Do Stocks Outperform Treasury Bills?*

Initial Draft: January 2017

Current Draft: August 2017

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*I thank for valuable comments Jennifer Conrad, Wayne Ferson, Campbell Harvey, Bruce Grundy, Mike Cooper, Philip Bond, Andreas Stathapoulos, Feng Zhang, Peter Christoffersen, Todd Mitton, Ed Rice, Ran Duchin, Jennifer Koski, Ilya Dichev, Luke Stein, Sunil Wahal, George Aragon, Seth Pruitt, Thomas Gilbert, David Schreindorfer, Kumar Venkataraman, Kris Jacobs, Roni Michaely, Bjorn Flesaker, Baozhong Yang, as well as seminar participants at the University of Washington, Arizona State University, Chinese University of Hong Kong, Simon Fraser University, and participants at the University of British Columbia Summer Research and Chicago Quantitative Alliance Spring conferences, and Goeun Choi for laudable research assistance.

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Abstract

Most common stocks do not. Slightly more than four out of every seven common stocks that have appeared in the CRSP database since 1926 have lifetime buy-and-hold returns, inclusive of reinvested dividends, less than those on one-month Treasuries. When stated in terms of lifetime dollar wealth creation, the entire gain in the U.S. stock market since 1926 is attributable to the best-performing four percent of listed companies. These results highlight the important role of positive skewness in the cross-sectional distribution of stock returns. The skewness of multi-period returns arises both from positive skewness in monthly returns and because the compounding of random returns induces skewness. The results help to explain why active strategies, which tend to be poorly diversified, most often underperform market averages.

I. Introduction

The question posed in the title of this paper may seem nonsensical. The fact that stock markets provide long term returns that exceed the returns provided by low risk investments such as government obligations has been extensively documented, for the U.S. stock market as well as for many other countries.[1] In fact, the *degree* to which stock markets outperform is so large that there is wide-spread reference to the "equity premium puzzle."[2]

The evidence that stock market returns exceed returns to government obligations in the long run is based on broadly diversified stock market portfolios.[3] In this paper, I document that most individual U.S. common stocks provide buy-and-hold returns that fall short of those earned on one-month U.S. Treasury Bills, implying that the positive return premium observed for broad equity portfolios are attributable to relatively few stocks.[4] I rely on the Center for Research in Securities Prices (CRSP) monthly stock return database, which contains all common stocks listed on the NYSE, Amex, and NASDAQ exchanges. Of all monthly common stock returns contained in the CRSP database from 1926 to 2016, only 47.8% are larger than the one-month Treasury rate. In fact, less than half of monthly CRSP common stock returns are positive.

When focusing on stocks' full lifetimes (from the beginning of sample or first appearance in CRSP through the end of sample or delisting from CRSP), just 42.6% of common stocks, slightly less than three out of seven, have a buy-and-hold return (inclusive of reinvested dividends) that exceeds the return to holding one-month Treasury Bills over the same horizon.

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[1] See, for example, the evidence compiled in chapter 10 of Corporate Finance, by Stephen Ross, Randolph Westerfield, and Jeffrey Jaffe, McGraw-Hill Irwin, 2013.

[2] Mehra and Prescott (1984) first drew attention to the magnitude of the equity premium for the broad U.S. stock market. Dozens of papers have since sought to explain the premium.

[3] The equity premium is most often measured by market returns that are constructed as capitalization-weighted averages of returns to individual securities. Those studies that consider equal-weighted average returns generally report even higher stock market performance.

[4] Since first circulating this paper, I have become aware of blog posts that document findings with a similar, but less comprehensive, flavor. See "The risks of owning individual stocks" at http://blog.alphaarchitect.com/2016/05/21/the-risks-of-owning-an-individual-stock/ and "The capitalism distribution" at http://www.theivyportfolio.com/wp-content/uploads/2008/12/thecapitalismdistribution.pdf.

More than half of CRSP common stocks deliver negative lifetime returns. The single most frequent outcome (when returns are rounded to the nearest 5%) observed for individual common stocks over their full lifetimes is a loss of 100%.[5]

Individual common stocks tend to have rather short lives. The median time that a stock is listed on the CRSP database between 1926 and 2016 is seven and a half years. To assess whether individual stocks generate positive returns over the full ninety years of available CRSP data, I conduct bootstrap simulations. In particular, I assess the likelihood that a strategy that holds one stock selected at random during each month from 1926 to 2016 would have generated an accumulated 90-year return (ignoring any transaction costs) that exceeds various benchmarks. In light of the well-documented small-firm effect (whereby smaller firms earn higher average returns than large, as originally documented by Banz, 1980) it might be been anticipated that individual stocks would tend to outperform the value-weighted market. In fact, repeating the random selection process many times, I find that the single stock strategy underperformed the value-weighted market in ninety six percent of the simulations, and underperformed the equal-weighed market in ninety nine percent of the simulations.[6] The single-stock strategy outperformed the one-month Treasury bill over the 1926 to 2016 period in only twenty seven percent of the simulations.

The fact that the overall stock market generates long term returns sufficiently large to be referred to as a puzzle, while the majority of individual stocks fail to even match Treasury bills, can be attributed to the fact that the cross-sectional distribution of stock returns is positively

[5] The CRSP database ceases coverage if a stock is delisted by the stock exchange. CRSP obtains a final delisting price for such stocks based on a trade price or quotation from "another exchange or over-the-counter." In the case of involuntary delisting this final price is often small, but not necessarily zero. Hence the computed lifetime return for such a stock is very often close to, but not exactly, -100%.

[6] The equal-weighted market return exceeds the value-weighted return over long time periods, and thus provides a higher hurdle, both because of the small firm effect and because of the active rebalancing implicit in equal weighting. For discussion, see Asparouhova, Bessembinder, and Kalcheva (2013).

skewed.[7] Simply put, very large positive returns to a few stocks offset the modest or negative returns to more typical stocks. The importance of positive skewness in the cross-sectional return distribution increases for longer holding periods, due to the effects of compounding, as discussed further in Section V.

Perhaps the most striking illustration of the degree to which outperformance is concentrated in relatively few stocks arises when measuring aggregate stock market wealth creation. I define stock market wealth creation as an accumulation of value in excess of the value that would have obtained had the invested capital earned one-month Treasury bill interest rates. I calculate that the approximately 25,300 companies that issued stocks appearing in the CRSP common stock database since 1926 are collectively responsible for lifetime shareholder wealth creation of nearly $35 trillion dollars, measured as of December 2016. However, the ninety top-performing companies, slightly more than one third of one percent of the total, collectively account for over half of the wealth creation. The 1,092 top-performing companies, slightly more than four percent of the total, account for all of the wealth creation. That is, the other ninety six percent of companies whose common stock has appeared on CRSP collectively generated lifetime returns that match the one-month Treasury bill.

