

Modified Dollar Cost Averaging Investment Strategy: Evidence from Major Developed International Stock Markets

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Abstract

The Dollar Cost Averaging (DCA) method is widely used by individual investors as well as financial professionals and has been discussed extensively in the current literature. This study examines a modified DCA (MDCA) approach using a set of international stock market data. The research will test the hypothesis that the simple modification could enhance investor returns over those from the traditional DCA strategy. This is a subject of great interest to both academic researchers as well as to investors. Empirical results indicate that the MDCA strategy outperforms the DCA method across all of the international stock markets investigated.

I. Introduction

Due to behavioral bias and emotion, many investors do not truly follow the basic investing principle of ‘Buy Low, Sell High.’ Investors tend to chase high-flying stocks as the shares reach all-time-highs and tend to sell shares of beaten-down companies. Although it has been well-documented that stock markets around the world follow some form of ‘mean-reverting’ property, many investors still are not able to correct individual cognitive errors.

Several prominent authors and practitioners have discussed the Dollar-Cost Averaging (DCA) strategy that may help investors stay the course when stock markets go down. Malkiel (1999) refers to DCA as “A policy of staying the course and steadily putting new savings into your portfolio (no matter how uncertain the outlook) is the time tested and surest method to accumulate wealth.” Statman (1995) states: “The rules of dollar-cost averaging serve to combat lapses in self-control as cognitive errors influence investors to terminate their investment plans”. Hirt and Block (1990) discuss that “The intent of dollar-cost averaging is to avoid the common practice of buying high and selling low.” Authors such as Constantinides (1979), Rozeff (1994) and Samuelson (1994) are more critical of the practical use of the DCA method.

The Wall Street Journal in an article titled, “How Investing Dimes Can Beat Dollars,” contends that the DCA approach works well, especially when stock markets experience a long period of declines [see Geer (2013)]. Academic studies such as Bierman and Hass (2004), Brennan, Li, and Totous (2005) illustrate the importance of the DCA model and find that DCA

outperforms a lump-sum approach. Other studies such as Richardson and Bagamery (2001), Chen and Estes (2007), Chen and Estes (2010) and Dunham, Friesen and Geoffrey (2012) make improvements to the DCA model.

On the other hand, Leggio and Lien (2003) find that the DCA approach is inferior to the lump-sum method. Atrra and Mann (2001) and Grable and Chatterjee (2015) demonstrate that the DCA approach works well only during periods of stock market declines. During periods of stock market advances, the DCA method significantly underperforms the lump-sum approach.

In this study, we focus on investors who have economic constraints (i.e., cannot invest with a large lump-sum) and who must make investment contributions into a retirement account with installments. Therefore, we are focused on improving the current model of DCA, rather than entering into the debate as to whether investors should invest in a lump-sum or by installments. We examine a simple and intuitive modification to enhance the investment returns of the conventional Dollar-Cost Averaging (DCA) strategy. We study a modified DCA (or MDCA) approach to allow investors to systematically purchase more (less) shares of a given investment when stock markets decline (appreciate), when compared with the DCA method. The MDCA can be viewed as a ‘magnified’ version of DCA and it delivers superior investment results relative to DCA.

We select six developed stock market indices around the world to examine whether the MDCA strategy outperforms the DCA method. These stock markets are the S&P 500 (USA), NASDAQ Market Index (USA), FTSE 100 (UK), DAX (Germany), Nikkei 225 (Japan) and Hang Seng (Hong Kong). We select these major developed stock market indices because these markets are well-established and investors in these markets already have had long-running defined contribution retirement plans available for savings. For example, 401(k), 403(b) and IRAs are available in the United States, National Employment Savings Trust (NEST) is offered in the United Kingdom and the private-sector Employees' Pension Insurance (EPI) plan in Japan.

We find that MDCA approach outperforms the DCA method in all of the six major stock markets over the period January 1996 through December 2015. The results suggest that an investor employing the MDCA strategy, on average, would realize an additional total investment return of over the traditional DCA approach. In addition, the results also indicate that the average cost per share purchased using the MDCA method is lower than that using the DCA approach. The results are robust in five-year and ten-year rolling period analysis.

