An Empirical Examination of the Effectiveness of Dollar-Cost Averaging Using Downside Risk Performance Measures

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Abstract

Some studies find the dollar-cost averaging investment strategy to be sub-optimal using a traditional Sharpe ratio performance ranking metric. Using both the Sortino ratio and the Upside Potential ratio, we empirically test four investment strategies for alternative asset investments. We find the relative ranking of dollar-cost averaging remains inferior to alternative investment strategies. (JEL G1, G11, N2)

Introduction

"Q: What can I do to limit my exposure? A: You can use a technique I love—Dollar Cost Average" (Orman 2001).

"Invest a few times a year is certainly better than nothing, but there's a better way: a systematic method known as DCA" (Schwab 2002).

"For low-volatility funds, investing all your money at once should give the best returns. For high-volatility funds, DCA will mean higher profits and better returns over time" (Teitelbaum 2000).

Dollar-cost averaging is a popular investment method wherein an investor with a sum of money to invest does not invest the entire sum immediately; rather, he invests a fixed proportion of the investment dollars at regular increments across time. This method is thought to guarantee the investor does not invest his entire sum at a market high and thus regrets his investment decision ex post.

Since Constantinides (1979) demonstrated that dollar-cost averaging plans are suboptimal theoretically, many empirical studies have compared the dollar-cost averaging method of investing (hereafter known as DCA) to alternative methods of investing and found DCA to be sub-optimal (Rozeff 1994; Williams and Bacon 1993; Bacon, Williams, and Arinina 1997; Knight and Mandell

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1993; Thorley 1994). Recent studies introduce a behavioral rationale for the existence of DCA and still find DCA to be a sub-optimal investing technique (Statman 1995; Shumway 1997; Leggio and Lien 2001). Yet the popularity of DCA as an investment technique remains.

Despite earlier studies failing to empirically demonstrate that DCA is a mean-variance efficient investing technique, given the popularity of DCA, it warrants careful examination. We evaluate the DCA investing strategy relative to alternative strategies and rank performance using the Sortino ratio and the Upside Potential ratio. We find the ranking of the DCA strategy relative to alternative investment strategies remains inferior when the rankings are based upon risk-adjusted performance measures.

The paper is organized as follows: the next section outlines DCA and alternative investment strategies; the third section reviews the literature on DCA; the fourth section describes the Sharpe, Sortino, and Upside Potential ratios and the study methodology; the fifth section describes the data; the sixth outlines the results; and the seventh adds concluding remarks.

Investing Strategies

Mutual fund managers often must determine strategies to recommend to their clients as to the timing of disbursing available cash to purchase assets. The typical choices are lump sum investing, a buy and hold strategy, value averaging, or dollar-cost averaging.[1]

Lump Sum Investing

Lump sum investing (LS) requires the investor to use the entire investment dollars to purchase assets up front. For example, if an investor has $10,000 available to spend, he purchases $10,000 worth of assets now, leaves the investment dollars in place, and computes the return earned on this investment over a given period of time.

The advantage to LS investing is that an individual determines an optimal asset allocation, purchases the desired assets immediately, and begins earning equity excess returns on the chosen portfolio. A disadvantage of this strategy is that the investor may inadvertently commit all of his funds at a market high, an inopportune time to invest.

Buy and Hold Strategy

An alternative investment strategy is known as buy and hold (BH). With BH, an individual places some portion of his wealth in risky assets, and the remaining portion of his wealth is held in less risky assets such as treasury bills (T-bills). The investment dollars remain in the original distribution for some period of time; then the overall return for the investing strategy is calculated. For example, if an investor has $10,000 to invest, he may choose to place 50 percent of his wealth in a market index fund and hold the remaining 50 percent of his wealth in T-bills. He does not adjust his position, and at the end of the year he calculates the return on his portfolio.

