

Testing an Equity Hedge Fund Strategy with Monte Carlo Simulation

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ABSTRACT

A successful hedge fund manager's claim that his strategy of randomly selecting 50 stocks outperforms the S&P 500 is the setting for an interactive Excel assignment. Students create a financial model to simulate the strategy's performance for various time periods. Incorporating a 10-line macro, students are introduced to distribution bootstrapping and the power of Virtual Basic for Applications (VBA). Students use their spreadsheets to examine the impact of varying the number of stocks selected and reasons for why the strategy is likely to be successful only some of the time.

INTRODUCTION

Hedge funds are an important topic for any business school finance program. A text commonly used in investment courses, "Investment Analysis & Portfolio Management" by Reilly and Brown (2012, page 931), states: "One of the most significant developments in the professional asset management industry over the past 20 years has been the emergence of the global market for hedge fund investing." Another commonly-used text, "Investments" by Bodie, Kane, and Marcus (2011, page 903) states: "In short, hedge funds raise the full range of issues that one might confront in active portfolio management."

Hedge fund strategies vary widely and include long-short equity strategies, convertible arbitrage, and merger arbitrage. One strategy in particular attracted media attention in the summer of 2014 when successful hedge fund manager David Harding, founder and CEO of Winton Capital, claimed that his strategy of investing money equally in 50 stocks – chosen randomly – outperforms the S&P 500 more than 99% of the time.

This paper describes an interactive Excel assignment that allows students to test Mr. Harding's strategy. First, students build an Excel spreadsheet to test the strategy for one time period. Using random number and conditional logic functions, they simulate the creation of an equally-weighted portfolio of 50 randomly-selected S&P 500 stocks. They then calculate the portfolio's holding period return and compare it to the return of the S&P 500 total return index. Next, they use Excel's data table feature to model 1,000 trials of the simulation to obtain the strategy's outperformance statistic, which is the percentage of the 1,000 trials for which the strategy's return is better than that of the S&P 500. Using a macro, students give themselves the ability to run the 1,000-trial simulation 100 times to bootstrap the distribution of the strategy's outperformance statistic. Intriguingly, the strategy's outperformance statistic has a mean and

median of 81%, with a standard deviation of 1.2%. Although the strategy does not outperform the index more than 99% of the time, the performance is very impressive.

Students next use their spreadsheets to compare the strategy's performance for four time periods. For two of the time periods, the strategy is more likely to *underperform* the index rather than outperform it. Their results suggest that the strategy is more likely to outperform the S&P 500 index during time periods (1) when the index's larger-weight stocks underperform the smaller-weight stocks and (2) more than half the stocks in the index outperform the index. Students modify their spreadsheets to analyze the strategy's performance for different portfolio sizes (e.g., 25 stocks chosen randomly rather than 50). They also analyze an example of a special case for which some of the inferences they have drawn during their earlier analyses are incorrect.

The strategy's outperformance statistic is the *probability* that the strategy will outperform the index. As a final test of whether the students can apply what they have learned, they are asked to analyze the strategy's *active return*, which is the strategy's return minus the return of the index. This final analysis also sets the stage for an introduction to the topic of analyzing the strategy's risk and transaction costs, which are left to a future assignment.

Madhavan (2002) describes challenges faced by hedge fund managers as they implement their strategies: "A hedge fund's principals spend countless hours developing their investment strategy. After extensive back testing and simulated trading, they finally 'go live' – only to discover that actual performance falls far short of their expectations." Academic researchers document survivorship bias, backfilling bias, and selection bias in hedge fund self-reporting databases (e.g., Malkiel and Saha 2005, Aggarwal and Jorion 2010, and Aiken, Clifford and Ellis 2013). Survivorship bias occurs because some funds have such poor performance that they are shut down. Backfilling bias is due to fund managers' waiting to report fund performance until the fund has a history of good performance and then filling in the history when results are favorable. Selection bias results from managers' decisions to report the performance of some, but not all, of their funds. Biases in the self-reporting databases are consistent with the idea that hedge fund managers must deal with great uncertainty when trying to predict the success of their own strategies: if it were easy to predict which strategies will be successful, there would be little reason for these biases to exist. The assignment described in this paper gives students hands-on experience with some of these challenges and uncertainty.