At first glance, the finding that most stocks generate negative lifetime return premia (relative to Treasury Bills) is difficult to reconcile with models that presume investors to be risk-averse, since those models imply a positive anticipated return premium.[8] Note, however, that implications of standard asset pricing models are with regard to stocks' *mean* excess return,

[7] That individual stock returns are positively skewed, and that return skewness declines as portfolios are diversified, has been recognized at least since Simkowitz and Beedles (1978). Numerous authors have assessed the cross-sectional relation between mean returns and skewness (either individual stock return skewness or the co-skewness of stock returns with the broader market, generally reporting lower returns for more highly skewed stocks, consistent with an investor preference for skewness as implied by Kraus and Litzenberger (1976). See for example Harvey and Siddique (2000), Mitton and Vorkink (2007), Conrad, Dittmar and Ghysels (2013) and Amaya, Christoffersen, Jacobs, and Vasquez (2016).

[8] I use the terms return premium and excess return interchangeably, in each case referring to the difference between the stock return and the Treasury return.

while the fact that the majority of common stock returns are less than Treasury returns reveals that the *median* excess return is negative. Thus, the results are not necessarily at odds with the implications of standard asset pricing models. However, the results challenge the notion that most individual stocks generate a positive return premium, and highlight the importance of skewness in the cross-sectional distribution of stock returns.

These results complement recent time series evidence regarding the stock market risk premium. Savor and Wilson (2013) show that approximately sixty percent of the cumulative stock market return premium accrues on the relatively few days where macroeconomic announcements are made. Related, Lucca and Moench (2016) show that half of the equity premium in U.S. markets since 1980 accrues on the day before Federal Reserve Open Market Committee (FOMC) meetings. Those papers demonstrate the importance of not being out of the market at key points in time, while the results here show the importance of not omitting key stocks from investment portfolios.

For those who are inclined to focus on the mean and variance of portfolio returns, the results presented here reinforce the importance of portfolio diversification. Not only does diversification reduce the variance of portfolio returns, but non-diversified stock portfolios are subject to the risk that they will fail to include the relatively few stocks that, ex post, generate large cumulative returns. Indeed, as noted by Ikenberry, Shockley, and Womack (1998) and Heaton, Polson, and Witte (2017), positive skewness in returns helps to explain why active strategies, which tend to be poorly diversified, most often underperform relative to market-wide benchmarks. At the same time, the results potentially justify the selection of less diversified portfolios by those investors who strongly value skewness, i.e., the possibility of large positive outcomes, despite the knowledge that a poorly-diversified portfolio is more likely to underperform the overall market. Further, the results highlight the potentially large gains from

active stock selection *if* the decision maker has a comparative advantage in identifying in advance the stocks that will generate extreme positive returns.

Ingersoll, Spiegel, Goetzmann, and Welch (2007) note that performance evaluation measures such as the Sharpe Ratio or Jensen's Alpha were designed to be used in a world where asset returns confirm to simple distributions such as normal or lognormal. The evidence reported here indicates that longer-term stock returns in particular do not conform to these simple distributions, implying the potential need for reassessment of standard methods of evaluating investment management performance.

I find that rates of underperformance are higher for stocks that have entered the CRSP database in recent decades. This recent evidence supports in particular the implications of Noe and Parker (2004) that the internet economy will be associated with "winner take all" outcomes, characterized by highly skewed returns.[9] It is well known that returns to early stage equity investments such as venture capital are highly risky and positively skewed, as most investments generate losses that are offset by spectacular gains on a few investments. The evidence here shows that such a payoff distribution is not confined to pre-IPO investments, but also characterizes the structure of longer term returns to investments in public equity, particularly smaller firms and firms listed in recent decades.

II. The Distribution of Buy-and-Hold returns

I study returns, inclusive of reinvested dividends, for all CRSP common stocks (share codes 10, 11, and 12) from July 1926 to December 2016.[10] The starting date is the earliest for

[9] The evidence is also broadly consistent with the Gullon, Larkin, and Michaely (2017) finding of increasing industry concentration accompanied by abnormally high returns to successful firms in recent years.

[10] The sample excludes fifty seven common stocks for which CRSP data on shares outstanding is always equal to zero. These stocks were listed for between one and nineteen months, and thirty nine of the fifty seven stocks had

which one-month Treasury bill data is available from Kenneth French's website. The data includes 25,967 distinct CRSP permanent numbers (PERMNOs), which I refer to as stocks.[11] I include in all calculations the CRSP delisting return for those stocks removed from listing prior to the end of 2016. When studying periods longer than one month I create buy-and-hold returns by linking monthly gross (one plus) returns. Buy-and-hold returns capture the experience of a hypothetical investor who reinvests dividends but does not otherwise alter her position after the initial purchase of shares.[12]

a. Monthly Returns

Panel A of Table 1A reports some summary statistics for the 3,575,216 monthly common stock returns contained in the CRSP database from July 1926 to December 2016. The data confirms that the mean return premium is positive, as the average monthly return is 1.13%, compared to an average one-month Treasury bill rate of 0.37%. Several additional observations regarding monthly common stock returns are noteworthy. First, monthly returns are positively skewed, with a skewness coefficient (the third sample central moment standardized by the variance to the 3/2 power) equal to 6.96. Second, monthly returns are highly variable, with a standard deviation of 18.1%. Third, and most important, only a minority, 47.8%, of CRSP

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a negative mean monthly return. Their inclusion would therefore strengthen the conclusions drawn here. The sample also excludes 14 common stocks that entered the database during December 2016, but for which no return data was yet available.

[11] According to the CRSP data guide (available at http://www.crsp.com/files/data_descriptions_guide_0.pdf), the PERMNO is "a unique permanent identification number assigned by CRSP to each security. Unlike the CUSIP, Ticker Symbol, and Company Name, the PERMNO neither changes during an issue's trading history, nor is it reassigned after an issue ceases trading. The user may track a security through its entire trading history in CRSP's files with one PERMNO, regardless of name or capital structure changes." In a relatively few cases a firm issues multiple classes of common stock, each of which is assigned a unique PERMNO by CRSP. I consider each separately, since returns can differ across share classes. However, when considering lifetime wealth creation in Section IV, I aggregate wealth creation across share classes.

[12] However, buy-and-hold returns do not capture the investment experience of investors in aggregate, as investors fund new equity issuances and receive the proceeds of share repurchases, but do not reinvest dividends. The experience of investors in aggregate is considered in Section V.

monthly stock returns exceed the one-month Treasury return in the same month. In fact, less than half (48.4%) of monthly stock returns are positive.[13]

The results contained in Table 1A pertain to the pooled distribution of all 3.58 million monthly common stock returns in the database, applying equal weight to each. As such the outcomes reflect both time series and cross sectional variation. To focus specifically on the cross sectional distribution, I compute the skewness of the return distribution separately for each calendar month. The resulting standardized skewness coefficient is positive for 1,005 of the 1,086 months, and the time series mean of the monthly skewness coefficients is 2.56. Thus the data shows that positive cross-sectional skewness is pervasive in the CRSP monthly return data.

b. Annual and Decade Returns

Panels B and C of Table 1A report summary statistics for CRSP common stock returns computed on a calendar year and decade basis, respectively. The full July 1926 to December 2016 database includes 90 ½ years. I assign the last half of 1926 to the first decade. The non-overlapping decades are defined as July 1926 to December 1936, January 1937 to December 1946, January 1947 to December 1956, etc. For stocks that list or delist within the calendar period, I measure the return over the portion of the calendar interval that the stock was included in the CRSP data.[14] For each stock, I compute the simple sum of returns as well as the buy-and-hold return for the interval. The former reveals whether the arithmetic mean return is positive, while the latter reveals the magnitude of the actual gain or loss to a hypothetical investor who reinvests dividends but otherwise does not trade. I also compute the geometric mean of monthly

[13] Ironically, less than half are negative as well, as 4.76% of monthly returns are exactly zero. The relatively large number of zero returns likely reflects the rounding of prices, particularly prior to decimalization in 2001.

