Diversification of Equity Portfolio : Theory and Practice

Subrata K. Mitra[*]

1.0 Introduction

Portfolio diversification is the practice of spreading one's money among many different investments. It is a common sense concept that has many parallels in popular language and Culture (for example "Don't put all your eggs in one basket"). Its theoretical foundations were introduced in the normative work of Harry Markowitz (1952, 1959), and later confirmed by the work of William Sharpe (1964).

Despite documented benefits of diversification, many investors do not diversify their stocks in their portfolios. Average number of stock in individuals portfolio is about four. Degree of diversification depends on investors' age, education, occupation and income. Various psychological factors, such as, overconfidence, excitement, familiarity with certain stocks, gambling instinct, etc., are various reasons of not diversifying. Many believe that a few chosen stocks, like a few lottery tickets provide a chance for becoming rich but a well-diversified portfolio of stocks, like a well-diversified portfolio of lottery tickets, only give mediocre results.

2.0 Benefits of Diversification

Markowitz's initial assumption was that risk-averse, mean-variance utility agents were concerned with only two elements of their portfolios – the expected return, as measured by the mean rate of return, and the risk, as quantified by the standard deviation or variance of the mean rate of return. When risky assets are aggregated, their correlation often determines the majority of the total risk rather than individual volatilities. Consequently, the total risk of a carefully constructed portfolio should be less than the sum of the risks in the portfolio's component pieces. Markowitz thus suggested a quadratic programming algorithm to calculate the optimal combination of assets.

2.1 Naive Diversification

Although diversification has become the *'mantra'* of investment allocation decisions, in practice, it does not just blindly apply the diversification principles set forth by Markowitz. For example, very few investors effectively take correlation between stock returns into account when making complex portfolio decisions. Rather, they prefer to allocate assets using simpler rules, such as dividing allocations evenly among the assets available. This approach, also known as the "1/N heuristics" or "naive diversification", has a long history in asset allocation. A 4th century writing gave the following asset allocation advice: "A man should always place

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[*] Manager, Industrial Engineering, Industrial engineering Deptt. , Century Enka Limited. The views expressed and the approached suggested in this paper are entirely personal and not necessarily of NSE.

his money, a third into land, a third into merchandise, and keep a third on hand". Harry Markowitz reported that he used this rule himself and justified his choice on psychological grounds: "My intention was to minimize my future regret. So I split my contributions fifty-fifty between bonds and equities". Simply stated, naive diversification is a protection against ignorance. It aims to spread assets evenly in the portfolio in order to reduce overall risk, while at the same time ignoring the mathematical complexities underlying modern portfolio theory.

2.2 Optimal level of diversification

So what is the optimum level of diversification? This matter has been extensively debated in financial literature for over 30 years; see, Evans and Archer (1968), Blume and Friend (1975), Cohn, Lewellen, Lease, and Schlarbaum (1975), Elton and Gruber (1977), Kelly (1995), Guiso, Japelli, and Terlizze (1996), Bertaut (1998), Heaton and Lucas (2000), Perraudin and Sorensen (2000), Statman (1987), Statman (2002), Alok Kumar and Goetzmann (2002), among others.

Nevertheless, the definitive answer to that question has remained elusive. Even worse, several studies contradict each other. As an illustration, Evans and Archer (1968) observed that most of the effects of diversification take place with the aggregation of eight to ten securities and raised doubts about the usefulness of increasing portfolio sizes beyond that point, while Statman (2002) concluded that optimum level of diversification exceeds 120 stocks.

2.3 Factors determining benefits of diversification

The optimal level of diversification is determined by marginal analysis; 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 while the costs are transaction and holding costs. Risk is measured in the mean-variance framework by the standard deviation of portfolio returns.

The following factors come into play in determining optimum diversification level

1. Cost of maintaining a diversified portfolio

2. Correlation among individual stocks

3. Expected Equity Premium

2.3.1 Cost of maintaining a diversified portfolio

Maintenance of a diversified portfolio is difficult and costly. Collecting information, analysing them and then instantly acting on portfolio re-balancing is a full time job. Changing portfolio structure based on ever changing information also entails transaction cost.

It is very difficult for any small investors to monitor over a dozen of stocks. The ideal route for

such investors is left to investment in Mutual Funds, where professionals maintain a large number of stocks.

But such diversification do not come free of cost, Mutual fund put annual charges over and above its transaction cost. Thus cost of diversification through a mutual fund can be anything between 1% to 3% per annum. Further benefits of having a diversified portfolio by such professionals are doubtful as returns from Mutual fund generally lag the overall market return.