II. Background and Hypotheses

The Dollar Cost Averaging (DCA) investment strategy involves fixed amount of funds invested on a regular basis over a period of time. Individual investors commonly utilize the DCA approach in their defined contribution retirement accounts (e.g., 401(k), 403(b) and IRAs) as this type of “automatic” investing strategy is simple to execute and is easily fit into a monthly/annual

budget. The rationale behind the DCA is that investors can purchase more shares of stocks, mutual funds or other types of investments when the stock market declines. Thus, the average purchase price of the investment would be lower as the investor is able to acquire more shares at lower stock market price levels. An example of the DCA approach can be found in Table 1. The example demonstrates how the same constant amount of monthly contribution is made to purchase index shares in the German DAX stock index over a twelve-month period.

The chief objective of this research is to determine whether the DCA could be modified to deliver enhanced investment performance in various international stock markets. Earlier studies are focused on either improving the DCA or on analyzing DCA performance in international markets, but our study combines both tasks by refining the DCA and testing a new modified DCA strategy in different major stock markets around the world.

We examine a modified Dollar-Cost Averaging (MDCA) strategy and test the following (null) hypotheses:

HO1-a: The MDCA strategy does not provide additional investment return over the traditional DCA approach.

HO1-b: The (null) relationship in HO1-a does not change when the MDCA and DCA methods are examined using five-year and ten-year rolling periods.

We consider the percentage change in investment gains from the two competing investment approaches. We investigate percentage change instead of total dollar of investment gains because the total amount of investment between the two methods would differ slightly due to stock market fluctuations.

HO2-a: The average price per share paid to acquire shares of an investment will be the same whether an investor employs MDCA or DCA method.

HO2-b: The (null) relationship in HO2-a does not change when the MDCA and DCA methods are examined using five-year and ten-year rolling periods.

We study an important property of the MDCA or DCA approach; that is, investors can expect to pay, on average, less for each share of investment if they purchase shares when stock markets go down. The goal is to determine the percentage of saving resulting from each of the investing strategy. The MDCA approach could also help investors correct some cognitive errors and behavior bias suggested by Kahneman and Tversky (1982) and Dichtl and Drobetz (2011).

III. Data and Methodology

We examine the MDCA strategy using stock market index data from six major developed countries: S&P 500 (USA), NASDAQ (USA), FTSE 100 (United Kingdom), DAX (Germany), NIKKEI 225 (Japan) and Hang Seng (Hong Kong). We collect monthly stock market index prices from the Yahoo Finance websites to compute monthly index returns over the period January 1996 through December 2015. Yahoo Finance provides historical stock market data to investors without a fee and the financial data can be easily downloaded and imported into Excel Spreadsheets for data analysis. Similar to previous studies, we exclude dividends generated by the stock market index since dividend yields are the same for both MDCA and DCA methods for each underlying stock market index studied.

For the DCA approach, we assume, for simplicity, that a monthly fixed amount of \$1,000 is invested in the underlying stock market index during the period under investigation. We calculate each monthly purchase ($SH_{DCA,t}$) by dividing the constant amount of investment (C_t) by the corresponding stock index price (PI_{t-1}). Thus, average index price per share purchased (\overline{PPS}) following the DCA method is the total amount of investment accumulated over the period study divided by the total number of shares purchased during the same time period.

$$SH_{DCA,t} = C_t / PI_{t-1} \quad (I)$$

$$\overline{PPS} = \sum_{t=1}^N SH_{DCA,t} / \sum_{t=1}^N C_t \quad (II)$$

The modification to the DCA is similar to that employed by Richardson and Bagamery (2011). In the first step of the modification, we start the initial amount of monthly investment at \$1,000; however, all subsequent monthly investment contributions (MC_t) are determined by the preceding month's index rate of return (RI_{t-1}). The objective of this first modification (expressed in Equation III) is to capture monthly fluctuations in the underlying stock index. The modification systematically varies the monthly investment amounts to take advantage of market advances and declines. It allows investors to invest more (less) funds when the market index is lower (higher) each and every month. For instance, if the underlying stock index (e.g., the FTSE 100 Index) had a positive (negative) return of 10% in January, then the MDCA investor would reduce (increase) the February contribution by 10% or \$900 (\$1,100).