[14] The alternative of including only those stocks that were listed continuously for the full calendar interval would introduce a severe survivorship bias. In those cases where a stock is listed for only a portion of the calendar interval, I also compute benchmark returns (to Treasury-Bills and the overall stock market) over the same shorter interval for comparison.

returns for each stock over each interval.[15] (Since I will subsequently assess the cross sectional mean and median of this statistic I will refer to the geometric return for each stock, to avoid confusion.) The sum of returns is positive more often than the geometric return, as some stocks have positive arithmetic mean returns even though buy-and-hold investors suffer losses.

Figure 1 displays the frequency distribution of annual (Figure 1A) and decade (Figure 1B) buy-and-hold returns (to a maximum of 500%). The frequency distribution of annual returns (rounded to the nearest 2%) displays a notable spike at zero (which is also the most frequent outcome), and smaller spikes at 100% and 200%, presumably as the result of price rounding. The positive skewness of annual buy-and-hold returns can be observed, in part because numerous returns exceed 100%, while, due to limited liability, no returns are less than -100%.[16]

The frequency distribution of decade buy-and-hold returns in Figure 1B also reveals substantial positive skewness.[17] Unlike annual returns, where the most frequent observation is zero, the most frequently-observed decade buy-and-hold return (rounded to the nearest 5%) is -100%.[18] Zero returns at the decade horizon are only slightly more frequent than small positive or negative returns. On balance, the frequency distribution of decade buy-and-hold returns is notably asymmetric, with the most frequent outcomes near -100% and many outcomes greater than 100%. The divergence of the decade buy-and-hold return distribution as from simple benchmarks such as the normal or the lognormal distribution is notable.

[15] The geometric mean for a sample of n returns is the nth root of one plus the buy-and-hold return, less one.
[16] A total of 20,983 (6.6% of all annual return observations) buy-and-hold returns exceed 100%. Of these, 834 exceed 500% and are not displayed on Figure 1A. The maximum annual buy-and-hold return was 11,060%.
[17] A total of 16,010 (29.1% of all decade return observations) buy-and-hold returns exceed 100%. Of these, 3,242 exceed 500% and are not displayed on Figure 1A. The maximum decade buy-and-hold return was 25,260%.
[18] The data contains only 375 occurrences where a stock has a delisting return of exactly -100%. More often the final (delisting) share price is small but positive, implying a holding return through the delisting date slightly better than -100%. For purposes of my computations the -100% delisting returns are reset to -99.99%, which precludes the loss of the observation when I compute buy-and-hold returns as the exponential of the summed log returns, less one.

The statistics on Panels B and C of Table 1A verify that that annual and decade buy-and-hold returns are strongly positively skewed. The standardized skewness coefficient is 19.85 for annual returns and 16.32 for decade returns. Note also that mean buy-and-hold returns substantially exceed median returns. The mean annual buy-and-hold return is 14.74%, while the median is 5.23%. The divergence is more notable for the decade horizon, where the mean buy-and-hold return is 106.8%, compared to a median of 16.1%.

The mean decade buy-and-hold return of 106.8% exceeds the average sum of returns, which is 73.5%. However, the sum of returns (or arithmetic mean return) is positive more frequently than the buy-and-hold return. At the decade horizon, 73.9% of arithmetic mean returns are positive, while only 56.3% of buy-and-hold returns are positive. The fact that the standardized skewness of decade buy-and-hold returns greatly exceeds that of the sum of annual returns (16.32 vs. 0.48) highlights the important role of compounding in generating skewness over multiple periods.

At the annual horizon, a slight majority (51.6%) of stocks generate buy-and-hold returns that exceed the buy-and-hold return on one-month Treasury Bills. Notably, at the decade horizon, a minority (49.5%) of stocks outperform Treasury Bills.

The effects of positive skewness in the distribution of buy-and-hold returns can also be observed when comparing individual stocks to market-wide benchmarks. At the decade horizon, only 37.3% of stocks have buy-and-hold returns that exceed the accumulated return to the value-weighted portfolio of all common stocks, and just 33.6% outperform the accumulated return to the equal-weighted portfolio of all common stocks.

The comparison of geometric returns across the annual and decade horizons is informative. The cross-sectional median geometric return is positive at both horizons, but is larger (0.49% per month) at the annual horizon than at the decade (0.33% per month) horizon.

Notably, the distribution of geometric returns across stocks is positively skewed at the annual horizon (skewness statistic of 5.79) but is negatively skewed at the decade horizon (skewness statistic of -3.13). That is, extreme negative geometric returns are relatively more common (compared to extreme positive geometric returns) at the decade horizon than at the annual horizon.

The positive cross-sectional skewness in decade buy-and-hold returns could, in principle, have been attributable in part to positive skewness in geometric returns. Since the actual skewness in geometric returns is negative, the skewness in decade buy-and-hold returns can be attributed to a combination of positive skewness in monthly returns and the effects of compounding. The effect of the compounding of random returns on skewness is explored further in Section V.

c. Lifetime Returns

In Panel D of Table 1A, I report on lifetime returns to CRSP common stocks. Figure 1C displays the frequency distribution of lifetime buy-and-hold returns (rounded to the nearest 5%, to a maximum of 1,000%) For each stock, the lifetime return spans from July 1926 or the month that CRSP database first contains a return for the stock until December 2016 or the delisting month. Lifetime returns to delisted stocks include the delisting return.

While 71.7% of individual stocks have a positive arithmetic average return over their full life, only a minority (49.5%) of CRSP common stocks have a positive lifetime buy-and-hold return, and the median lifetime return is -2.29%. This result highlights that arithmetic mean returns overstate actual performance.

The distribution of lifetime buy-and-hold returns is also highly positively skewed. The standardized skewness coefficient is 154.8. While the median lifetime buy-and-hold return is

negative, the cross-sectional mean lifetime return is over 18,000 percent.[19] Also reflective of the positive skewness, only 574 stocks, or 2.2% of the total, have lifetime buy-and-hold returns that exceed the cross-sectional mean lifetime return. Strikingly, and as can be observed on Figure 1C, the most frequent or modal lifetime return is a loss of essentially 100%.[20] A total of 3,071 CRSP common stocks, or 11.83% of the total, suffered essentially complete losses as measured by lifetime buy-and-hold returns.