2.3.2   Correlation among individual stocks

It is found that correlation between stocks returns are important in determining benefits of diversification. The less the correlation between stock returns the greater is the diversification benefit. Fortunately, the correlation among stocks is declining. Campbell, Lettau, Malkiel and Xu (2000) studied U.S. stocks and found a clear tendency for correlation among individual stocks to decline over time. Correlation based on five years of monthly data decline from 0.28 in the early 1960s to 0.08 in 1997. They concluded that declining correlation among stocks imply that the benefits of portfolio diversification have increased over time.

2.3.3   Expected Equity Premium

Equity premium is elusive nowadays. S&P CNX Nifty coined in the year 1995 with a base value of 1000 is languishing at below 1000 level in March 2003. Thus the market in last 8 years did not give any return, forget returns over risk free rate of return. However there has to an '*ex- ante*' equity premium, as per CAPM, to attract risk averse investors to invest in risky securities.

Glassman and Hassett (1999) argue that stock prices would soar once people understand that the long-term risk of stocks is no higher than the long-term risk of bonds. On that day the expected return of stocks will be equal to that of bonds and the equity premium will be zero. However, financial economists doubt that the day of zero equity premiums is near. Welch (2000) surveyed 226 academic financial economists and found that they expect an arithmetic equity premium of 7% over 10 to 30-year horizon.

Benefit of diversification is directly related to Equity Premium as shown in the following chapter.

2.4 Estimating Diversification Benefits

Though it is very difficult to ascertain benefits of diversification accurately, Statman (2002) proposed following basis to arrive at a reasonable estimate.

Assume that all stocks have an identical expected return (R), an identical expected standard deviations (σ), and that each pair of stocks has an identical expected correlation (ρ). Now consider a portfolio of 'n' randomly chosen and equally weighted stocks, whose expected return is equal to R, the expected return of a single stock. The expected standard deviation of a n-stock portfolio is :

$$\sigma_n = \sigma \sqrt{(1/n + \rho(n-1)/n)} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(Eqn. 1)}$$

In the above equation the expected standard deviation of the portfolio declines when the number of stocks in the portfolio increases. Now, compare a portfolio of 'n' stocks to a portfolio with a larger number of 'm' stocks. If investors can borrow and lend at a common rate of R_f, they can lever a portfolio of m stocks such that the expected standard deviation of the levered m-stock portfolio is equal to σ_n, the expected standard deviation of an n-stock portfolio. The expected return of the levered m-stock portfolio is:

$$R_{nm} = R_f + (\sigma_n / \sigma_m)\, EP \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(Eqn. 2)}$$

Where σ_m is the expected standard deviation of an m-stock portfolio, and EP, the expected equity premium, is the difference between R and R_f. The difference between the expected return of its corresponding levered m-stock portfolio (R_{nm}) and the expected return of an n-stock portfolio (R) is the benefit of increased diversification from n to m stocks (B_{nm}). It can be expressed as follows.

$$B_{nm} \qquad = R_{nm} - R$$

$$= [R_f + (\sigma_n / \sigma_m)EP] - [R_f + EP]$$

$$= (\sigma_n/\sigma_m - 1)\, EP$$

$$= [\sqrt{((1/n + \rho(n-1)/n)/(1/m + \rho(m-1)/m))}]\, EP \dots\dots\dots \text{(Eqn. 3)}$$

This formula reasonably captures the effect of correlation and Equity Premium in estimating benefits of diversification from 'n' stocks to 'm' stocks. We have used the formula to compare the benefits of diversification simulating following choices.

Parameter	Choice of parameter values*
No. of Shares in the Portfolio	4, 10, 20, 30, 50, 100, . . , 500
Extra cost of diversification (over 4 stock portfolio)	< 20 stock portfolio 0.5% 20 to 50 stock portfolio 1.0% > 50 stock portfolio 1.5%
Expected Equity Premium	2%, 5% and 10%
Correlation between any two pair of stocks	0.1% and 0.2%

*The choices are arbitrary and used for broad comparison only.

The benefits of diversification with above choices are given in Table-1 and Table-2 and graphically represented in Chart-1 and Chart-2. The benefits of diversification are calculated over 4-stock portfolio as majority of investors, as per Kumar and Goetzmann (2002), hold about 4 stocks. The charts show that investors could possibly get more benefit by increasing diversification.

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It is also seen in the charts that the incremental benefits of diversification decreases as number of stock in the portfolio increases. Whereas cost of diversification increases with increase in number of stocks. If the benefit of increased diversification is less than cost of increased diversification, the increased diversification is no longer profitable. The investor can make appropriate trade off to select number of stocks depending on his cost of diversification.

