m} - 1 \right) EP \\ &= \left\{ \frac{(1/n) + [(n-1)/n]\rho}{(1/m) + [(m-1)/m]\rho} - 1 \right\} EP. \end{aligned} \tag{4}$$

Consider the case in which the expected correlation between any pair of stocks is 0.08, which is the estimate by Campbell et al. For 1997, and the expected equity premium is 8.79 percent, which is the mean realized equity premium for 1926–2001. Using Equation 2 to compare a portfolio of n = 20 stocks with the Total Market portfolio of m = 3,444 stocks produces a standard deviation of returns for the portfolio of 20 stocks of

$$\begin{aligned} \sigma_{20} &= \sigma \sqrt{\frac{1}{20} + \frac{20-1}{20} \times 0.08} \\ &= 0.355\sigma, \end{aligned} \tag{5}$$

and a standard deviation for the portfolio of 3,444 stocks of

$$\begin{aligned} \sigma_{3,444} &= \sigma \sqrt{\frac{1}{3,444} + \frac{3,444-1}{3,444} \times 0.08} \\ &= 0.283\sigma. \end{aligned} \tag{6}$$

Table 1 and Figure 3 show that the benefit of increasing diversification from a 20-stock portfolio to a 3,444-stock portfolio is equal to 2.22% percentage points in extra return. This benefit is calculated from Equation 4 as follows:

$$B_{20,3444} = \left(R_f + \frac{0.355\sigma}{0.283\sigma} 8.79\%\right) - \left(R_f + 8.79\%\right) \\ = 2.22\%. \tag{7}$$

Now the question is: What is the cost of the increased diversification to obtain that benefit? The expected gross annual cost of increasing diversification from 20 stocks to 3,444 using the Vanguard Total Market Fund is 0.20 percent, the expense ratio of the fund, but the net cost in relation to a portfolio of 20 individual stocks is smaller than 0.20 percent because a portfolio of 20 individual stocks involves transaction and holding costs. Although the cost of buying individual stocks may be incurred only once and stocks can be held for decades, additional costs are likely because portfolios must be revamped when some companies merge and other companies go bankrupt. Moreover, costs are associated with keeping track of individual stocks. For example, consider a stock portfolio worth $13,869, the median value of portfolios studied by Goetzman and Kumar. An investor who each year engages in a single round-trip costing a total of $20 would incur transaction costs exceeding 0.14 percent of the value of the portfolio. Indeed, it is hard to imagine a portfolio of individual stocks with a lower annual cost than the 0.20 percent annual cost of the total market portfolio.

Still, if 0.14 percent is accepted as a conservative estimate of the expected annual costs of buying and holding portfolios of individual stocks, the net cost of increasing diversification from 20 (or any other number of individual stocks) to 3,444 stocks through the Vanguard Total Market Fund is 0.06 percent, the difference between the 0.20 percent cost of the Total Market Fund and the 0.14 percent cost of buying and holding a portfolio of individual stocks.

Table 1 and Figure 4 show that with an equity risk premium of 8.79 percent and a correlation between any two stocks of 0.08, the optimal level of diversification is 700 stocks. The risk reduction benefit of increasing diversification beyond 700 stocks to 3,444 is only 0.06 percent, equal to the

0.06 percent net cost of replacing a 700-stock portfolio with the Total Market Fund.

The benefits of diversification decrease when the equity premium decreases. For example, Figure 4 shows that the optimal level of diversification declines to 300 stocks when the correlation remains at 0.08 but the expected equity premium declines from 8.79 percent to 3.44 percent. Similarly, the benefits of diversification fall when the correlation rises. The optimal level of diversification declines from 300 stocks to 70 stocks when the equity premium is 3.44 percent but the correlation increases from 0.08 to 0.28. (The 0.28 figure is equal to the estimate made by Campbell et al. of the correlation in the early 1960s.)