THE HEDGE FUND STRATEGY AND CLAIM

David Harding is the founder and CEO of Winton Capital, an investment company that manages in excess of \$30 billion.¹ As of 2014, Winton Capital was 10th on a list of the world's largest hedge-fund firms (Effinger and Burton 2015). Mr. Harding ranked 13th on Forbes' list of 25 highest earning hedge fund managers and traders in 2014 (Vardi 2015) and 10th on a list of the most influential people in European capital markets (Dow Jones 2015).

During a July 24, 2014 interview on CNBC, Mr. Harding stated that his strategy of investing money equally in 50 stocks chosen randomly outperformed the S&P 500 more than 99% of the time. A video of the interview is available at: <http://www.cnbc.com/id/101866644> . A video of a CNBC interview the following day, in which several equity analysts question the claim, can be viewed at: <http://video.cnbc.com/gallery/?video=3000295996>. The equity analysts do not believe the claim can be true; but they do not provide a test of the claim.

S&P 500 INDEX, PORTFOLIO RETURNS, AND VALUE-WEIGHTED VERSUS EQUAL-WEIGHTED STRATEGIES

This section can be given to students who have not yet taken an investments course. It provides information on the S&P 500 index, portfolio return calculations, and brief clarification of the terms “value-weighted” and “equal-weighted” portfolio strategies.

The S&P 500 index is managed by the S&P Dow Jones Indices firm. The index is called a “value-weighted” index because the weight in the index of each company is the value of its “free float” (i.e., shares available for trading) multiplied by its share price, divided by the sum of this value for all companies in the index. The index currently consists of 502 company tickers, not 500, because two companies (Google and Discovery Communications) have two share classes included in the index (e.g., tickers GOOG and GOOGL for Google). The S&P 500 month-end Factsheet (S&P Dow Jones Indices 2015a) and the S&P U.S. indices methodology document (S&P Dow Jones Indices 2015b) are excellent resources for obtaining information about the companies and sectors represented in the index and how the S&P Dow Jones Indices firm decides to include, add, or remove companies.

The holding period return (R_p) for a portfolio of n stocks for time period t is:

$$R_p = \sum_{i=1}^n w_i r_i$$

where w_i is the dollar-weight of stock i in the portfolio at the beginning of time period t and r_i is the holding period return of stock i , including dividends, for time period t . The investor’s total return for the holding period incorporates not only the capital gain (or loss) due to the stock’s price change but also the dividend yield.²

To create an investment portfolio to approximate the return of the S&P 500 index, investors would invest in each stock in the index with a weight (w_i) equal to the stock’s weight in the index. Such a strategy is an example of a “value-weighted” portfolio strategy. In contrast, the hedge fund portfolio strategy is an “equal-weighted” portfolio strategy. For each of the 50 stocks chosen randomly, w_i equals $1/50$.

DATA FOR TESTING THE STRATEGY

To test the strategy, students need constituent-level data for the S&P 500 index. Using actual data is problematic for this assignment. First, S&P Dow Jones Indices periodically adds and removes companies (e.g., due to mergers, acquisitions, or changes in a company’s market capitalization) and reweights the constituents to account for dividends or other distribution. Instructors might not have the data subscriptions used by professional money managers to obtain historical index data at the constituent level. Nor might they have the time to replicate the time series of S&P 500 constituents, weights, and returns with Compustat and CRSP data.³

To simplify the analysis, we use an approximation of the S&P 500 index holdings, weights, and returns. Our methodology uses data from the Select Sector SPDR ETF website⁴ for current S&P 500 index holdings and weights and uses price data from the finance.yahoo.com website to calculate returns. Historical weights of the index holdings for the index firms are estimated. The methodology does not replicate changes in constituents but assumes current constituents on the Select Sector SPDR ETF website are held in the index throughout the time

period analyzed. Select Sector SPDR ETF price data for the company's sector are used to backfill data for companies that did not yet exist during some portion of the time period. The methodology does not attempt to replicate the periodic reweighting of constituent weights by S&P Dow Jones Indices nor delisting returns of companies replaced due to mergers or acquisitions.