Perhaps most notably, only 42.6% of CRSP common stocks have lifetime buy-and-hold returns that exceed the buy-and-hold return on one-month Treasury Bills over the same time periods. The answer to the question posed on the title of this paper is that most common stocks, (slightly more than four out of every seven) *do not* outperform Treasury bills over their lives. The fact that the broad stock market does outperform Treasuries over longer time periods is fully attributable to the positive skewness of the stock return distribution – i.e. to the relatively few stocks that generate large returns, not to the performance of typical stocks.

The importance of the positive skewness in the stock return distribution can also be illustrated by comparing the buy-and-hold returns of individual stocks to the accumulated returns earned on the equal and value-weighted portfolios of all common stocks. As shown on Panel D of Table 1A, only 30.8% of individual common stocks generated lifetime buy-and-hold returns that exceed the performance of the value-weighted portfolio over the same intervals, and only 26.1% outperformed the equal-weighted portfolio.

[19] The maximum lifetime buy-and-hold return is 244.3 million percent, by the firm now known as Altria Group, Inc.
[20] As noted, the lifetime return is rarely exactly -100%, as the final delisting share price is generally small but positive. Since Figure 1C displays returns rounded to the nearest 5%, the precise statement is that 3,071 stocks generated a lifetime return of less than -97.5%.

d. **Outcomes by Delisting Reason**

The large majority of the 25,967 individual CRSP common stocks considered in this study exit the database at some point before the sample ends at December 31, 2016. CRSP provides a delisting code (variable name dlstcd) for each common stock. Based on these delisting codes, I assign each common stock to one of three categories, Still Trading (first digit of dlstcd is 1), Merged, Exchanged, or Liquidated (first digit of dlstcd is 2, 3, or 4), and Delisted by Exchange (first digit of dlstcd is 5). Table 1B reports on lifetime returns to common stocks, delineated by the three delisting categories.

Not surprisingly, the 4,138 stocks in the "Still Trading" group (Panel A of Table 1B) most often generated favorable outcomes. The mean lifetime return for these stocks is 106,000%, and a majority of these stocks deliver lifetime buy-and-hold returns that exceed zero (64.1%) and that exceed the buy-and-hold return on one-month Treasury Bills (60.1%) over the same periods. For these stocks as well skewness is empirically important. The skewness coefficient for lifetime buy-and-hold returns is 61.9, and the median lifetime return of 64.8% is far less than the mean of 106,000%. Even in the relatively successful "Still Trading" group, only a minority (39.4%) of individual stocks have lifetime buy-and-hold returns that exceed the value-weighted portfolio return over the same time horizons.

Panel B of Table 1B reports results for the 12,560 stocks that delisted due to Merger, Exchange, or Liquidation. In some dimensions these stocks outperformed stocks in the "Still Trading" group, reflecting that a departure from the database as a result of being acquired is typically a value-enhancing event. Specifically, 73.8% of stocks in the Merger, Exchange, or Liquidation group delivered positive lifetime buy-and-hold returns, and 63.0% outperformed one-month Treasury bills over their lifetimes. For these stocks as well return skewness is strong, as the skewness coefficient is 60.5, the median lifetime return of 103% is substantially

less than the mean lifetime return of 3,825%, and less than half of the Merger, Exchange, or Liquidation stocks outperformed the value-weighted portfolio return over their lifetimes.

A total of 9,187 stocks were delisted by their trading exchange (Panel C of Table 1B).[21] The median lifetime buy-and-hold return for these stocks was -91.95%. Only 9.8% of these stocks generated a positive lifetime buy-and-hold return, and only 6.8% outperformed one-month Treasury Bills. The skewness coefficient for lifetime returns to these stocks is 55.0, quite comparable to that of the stocks in the "Still Trading" and "Merged, Exchanged, or Liquidated" categories. The mean lifetime return to stocks delisted by the exchange is -0.8%, greatly exceeding the median lifetime buy-and-hold return of -92.0%.

On balance the results on Table 1B show that the potentially surprising finding that the majority of individual stocks underperform Treasury bills over their full lifetimes is primarily attributable to the stocks that were removed from listing by the stock exchanges. While this finding may seem reassuring, it is of little practical usefulness unless one can predict in advance the category in which a given stock will eventually be found. The results on Table 1B also highlight that skewness in the cross-sectional return distribution is empirically important for all three groups of stocks.

e. **The potential role of firm leverage**

Black and Scholes (1973) observed that the equity claim in a levered firm can be viewed as a call option, with a positively-skewed payoff distribution. To assess whether the positive skewness in stock returns documented here can be attributed to leverage, I examine the distribution of returns to those CRSP common stocks identified by Strebulaev and Yang (2013)

[21] The specific reason for delisting by an exchange is not always reported in the CRSP database. Among those where a reason is reported, 1,071 stocks were delisted because "price fell below acceptable level", 1,378 were delisted because of "insufficient capital, surplus, and/or equity, 1,004 were delisted because they were "delinquent in filing" or due to nonpayment of fees, and 974 were delisted because they did not "meet exchange's financial guidelines."

as "zero leverage" or "almost zero leverage" firms.[22] Their identification is on an annual basis, and covers the 1962 to 2009 period.

Table 1C reports results that correspond to those on Table 1A, but include only unlevered firms as identified by Strebulaev and Yang. Since their identification is annual, and firms that are unlevered in a given year need not remain so thereafter, I report results only for monthly and annual returns for those stock/years identified by Strebulaev and Yang. The results on Table 1C indicate that unlevered firms on average deliver strong stock market returns. For example, the mean annual buy-and-hold return for stock in unlevered firms is 27.23%, compared to 14.74% for the entire sample (Table 1A).

Most important, the results on Table 1C indicate that the distribution of stock returns to unlevered firms is also positively skewed. At the monthly horizon the skewness of unlevered stock returns is 4.37, compared to 6.96 (Panel A of Table 1A) for the entire sample. At the annual horizon the skewness of buy-and-hold returns to unlevered stocks is 23.96, which exceeds the skewness of annual buy-and-hold returns for the full sample, which is 19.85 (Panel B of Table 1A). I conclude that the notable positive skewness in the distribution of CRSP common stock returns is not primarily due to firms' use of financial leverage.

f. Return Distributions by Firm Size, Decade of Initial Appearance, and Initial Listing Exchange.

In Table 2A I report a number of statistics regarding buy-and-hold returns to common stocks, when stocks are stratified based on market capitalization, for monthly (Panel A), calendar year (Panel B), and non-overlapping decade (Panel C) horizons.[23] Each stock is assigned to a

[22] I thank Ilya Strebulaev and Baozhong Yang for identifying the zero-leverage firms. Zero leverage firms have no short or long term debt, while "almost zero leverage" firms have book leverage ratios less than 5%.

[23] I omit results for lifetime returns, since market capitalization at original listing is not very informative regarding a firm's longer term market capitalization.

size decile group based on its market capitalization at the end of the last month prior to the interval for which the return is measured (for stocks already listed at the beginning of the interval) or at the time of its first appearance in the database (for stocks initially listed during the interval). Each decile group contains ten percent of the stocks in the database as of the month prior to the interval over which the return is measured.