A conservative estimate of the current optimal level for diversification in mean–variance portfolio theory, based on the 3.44 percent Fama and French estimate of the equity premium and the 0.08 Campbell et al. estimate of the recent correlation among U.S. stocks, is 300 stocks. This estimate is much higher than the rule of thumb reported by Campbell et al., in which 20 stocks make a diversified portfolio, or the Rule of Five (holding no fewer than five stocks) advocated by the National Association of Investment Clubs (Wasik 1995). Nevertheless, the average number of stocks held in actual portfolios is lower than the number of stocks advocated in any diversification rules of thumb.

Behavioral Diversification

Although lack of diversification is a puzzle to mean–variance portfolio theorists, it is a main feature of behavioral portfolio theory. Polkovnichenko found in simulations of behavioral portfolio theory that optimal behavioral portfolios include an allocation of 15–50 percent to a single stock.

Investors want more than protection from poverty, they want to riches as well. They construct their portfolios as layered pyramids with bonds in the bottom layer for protection from poverty, stock mutual funds in the middle layer for moderate riches and individual stocks and lottery tickets in the top layer for great riches.

People who hold undiversified portfolios, like people who buy lottery tickets, are gambling; they are accepting high risks without compensation in the form of high expected returns. Although gambling behavior is usually recognized as inconsistent with mean–variance portfolio theory, it is often dismissed as no more than a minor irritant to the theory—something people do for "entertainment" with minor amounts of "play money."

But gambling behavior should be considered a major puzzle to mean–variance portfolio theory because it consumes major amounts of investor money. Goetzmann and Kumar found that, on average, the value of investors' undiversified stock portfolios was 79 percent of their annual income; Polkovnichenko found that, on average, the value of investors' undiversified stock portfolios was 15–33 percent of households' total financial wealth; and Moskowitz and Vissing-Jorgensen (2002) found that equity in privately held companies was more than 70 percent in the portfolios of entrepreneurs, even though the average return on private equity in these undiversified portfolios was no higher than the average return of a diversified portfolio of public equity.

Gamblers are often derided as mathematically challenged risk seekers who are overly optimistic about their odds and overly eager to take risks. The same might be said about undiversified investors. But what is motivating the behavior of both gamblers and undiversified investors is aspirations, not cognitive errors in mathematics or risk seeking. As Friedman and Savage wrote, "Men will and do take great risks to distinguish themselves, even when they know what the risks are" (p. 299). People gamble and hold undiversified portfolios because these activities are often their only ways to move from working class to middle class or from middle class to upper class. *Gambling in America* (1976, p. 82) reported that when gamblers and nongamblers were asked to rate their need for "chances to get ahead" on a scale from a low of 1 to a high of 8, the mean score of the gamblers was 5.35 whereas the mean score for the nongamblers was 4.69.

Undiversified portfolios offer people with high aspirations a better chance to get ahead than do diversified portfolios. Consider simulations with the stocks of the S&P 500 Index during the 22 years from 1980 through 2001. Investors with $1,000 in five-stock portfolios randomly selected at the beginning of each year since 1980 would have had a 10 percent chance to accumulate $45,669 or more by the end of 2001. The corresponding number for investors with more diversified, 50-stock portfolios was only $32,108.

Investors with undiversified portfolios may indeed have a higher tolerance for risk than those with diversified portfolios. Gentry and Hubbard (2001) compared the composition of portfolios of entrepreneurs with those of nonentrepreneurs and found the investments of entrepreneurs outside their enterprises to be no more conservative than the overall portfolios of nonentrepreneurs. This finding may indicate that entrepreneurs have a higher tolerance for risk, but it may mean that entrepreneurs and other undiversified investors allocate more to the upside-potential layers of their portfolios because they already have substantial downside-protection layers. For example, Heaton and Lucas (2001) pointed out that the entrepreneurs' enterprises bring them substantial income, which may fill the entrepreneurs' downside-protection layer. Similarly, *Gambling in America* reported that gamblers were "more likely to have their future secured by social security and pension plans than non-gamblers and hold 60 percent more assets. . . ." (p. 66). And Harrah's *Profile of the American Casino Gambler* (2003) reported that gamblers have higher incomes, on average, than the general population and that when gamblers are away from casinos, they are more risk averse than the general population. For example, 50 percent of gamblers save in retirement plans compared with 40 percent of the general population and 61 percent of gamblers always or almost always pay off their credit cards in full every month, compared with 52 percent of the general population.