Using this methodology and S&P 500 constituents as of September 9, 2015, we approximated the S&P 500 data needed for four time periods. The time periods were selected by visually observing a daily chart for the S&P 500 index and selecting 2 time periods that had a return of more than 5% and 2 time periods with a return of less than -5% within the 12 months prior to September 9, 2015. The time periods are:

- July 17, 2015, to August 25, 2015
- January 15, 2015, to July 17, 2015
- October 15, 2014, to December 2, 2014
- September 9, 2014, to October 16, 2014

A data spreadsheet for each period is available as an Excel file at: <http://www.unm.edu/~lboni01/MC1/>. Each file includes the list of constituents, weight in the S&P 500 at the beginning of the time period and holding period return (including dividend yield), and holding period return of the approximated index. Students first work with the data for July 17, 2015 to August 25, 2015. Exhibit 1 shows data for the first 5 companies.

Exhibit 1. First 5 Rows of Data Spreadsheet for July 17, 2015 to August 25, 2015

	A	B	C	D	E	F
			Weight at beginning of time period	Holding period return		Holding period return of the approximated index
1	Ticker	Company Name				
2	A	Agilent Technologies Inc	0.000703	-0.139925		-0.1198
3	AA	Alcoa Inc	0.000745	-0.224492		
4	AAL	American Airlines Group Inc.	0.001477	-0.092090		
5	AAP	Advance Auto Parts Inc	0.000661	0.008957		
6	AAPL	Apple Inc.	0.039579	-0.196038		

To calculate the holding period return (R_p) for the S&P 500 index (including dividends), students can use Excel's *sumproduct* function with cells C2:C503 and D2:D503. The calculation confirms that the S&P 500 index total return for the period is -11.98%, as shown in cell F2 of the data file.

SPREADSHEET TO SIMULATE STRATEGY FOR FIRST TIME PERIOD

We show students one approach for adding formulas to the Excel data worksheet to randomly select 50 stocks to create an equal-weighted portfolio.⁵ A screenshot of the first 8 rows of the worksheet we build with students is shown in Exhibit 2. (Columns A through F are the data file provided to students for July 17, 2015 to August 25, 2015, shown in Exhibit 1.)

Exhibit 2. First 8 Rows of Spreadsheet Example of One Simulation of the Strategy

	A	B	C	D	E	F	G	H	I	J	K	L
1	Ticker	Company Name	Weight at beginning of time period	Holding period return		Holding period return of the approximated index	random #	Random # value (50th largest) =		50	EW 50 Strategy return =	-11.21%
2	A	Agilent Technologies Inc	0.000703	-0.139925		-0.1198	0.355321	0.90622				
3	AA	Alcoa Inc	0.000745	-0.224492			0.132967					
4	AAL	American Airlines Group Inc.	0.001477	-0.092090			0.897445					
5	AAP	Advance Auto Parts Inc	0.000661	0.008957			0.892707					
6	AAPL	Apple Inc.	0.039579	-0.196038			0.786483					
7	ABBV	AbbVie Inc.	0.006401	-0.132590			0.983862			1	-13.2590%	
8	ABC	AmerisourceBergen Corp	0.001308	-0.137090			0.666503					

The instructions for creating the spreadsheet are:

Step	Cell(s)	Cell Contents	Instructions
1	G2	=RAND()	Use Excel function to obtain random number.
2	G3:G503		Copy cell G2 and paste to cells G3 to G503.
3	I1	=LARGE(G2:G503,50)	Use Excel function to obtain the random number that is the 50 th largest value of the 502 random numbers.
4	J2	=IF(G2>=I1, 1, " ")	Use conditional logic "IF" statement to flag the 50 stocks with random number greater or equal to the value in cell I1.
5	J3:J503		Copy cell J2 and paste to cells J3 to J503.
6	K2	=IFERROR(J2*D2," ")	Use conditional logic "IFERROR" statement to obtain the return for each of the 50 stocks with random number greater or equal to the value in cell I1.
7	K3:K503		Copy cell K2 and paste to cells K3 to K503.
8	J1	=SUM(J2:J503)	This cell checks that 50 stocks were selected.
9	L1	=AVERAGE(K2:K503)	This cell calculates the portfolio equal-weighted return.

The equal-weighted portfolio return for the 50 stocks is -11.21% (shown in cell L1), which is better than the index return of -11.98%. With each click of the "F9" key, the spreadsheet randomly selects 50 stocks for a portfolio and calculates its equal-weighted return in cell L1.

EXCEL'S DATA TABLE FEATURE TO MODEL 1,000 TRIALS

We now add formulas and use Excel's data table feature to model 1,000 trials of the strategy for the July 17, 2015 to August 25, 2015, time period. A screenshot of the first 12 rows of the completed worksheet is shown in Exhibit 3.

Exhibit 3. First 12 Rows of Spreadsheet Example for 1,000 Trials of the Strategy

	G	H	I	J	K	L	M	N	O	P	Q
1	random #	Random # value (50th largest) = 0.90622		50	EW 50 Strategy return =	-11.21%					
2	0.355321										
3	0.132967										
4	0.897445										
5	0.892707										
6	0.786483										
7	0.983862			1	-13.2590%						
8	0.666503										
9	0.332434										
10	0.675279						EW N ret	Check #	EW N - Index ret	Flag +	
							-11.21%	50	0.77%		1
11	0.586845						-9.78%	50	2.20%		1
12	0.730348						-10.67%	50	1.31%		1

Number of trials	1,000	
Number & % winners	813	81.3%
Average return delta	0.96%	

The instructions for adding columns N through Q to the spreadsheet are:

Step	Cell(s)	Cell Contents	Instructions
1	N10	=L1	This is the strategy's return for one simulation.
2	O10	=J1	This is the check that 50 stocks are selected.
3	P10	=N10-F2	This cell calculates the strategy return minus the index return.
4	Q10	=IF(P10>0, 1, " ")	Flag = 1 if the strategy outperforms the index.
5	N11:Q1010		Create data table (see instructions below).
6	P4	=COUNT(P11:P1010)	Count the number of trials.
7	P5	=SUM(Q11:Q1010)	Determine the number of trials that outperformed.
8	P6	=AVERAGE(P11:P1010)	Calculate the average active return.
9	Q5	=P5/P4	Calculate percentage of trials that outperformed.

The instructions for creating the data table are:

- 1) Highlight cells M10:Q1010.
- 2) In the ribbon, select: Data, What-If, Data Table.
- 3) Leave the "row input cell" blank and put any empty cell (outside data table cells) in "column input cell" (e.g., use cell R2 for the column input cell).

In Exhibit 3 the summary statistics for the 1,000 randomly-chosen portfolios of 50 stocks, starting in row 11 (we exclude the trial in row 10) and ending in row 1010, indicate that 813 of the portfolios (81.3%) outperformed the index. The average of the active return (which equals the portfolio's return minus the index return) for the 1,000 portfolios was 0.96%.

