NORTH-HOLLAND

Financial Services Review 10 (2001) 117–127

FINANCIAL SERVICES REVIEW

Does loss aversion explain dollar-cost averaging?

Karyl B. Leggio[a,*], Donald Lien[b,1]

[a]*Bloch School of Business and Public Administration, University of Missouri at Kansas City, Kansas City, MO 64110, USA*

[b]*College of Business, University of Texas at San Antonio, San Antonio, TX 78249-0631, USA*

Received 19 September 2000; received in revised form 20 June 2001; accepted 13 December 2001

Abstract

Some studies find the dollar-cost averaging investment strategy to be sub-optimal from a mean variance expected utility of wealth perspective. Statman [The Journal of Portfolio Management (1995) fall] introduces a behavioral rationale for the persistence of dollar-cost averaging. Using prospect theory to create an alternative utility function that does not require investors to be strictly risk averse, we empirically test Statman's conjecture for four investment strategies and for alternative stock investments. We find loss aversion still does not explain the existence of the dollar-cost averaging investment strategy.

JEL classification: G1; G11; N2

Keywords: Dollar-cost averaging; Loss aversion; Asset allocation

1. Introduction

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 sub-optimal theoretically, many studies have compared the dollar-cost averaging method of investing (hereafter known as DCA) to a lump sum method of investing (Rozeff, 1994; Williams & Bacon, 1993), a buy and hold strategy (Bacon, Williams, & Arinina, 1997; Knight & Mandell, 1993), or a value averaging method of portfolio rebalancing (Thorley, 1994).

* Corresponding author. Tel.: +1-816-235-1573; fax: +1-816-235-6606.

E-mail addresses: leggiok@umkc.edu (K.B. Leggio), dlien@utsa.edu (D. Lien).

[1] Tel.: +1-210-458-7312; fax: +1-210-458-5837.

1057-0810/01/$ – see front matter
PII: S1057-0810(02)00090-2

Most comparisons find DCA to be lacking for investors who have strictly concave utility functions; however, recent research notes the value of DCA when the investment instruments are highly volatile (Milevsky & Posner, 1999).

Statman (1995) introduces a behavioral rationale for the existence of DCA. Using Tversky and Kahneman's prospect theory (1992), he notes that investors evaluate choices relative to a reference point. Whereas standard investors are presumed to always be risk averse, prospect theory investors have S-shaped utility curves, displaying risk averse behavior over gains but risk-seeking behavior over losses. Investors also seek to minimize the regret associated with an ex post bad investment outcome. Statman believes investors who follow a rule such as that imposed by DCA (i.e., "invest 1/12 of your total dollars each month in an asset regardless of the asset's price.") feel removed from some of the responsibility of a bad investment outcome and experience a reduction in regret. Investor aversion to loss and reliance upon rules to help minimize regret help to theoretically explain the persistence of the DCA method of investing.

Researchers are beginning to incorporate loss aversion into investor utility functions to create equilibrium asset pricing models (Shumway, 1997). In this paper we use monthly return data to compare DCA to alternative investment strategies when prospect theory explains investor utility functions. We find investor utility is lowest for a DCA investment strategy for relatively volatile assets such as small cap stocks, and is inferior to all investing strategies except value averaging for large cap stocks. Investors will also prefer a buy and hold investing strategy to dollar-cost averaging for stocks. These results do not support dollar-cost averaging as an investment strategy.

2. Investing strategies

Investment advisers 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.

2.1. 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.

2.2. 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 (Thorley, 1994). For example, if an investor has $10,000 to invest, he may choose to place 50% of his wealth in a market index fund and hold the remaining 50% 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 assures, on average, that the percentage of total wealth invested in the risky asset will increase 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 & Mandell, 1993).

2.3. 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% 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 ($2,000 − $1,020) to the account. Alternatively, if the first month's investment of $1,000 had lost 5%, the second month the individual needs to invest $1,050 ($2,000 − $1,000 × 5% loss = $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.

2.4. 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 expected utility of wealth for a strictly concave utility

function as described by Markowitz (1952). This shortcoming, of course, presumes that the investor's utility curve is strictly concave. Prospect theory questions this presumption.