The story of Ashley Revell illustrates the survey findings. Reuters (2004) reported that Mr. Revell, a 32-year Londoner, sold all his possessions, including his clothes, and bet it all on red at a roulette table in Las Vegas. Mr.

Revell surely placed much emphasis on the upside potential layer of his portfolio pyramid, but he had a downside protection layer as well, consisting of family and human capital. “I knew even if I lost I’d always have a home to go to,” he said and added that he decided to take his big plunge while he was still young. As luck would have it Mr. Revell won, walking away from the casino with $270,600.

Investors with undiversified portfolios may be overestimating the expected returns of their undiversified portfolios or underestimating the risks of their own portfolios. Fisher and Statman (2002) found that investors are overly optimistic about their returns. The authors reported, based on Gallup surveys, that investors expect higher returns from their own portfolios than from the stock market as a whole. Similarly, Benartzi found that participants in 401(k) programs concentrate their portfolios in the stocks of their employers, thus overestimating the expected returns from these stocks and underestimating their risk. In particular, Benartzi found that only 16.4 percent of respondents in his survey realized that a portfolio concentrated in company stock is riskier than a portfolio diversified into the overall stock market.

The description of individual stocks as individual casino bets or lottery tickets does not imply that investors choose their stocks randomly, as they might choose roulette colors or lottery numbers. Rather, investors tend to choose stocks of companies they are familiar with, echoing the common recommendation to “invest in what you know”. Indeed, many casino bettors and lottery buyers follow the same recommendation by betting on favorite colors at the roulette table or choosing lottery tickets with numbers that correspond to their children’s birthdays.

There is some evidence that familiarity does increase the odds of winning. For example, Massa and Simonov (2003) and Bodnaruk (2003) found that investors had higher returns with stocks selected from their geographical vicinity than with other stocks. However, he overall evidence of investor ability to pick good stocks is discouraging. Benartzi found that high allocations to company stocks increase portfolio risk but that extra risk is not rewarded by extra return; company stocks do not perform better, on average, than other stocks. Barber and Odean (2000) found that, on average, returns going to investors who pick individual stocks and trade them infrequently trail the market. Those who pick individual stocks and trade frequently trail the market by even more.[2]

Skill in stock selection can overcome the disadvantage of limited diversification. For example, Table 1 and Figure 3 show that the gross benefit from increasing diversification from 20 stocks to 3,444 stocks is 2.22 percent if the correlation is 0.08 and the equity premium is 8.79 percent. The net benefit of increasing diversification when the 0.06 percent net cost of the Vanguard Total Market Fund is subtracted is 2.16 percent. So, investors who can beat the market by more than 2.16 percentage points a year overcome the disadvantage of 20-stock diversification.

In summary, in behavioral theory, investors do not diversify fully because diversified portfolios leave them with too little hope of reaching their upside-potential aspirations. Behavioral investors place great importance on the upside-potential layers in their portfolios, but at the same time, they do not neglect the downside-protection layers. Indeed, behavioral investors establish downside-protection layers of their portfolios while holding only an undiversified handful of stocks in the upside-potential layers.

Conclusion

The benefits and costs of diversification under the rules of mean–variance portfolio theory are different from those under the rules of behavioral portfolio theory. Reduction of risk is always a benefit in mean–variance portfolio theory. The optimal number of stocks in a portfolio is at least 300 because the benefits of diversification at this level of diversification exceed their costs.But reduction of risk is not always a benefit in behavioral portfolio theory.

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[2]Massa and Simonov (2003) and Bodnaruk (2003) found, however, that familiarity improved the odds of selecting winning stocks. Investors had higher returns with stocks selected from their geographical vicinity than with other stocks.

Why do investors forgo the benefits of diversification? Goetzmann and Kumar argued that investors forgo the benefits of diversification because diversified portfolios are difficult to implement. They wrote that "investors realize the benefits of diversification but face a daunting task of implementing and maintaining a well-diversified portfolio" (p. 20). But this cannot be true. Index funds provide an easy way to implement and maintain well-diversified portfolios. Such funds have been advocated for many years in newspaper and magazine articles directed at individual investors. Moreover, the minimum amount required for a Vanguard Total Market Fund account is $3,000, much lower than the $13,869 median value of the accounts studied by Goetzmann and Kumar.