$$MC_t = C_t \times (1 - RI_{t-1}) \quad (III)$$

Furthermore, we reset the initial investment amount each year to avoid “negative” investment contributions, resulting in short sale position. Negative amounts of investment may occur if the underlying stock index experiences a series of price appreciation during the year. Unlike earlier research, we do not reset the initial investment amount back to \$1,000. Instead, we reset the initial amount each year by the process similar to the modification expressed in Equation III. Therefore, the initial investment amount for the current year is reset according to the previous year's stock index return. For example, for the year 2012, we reset the German

DAX Index initial investment amount to \$1,146.92 since the DAX Index declined 14.692% in the year 2011 [See Table 1]. To compute the monthly share purchases as well as the average price per share for the MDCA method, we follow the same methods in Equations I and II above.

Table 1. Example MDCA & DCA Calculations (German DAX Index)

Month/ Year	Index Price Level	Index Return	MDCA		DCA	
			Contribution	Shares	Contribution	Shares
Dec/2011	6914.19	3.374%	\$1,000.00	0.1446	\$1,000	0.1446
Jan/2012	7077.48	2.362%	\$976.38	0.1380	\$1,000	0.1413
Feb/2012	7272.32	2.753%	\$949.50	0.1306	\$1,000	0.1375
Mar/2012	7041.31	-3.177%	\$979.67	0.1391	\$1,000	0.1420
Apr/2012	7514.46	6.720%	\$913.84	0.1216	\$1,000	0.1331
May/2012	7293.69	-2.938%	\$940.68	0.1290	\$1,000	0.1371
Jun/2012	7376.24	1.132%	\$930.04	0.1261	\$1,000	0.1356
Jul/2012	7158.77	-2.948%	\$957.46	0.1337	\$1,000	0.1397
Aug/2012	5784.85	-19.192%	\$1,141.21	0.1973	\$1,000	0.1729
Sep/2012	5502.02	-4.889%	\$1,197.01	0.2176	\$1,000	0.1818
Oct/2012	6141.34	11.620%	\$1,057.92	0.1723	\$1,000	0.1628
Nov/2012	6088.84	-0.855%	\$1,066.96	0.1752	\$1,000	0.1642
Dec/2012	5898.35	-3.129%	\$1,146.92	0.1944	\$1,000	0.1695

Rate of returns from MDCA and DCA techniques are determined by the following equation:

$$R = \frac{[(PI_t \times SH_t) - \sum_{t=1}^N C_t]}{\sum_{t=1}^N C_t} \quad (IV)$$

Using a set of international stock market index data, we examine whether the MDCA strategy is superior to the conventional DCA approach by comparing the average price paid to acquire the index shares and the investment returns from the two methods over the period January 1996 through December 2005. We also conduct five-year and 10-year rolling tests to determine if the MDCA approach outperforms the DCA method consistently. In particular, we investigate the following relationships between the two investment approaches:

$$\overline{PPS}_{MDCA} - \overline{PPS}_{DCA} < 0; \text{ and}$$

$$R_{MDCA} - R_{DCA} > 0$$

IV. Empirical Results

Table 2 presents the descriptive statistics for the monthly stock market index returns of the S&P 500, NASDAQ, FTSE 100, DAX, NIKKEI 225 and Hang Seng. The time period under investigation is from January 1996 to December 2015. The descriptive statistics provides

preliminary information about the variation and the range of the index return series. The highest mean monthly returns are in the NASDAQ Market Index and German DAX Index, at 0.894% and 0.859% respectively and the lowest are in NIKKEI 225 Index. As expected, the NASDAQ and DAX also have very high level of volatility (as measured by standard deviation), while Hang Seng is the most volatile market index among six the developed stock markets. Moreover, Hang Seng has the highest range of monthly returns (28.813% to -29.407%), followed by DAX (21.378% to -25.422%) and NASDAQ (21.976% to -22.902%). The return distribution for all of the stock markets appears to be non-normal. All of the stock indices have negative skewness. The kurtosis for Hang Seng, DAX and NSASAQ suggests that each series exhibits fat tails. These results are consistent with those of Aggarwal, Inclana and Leal (1999).