3. Review of literature

Research on the dollar-cost average investing technique 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 these 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 to theoretically 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 compared DCA to alternative investment techniques. Edleson (1988) compares DCA to 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 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 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 test the effectiveness of DCA. Abeysekera and Rosenbloom (2000) use Monte Carlo simulation to develop a model to question the belief that DCA investing lead 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 look 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 a riskier investment instrument, these results support the simulation model outcomes; namely, DCA is an inferior investment strategy.

Not all research supports the superiority of alternative investment techniques. Israelsen (1999) studies the annual holding period returns for 35 of the largest equity funds over a 10-year period. The DCA investing strategy lead 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) contradict these results and find DCA to be superior to LS investing especially for volatile securities. Finally, Statman (1995) introduces a behavioral rationale to the debate. He notes that DCA is a sub-optimal strategy but persists due to the 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. It is within this behavioral framework that we proceed to empirically evaluate DCA.

4. Methodology

4.1. Prospect theory

Prospect theory is an alternative to expected utility theory and is used to explain decision making when outcomes are uncertain. Expected utility theory is based upon three tenets: the overall utility of a choice is equal to the sum of the expected utilities of all possible outcomes; a choice is acceptable if it adds value to the existing asset portfolio; and investors are risk averse (Markowitz, 1952).

Tversky and Kahneman (1992) note a deviation in actual investor behavior that is not explained by this normative model. Whereas expected utility theory has investors evaluate decisions based upon the impact on investor total wealth, prospect theory has investors evaluate choices in terms of potential gains and losses relative to reference points (Statman, 1995). Prospect theory breaks the investor choice process into two phases: framing and valuation. In the framing phase, investors analyze the choices and frame the effective acts, contingencies, and outcomes (Tversky & Kahneman, 1986, 1992). The framing phase is impacted by the manner in which the problem is presented as well as by the norms, habits, and expectancies of the investor. In the valuation phase, investors determine the value of each alternative and choose the preferred opportunity.

Expected utility theory says investors are risk averse with a concave value (utility) function. With prospect theory, outcomes are expressed as deviations (both positive and negative) from a reference point; the value function is S-shaped with the curve concave for gains and convex for losses.

A final important property of the prospect theory value function is that of investor loss aversion. Investor response to a loss is more extreme than the response to a gain. In addition

to an S-shaped value function, therefore, the slope of the utility function is steeper for losses than for gains with prospect theory.

4.2. Investor utility function

Whereas Markowitz assumes constant relative risk aversion, Kahneman and Tversky (1979) propose the following two-part value function:

$$\begin{cases} v(x) = x^{\alpha}, & \text{if } x \geq 0 \\ v(x) = -\lambda(-x)^{\alpha}, & \text{if } x < 0 \end{cases}$$

where x is the outcome, i.e., the excess return over T-bills, α measures the sensitivity to increasingly large gains or losses, and λ is the loss aversion coefficient. Prospect theory finds investors are loss averse or more sensitive to wealth losses than to wealth gains. The loss aversion hypothesis is based upon clinical studies of investor actions; Tversky and Kahneman (1992) observe investors find an outcome acceptable if the probability of a gain is nearly twice that of a loss. Using a non-linear regression procedure, they find the parameter estimates to be 2.25 for λ (loss aversion) and 0.88 for α (risk aversion).

4.3. 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 1-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 1 year. With a BH investment strategy, the individual chooses to invest 50% of the initial wealth in a risky asset and the remaining 50% of his wealth in the risk-free asset (T-bills). 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 \$120.00 at the end of the year, he increases the value of the investment by \$10.00 each month. If the investment earns a positive return in month T_1, then the 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 \$10.00 and earns 10% the first month, the value of the investment has grown to \$11.00. For second month, the individual wants the invested dollars to total \$20.00. Since the invested funds grew to \$11.00, the investor must add an additional \$9.00 to the account to have the total invested funds equal \$20.00. The portion of the investor's wealth (\$120.00 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 \$10.00 each month; conversely, when the monthly return is negative, the investor adds more than \$10.00. 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 1/12 of his initial wealth in the risky asset at T_0 and keeps the remaining wealth in T-bills. Each month, an additional 1/12 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 annualized excess returns are then applied to the prospect theory value function to determine a function value.