This strategy requires an investor to determine assets of interest up front and use a portion of the available funds to purchase some percentage of risky assets; no additional transactions are required during the investment time period. A disadvantage of this strategy is that the risk of the portfolio increases over time. The excess returns associated with an investment in a market fund assure, on average, that the percentage of total wealth invested in the risky asset will increase

[1] Lump sum and buy and hold investing are variations of the same investment strategy. Merton (1973) notes that the buy and hold strategy is sub-optimal. However, to be consistent with previous research that empirically compares dollar-cost averaging to both lump sum and buy and hold investing, we include both investment techniques in our analysis.

relative to the wealth allocated to the risk-free asset over time. Investors typically determine an optimal level of risk to be achieved over time. They either under-invest in the risky asset originally knowing that the percentage of total wealth in risky assets will grow throughout the life of the investment, or they partition the investment dollars in the optimal mix of risky and risk-free assets up front and watch the riskiness of the portfolio increase. Either strategy results in a sub-optimal distribution of the investor's wealth during the life of the investment (Knight and Mandell 1993).

Value Averaging

Value averaging (VA) allows investors to take advantage of price fluctuations and increase purchases when prices are low and decrease or stop purchases when stock prices are high. Individuals using VA are concerned with increasing the cumulative value of their investment by a set amount each period. For example, let's say an investor wants to increase the value of his portfolio by $1,000 each month. The individual invests $1,000 and earns 2 percent the first month. The investment is now worth $1,020. For the second month, the individual wants the total value invested to be $2,000, so he adds an additional $980 ($,2000 – $1,020) to the account. Alternatively, if the first month's investment of $1,000 had lost 5 percent, the second month the individual would need to invest $1,050 ($2,000 – $950).

Value averaging is most suited for volatile investments, since the individual essentially "buys low, sells high." It requires a high degree of discipline on the part of the investor to stick with the strategy. It also requires the resources to increase investment contributions after a period of negative returns.

Dollar-Cost Averaging

Dollar-cost averaging (DCA) requires an individual to invest the same amount of money at regular intervals, such as every week, month, or quarter. By following DCA, an investor ends up purchasing more shares when prices fall and fewer shares when prices rise.

DCA is a simple, forced savings plan that results in lower transaction costs than with a plan that requires frequent portfolio rebalancing. It allows investors to hedge against regret that results from investing a lump sum during a market high (Pye 1971). DCA does not, however, maximize an investor's reward to risk payoff as measured by the Sharpe ratio (Leggio and Lien 2001). There is, however, some doubt that the ranking found by the Sharpe ratio does not apply to positively skewed return distributions (Lien 2002).

Review of Literature

Dollar-Cost Averaging

Dollar-cost average investing research yields mixed results. The strategy relies upon investors' being disciplined enough to continue to invest even when the investment's recent history has been bleak. Investing a fixed dollar amount during stock price declines results in an increase in the number of shares an investor is able to purchase. Then, when the stock price appreciates, the investor benefits from the capital gains resulting from ownership of a greater number of shares.

The early studies of DCA acknowledge the reduction of investing risk with this strategy. Investors with an inheritance or an existing sum of money to invest wish to avoid the regret associated with investing the entire sum at what ex post was a market high. As a result, to minimize investor regret, financial advisers advocate a gradual transfer of the investment dollars

into the risky asset. Constantinides (1979) acknowledges DCA's ability to reduce the risk of investing but still finds DCA theoretically to be a sub-optimal investment strategy when compared to "jumping in" to the market and investing the entire amount in one lump sum.

Several researchers have empirically compared DCA to alternative investment techniques. Edleson (1988) compares DCA to value averaging (VA) and finds investors are better off with a VA investment strategy rather than with DCA investing.

Harrington (2001) disputes these findings. Looking at 10 years (1990-2000) of quarterly data for investors who purchase the S&P 500 index, Harrington also considers the impact of transaction costs and taxes on returns. He compares the investing strategy of DCA to VA and lump sum (LS) investing and finds LS results in superior annualized returns, although DCA outperforms VA.

Rozeff (1994) also finds LS to yield superior annualized returns to a DCA investing strategy. He reasons that since the stock market has positive expected risk premia, LS is the superior investing strategy since it causes investment dollars to experience more independent return realizations, which increases the expected return and decreases the volatility of the investment.