MACRO TO BOOTSTRAP THE DISTRIBUTION OF THE OUTPERFORMANCE STATISTIC

When each student has created the spreadsheet model, we ask students to hit "F9" to recalculate the percentage of 1,000 trials that the strategy outperforms the index. To quickly get an estimate of the range of outcomes, we ask the students to raise their hands if they found the strategy beat the index more than half of the time, then we ask how many of them beat the index more than 60% of the time, etc. We then ask the students to run the 1,000-trial simulation 10 times to observe a range of outcomes for their summary statistic. Intriguingly, the strategy outperforms the S&P 500 index for about 80% of the 1,000 trials.

We next discuss the observation that each time students recalculated their 1,000-trial simulations, they obtained slightly different estimates for the outperformance statistic. This introduces them to the concept that the outperformance statistic is a random variable, and we would like to know its distribution.

To obtain an estimate of the distribution, we will "bootstrap" the distribution by obtaining 100 estimates for the outperformance statistic. To obtain the 100 estimates, we will need to run the 1,000-trial simulation 100 times. We ask students how long they think it will take them to manually perform and record the results of 100 runs of the 1,000-trial simulation. We tell them that instead of doing that, we can save a lot of time by modifying the spreadsheet to let Excel do the work for them. We then introduce them to Excel's programming language, VBA, and spreadsheet macros. We then show them how to add a macro to their spreadsheets to run the 1,000 trial simulation 100 times.

For the macro, the outperformance statistic we need from each of the 1,000 trial simulations is in cell Q5. First, in the spreadsheet, we point cell S2 to cell Q5 (i.e. we enter "=Q5" in cell S2.) The code for macro **MC100**, provided in Exhibit 4, produces results in column S of the spreadsheet.⁶ An example of the first 17 rows of the spreadsheet, after incorporating the macro, is shown in Exhibit 5. Macro **MC100** copies and pastes the result from cell Q5 (by using the value in cell S2) for 100 runs of 1,000 trials in cells S3:S102. In column V of the spreadsheet, we use Excel's *percentile.inc* function (using column U to indicate percentile of interest) to obtain the distribution for the 100 results produced by the macro.

Exhibit 4. Macro Code for MC100 to Perform 100 Runs of the 1,000-Trial Simulation

```
Sub MC100()  
,  
' MC100 Macro  
,  
With ActiveSheet.Range("S2").Select  
Selection.Copy  
  
For j = 1 To 100
```

ActiveCell.Offset(1, 0).Select
 Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
 :=False, Transpose:=False

Next j

End With

End Sub

Exhibit 5. Spreadsheet Example for 100 Runs of the 1,000-Trial Simulation

	N	O	P	Q	R	S	T	U	V	W	X
1						Macro MC100 copies and pastes value of cell Q5 for 100 runs (1,000-trials each) in cells S3:S102. Excel's <i>percentile.inc</i> function reports distribution for the 100 runs in column V.					
2						81.3%		1.00	0.838		
3						80.6%		0.99	0.836		
4	Number of trials		1,000			79.0%		0.95	0.831		
5	Number & % winners		813	81.3%		81.7%		0.90	0.828		
6	Average return delta		0.96%			80.7%		0.75	0.817		
7						78.5%		0.50	0.810		
8						82.0%		0.25	0.801		
9	EWN ret	Check #	EWN - Index ret	Flag +		81.5%		0.10	0.794		
10	-11.21%	50	0.77%	1		83.4%		0.05	0.790		
11	-9.78%	50	2.20%	1		81.5%		0.01	0.779		
12	-10.67%	50	1.31%	1		79.2%		0.00	0.776		
13	-10.76%	50	1.22%	1		80.8%					
14	-10.93%	50	1.05%	1		83.8%		mean	0.810		
15	-11.52%	50	0.45%	1		82.2%		median	0.810		
16	-11.55%	50	0.43%	1		80.8%		std	0.0128		
17	-13.08%	50	-1.10%			77.6%					

COMPARING THE STRATEGY FOR FOUR TIME PERIODS AND INFERENCES ABOUT PERFORMANCE

Students can quickly copy and paste into their spreadsheet the data for each of the other three time periods and repeat the analysis. Table 1 reports the index total return for each period and the distribution of the outperformance statistic. Distributions are calculated using 100 runs of the 1,000-trial simulation for each period. Of course, the distribution results change, even if only slightly, each time the macro is run.⁷