5. Data

The empirical study data comes from Ibbotson and Sinquefeld (2000). The monthly returns for 1970–1999 are used. The risky assets considered are large company stocks (S&P 500 composite) and Ibbotson small company stocks. The risk-free asset used is U.S. T-bills.

To avoid autocorrelation errors, the annualized return calculations are not overlapping returns. The returns are calculated based on monthly returns for January through December of 1970, January through December of 1971, 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 value functions 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.

6. 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. The excess returns are then applied to the value function to determine the investment strategy that maximizes the investor's prospect utility. For purposes of benchmarking, we calculate the expected returns and volatility for a portfolio of T-bills during the study period. The annualized return is 5.04% with a standard deviation of 2.79%. Using prospect theory, the value function is zero as the T-bill return is the reference point for the investor. The results are consistent for all four investing strategies since the investing strategies presume dollars not yet invested in the risky asset are invested in T-bills.

6.1. Data analysis

The sample consists of 30 observations covering the years 1970–1999. Table 1 reports the results for the full sample. While the benchmark portfolio results report returns for a

Table 1
Annualized excess returns and value functions, 1970–1999

Strategy	Mean	S.D.	Sharpe ratio	Value function	*p*-Value
Asset: large stocks					
Lump sum	9.28	20.39	0.456	3.95	0.28
Buy and hold	4.64	10.19	0.456	2.15	0.84
Dollar-cost average	4.97	12.88	0.386	1.90	–
Value average	4.01	9.15	0.438	1.48	0.87
Asset: small stocks					
Lump sum	13.72	34.03	0.403	5.00	0.004***
Buy and hold	6.86	17.01	0.403	2.72	0.002***
Dollar-cost average	4.24	19.58	0.216	−2.91	–
Value average	8.78	15.52	0.566	7.10	0.008***

*** $p < 0.001$.

portfolio of T-bills, note the reported results for stocks 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). Likewise BH always yields a higher mean return than DCA for both large and small cap stocks. DCA yields superior excess returns to VA for 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. Similarly, since BH requires an investor to maintain one-half of his wealth in T-bills throughout the life of the investment, this is a less risky investment strategy. VA investing leads to less volatility than DCA for both large and small cap stocks.

The four investing strategies lead to some mean variance inefficiencies. Expected utility of wealth theory tells us that a strategy that earns a higher return is more risky and thus has a higher standard deviation; the empirical results are contradictory. For example, for small cap stocks, the DCA strategy results in a mean portfolio return of 4.24 with a standard deviation of 17.58. Yet BH investing results in a mean portfolio return of 6.88 with a standard deviation of 17.01. This inefficiency supports Constantinide's contention that DCA is not a mean variance efficient method of investing. An informed investor with Markowitz's expected utility function thus will prefer the BH investing strategy to a DCA strategy for small cap stocks. The goal for prospect theory, however, is not to choose the strategy that satisfies Markowitz's model; it is to choose a strategy that maximizes the prospect theory value function.

To test if the inefficiency of DCA disappears for an investor with Kahneman and Tversky's (1979) S-shaped utility function, the average value function is computed, and the results are reported in Table 1. For large and small cap stocks, both LS and BH strategies lead to higher value functions than result from the DCA strategy. In fact, for small cap stocks

(the more risky asset investment considered), only DCA leads to a negative value function outcome. Small cap stocks are volatile. For the 30 years of this study, the annualized returns for small caps ranged from a low of −31% to a high of 58%. With prospect theory value functions, risk averse investors' responses are more extreme to losses. In addition, dollars are transferred to the risky asset over time and may not yet be invested in small cap stocks during periods of high returns. The DCA strategy thus 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. This result contradicts Milevsky & Posner's (1999) findings that show DCA is the preferred strategy for volatile investments.