Thorley (1994) compares the DCA strategy to a buy and hold (BH) investment. Thorley notes that investment advisers sell the DCA strategy to clients since the scheduled savings plan helps individuals avoid the temptation to consume earnings. The study finds that DCA leads to a reduction in expected returns and an increase in risk when compared to the BH strategy.

Several studies use simulation to empirically test the effectiveness of DCA. Abeysekera and Rosenbloom (2000) use Monte Carlo simulation to develop a model to question the belief that DCA investing leads to superior returns. The study shows that DCA investing leads to lower expected returns and lower volatility of returns. For investments with low volatility, LS is the superior investment strategy. For investments in assets with high volatility, the results are less clear-cut. LS outperforms DCA but exposes the investor to greater risk. Scherer (1998) also finds DCA underperforms in simulation modeling.

Vora and McGinnis (2000) take a different approach. Rather than looking at an individual's investment decision, the authors consider an investor's disinvestment decision. Retirees who remove dollars from their portfolio on a regularly scheduled basis see superior portfolio performance if the portfolio is invested in stocks as compared to a portfolio of bonds. The dominance of the stock returns over the bond returns increases as the investment's horizon increases. These results call into question the concept that bonds are a safer investment as consumers age. Since stocks are riskier investment instruments, these results support the simulation model outcomes; namely, DCA is an inferior investment strategy.

Not all research supports the superiority of alternative investment techniques. Israelson (1999) studies the annual holding period returns for 35 of the largest equity funds over a 10-year period. The DCA investing strategy leads to higher returns for 19 of the 35 funds. The study concludes that DCA is a superior strategy for funds with low volatility while LS is best for volatile funds. Milevsky and Posner (1999) find DCA to be superior to LS investing, especially for volatile securities when the investment ends up with a zero return or with a loss.

Finally, Statman (1995) introduces a behavioral rationale to the debate. He notes that DCA is a sub-optimal strategy but persists due to behavioral characteristics of investors. Research indicates investors prefer stocks that pay dividends (the "bird in the hand" rationale), are reluctant to realize losses, and believe that investing in good company stocks leads to higher expected returns. DCA provides a rule for investors to follow to minimize regret. Empirical testing does not support these results (Leggio and Lien 2001). Using monthly returns since 1970 for a portfolio of large-cap and small-cap stocks in turn, the study finds DCA to be an inferior investing strategy when ranked according to either loss aversion value functions or the Sharpe ratio. It is with this in mind that we seek alternative risk measurements to explain the existence of DCA.

Risk-Adjusted Performance Measures

Roy (1952) first considered the shortfall risk of an investment. Roy's safety-first model considers insolvency when making a decision as opposed to focusing strictly on value maximization. With this model, investors explicitly consider the probability of insolvency and are willing to incur costs and set premiums to cover specific risks. More recent work measures downside risk by the shortfall probability relative to a minimum return threshold (Leibowitz and Kogelman 1991). The problem with both of these works is that they do not consider the return-risk tradeoff. They are based on the lexicographic approach of the safety-first principle.

Despite some well-known limitations, the Sharpe ratio (i.e., the excess return per unit of standard deviation) has been widely adopted as a performance measure to evaluate and select investment alternatives. Variance is a two-sided measure, implying the individual dislikes any deviation from the mean regardless of the direction of the deviation. This is hardly the notion of risk perceived by an individual. In a recent survey, Adams and Montesi (1995) found that corporate managers are mostly concerned with the occurrence of bad outcomes compared to a reference point referred to as the "downside risk." Similar evidence was provided in Sortino and Price (1994). Indeed, the prospect theory of Kahneman and Tversky (1979) suggests that an individual weighs losses much more than gains. Empirical evidence of the so-called "loss aversion" has been established in recent literature (Benartzi and Thaler 1995; Thaler et al. 1997; and Odean 1998).

Dissatisfaction with the variance as a risk measure, coupled with other behavioral evidence, has led some researchers to propose alternative risk-adjusted performance measures. Two of these measures are the Sortino Ratio and the Upside Potential Ratio. Despite criticisms of the ad hoc nature of calculating these ratios (Leland,1999), the continued popularity of the DCA method of investing deserves careful examination. The Sortino and Upside Potential Ratios are an attempt to justify DCA investing since it fails the test of superiority as a mean-variance efficient investment technique.