The data reported on Table 2A show a distinct pattern by which small stocks more frequently deliver returns that fail to match benchmarks. At the decade horizon, only 42.4% of stocks in the smallest decile have buy-and-hold returns that are positive and only 36.6% have buy-and-hold returns that exceed those of the one-month Treasury bill. In contrast, 81.3% of stocks in the largest decile have positive decade buy-and-hold returns, and 70.5% outperform the one-month Treasury Bill. Only 29.7% of smallest-decile stocks have decade buy-and-hold returns that exceed the return to the value-weighted market over the same period, and only 28.0% beat the equal-weighted market.

However, as has previously been noted (e.g. Kumar, 2009), small stocks generate "lottery-like" returns, as evidenced by the large positive skewness in the return distribution. The standardized skewness of the decade buy-and-hold returns for the smallest decile of stocks is 12.55, which substantially exceeds that of the largest decile of stocks, which is 6.96.

While large capitalization stocks display less return skewness than small stocks, positive skewness in the large stock distribution manifests itself in the fact that most large stocks fail to match the overall market. The percentage of large stock buy-and-hold returns that exceed the matched return to the value-weighted market is 48.9% at the monthly horizon, 46.7% at the annual horizon, and 44.7% at the decade horizon.

In Table 2B I report on lifetime buy-and-hold returns, delineated by the decade of the stock's initial appearance in the CRSP database (Panel A) and by the exchange on which the

stock was listed at the time of its initial appearance (Panel B). A total of 920 stocks entered the data up to 1936. These included stocks already listed at the initiation of CRSP coverage, as well as new listings. Only 490 stocks entered the database over the following twenty years, through 1956, followed by 1,599 new stocks during the 1957 to 1966 decade. A total of 4,548 stocks were added to the database between 1967 and 1976, including 2,828 that entered during 1972, when Nasdaq stocks were first included in the CRSP data. The rate of new stock appearances accelerated thereafter, to 5,151 during 1977 to 1986, 6,860 during 1987 to 1996, and 4,153 during 1997 to 2006. During the most recent 2007 to 2016 decade only 2,238 stocks entered the database.

The data reported on Panel A of Table 2B shows that positive skewness is present in buy-and-hold returns for stocks that entered the database during each decade. Skewness coefficients range from 6.49 for stocks that first appeared during the most recent decade to 40.52 for stocks that first appeared between 1977 and 1986. Reflecting the positive skewness, only a minority of stocks that entered the database during each decade outperformed the value-weighted market over their lives, ranging from 20.9% of the stocks that appeared between 1977 and 1986 to 44.8% of stocks that first appeared during the 1957 to 1966 decade.

The observation that most stocks underperform Treasury Bills is attributable to stocks that entered the database since 1966. For stocks that entered the database in earlier decades, a majority, ranging from 61.5% of stocks entering between 1957 and 1966 to 87.0% of stocks entering between 1947 and 1956, had lifetime buy-and-hold returns larger than one-month Treasuries over the same horizons. In contrast, for stocks entering the database since 1966, a minority outperform Treasury Bills over their lifetimes, ranging from 31.7% of the stocks that appeared between 1977 and 1986 to 46.9% of stocks that entered the database between 1967 and 1976. In fact, the median lifetime return is negative for stocks entering the database in every

decade since 1977. The relatively high rates of underperformance for stocks that entered the CRSP data since the 1960s is likely linked to the fact that the younger firms have been brought to the public markets in recent decades, as documented by Fink, Fink, Grullon, and Weston (2010).

The results reported in Panel B of Table 2B demonstrate that the phenomenon of individual stocks underperforming Treasury bill returns over their lifetime is mainly attributable to stocks that were listed on the Nasdaq and AMEX exchanges when they entered the database. Of those stocks that initially appear on the NYSE, 71.6% had a positive lifetime buy-and-hold return and 65.3% had a lifetime buy-and-hold return that exceeded the one-month Treasury bill return. In contrast, only 44.3% of stocks that were listed on the AMEX at the time of their initial appearance in the CRSP data and 37.2% of the stocks that were listed on Nasdaq at the time of their original appearance had lifetime returns that outperformed one-month Treasury returns.

Note, though, that the effects of positive skewness are apparent for all stocks, including those that first appeared on the NYSE. Only a minority of stocks outperformed the value-weighted average market return over their full lifetimes, ranging from 28.2% of Nasdaq stocks, 33.5% of AMEX stocks, and 40.2% of NYSE stocks.

In combination, the results reported here show that skewness is pervasive, and that most stocks underperform the value-weighted market as a consequence. However, the finding that most stocks underperform the one-month Treasury bill is concentrated in stocks of smaller than median market capitalization, stocks that entered the CRSP database since the mid-1960s, and stocks that were listed on exchanges other than the NYSE at the time of their initial appearance.

III. Randomly Selected Stocks over the Full Ninety Years

The CRSP dataset I employ include returns pertaining to ninety calendar years, spanning 1926 to 2016. In section III, I report on lifetime returns to CRSP common stocks, showing that the majority fail to outperform one-month Treasury bills over their lifetime. However, for most stocks the lifetime return pertains to a period much shorter than the full ninety year sample. In fact, just thirty six stocks were present in the database for the full ninety years. The median life of a common stock on CRSP, from the beginning of sample or first appearance to the end of sample or delisting, is just 90 months, or 7.5 years. The 90^{th} percentile life span is 334 months, or just under 28 years.

To obtain evidence regarding the long-term performance of individual stock positions that spans the full ninety years, I adopt a bootstrap procedure. In particular, for each month from July 1926 to December 2016 I select one stock at random, and then link these monthly returns. The resulting continuous return series represents one possible outcome from a strategy of holding a single random stock in each month of the sample, ignoring any transaction costs. I compare returns from the one-stock strategy at the annual, decade, and ninety-year horizons to several benchmarks, including zero, the accumulated return to holding one-month Treasury bills over the same interval and the accumulated return on the value-weighted portfolio of all common stocks over the same interval. I repeat the procedure 20,000 times, to obtain a bootstrap distribution of possible returns to single stock strategies.

The results, reported on Table 3, reveal that, ignoring transaction costs, single stock strategies would have been profitable on average. The mean accumulated return to the single stock strategy is 16.6% at a one-year horizon, 245.4% at a decade horizon, and 949,826% at the 90-year horizon. However, the skewness in the distribution of bootstrapped single stock strategies is extreme – the standardized skewness coefficient is 6.99 at the annual horizon, 65.0

at the decade horizon, and 96.5 at the 90-year horizon, implying that these mean returns greatly exceeded typical returns.

In light of the well-documented small firm effect, it might be anticipated that single stock portfolios would tend to frequently outperform benchmarks that included larger stocks over long horizons. In fact, despite the positive mean returns, most single stock portfolios performed poorly, especially at the 90-year horizon. While a slight majority (50.8%) of single stock strategies generated a positive 90-year return, the median 90-year return is only 9.5%, compared to a buy-and-hold return on Treasury bills of 1,928%. Only 27.5% of single stock strategies produced an accumulated 90-year return greater than one-month Treasury Bills. That is, the data indicates that in the long term (defined here as the 90 years for which CRSP and Treasury bill returns are available) only about one fourth of individual stocks outperform Treasuries. Further, only 4.0% of single stock strategies produced an accumulated return greater than the value-weighted market.