Table 1 also reports the market-weighted return of the largest 50 companies in the index for comparison with the index for each period. The equal-weighted return for the 502 stocks in the index is also reported along with the percentage of the 502 stocks that had a return greater than the index return for the period. For example, for the first time period, a value-weighted portfolio of the largest (market-value) 50 stocks in the index had a return of -13.19%; an equal-

Table 1. Analysis for 50-Stock Strategy for 4 Time Periods.

	July 17, 2015, to August 25, 2015	January 15, 2015, to July 17, 2015	October 15, 2014, to December 2, 2014	September 9, 2014, to October 16, 2014
S&P 500 Total Return	-11.98%	7.84%	11.44%	-6.24%
<i>Random 50-Stock Equally-Weighted Strategy Outperformance Statistic</i>				
(Based on 100 Runs of 1,000-Trial Simulations):				
Mean	0.809	0.268	0.644	0.264
Standard Deviation	0.0117	0.0122	0.0141	0.0154
100% Maximum	0.847	0.305	0.676	0.297
99%	0.841	0.304	0.676	0.295
95%	0.832	0.286	0.668	0.285
90%	0.825	0.281	0.664	0.282
75%	0.817	0.276	0.654	0.275
Median	0.808	0.268	0.644	0.266
25%	0.801	0.260	0.635	0.253
10%	0.796	0.251	0.627	0.240
5%	0.794	0.249	0.620	0.235
1%	0.789	0.244	0.613	0.228
0% Minimum	0.788	0.241	0.607	0.225
<i>Additional Information:</i>				
Market-Weighted Return (Largest 50 Stocks)	-13.19%	10.32%	10.58%	-5.40%
Equal-Weighted Return (S&P 500 Stocks)	-11.00%	6.41%	11.91%	-6.76%
Percentage of S&P 500 stocks with return > S&P 500 return	55.8%	46.0%	51.6%	47.2%
<i>Memo:</i>				
Actual S&P 500 return*	-11.97%	7.82%	11.26%	-6.14%

* Calculated using S&P 500 index data at the WSJ website: <http://quotes.wsj.com/index/XX/SPXT/historical-prices>

weighted portfolio of all 502 stocks had a return of -11.00%; and 55.8% of the 502 stocks had a return better than the S&P 500 index return of -11.98%.

For two of the time periods, the strategy was more likely to *underperform* the index rather than outperform it. The results in Table 1 suggest that the strategy is more likely to

outperform the index when: (1) the larger-weight stocks underperform the smaller-weight stocks and (2) more than half the stocks in the index outperform the index.

To further analyze these inferences, students can easily modify their spreadsheets to examine the strategy's performance when the number of stocks in the portfolio is different from 50 stocks. Table 2 reports the median and standard deviation of the outperformance statistic for each time period for various cases of portfolio size (e.g., 25 stocks chosen randomly rather than 50). These results suggest several more inferences can be drawn.

1. For portfolios of 502 stocks, all stocks are selected each time and the strategy return equals the equal-weighted return for the "all stock" portfolio. The outperformance statistic equals either 100% or 0%, depending on whether the equal-weighted return is better or worse than the S&P 500 index return. The standard deviation equals 0.
2. For 1-stock portfolios, the probability of being randomly selected is equal for each of the 502 stocks. The median of the outperformance statistic is about equal to the percentage of stocks with a return greater than that of the index.
3. When the percentage of stocks with return greater than the index's return is more (less) than 50%, the median of the outperformance statistic increases (decreases) monotonically with portfolio size (i.e., as the number of stocks increases from 1 to 502).