The Sortino Ratio constructs a risk-adjusted performance measure by replacing the standard deviation with the downside risk measure. Sortino, van der Meer, and Plantinga (1999) further suggest that the return should be replaced with the upside potential. In fact, following the prospect theory of Kahneman and Tversky (1979), an individual is risk averse when the return exceeds the reference point but risk seeking otherwise. For a risk-return tradeoff to take place, we should consider only the upside potential. The ratio of the upside potential to the downside risk is termed the "Upside Potential Ratio."

Plantinga, van der Meer, and Sortino (2001) apply the Sharpe ratio, Sortino ratio, and Upside Potential ratio to evaluate mutual fund performance. They demonstrate that the upside potential ratio is a better measure than the Sharpe ratio. Moreover, they attribute the difference to the skewness of the return distribution. Lien (2002) finds portfolio distributions with positive skewness and sufficiently large Sharpe ratios will have the opposite ranking using both the Sortino ratio and the Upside Potential ratio when compared to the Sharpe ratio. We test to see if these results hold for alternative investing strategies.[2]

[2] The downside risk measure adopted here is a second-order lower partial moment. It is closely related to the concept of conditional value at risk (CVaR) or expected shortfall. An alternative risk measure is the value at risk (VaR). Because VaR is not coherent whereas CVaR is, the latter is advocated as a replacement of the former in recent academic research and practical applications.

Methodology

Ratio Calculations

Let X denote the asset return with a probability density function $f(.)$. Denote the mean of X by μ and denote the standard deviation of X by σ. The Sharpe ratio is defined as the excess return over the standard deviation of X. That is,

$$Sh = (\mu - r)/\sigma, \tag{1}$$

where r is the risk-free rate of return. The Sortino ratio replaces the standard deviation with the downside risk measure δ, where

$$\delta^2 = \int_{-\infty}^{r} (r - x)^2 f(x) dx. \tag{2}$$

Consequently, the Sortino ratio is

$$So = (\mu - r)/\delta. \tag{3}$$

The Upside Potential ratio, advocated by Sortino, van der Meer, and Plantinga (1999), refines the Sortino ratio by replacing the excess return with the upside potential, _, defined as follows:

$$\theta = \int_{r}^{\infty} (x - r) f(x) dx. \tag{4}$$

Consequently, the Upside Potential ratio (*UPR*) can be written as:

$$UPR = \theta / \delta. \tag{5}$$

Application

For the purpose of this study, investors are presumed to have chosen an asset of interest in which to invest. We assume the investors have a fixed sum of money available to invest at time T_0. The investment is assumed to be for a one-year time frame. This time frame is reasonable because investors typically evaluate their portfolio returns prior to the end of the year or prior to filing income taxes each year. With LS, the investor deposits the entire fixed sum in a risky asset and calculates the annualized return at the end of one year. With a BH investment strategy, the individual chooses to invest 50 percent of the initial wealth in a risky asset and the remaining 50 percent of his wealth in the risk-free asset (T-bills).[3] The investor then calculates the annualized return on his portfolio at year-end.

With a VA strategy, the goal is to increase the value of the investment by a set amount each period. We assume individuals evaluate the investment strategy each month. If the individual wants the value of the investment to be \$120 at the end of the year, he increases the value of the investment by \$10 each month. If the investment earns a positive return in month T_1, then the

[3] We selected to report results for an even distribution of wealth between the risky and risk-free asset to be consistent with previous studies that compare empirically DCA to alternative investing strategies. We did consider alternative distributions of wealth between the two assets and found the results to be consistent.

contribution to the account in month T_2 is reduced by the amount of the return earned in T_1. For example, if an investor deposits \$10 and earns 10 percent the first month, the value of the investment has grown to \$11. For month two, the individual wants the invested dollars to total \$20. Since the invested funds grew to \$11, the investor must add an additional \$9 to the account to have the total invested funds equal \$20. The portion of the investor's wealth (\$120 in this example) not yet invested in the risky asset is invested in the risk free asset.