I repeat the bootstrap simulations to assess the effects of diversification. In particular, for each month from July 1926 to December 2016 I select sets of five, twenty five, fifty, and one hundred stocks at random. Within each month, I compute the value-weighted return to the portfolio, and I then link these monthly returns. The procedure is repeated 20,000 times.

The results, also reported on Table 3, support several conclusions. First, the skewness of accumulated returns decreases rapidly as the number of stocks in the portfolio is increased. Focusing on the annual horizon, the standardized skewness coefficient of accumulated returns decreases from 6.99 for single stocks to 1.08 for five stock portfolios, and 0.10 for twenty-five stock portfolios. The skewness of annual returns is actually negative (-0.09 and -0.21,

respectively) for fifty and one-hundred stock portfolios.[24] That is, the simulations verify that skewness is eliminated by diversification.

Second, the skewness of longer horizon returns exceeds the skewness of short horizon returns. For twenty-five stock portfolios, for example, the standardized skewness coefficient increases from 0.10 at the annual horizon to 1.64 at the decade horizon and 10.02 at the ninety-year horizon. This result verifies that skewness arises due to compounding, even for portfolios where the skewness of single-period returns has been largely eliminated through diversification. This issue is assessed further in Section V.

Third, rates of underperformance relative to benchmarks decline as more stocks are added to the portfolio, reflecting the decrease in skewness. For example, the percentage of bootstrapped decade returns that exceed the buy-and-hold return on the one-month Treasury bill increases from 47.8% with single stock holdings to 72.3% with five stocks, 86.7% with twenty five stocks, and 93.1% with one hundred stocks.

Note, though, that the percentage of return outcomes that exceed the accumulated return to the value-weighted market is always less than fifty, even without any deduction for fees or trading costs. This result is of particular relevance, since the return performance of active managers is often measured relative to value-weighted benchmarks such as the S&P 500. For twenty five stock portfolios, for example, the percentage of return outcomes that exceeds the value-weighted portfolio return is 48.7% at the annual horizon, 45.4% at the decade horizon, and 36.8% at the 90-year horizon. These observations, which again reflect the substantial positive skewness in the distribution of stock returns, help to explain the result that most active managers, who tend to be poorly diversified, most often underperform the broad stock market.

[24] Albuquerque (2012) presents evidence that negative (as opposed to zero) skewness in diversified portfolio returns can attributed to heterogeneity in information announcement dates across stocks.

IV. Aggregate Value Creation in the U.S. Stock Market

The results reported here show that most individual common stocks have generated buy-and-hold returns that are less than the buy-and-hold returns that would have been obtained from investing in U.S. Treasuries over the same time periods. Stated alternatively, the fact that the overall stock market has outperformed Treasuries is attributable to positive skewness in returns, i.e. to large returns earned by relatively few stocks.

However, rates of return are percentages, and as such are insensitive to scale. Further, as noted, buy-and-hold returns measure the experience of a hypothetical investor who reinvests dividends, but otherwise makes no transactions after the initial purchase of shares. The experience of this hypothetical investor will necessarily differ from the experience of investors in aggregate, because equity investors collectively do not reinvest dividends, but do fund new equity issuances and receive the proceeds of equity repurchases.[25] For these reasons, a high buy-and-hold return need not imply large wealth creation for investors in aggregate, and vice versa.

Consider, as a case in point, General Motors Corporation (GM), which delisted in June 2009 following a Chapter 11 bankruptcy filing.[26] The delisting share price for its main class of common stock was $0.61, down from $93 less than a decade earlier and $23 a little over two years earlier. Had the delisting share price been zero instead of sixty one cents, GM's lifetime buy-and-hold return would have been -100%. However, GM paid more than $64 billion in dividends to its shareholders in the decades prior to its bankruptcy and also repurchased shares on multiple occasions, and these funds were collectively used by investors for other purposes

[25] Dichev (2007) focuses attention on these shortcomings in buy-and-hold returns, and reports on what he terms "dollar weighted" returns, for aggregate stock markets in several countries. In particular, he computes for each aggregate stock market the internal rate of return to investors, when considering distributions to and from shareholders.

[26] A new General Motors stock emerged from the bankruptcy filing and completed an IPO in November 2010.

prior to GM's bankruptcy filing. In fact, as I show below, GM common stock was one of the most successful stocks in terms of lifetime wealth creation for shareholders in aggregate, despite its ignoble ending.

To assess the practical importance of the fact that most stocks deliver buy-and-hold returns that underperform Treasury bills, I create a measure of dollar wealth creation for each of the 25,967 individual CRSP common stocks in the sample, using the following framework. Let W_0 denote an investor's initial wealth, and assume an investment horizon of T periods. The investor chooses each period to allocate her wealth between a riskless bond that pays a known period t return R_{ft}, and a risky equity investment that pays an uncertain return R_t, = R_{ct} + R_{dt}, where R_{ct} is the capital gain component of the period t return and R_{dt} is the dividend component. Dividends are returned to the investor's bond account. Separate from the dividend, the investor potentially makes an additional time t investment (from the bond account) in the risky asset in the amount F_t (with a repurchase of shares by the firm denoted by $F_t < 0$). Let W_t, B_t, and I_t, denote the investor's total wealth, the value of her position in riskless bonds, and the value of her position in the risky asset, respectively, at time t, with W_t, = B_t, + I_t.

The value of the investor's position in the riskless bond evolves according to $B_t = B_{t-1}(1+R_{ft}) + I_{t-1}*R_{dt} - F_t$, as the investor earns interest, collects any dividend, and potentially increases or decreases her investment in the risky asset. The value of the investor's position in the risky asset evolves according to $I_t = I_{t-1}*(1+R_{ct}) + F_t$, that is based on the capital gains return and any net new investment. The investor's overall wealth at time t can be expressed as $W_t = B_{t-1}(1+R_{ft}) + I_{t-1}*(1+R_t)$, and we can state:

$$W_t - W_{t-1}*(1+R_{ft}) = I_{t-1}*(R_t - R_{ft}).^{27} \quad (1)$$

[27] Note that F_t and R_{dt} have been eliminated from expression (1). Dividends and new investments in the risky asset matter only indirectly, though their effect on I_t.

Expression (1) states that the investor's actual wealth at time t, in excess of that which would have been attained had she invested her prior period wealth entirely in risk free bonds, is the product of the dollar investment in the risky asset times the asset's excess return. The right side of expression (1) can therefore be interpreted as the dollar wealth created during period t by investing some funds in the risky asset rather than the risk-free bond.