Table 2. Descriptive Statistics

	<i>S&P 500</i>	<i>NASDAQ</i>	<i>FTSE 100</i>	<i>DAX</i>	<i>NIKKEI 225</i>	<i>Hang Seng</i>
Mean	0.606%	0.894%	0.302%	0.859%	0.145%	0.587%
Standard Deviation	0.044260	0.069117	0.040416	0.063618	0.056574	0.072415
Kurtosis	0.999939	1.161275	0.522453	1.885072	0.579807	2.210468
Skewness	-0.628910	-0.384651	-0.568124	-0.523112	-0.469239	-0.016950
Lowest Return	-16.942%	-22.902%	-13.024%	-25.422%	-23.827%	-29.407%
Highest Return	10.772%	21.976%	8.857%	21.378%	12.850%	28.813%

Table 3 provides results covering the entire period from January 1996 to December 2015. We find that MDCA approach outperforms the DCA method in all of the six major stock markets. The results suggest that an investor employing the MDCA strategy, on average, would realize an additional total investment return of 12.312% over the traditional DCA approach when investing in the NASDAQ Index. The MDCA strategy also provides additional returns of 2.079%, investing in FTSE 100, 2.767% in S&P 500, 6.008% in Hang Seng, 6.033% in Japan and 7.645% in DAX, respectively. Furthermore, we find that the MDCA approach results in lower cost per share purchased, relative to the DCA method across all of the stock markets. The MDCA investor pays, on average, 5.329% less per share of NASDAQ Index than the DCA investor. For the MDCA approach, the NASDAQ Index offers the highest ‘discount’ on index share acquisition while the S&P 500 Index provides an average of 1.593% savings per share. We also find similar savings in DAX at 3.695%, NIKKEI 225 at 4.031% and Hang Seng at 4.153%.

The findings are intuitive – as MDCA investors purchase more (less) shares when the markets go down (up), they would not only earn higher rate of returns per dollar of investment, but they would also pay less for each and every share of the investment. Tables 4 and 5 present additional analysis based on two rolling periods: 60-month rolling and 120-month rolling. The results from the two rolling periods are similar; the MDCA strategy consistently outperforms the DCA approach across all of the six stock market indices and the results are independent of the time periods.

In the five-year rolling analysis, we discover that MDCA outperforms the DCA in 158 of the 180 trails (or 87.78% of the time) in the S&P 500 Index. Moreover, MDCA performs even better than DCA in the other stocks markets. For instance, MDCA is superior to DCA, investing in NASDAQ (with probability of 95.56%), in FTSE 100 (of 91.67%), in DAX (of 89.44%), in NIKKEI (of 100%) and in Hang Seng (of 100%). It appears that the results are associated with the return volatility of the underlying stock market index as shown in Exhibit 1 and Table 2. Moreover, the ten-year rolling results suggest that the MDCA approach outperforms the DCA method in longer term investment horizon. Table 5 shows that MDCA is superior to DCA in all (or 100%) of the 120-month rolling trails across all of the six stock markets. The results also indicate that the longer the investment horizon, the greater the rate of return per dollar of investment and the lower the price per share purchased for MDCA investors. These findings are consistent with Strong and Taylor (2001). In short, we present evidence that the MDCA approach has delivered greater investment performance than the DCA method.