Table 1
Benefit of Diversification over 4-stock Portfolio
when Correlation between stocks is 0.1

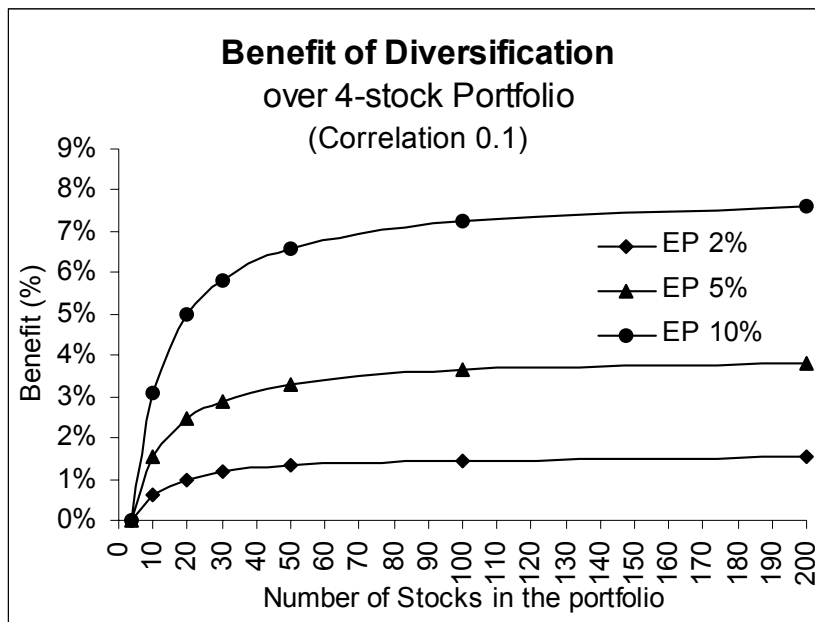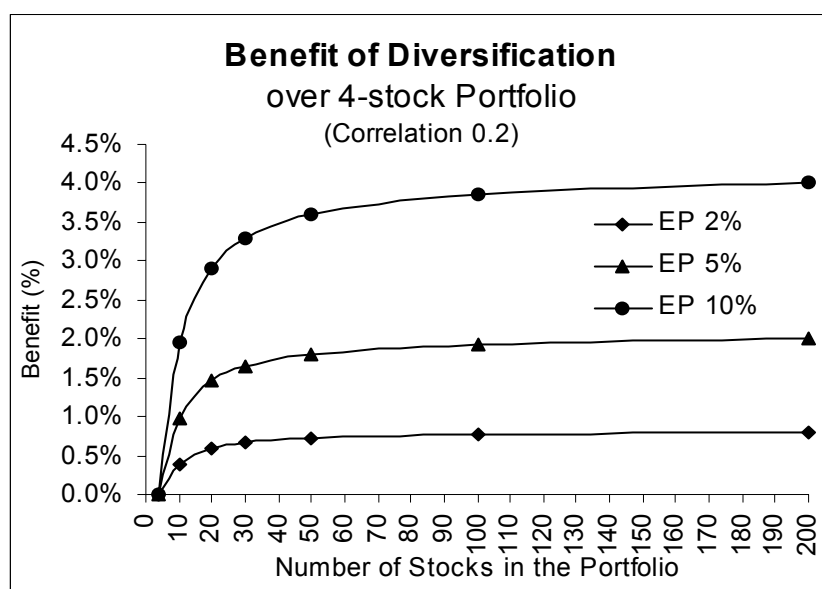| No of stock in Portfolio	Expected Equity Premium		
	2%	5%	10%
4	0.0%	0.0%	0.0%
10	0.6%	1.5%	3.1%
20	1.0%	2.5%	5.0%
30	1.2%	2.9%	5.8%
50	1.3%	3.3%	6.6%
100	1.5%	3.6%	7.3%
200	1.5%	3.8%	7.6%
500	1.6%	3.9%	7.9%
1000	1.6%	4.0%	7.9%

Chart 1

Table 2
Benefit of Diversification over 4-stock Portfolio
when Correlation between stocks is 0.2

No of stock in Portfolio	Correlation = 0.2		
	Expected Equity Premium		
	2%	5%	10%
4	0.0%	0.0%	0.0%
10	0.4%	1.0%	2.0%
20	0.6%	1.5%	2.9%
30	0.7%	1.6%	3.3%
50	0.7%	1.8%	3.6%
100	0.8%	1.9%	3.9%
200	0.8%	2.0%	4.0%
500	0.8%	2.0%	4.1%
1000	0.8%	2.1%	4.1%

Chart 2

Benefit of Diversification over 4-stock Portfolio (Correlation 0.2)

3.0 Diversification in Practice

Inspite of proven benefits of diversification degree of diversification among investors are low. Blume and Friend (1975) investigated diversification in household portfolios and found that the household portfolios are grossly under-diversified. In another study, Cohn, Lewellen, Lease, and Schlarbaum (1975) found that as wealth increases, a higher proportion of the total wealth is allocated to risky assets and investors exhibit decreasing relative risk aversion.