Let $FV_{t,T} = (1+ R_{ft+1})*(1+ R_{ft+2})* (1+ R_{ft+3})*\ldots *(1+ R_{fT})$ denote a future value factor obtained by compounding forward from time t to time T at the prevailing one-month Treasury interest rates. Applying expression (1) iteratively leads to the following expression:

$$W_T - W_0*FV_{0,T} =$$

$$I_0*(R_1 - R_{f1})\, FV_{1,T} + I_1*(R_2 - R_{f2})\, FV_{2,T} + \ldots + I_{T-2}*(R_{T-1} - R_{fT-1})*FV_{T-1,T} + I_{T-1}*(R_T - R_{fT}). \quad (2)$$

The first line of expression (2) can be interpreted as the investor's final wealth, in excess of the wealth the investor would have attained had she invested entirely in the risk free asset. Equivalently, expression (2) quantifies the wealth created by investing capital in the risky asset rather than the riskless bond. The second line of expression (2) shows that this dollar amount can be computed as the sum of the future values (using the risk free bond interest rate to compound forward) of the period-by-period wealth creation specified by the right side of expression (1).[28]

I implement expression (2) for each stock, using the beginning-of-period market capitalization (share price times shares outstanding, from CRSP) in the role of I_t. Results therefore apply to each stock's investors in aggregate. The calculation extends from the first

[28] Compounding at the risk free rate reflects the fact that the Treasury bill always comprises the opportunity cost on invested capital, or equivalently the return on cash given off by the risky asset, in this computation. An alternative would be to measure wealth creation from investing in a given asset rather than the value-weighted portfolio, in which case the value-weighted return would replace the risk free rate on the right side of expression (2). Note also that the compounding forward eliminates any need for an inflation adjustment, as the final outcome is a dollar amount at one specific point in time.

monthly return in the CRSP database to the last (including any delisting return). It therefore excludes returns earned by those who purchase IPOs at their offer prices or returns earned in the secondary market prior to the first full-month return included in CRSP. Compounding is accomplished by linking actual one-month Treasury rates from each month t to December 2016. The results indicate that the 25,967 individual common stocks that have appeared in the CRSP data since July 1926 have collectively created $34.82 trillion in wealth for investors, measured as of December 2016.

Some companies, including for example Alphabet and General Motors, have issued more than one class of common stock. CRSP assigns a separate permno to each, reflecting that returns typically differ across the classes of common stock issued by a given firm. The 25,967 common stocks (permnos) I study were issued by 25,335 firms (identified by the CRSP permco variable). Since it seems natural to measure dollar wealth creation at the company level, I aggregate the results of implementing expression (2) across permnos for those firms with multiple classes of stock.[29]

Table 4 reports on lifetime wealth creation for the fifty individual firms that created the most wealth. Firms are identified in the table based on CRSP permco and the most recent name in the CRSP database. For comparison, I also report the average compound annualized return (inclusive of reinvested dividends and without deducting the Treasury-bill rate) for each firm.[30] For firms with multiple classes of common stock the return pertains to the class that was outstanding for the longest time period, also identified in the Table.

[29] Expression (2) could not be implemented for three permcos. Each of these had a single monthly return observation in the database, but lagged market capitalization was not available.

[30] Letting BHR denote the buy-and-hold return (obtaining by linking monthly returns inclusive of dividends) and letting N denote the stock's life in calendar months, the annualized return is given as the 12/N root of (1+BHR), less one.

The largest amount of wealth creation attributable to any firm is $1.002 trillion, by Exxon Mobil Corporation. The second largest wealth creation is attributable to Apple, Inc., which created $745.7 billion in shareholder wealth, despite a CRSP life of only 433 months (compared to 1,086 months for Exxon Mobil and other firms that were present for the full sample.) Microsoft ($629.8 billion), General Electric ($608.1 billion), International Business Machines ($520.2 billion), Altria Group ($470.2 billion), Johnson and Johnson ($426.2 billion), General Motors ($425.3 billion), Chevron ($390.4 billion), and Walmart Stores ($368.2 billion) comprise the rest of the top ten firms in terms of lifetime value creation.

As noted, Exxon Mobil was responsible for lifetime wealth creation of $1.004 trillion. Thus, Exxon Mobile alone was responsible for 2.88% of the $34.82 trillion in net wealth creation by CRSP common stocks over the 1926 to 2016 period. Apple Corporation was responsible for an additional 2.14% of net stock market wealth creation. The right column of Table 4 displays the cumulative percentage of U.S. stock market wealth creation since 1926 accounted for by the indicated firm and those listed above it on the Table. It can be observed that the top fifty firms together accounted for 39.29% of the net stock market's wealth creation.

Figure 2A displays the cumulative percentage of net stock market wealth creation attributable to the 25,332 individual firms in the CRSP database, when firms are ranked from highest to lowest wealth creation. The curve asymptotes at 100%, by construction. It exceeds 100% for a broad range, reflecting the fact that total wealth creation would have been larger if not for the impact of the 14,661 (57.9% of total) companies with negative lifetime wealth creation.[31]

Figure 2B displays the same data as Figure 2A, but is confined to the 1,100 firms with the largest lifetime wealth creation. The curve on Figure 2B passes through 50% at just 90 firms

[31] The curve reaches a maximum of 117.27%, implying that gross wealth creation (obtained by summing wealth creation across all companies with positive outcomes), was 17.27% greater than net wealth creation.

and passes through 75% at 295 firms. That is, just 0.36% of all firms account for half of the cumulative net wealth creation in the U.S. stock market from 1926 to 2016, and 1.16% of the firms account for three quarters of the net wealth creation.

The curve on Figure 2B reaches 100% at 1,092 firms, which is 4.31% of the 25,332 firms that issued common stocks contained in the sample. The implication is that slightly more than four percent of the firms contained in the CRSP database collectively account for all of the net wealth creation in the U.S. stock market since 1926. Beyond the best-performing 1,092, an additional 9,579 firms (37.81%) created positive wealth over their lifetimes, just offset by the wealth destruction of the remaining 14,661 (57.88% of total) firms, so that the top 1,092 firms created the same wealth as the overall market. The 95.69% of firms outside the top group collectively generated dollar gains that matched those that would have accrued if the invested capital had earned one-month U.S. Treasury bill rates.[32]

It should be noted it would have been essentially impossible for this analysis to *not* find concentration in wealth creation. Some firms have long lives while others have short lives, and not surprisingly, the firms with the greatest wealth creation generally have longer lives. Firm size varies widely, and a given excess return implies more wealth creation for a large stock. Pure randomness will cause some stocks to outperform others. Further, monthly returns are positively skewed. Finally, the compounding of returns over multiple periods itself induces additional positive skewness in the distribution of long horizon returns, as discussed more fully in the next section. These explanations likely reinforce each other. Firms with large positive returns tend to both grow larger and to survive longer, while those with low returns become smaller and tend to delist. Nevertheless, the degree of concentration, with all of the net dollar wealth creation in

[32] Of course, equilibrium interest rates and stock market prices would surely have differed from those actually observed had the capital actually invested in these stocks been invested in Treasury obligations instead.

the U.S. market attributable to slightly more than four percent of the firms that have issued common stock, is striking.