With VA, during months of positive returns, the investor contributes less than \$10 each month; conversely, when the monthly return is negative, the investor adds more than \$10. The annualized return is calculated based upon the total annual contribution compared to the chosen final value of the investment.

For a DCA investing strategy, the investor deposits one-twelfth of his initial wealth in the risky asset at T_0 and keeps the remaining wealth in T-bills. Each month, an additional one-twelfth of the investor's wealth is transferred from T-bills to the risky asset so at year-end the entire initial wealth is invested in the risky asset. The annualized return is then calculated for the portfolio.

For all four investment strategies, the Sharpe ratio, Sortino ratio, and Upside Potential ratio are calculated and ranked.

Data

The empirical study data come from *Ibbotson Associates Valuation Edition 2000 Yearbook.* The monthly returns for 1926-1999 are used. The risky assets considered are large company stocks (S&P 500 composite), Ibbotson small company stocks, long-term government bonds, and long-term corporate bonds. The risk-free asset used is U.S. Treasury Bills (T-bills).

To avoid autocorrelations, the annualized return calculations are not overlapping returns. The returns are calculated based on monthly returns for January through December of 1926, January through December of 1927, etc. Since anomalous situations exist in monthly returns (i.e., the January effect) and since the chosen T_0 impacts outcomes, returns are also calculated for 12-month periods beginning in February, March, etc. Although the absolute size of the mean returns and ratios change with alternative sampling periods, the rank order of the investing strategies is not altered. We find the results to be consistent regardless of the starting month chosen and thus report the results for January through December of each year. Results for alternative investment start dates are available upon request.

Results

Excess returns are computed for each investment strategy for each year during the sample period. The mean excess return and the standard deviation for the excess returns for each strategy are computed. By construct, the mean and the standard deviation from the BH strategy are one-half of those from the LS strategy. Since BH rankings are identical to those for LS, we eliminate BH results from the reported data. The Sharpe, Sortino, and Upside Potential ratios are then calculated to determine the investment strategy that maximizes the investor's risk-adjusted return.

Full Sample

The sample consists of 74 observations covering the years 1926-99. Table 1 reports the results for the full sample. The reported results for assets are for excess returns. This is consistent with methods employed by previous studies.

Regardless of the asset considered, LS always yields the largest mean excess returns. Since DCA forces investors to keep the majority of their wealth in T-bills earning no excess returns

during the first half of the year, it is not surprising that the mean excess returns for DCA are always below the mean excess returns for Lump Sum investing. These results are consistent with Rozeff's findings (1994). DCA yields superior excess returns to VA for only large-cap stocks.

Since LS investing results in the largest excess returns, it is not surprising that the variability of excess returns (as measured by the standard deviation) is also always the highest for LS investing. LS requires investors to put all wealth in the risky asset up front, a riskier strategy. VA investing leads to less volatility than DCA for both large- and small-cap stocks.

Using the Sharpe ratio rankings, DCA is the most preferred investing strategy for both corporate and government bonds, but is the least preferred investing strategy for either large- or small-cap stocks. The DCA strategy penalizes investors for the downside risk of small-cap investing and may cause investors to lose the opportunity to profit from the upside potential of small-cap investing by delaying the transfer of dollars from T-bills to stocks.

TABLE 1. ANNUALIZED EXCESS RETURNS AND RISK MEASURES, FULL SAMPLE

Strategy	Mean	Std Dev	Sharpe Ratio	Sortino Ratio	Upside Potential Ratio
A. Asset: Large Stocks					
Lump Sum	9.28	20.39	0.456	4.05	2.53
Dollar Cost Average	4.97	12.88	0.386	2.54	2.61
Value Average	4.01	9.15	0.438	1.48	2.75
B. Asset: Small Stocks					
Lump Sum	13.72	34.03	0.403	4.95	5.62
Dollar Cost Average	4.24	19.58	0.216	2.17	4.56
Value Average	8.78	15.52	0.566	2.94	2.21
C. Asset: Corporate Bonds					
Lump Sum	2.11	8.62	0.245	5.45	6.43
Dollar Cost Average	1.48	5.27	0.281	5.23	4.67
Value Average	0.45	3.82	0.118	2.60	8.37
D. Asset: Government Bonds					
Lump Sum	1.69	9.08	0.186	4.04	6.21
Dollar Cost Average	1.32	5.28	0.250	4.67	4.28
Value Average	0.21	4.36	0.048	1.21	9.24

Using the Sortino ratio, Lump Sum investing is the preferred investing strategy for all asset classes with the exception of government bonds, whereas the Upside Potential ratio ranks Value Averaging the preferred investing strategy for all assets with the exception of small-cap stocks.