At this point, we introduce the students to the concept of confirmation bias, which is the tendency to look only for evidence that confirms a belief. We explain that careful analysis requires looking also for evidence that could be contradictory. As an illustration, we construct an extreme example of a hypothetical scenario in which just one of the S&P 500 stocks has a positive return and the return for each of the other stocks equals 0. Although the example is hypothetical, it will help us gain a better understanding of the factors that determine whether the equal-weighted strategy is likely to outperform the index.

For our hypothetical case, we choose Starbucks as the stock with a non-zero return, and we assume it has a return of 50%. At the beginning of the first time period we examined, Starbucks had an index weight of 0.4453% and was not one of the largest 50 stocks in the index. For the hypothetical case, because the returns of all other stocks are 0, the S&P 500 total return would simply equal 0.2226%, which is Starbucks' weight (0.004453) multiplied by its return (50%). Using the spreadsheet model, we obtain the results reported in the last column of Table 2. The outperformance statistic is dismal, with a median of less than 20% for all portfolio sizes. Our inference that the strategy is less likely to outperform the index when less than half the stocks in the index outperform the index holds: only Starbucks (0.2% of the 502 stocks) outperformed.

Our inference that the strategy is more likely to outperform the index when the larger-weight stocks underperform the smaller-weight stocks does not hold, however. The largest 50 stocks have a weighted-average return of 0%, which is less than the index return of 0.2226%. But for all portfolio sizes, the strategy is more likely to underperform than outperform the index.

Finally, we examine the inference that the median of the outperformance statistic appears to increase (decrease) monotonically with portfolio size when the percentage of stocks with return greater than the index's return is more (less) than 50%. In the Starbucks case, the percentage of stocks with return greater than the index is much less than 50% (just 0.2%). If our inference is correct, the median of the outperformance statistic should decrease monotonically as the number of stocks in the portfolio increases from 1 to 502. Instead, it increases monotonically to 19.8% for the 100-stock strategy. It then drops to 0% for the 250-stock case. Examining the

Table 2. Analysis of Strategy for Various Portfolio Sizes.

		July 17, 2015, to August 25, 2015	January 15, 2015, to July 17, 2015	October 15, 2014, to December 2, 2014	September 9, 2014, to October 16, 2014	Starbucks Example
	S&P 500 Total Return	-11.98%	7.84%	11.44%	-6.24%	0.22%
<i>Random Equally-Weighted Strategy Outperformance Statistic</i>						
<u># of Stocks</u>	(Based on 100 Runs of 1,000-Trial Simulations):					
502	Median	1.000	0.000	1.000	0.000	0.000
	Standard Deviation	0.0000	0.0000	0.0000	0.0000	0.0000
250	Median	0.996	0.036	0.858	0.032	0.000
	Standard Deviation	0.0021	0.0058	0.0120	0.0055	0.0000
100	Median	0.904	0.183	0.705	0.176	0.198
	Standard Deviation	0.0096	0.0115	0.0147	0.0118	0.0141
50	Median	0.813	0.266	0.645	0.266	0.101
	Standard Deviation	0.0124	0.0153	0.0137	0.0135	0.0091
25	Median	0.728	0.326	0.602	0.332	0.049
	Standard Deviation	0.0126	0.0161	0.0137	0.0150	0.0056
10	Median	0.659	0.375	0.591	0.396	0.020
	Standard Deviation	0.0165	0.0171	0.0160	0.0147	0.0048
1	Median	0.560	0.460	0.518	0.471	0.002
	Standard Deviation	0.0173	0.0136	0.0148	0.0141	0.0014
<u>Additional Information:</u>						
	Market-Weighted Return (Largest 50 Stocks)	-13.19%	10.32%	10.58%	-5.40%	0.00%
	Equal-Weighted Return (S&P 500 Stocks)	-11.00%	6.41%	11.91%	-6.76%	0.10%
	Percentage of S&P 500 stocks with return > S&P 500 return	55.8%	46.0%	51.6%	47.2%	0.2%

holding period return formula, we can see that for 100-stock portfolios, if Starbucks is selected, the portfolio's return will be $(1/100)*50\%$, or 0.5%, which is greater than the index return of 0.2226%. When Starbucks is not selected, the portfolio return is 0%. The probability of Starbucks being selected is 1 in 5, which about equals the 19.8% we obtained for the 100-stock strategy. But for 250-stock portfolios, if Starbucks is selected, the portfolio's return will be $(1/250)*50\%$, or 0.2%. Thus, the 250-stock portfolio strategy can never outperform the index.