Kelly (1995) examined equity portfolio diversification among households in the U.S. Using data from the 1983 Survey of Consumer Finances, he documented poor diversification among households. He

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found that the median number of stocks in an investor portfolio is only two and less than one third of the households hold more than ten stocks. Several studies e.g. Guiso, Japelli, and Terlizze (1996), Bertaut (1998), Heaton and Lucas (2000), Perraudin and Sorensen (2000), etc., have documented poor diversification by individual investors.

Kumar and Goetzmann (2002) examined the portfolios of more than 40,000 equity investment accounts from a large discount brokerage during a six-year period (1991-96). Using the historical performance for the equities in these accounts, they estimated the volatility and risk characteristics of their portfolios. They also found that a vast majority of investors in the sample were under-diversified. More than 25% of investor portfolios contained only 1 stock, more than 50% of them contained fewer than 3 stocks, and in any given monthly time-period, only 5-10% of the portfolios contained more than 10 stocks. Consequently, investor portfolios had extremely high volatility (more than 75% of investor portfolios had higher volatility than the market portfolio) and they exhibited even worse risk-return trade-off than randomly constructed portfolios.

4.0 Diversification and Demographics

Various studies, e.g., Cohn, Lewellen, Lease, and Schlarbaum (1975), Kelly (1995) , Guiso, Japelli, and Terlizze (1996), Bertaut (1998), Statman (2002), Kumar and Goetzmann (2002), among others have examined relation between investors' age, wealth and education level on their portfolio diversification.

4.1 Age

Degree of diversification is higher for old investors than for young ones as older people are supposed to be more mature and risk averse. Kumar and Goetzmann (2002) found a strong positive relation between age and the degree of diversification. They investigated the relation between age and the frequency of trading. Younger investors may be less diversified because of their higher degree of over-confidence. It was found that the trading frequency decreases with age. The portfolio turnover rate was 6.82% for the bottom age decile (age between 26-36) and 5.02% for the top age decile (age between 70-82). The difference between the turnover distributions of the two groups were statistically significant (p-value < 0.01). This suggests that young, active investors are over-focused and hold concentrated and under-diversified portfolios.

4.2 Education

It is found that proportion of investors with undiversified portfolio is higher among persons having low education level. Clotfelter and Cook (1989) found that the proportion of risky investment is higher among those with low levels of education than among people with high levels. While 49% of those with less than high school education gambled during the week of the survey, only 30% of college graduates did.

4.3 Occupation

Kumar and Goetzmann (2002) found that the non-professional category holds the least diversified portfolios while investors in the retired category fall on the other end of the diversification spectrum. For example, during the 1994-96 sub-period, investors in the non-professional category hold 4.56 stocks (the average normalized variance is 0.356) on average while investors in the retired category hold 6.89 stocks (the average normalized variance is 0.302). Using the Kolmogorov-Smirnov test they found that the distributions of diversification measures for non-professional and retired categories were significantly different from one other (p-value < 0.01). The average diversification level of investor portfolios in the professional category falls in between the average diversification level of non-professional and retired categories and again, the differences in diversification measure distributions are statistically significant (p-value < 0.01).

4.4 Income

It is also found that those with higher incomes held more diversified portfolios in comparison to those with low incomes. While Clotfelter and Cook (1989) found that people with low income spent higher proportions of their income on risky investments than people with high income. Kumar and Goetzmann (2002) observed that investors in the low income category hold on average of 4.71 stocks while the average number of stocks held by investors in the high income category is 5.84. Using the Kolmogorov-Smirnov test they that portfolio diversification of low income and high income categories are significantly different from each other (p-val < 0.01).