Most striking for the full sample results is the contradiction between the rankings for the Sharpe ratio and the Upside Potential ratio. For all asset groupings, the strategy ranked first for the Sharpe ratio ranks last for the Upside Potential ratio. For the investment advisers, the results for the full sample support the discontinuation of the use of the Sharpe ratio as an appropriate means

of evaluating the risk return tradeoff of alternative investing strategies. The results also call into question the value of DCA as an efficient investing strategy.

Since most investors choose to invest in a portfolio of assets as opposed to investing all their wealth in a single asset, Table 2 reports the results for two portfolios selected. We create a series of portfolios and report the results for two particular portfolios selected. We do not claim that either of the two reported portfolios contains the optimal mix of assets.

TABLE 2. ANNUALIZED EXCESS RETURNS AND RISK MEASURES, SELECTED PORTFOLIOS

Strategy	Mean	Std Dev	Sharpe Ratio	Sortino Ratio	Upside Potential Ratio
Portfolio: 60% Large-Cap Stocks, 40% Corporate Bonds					
Lump Sum	6.49	13.69	0.474	5.88	5.72
Dollar Cost Average	3.58	8.63	0.414	4.22	4.76
Value Average	2.63	6.18	0.425	7.29	7.21
Portfolio: 70% Government Bonds, 30% Small-Cap Stocks					
Lump Sum	3.97	9.81	0.405	5.92	5.53
Dollar Cost Average	2.40	5.90	0.407	4.80	4.32
Value Average	1.35	4.52	0.299	6.04	7.51

For both portfolios, according to both the Sortino ratio and the Upside Potential ratio, the results are consistent; namely, value averaging is the preferred investing strategy, with DCA being sub-optimal. The ranking of investing strategies varies with the Sharpe ratio and leads to contradictory results for the portfolio of 70 percent government bonds and 30 percent small-cap stocks. The Sharpe ratio ranks DCA the superior strategy with value averaging the least desirable investing strategy. Again we find evidence that the Sharpe ratio will not lead to the preferred ranking of investing strategies for investors who are concerned about downside risk relative to upside potential.

Segmented Data

The data span 74 years. To determine if there are indications of structural change in the sample data, we analyze the most recent 30 years of data (1970-99) and the most recent 50 years of data (1950-99). We examine additional data segments and find no significant change in the reported results. We therefore report results for the same time periods as are reported in the Williams and Bacon study (1993).

For the sample period of 1970-99, note that the Sharpe ratio and the Sortino ratio lead to identical rankings of investing strategies for all asset classes. For corporate bonds, the Upside Potential ratio also ranks the investing strategies consistently with the other ratios. However, for both large-cap stocks and government bonds, Upside Potential ratio ranks the preferred investing strategy as reported by the Sharpe ratio to be the least preferred strategy.

The results for the first segmented data indicate DCA is the preferred investing strategy for corporate bonds but is the least preferred strategy for small-cap stocks, regardless of the ranking methodology selected. The Upside Potential ratio also ranks DCA to be the least effective

investing strategy for government bonds. DCA does not appear to be a consistently efficient investing strategy.