Given the apparent correlation between the volatility of the index returns and the enhanced performance of the MDCA approach (see Table 3), we believe that a future research study can focus on applying the modified investment strategy in emerging markets around the world. Emerging markets such as Brazil, China, India, and Turkey tend to have more volatile market return properties than the developed stock markets investigated in this study and thus the MDCA method may further enhance the performance of regular investing program like Individual Retirement Accounts (IRAs) and 401(k)/403(b) accounts. A study that focuses on performance of different types of DCA models in emerging markets would be of great interest to both academic researchers and practitioners.

Table 3. Total Period Results (January 1996 – December 2015)

Stock Market Index	S&P 500	NASDAQ	FTSE 100	DAX	NIKKEI 225	Hang Seng
	MDCA - DCA	MDCA - DCA	MDCA - DCA	MDCA - DCA	MDCA - DCA	MDCA - DCA
Total Shares Purchased	10.655	16.709	3.618	3.781	3.575	2.056
Total Contributions	\$8,577.84	\$22,240.65	\$14,725.74	\$10,377.41	\$34,400.15	\$20,330.11
Ending Investment Value	\$21,778.10	\$83,666.83	\$22,583.24	\$40,615.38	\$68,037.56	\$45,049.88
Amount of Investment Gain	\$13,200.26	\$61,426.18	\$7,857.50	\$30,237.97	\$33,637.41	\$24,719.77
Percentage of Investment Gain	2.767%	12.312%	2.079%	7.645%	6.033%	6.008%
Average Cost per Share	-\$18.45	-\$109.67	-\$92.53	-\$185.00	-\$492.78	-\$603.99
Percentage of Saving per Share	1.593%	5.329%	1.771%	3.695%	4.031%	4.153%

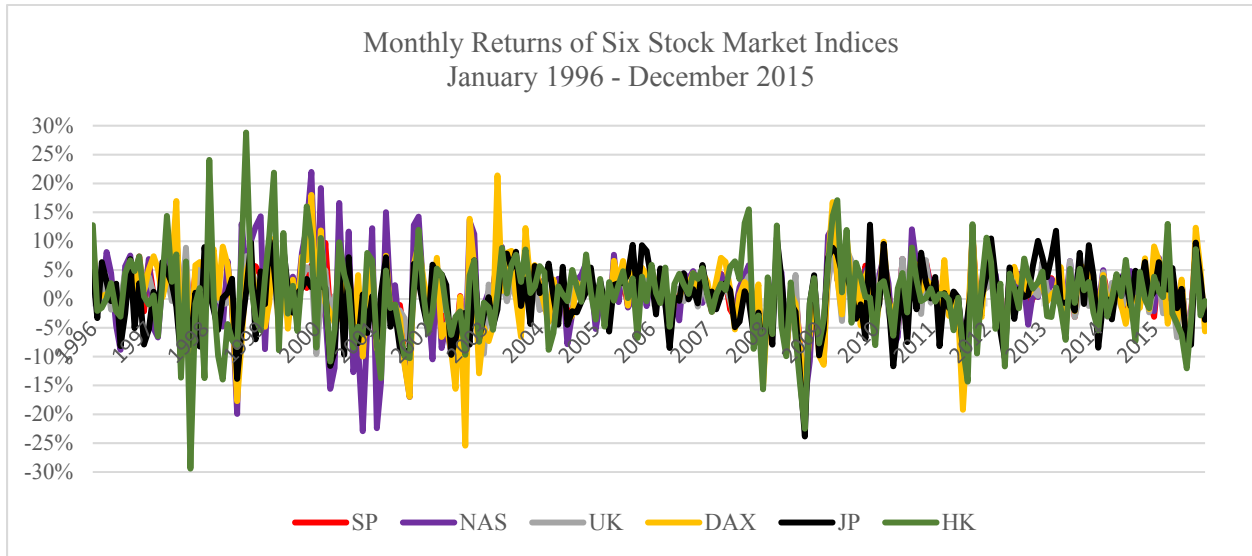
Table 4. Five-Year Rolling Period Results