Undiversified investors may be aptly described as "mathematically challenged" in the same way lottery players are often described. Good evidence indicates that undiversified investors overestimate the expected returns of their portfolios and underestimate the risks. But many lottery players understand the poor odds of gambling, and many undiversified investors understand their extra risk. Hope for riches, not risk seeking, motivates lottery players and undiversified investors.

The optimal number of individual stocks under the rules of behavioral portfolio theory is the number that balances the chance for an uplift into riches with the chance of a descent into poverty. But what is the right balance? In writing about the effects of the drop in the U.S. equity market of the early 2000s on the dreams of older Americans, Zernike (2002) described the undiversified portfolio of Gena and John Lovett, people in their late 50s, and quoted them as follows:

> "Our retirement is one-half of what it was a year ago," said Gena. "And because John works for GE we have mostly GE stock. I suppose we should have diversified, but GE stock was supposed to be wonderful. John's simply not looking at retirement. We simply told our kids that we're spending their inheritance." (p. A1)

Postponing retirement when one is in one's 50s and spending the kids inheritance are sad but not disastrous breaches of the downside-protection layer. The Lovetts are no longer rich, but neither are they poor. The consequences of undiversified portfolios can easily however, turn into disastrous ones. Replace GE in the Lovetts' experience with Enron or WorldCom and think of the consequences if no downside protection underlies the upside-potential layer in the portfolio.

The rules of optimal diversification in behavioral portfolio theory are similar to the rules of suitability that govern brokers and financial advisors. Suitability regulations require brokers to make sure that an investor's desire for upside potential does not breach the investor's need for downside protection. Roach (1978) commented on this point in quoting a U.S. SEC decision in which a broker was found liable for losses that resulted from recommending a particular stock to investors:

> "Whether or not customers Z and E considered a purchase of the stock . . . a suitable investment is not the test for determining the propriety of applicants' conduct. The test is whether [the broker] fulfilled the obligation he assumed when he undertook to counsel the customers of making only such recommendation as would be consistent with the customer's financial situation and needs. . . ." Both the NASD and the Commission here suggest that suitability is an objective concept which the broker is obliged to observe regardless of a customer's wishes. . . . The NASD's statement that the customer's 'own greed' may well have been their motivation reinforces the idea that the customer is not sovereign for suitability purposes. (p. 1126)

In short, although the rules of diversification in behavioral portfolio theory are not as precise as the rules in mean–variance portfolio theory, they are clear enough. Investors, financial advisors, and companies sponsoring

401(k) plans must be careful to draw a line between upside potential and downside protection in such a way that dreams of riches do not plunge investors into poverty.