To test for the differences in value function outcomes for DCA as compared to the three alternative investment strategies, *p*-values are reported. For small cap stocks, the DCA strategy leads to a value function that is negative and lower than the calculated value functions for the three alternative investing strategies. These differences are highly significant. The results support the hypothesis that DCA is an inferior strategy for investing in volatile assets (small cap stocks). While the differences in value functions for DCA and the alternative investing strategies is not statistically significant for large stocks, this may be due to the sampling period or investing horizon.

Table 2
Annualized excess returns and value functions, extended sample

Strategy	Mean	S.D.	Sharpe ratios	Value function	*p*-Value
Asset: large stocks[a]					
Lump sum	9.41	17.24	0.55	5.84	0.34
Buy and hold	4.71	8.62	0.55	3.17	0.74
Dollar-cost average	4.94	9.26	0.53	3.56	–
Value average	3.67	9.03	0.41	0.74	0.21
Asset: small stocks[a]					
Lump sum	12.44	25.53	0.49	6.28	0.02**
Buy and hold	6.22	12.77	0.49	3.41	0.01***
Dollar-cost average	3.95	13.6	0.51	−0.88	–
Value average	7.06	12.6	0.56	5.02	0.06
Asset: large stocks[b]					
Lump sum	9.28	20.39	0.456	3.95	0.28
Buy and hold	4.64	10.19	0.456	2.15	0.84
Dollar-cost average	4.97	12.88	0.386	1.90	–
Value average	4.01	9.15	0.438	1.48	0.87
Asset: small stocks[b]					
Lump sum	13.72	34.03	0.403	5.00	0.004***
Buy and hold	6.86	17.01	0.403	2.72	0.002***
Dollar-cost average	4.24	19.58	0.216	−2.91	–
Value average	8.78	15.52	0.566	7.10	0.008***

** $p < 0.05$.
*** $p < 0.001$.
[a] 1950–1999.
[b] 1926–1999.

Investors maximize value with lump sum investing for large stocks and with VA for small stocks; DCA is not the efficient investing strategy for either asset. The results contradict Statman's assertion that DCA is the appropriate investing strategy for loss averse investors.

6.2. Extended sample

The data spans the most recent 30 years. We also analyze the post-World War II era (1950–1999) and historic investing time frames (1926–1999), the same time periods as are reported in the Williams and Bacon study (1993). We find no significant change in the reported results. The results are qualitatively similar to those in the initial sample and appear in Table 2.

With respect to the value function for stocks, LS is superior to DCA for both large and small cap stocks for both alternative time periods. With small cap stocks, DCA yields a negative value function during both the 1950–1999 and historic time period. Since the small cap stocks are the most volatile, the DCA strategy is the least effective at capitalizing on positive excess returns and minimizing the impact of negative return periods for this asset grouping.

The results for the segmented data support the results for the full sample. DCA does appear to be an ineffective investment strategy from a prospect theory value function perspective for stocks.

7. Conclusion

Models depicting investors as risk averse with strictly concave utility functions do not accurately depict individual behavior. Alternative behavioral utility function models incorporating investor loss aversion have been developed. This paper empirically tests the prospect theory investor value function. We find DCA remains an inferior investing strategy using the parameter values estimated by Tversky and Kahneman for stocks.

The failure of DCA as an optimal investing strategy for all assets may be attributable to model parameter misspecification; however, the more likely scenario is that 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 cap stocks. DCA may fail to be an optimal investing strategy for riskier assets because loss aversion and risk aversion coefficients are overestimated. However, there are alternative reasons for the DCA sub-optimal results for stocks. Recent research indicates the time horizon and the frequency of portfolio rebalancing may impact results (Milevsky, Arye, & Posner, 1999; Shumway, 1997; Thorley, 1995). This study assumes the DCA investor transfers dollars from the risk-free asset to the risky asset on a monthly time schedule. We also assume investors are using a 1 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.

Acknowledgments

The research was motivated by a discussion with Joseph Sicilian concerning the fallacy of the dollar-cost averaging investment strategy. This paper benefited from helpful comments by Ann Martin, Jack Harrington, Karen Lahey, two anonymous referees, and session participants at the 2001 Midwest Finance Association meeting. The authors are solely responsible for any remaining errors.

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