5.0 Diversification and Performance

Benefits of diversification are well proven. Several academic studied have documented that risk adjusted return improves with degree of diversification. It can be found from Chart -1 and Chart –2 that benefit of diversification is upward sloping curve near the origin. Till the curve flattens, benefit can be derived by more diversification. Kumar and Goetzmann (2002) found that there is a strong positive relation between the degree of diversification and portfolio performance. Better-diversified portfolios earn higher risk-adjusted returns. For instance, in the 1994- 96 sub-period, the average Sharpe Ratio for 2-stock portfolios is 0.34 while portfolios with 15 or more stocks, on average, earn a Sharpe ratio of 0.56. For robustness, they split the sample into two 3-year sub-periods and compute Sharpe Ratio separately for each of the two sub-periods. They found presence of strong positive relation between diversification and performance in each of the two 3-year sub-periods. There was also an improvement in risk-adjusted performance over time. Sharpe ratio during the second 3-year sub-period (1994-96) is considerably higher than the Sharpe ratio during the first 3-year sub-period (1991-93).

Overall, the results suggested that better diversification translates into better risk-adjusted performance and investors may be able to achieve these levels of risk-adjusted performance by simply investing in one of the many available index funds.

6.0 Why Investors Don't Diversify?

Diversification is easier to preach than to practice. From a small investors standpoint, keeping track of a huge number of stocks, monitoring trends and correlation, and finally rebalancing portfolio after every major market moves is not an easy task. It is always easier to track prices of select favorites than getting lost in the market. Merton (1987) suggests that due to search and monitoring costs investors may limit the number of stocks in their portfolios.

Mutual fund may be easy alternative, but past results of most of the funds including the giant US-64 are not encouraging. No investor likes to burn his hard-earned money on the hand of others. If risks are to be taken, take it on your own and enjoy the thrill. Investors may also develop a false perception that they can manage their portfolio risks by a thorough understanding of a small number of firms better than relying on a Mutual fund.

Lack of diversification may also result from psychological factors, such as, illusion of control, Overconfidence, Excitement, Recovering loss, etc.

6.1 Illusion of control & Overconfidence

Investors may develop an illusory sense of control because they are directly involved in the investment process and they make their own choices instead of relying on others (as in the case of mutual funds) for their investment decisions. Familiarity with a certain set of stocks may further exacerbate the illusion of control where investors may fail to realize that more knowledge or more information does not necessarily imply control over the outcome (i.e., returns earned by the portfolio). Huberman (2001) finds that investors do indeed have a strong tendency to invest in stocks that they are familiar with. An illusion of control creates an inappropriate level of over-confidence and over-confident investors may mistakenly believe that they can earn superior performance by active trading and consequently they may choose not to diversify. As suggested in Kelly (1995), a sense of over-confidence can also emerge among investors simply because they may believe that their stock-picking abilities are superior to that of the market.

6.2 Recovering Loss

Brenner and Brenner (1987) found that people whose realised wealth is significantly lower than their aspiration levels, due to illness, accident, or loss of job are inclined to go for risky investment. Kahneman and Tversky (1979) observed that people in the domain of losses accept risk and when they are in the domain of gains they reject risk. People in the domain of losses have "dug so many holes" for themselves they take risk because they want a "ticket out" of poverty, not because they like risk.

7.0 Conclusion

The opinion among investors about benefits of diversification is grossly divided. Well-diversified portfolio can only give average return. During the last IT boom, IT stocks zoomed by several times, leaving

diversified portfolios into a bad shape. Investors seeking extraordinary return have to be too selective to invest only in their preferred stocks anticipating forthcoming boom. The boom may or may not come, but it provides aspiration of becoming rich. People always found to prefer high risk to low risk in upside potential layers, whereas low risk is preferred over high risk in downside potential. Thus people protect the downside potential by taking insurance policies, investing in fixed deposits and in Mutual fund. At the same time they take high risks in by holding a handful of risky stocks or lottery tickets to take a chance of becoming rich. The optimal number of individual stocks is the number that balances the chance for uplift into riches with the chance of a descent into poverty.

The mean variance behavior was offered as a prescription for wise investment behavior, not as a description of actual investment behavior. Markowitz explained "The fiduciary should not gamble", that is, the fiduciary who is responsible for serious amounts of other people's money should not incur risk without demanding reward. The mean-variance prescription of Markowitz is built on the premise that investors are always risk averse.

Perhaps it is the time to question the role of mean-variance framework as a prescriptive framework. It is true that the fiduciaries that are responsible for other people's money should not take high risk, but how much insurance is enough. Without risk and active participation any portfolio is likely to face fate similar to US-64 fiasco. Is it really unwise to engage in some calculated risk-seeking behavior. People do not invest all their money in the stock market. Only a part of investment goes into it. Investing a part of his saving into a select few dream stocks investors can dream to become rich in the next Bull-Run. Is holding undiversified portfolio is really bad?

However, investors must be cautious while allocating funds in undiversified favorite script. A part should be kept aside as insurance from the investment corpus to face any eventual fallout. Dreams of riches should not plunge investors into poverty.

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