Returns	S&P 500	NASDAQ	FTSE 100	DAX	NIKKEI 225	Hang Seng
Total trails	180 (100%)	180 (100%)	180 (100%)	180 (100%)	180 (100%)	180 (100%)
MDCA superior	158 (87.78%)	172 (95.56%)	165 (91.67%)	161 (89.44%)	180 (100%)	180 (100%)
MDCA inferior	22 (12.22%)	8 (4.44%)	15 (8.33%)	19 (10.56%)	0 (0%)	0 (0%)
Average Difference	2.123%	4.609%	1.761%	4.041%	3.493%	3.537%
Average Cost per Share						
Total trails	180 (100%)	180 (100%)	180 (100%)	180 (100%)	180 (100%)	180 (100%)
MDCA superior	158 (87.78%)	172 (95.56%)	165 (91.67%)	161 (89.44%)	180 (100%)	180 (100%)
MDCA inferior	22 (12.22%)	8 (4.44%)	15 (8.33%)	19 (10.56%)	0 (0%)	0 (0%)
Average Difference	-\$21.99	-\$82.24	-\$85.53	-\$163.28	-\$393.23	-\$426.77
Average % Difference	-1.884%	-4.038%	-1.636%	-3.117%	-3.359%	-2.742%

Table 5. Ten-Year Rolling Period Results

Returns	S&P 500	NASDAQ	FTSE 100	DAX	NIKKEI 225	Hang Seng
Total trails	120 (100%)	120 (100%)	120 (100%)	120 (100%)	120 (100%)	120 (100%)
MDCA superior	120 (100%)	120 (100%)	120 (100%)	120 (100%)	120 (100%)	120 (100%)
MDCA inferior	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Difference	2.728%	6.895%	2.351%	6.399%	4.177%	5.610%
Average Cost per Share						
Total trails	120 (100%)	120 (100%)	120 (100%)	120 (100%)	120 (100%)	120 (100%)
MDCA superior	120 (100%)	120 (100%)	120 (100%)	120 (100%)	120 (100%)	120 (100%)
MDCA inferior	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Difference	-\$26.62	-\$107.72	-\$108.33	-\$226.56	-\$456.76	-\$546.49
Average % Difference	-2.304%	-5.067%	-2.108%	-4.559%	-3.952%	-3.674%

**Exhibit 1. Monthly Return Chart of Six Major World Stock Market Indices
January 1996 – December 2015**



V. Conclusion

Utilizing a set of international stock market data, we examine a modified version of the Dollar-Cost Averaging (MDCA) strategy. Over the period from January 1996 through December 2015, we find that the MDCA outperforms the conventional DCA approach across all of the six major world stock market indices studied: S&P 500 (USA), NASDAQ Market Index (USA), FTSE 100 (UK), DAX (Germany), Nikkei 225 (Japan) and Hang Seng (Hong Kong). The results are similar in the five-year and ten-year rolling period analysis. The findings are intuitive – as the MDCA investors purchase more (less) shares when the markets go down (up), relative to the DCA investors, they would not only earn higher rate of returns per dollar of investment, but they would also pay less for each and every share of the investment.

This study provides novel results about performance enhancement of the traditional DCA approach. Following the MDCA strategy, investors can take further advantage of the ‘mean-reverting’ characteristics of the stock markets. The MDCA method follows a systematic and disciplined approach to investing. It may help correct investors’ behavioral bias and emotion when stock markets significantly decline or advance. In essence, the MDCA investor truly follows the ‘Holy Grail’ of investing – Buy Low, Sell High.

It appears that the results may be correlated with the volatility of the underlying stock market index. Table 3 and Exhibit 1 show that the three most volatile stock indices – NASDAQ, DAX and Hang Seng also have the best return performance and lowest cost per share paid in the analysis of the MDCA approach. A future study may examine whether the DCA framework performs better when the underlying asset is more volatile. Emerging markets such as Brazil, China, India, and Turkey tend to have more volatile market return properties than the developed

stock markets investigated in this study and thus the MDCA method may further enhance the performance of regular investing program like Individual Retirement Accounts (IRAs) and 401(k)/403(b) accounts.

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