TABLE 3. ANNUALIZED EXCESS RETURNS AND RISK MEASURES, 1970-99

Strategy	Mean	Std Dev	Sharpe Ratio	Sortino Ratio	Upside Potential Ratio
A. Asset: Large Stocks					
Lump Sum	7.76	16.18	0.48	4.95	2.93
Dollar Cost Average	3.60	8.88	0.41	4.46	3.46
Value Average	3.46	9.38	0.37	3.73	3.28
B. Asset: Small Stocks					
Lump Sum	9.70	22.84	0.42	4.49	4.02
Dollar Cost Average	1.83	12.17	0.15	1.87	3.44
Value Average	6.96	13.35	0.52	4.93	3.93
C. Asset: Corporate Bonds					
Lump Sum	3.01	11.91	0.25	3.79	5.69
Dollar Cost Average	2.79	6.85	0.41	6.24	6.19
Value Average	-0.13	5.22	-0.02	-0.34	4.60
D. Asset: Government Bonds					
Lump Sum	2.90	12.33	0.24	3.91	4.87
Dollar Cost Average	3.00	6.71	0.45	7.07	4.78
Value Average	-0.40	5.96	-0.07	-1.15	5.20

For the sample period of 1950-99, the Sharpe and Sortino ratio ranking orders are identical for both corporate and government bonds; the Sortino and Upside Potential ratios have identical rankings for the large-cap stocks. Most interesting in this data segmentation is that for all asset groupings with the exception of large-cap stocks, the Sharpe ratio and Sortino ratio always choose the same investing strategy as the most preferred method, and the Upside Potential ratio always chooses that same strategy as the least preferred. This is particularly important for both classifications of bonds: the Sharpe and Sortino ratios select DCA as the preferred investing strategy whereas the Upside Potential ratio chooses DCA as the least preferred methodology. Since Upside Potential most accurately reflects the "risk of interest" for investors, namely the upside potential relative to the downside risk, data for the most recent 50 years also fails to support DCA as a consistently superior investing strategy.

TABLE 4. ANNUALIZED EXCESS RETURNS AND RISK MEASURES, 1950-99

Strategy	Mean	Std Dev	Sharpe Ratio	Sortino Ratio	Upside Potential Ratio
A. Asset: Large Stocks					
Lump Sum	9.41	17.24	0.55	8.10	8.06
Dollar Cost Average	4.94	9.26	0.53	8.35	8.54
Value Average	3.67	9.03	0.41	5.73	6.36
B. Asset: Small Stocks					
Lump Sum	12.44	25.53	0.49	7.66	7.34
Dollar Cost Average	3.95	13.6	0.51	4.76	8.04
Value Average	7.06	12.6	0.56	8.44	5.28
C. Asset: Corporate Bonds					
Lump Sum	1.23	10.03	0.12	2.24	3.69
Dollar Cost Average	1.26	6.12	0.21	3.49	3.47
Value Average	-0.24	4.28	-0.06	-1.07	4.96
D. Asset: Government Bonds					
Lump Sum	0.92	10.48	0.09	1.65	3.68
Dollar Cost Average	1.23	6.14	0.2	3.18	3.15
Value Average	-0.31	4.89	-0.06	-1.26	4.29

Conclusion

Investment advisers recommend DCA as an investing strategy that increases returns while reducing the investor's exposure to risk. This paper empirically tests the DCA investing strategy relative to three popular alternative investing strategies. We find DCA consistently remains an inferior investing strategy to Lump Sum investing using the risk-adjusted performance measures.

The failure of DCA as an optimal investing strategy for all assets and portfolios considered is likely because DCA is a conservative investing strategy best suited for investors interested in a forced savings plan that avoids the consumption of earnings.

DCA is not an appropriate investment strategy for volatile assets such as small or large cap stocks; it also fails as an investing strategy for corporate or government bonds or for portfolios of assets. However, there may be an alternative reason for the DCA sub-optimal results. Recent research indicates the time horizon and the frequency of portfolio rebalancing may impact results (Milevsky, Arye, and Posner 1999; Shumway 1997; and Thorley 1995). This study assumes DCA transfers investment dollars from the risk-free asset to the risky asset on a monthly time schedule. We also assume investors are using a one-year time frame for calculating portfolio returns. A question remains as to whether DCA is justified under alternative investing time horizons or under alternative investing dollar fund transfer periods. The results in this paper fail to support the

existence of DCA as an investment strategy; further research is needed to evaluate the effect of DCA under alternative time frames and investing horizons.

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