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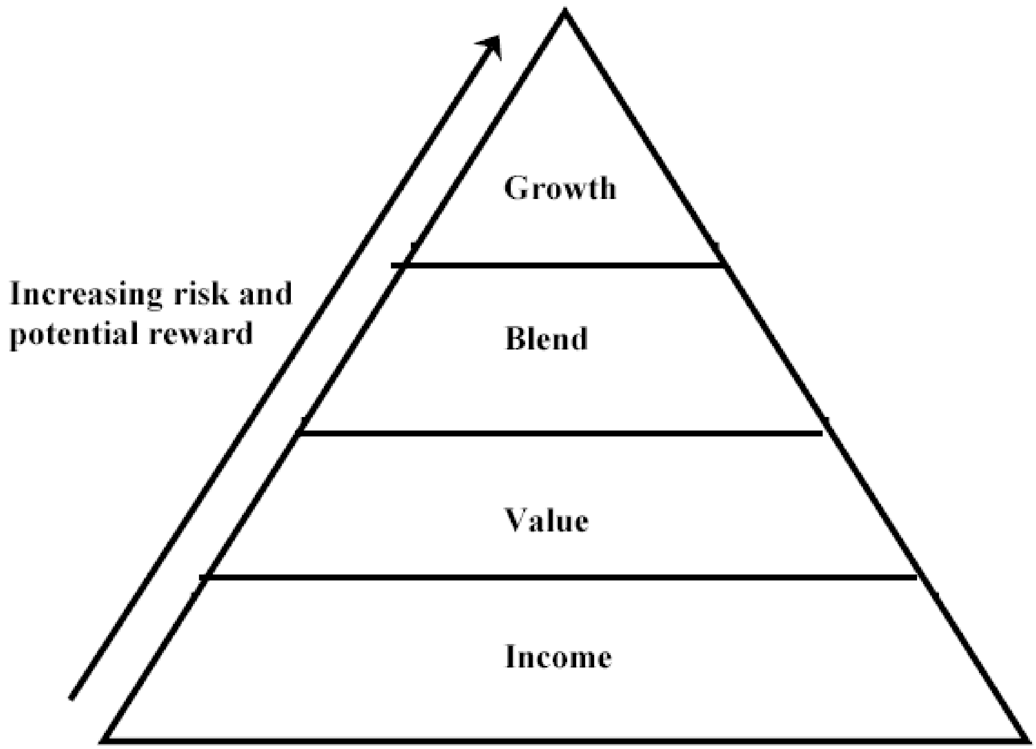
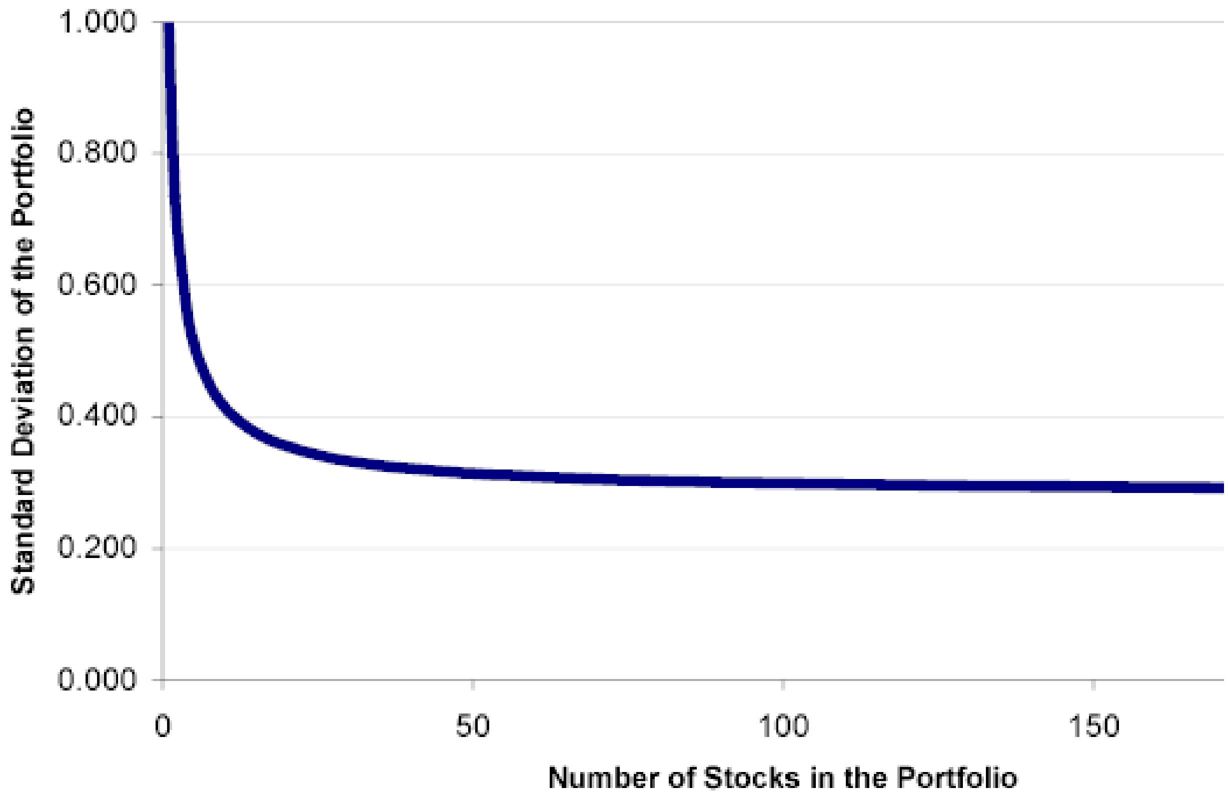
Figure 1. Portfolio as Layered Pyramid