EXTENDING THE ANALYSIS FOR THE ACTIVE RETURN STATISTIC

The outperformance statistic we have examined is the *probability* that the strategy will outperform the index. To test students' comprehension, they can be asked to analyze the strategy's *active return*, which equals the strategy's return minus the return of the index. The spreadsheet, pre-macro, calculates active return (see column P of Exhibit 3). The active return is a random variable. Its distribution can be obtained from any 1,000-trial simulation (the macro is not used). This analysis opens the conversation to an important topic not yet discussed – the strategy's risk – which can be addressed in a future assignment.

CONCLUSIONS

Bodie, Kane, and Marcus (2011, page 832) emphasize “evaluating hedge funds poses considerable practical challenges.” Hedge fund strategies are typically much more sophisticated than the strategy examined here. Strategies often incorporate leverage, short selling, multiple assets, arbitrage, derivatives, or illiquid securities. Although the strategy examined in this Excel assignment is not complex, the assignment is still quite useful because it can be used early in the student's program of study. In particular, instructors can use the assignment to achieve four important objectives.

First, finance professionals who have programming skills have a great advantage over those who do not. By exposing students to Excel's programming language (VBA) early in their course of study, students have time to plan and are motivated to register for one or more programming courses. From our experience and conversations with instructors at other business schools, we conclude that too often students do not experience the benefits of programming languages (such as VBA) until they use an Excel macro for an assignment or two during their final semester. At that point, students are likely to want to learn more but are unable to take any semester-long programming courses prior to graduation.

Second, students will likely have the opportunity to use Excel to create simulation models in many of their finance courses. Students benefit from learning early in their coursework that producing an outcome from a simulation is different from bootstrapping the distribution of simulation outcomes. Third, students benefit from learning early that using financial models alone – not in combination with careful analysis – can lead to incorrect inferences.

Finally, finance professionals who have an understanding of behavioral biases are better able to perform careful analyses. For example, a common mistake when performing an analysis is looking for information that confirms the analyst's belief rather than seeking out contradictory evidence. This is an example of *confirmation bias*. In the assignment, students analyze the hypothetical Starbucks example, which provides information that contradicts some of the inferences they had drawn from their earlier analyses. By explaining confirmation bias while discussing the Starbucks example, instructors may motivate students to register for a course in

behavioral finance (if offered) or to add a text on behavioral finance (e.g., Pompian 2006) to their reading lists.

ENDNOTES

¹ See the Winton Capital website < <https://www.wintoncapital.com/AboutUs/> > Accessed September 20, 2015.

² Lei and Li (2015) show the importance of using the S&P 500 total return (i.e. including the dividend component) when using the index as the benchmark to measure portfolio performance.

³ See Dobelman, Kang, and Park (2014) for a discussion of using CRSP and Compustat to replicate S&P 500 data.

⁴ <http://www.sectorspdr.com/sectorspdr/features/about>

⁵ For alternative approaches, see Benninga (2014), pages 736 – 744.

⁶ See Wann (2015, page 26) or Benninga (2014), or search with Google using the phrase “create or delete macro Excel” for instructions for adding macros to spreadsheets.

⁷ For comparison as to how well the 4 datasets approximate the actual S&P 500 total return, Table 1 also reports returns that were calculated using the total return index data from the Wall Street Journal website: <http://quotes.wsj.com/index/XX/SPXT/historical-prices>. For each of the 4 periods, the approximated index total return is within 20 basis points of the actual S&P 500 total return.

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