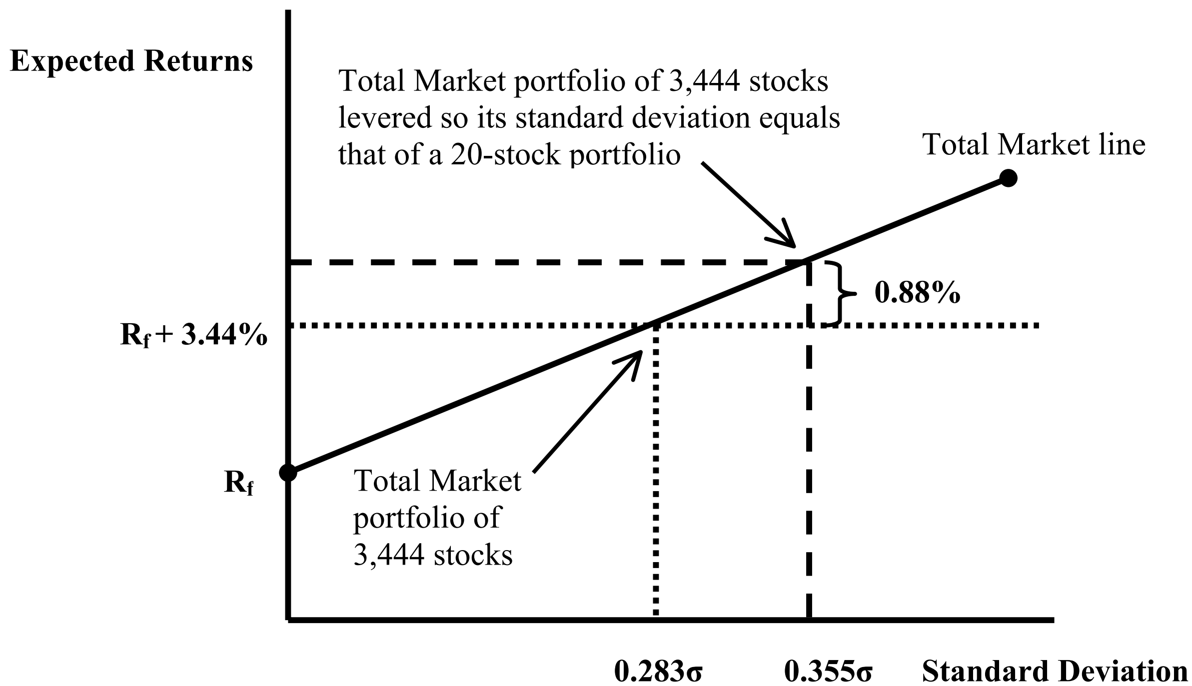
Source: Putnam Investments.

Figure 2. Decline in Standard Deviation with Increasing Diversification



Note: The correlation between the returns of any two stocks is 0.08, and the standard deviation of any stock is 1.0.

Figure 3. Levered vs. Unlevered 3,444-Stock Portfolio on the Total Market Line: Mean–Variance Theory



Notes: Standard deviations come from Equations 5 and 6; the 8.79 percent equity risk premium is the realized mean equity risk premim during 1926-2001; the benefit is calculated from Equation 7. The line beginning at L shows the return per risk to the Total Market Portfolio of 3,444 stocks *levered* to the standard deviation of a 20-stock portfolio, 0.355; that is, the return is calculated as R_f + (0.355σ/0.283σ) × 8.79%. The line beginning at U shows the return per risk to the *unlevered* Total Market Portfolio of 3,444 stocks with standard deviation of 0.283; the return is calculated as R_f + 8.79%.

Figure 4: The optimal level of diversification by the rules of mean-variance portfolio theory