V. How can Most Return Premia be Negative, if Investors are Risk Averse?

The empirical results reported here, including that the majority of individual stocks underperform one-month Treasury bills over their full lifetimes and that the bulk of the dollar wealth created in the U.S. stock markets can be attributed to a relatively few successful stocks, are potentially surprising. In large measure, these results reflect the empirical fact that the median stock return is negative, even while the mean stock return is positive. I will now outline why negative median stock returns should be anticipated as the norm, particularly for more risky stocks and over longer holding periods.

a. Skewness in Single-Period Returns

To better understand how the majority of stock return premia can be negative even while investors are risk averse and demand a positive expected return premium, consider as a benchmark the case where single-period excess stock returns are distributed lognormally. The log normal distributional assumption has been widely used to model stock prices.[33]

Let R denote a simple excess return for a single period. Assume that $r \equiv \ln(1 + R)$ is distributed normally with mean μ and standard deviation σ. The expected or mean excess return, E(R), is $\exp(\mu + 0.5\sigma^2) - 1$. In contrast, the median excess return is $\exp(\mu) - 1$, which is less than the mean return for all $\sigma > 0$, with the divergence of the mean from the median larger if there is more return volatility. The log normal distribution does not have a distinct skewness

[33] See, for example, Rubinstein (1976) and Black and Scholes (1973).

parameter. However, the skewness of simple returns is positive for all $\sigma > 0$, and is monotone increasing in σ.[34]

Note that the mean excess log return, μ, can be stated as $\mu = \ln[1 + E(R)] - 0.5\sigma^2$. If μ is negative then the median simply excess return is also negative. This occurs if

$$\sigma^2 > 2*\ln[1 + E(R)]. \quad (3)$$

Stated alternatively, the log normality assumption implies that more than half of single period excess returns will be negative if the excess return variance, σ^2, exceeds twice the continuously compounded equivalent of the mean simple excess return. For example, a stock that has an expected simple excess return of 0.8% per month will, assuming the lognormal distribution applies, have a negative median excess monthly return if the standard deviation, σ, exceeds 12.6%. By comparison, the full sample standard deviation of monthly CRSP common stock returns is 18.1%.

In summary, if excess returns are distributed log normally the mean excess return will exceed the median for all stocks, and the median excess return will be negative for stocks with sufficiently high return variance. While actual stock returns do not conform exactly to the log normal distribution, this discussion shows that the finding that the median excess return is negative would be implied if returns were log normal, in light of observed return variances.[35]

b. Skewness in Multi-Period Returns

It is intuitive that skewness in single period returns will typically also imply skewness in returns compounded over multiple time periods. In the case of independent draws from a log normal distribution, the skewness of multi-period returns increases with the number of periods,

[34] See, for example, http://www.itl.nist.gov/div898/handbook/eda/section3/eda3669.htm.
[35] However, the occurrence of -100% returns is at odds with the log normal assumption.

as the return standard deviation (which in turn solely determines skewness) is proportional to the square root of the number of elapsed periods.

It appears to be less widely appreciated that the compounding of random returns over multiple periods will typically impart positive skewness to longer horizon returns, even if the distribution of single-period returns is symmetric.[36] Consider, as a simple example, the case where single-period stock returns are either 20% or -20%, with equal probability. This distribution is symmetric about a mean of zero. Assuming independence across periods, two period returns are 44% (probability 25%), -4% (probability 50%) or -36% (probability 25%). The two period return distribution is positively skewed; note that the median (-4%) that is less than the zero mean, and that the probability of observing a negative two-period return is seventy five percent.[37]

It is sometimes assumed that single-period stock returns are approximately distributed normally, and this assumption often underlies the focus on mean-variance efficiency as a criterion for portfolio selection. To my knowledge, the statistical properties of multiple-period returns generated by successive draws from the normal distribution have not been carefully explored.[38] I therefore rely on simulations to assess the effects of compounding on the median buy-and-hold return and the skewness of buy-and-hold returns, when single-period returns are distributed normally. In particular, I construct simulated monthly returns as random draws from

[36] To my knowledge, this point was first demonstrated by Arditti and Levy (1975). Ensthaler, Nottmeyer, Weizsacker, and Zankiewicz (2017) report experimental evidence indicating that subjects fail to appreciate the importance of multi-period compounding and the skewness that it imparts, a phenomenon they refer to as "skewness neglect."

[37] The standardized skewness coefficient in this case is 0.412. Note though, that a simple comparison of the mean to the median need not reliably reveal the sign of the skewness coefficient for more complex distributions. See, http://ww2.amstat.org/publications/jse/v13n2/vonhippel.html. An exception to the conventional wisdom that positive skewness necessarily implies that the mean is larger than the median can be observed for geometric returns on Panel B of Table 1A herein.

[38] The product of normally distributed variables is not normally distributed. Results reported in Siejas-Macias and Oliveira (2012) shed some light on the issue. They show that the distribution of the product of two positive-mean independent normal random variables is positively skewed in the limiting case where the ratio of the variance to the mean approaches zero. Since multi-period returns are obtained by multiplying gross (one plus) returns, the positive mean condition is satisfied for rates of return.

normal distributions, and compute multi-period buy-and-hold returns by linking gross monthly returns.

I assume that returns are independent and identically distributed across time. I set the monthly mean return equal to 0.5%, and consider investment horizons of one year, five years, and ten years, for standard deviations, σ, of monthly returns ranging from zero to twenty percent. For each standard deviation, I simulate returns for 100,000 non-overlapping ten year periods (equivalently, 1 million one-year periods). Results, reported in Table 5, are computed across these simulation outcomes.[39]

The standard deviation of monthly returns to the value-weighted portfolio of all CRSP common stocks from 1926 to 2016 is 5.4%, while that for the equal-weighted portfolio is 7.3%. In contrast, the pooled distribution of individual monthly common stock returns has a standard deviation of 18.1%. As a consequence, simulation results obtained when the monthly return standard deviation is set to 6 or 8% are most relevant for diversified portfolios, while results obtained when the standard deviation is set higher levels are of more relevance for individual stocks.

The left column of Table 5 reports simulation results when returns are riskless, as a benchmark. Buy-and-hold returns are 6.17% for twelve months, 34.89% for five years, and 81.94% for ten years. Given the assumptions of independent and identical draws, these benchmarks also represent the expected or mean buy-and-hold return at each horizon.

Panel A of Table 5 demonstrates the effect of compounding on the skewness of buy-and-hold returns. Even though each single-period return is drawn from a zero-skew normal distribution, the skewness of buy-and-hold returns is positive at all multi-period horizons.

[39] I do not constrain simulated return draws to be -100% or greater. Therefore, the simulation results show that limited liability is not required to induce skewness in multi-period returns.

Skewness increases with the number of months over which returns are compounded, and with the standard deviation of monthly returns, σ. When risk is modest (σ = .02), the skewness of buy-and-hold returns ranges from 0.186 at the one-year horizon to 0.683 at the ten-year horizon. When risk is high (σ = .20) the skewness of buy-and-hold returns is 2.333 at the one-year horizon, 19.465 at the five-year horizon, and 41.954 at the ten-year horizon.

The skewness induced by compounding is associated with median buy-and-hold returns that are less than corresponding means, as demonstrated in Panel B of Table 5. At a one-year horizon, the median buy-and-hold return declines monotonically from 6.17% when there is no risk, to 0.42% when the standard deviation of monthly returns is 10%, and to -15.62% when the standard deviation of monthly returns is 20%. The effect of compounding is more dramatic at longer horizons, because the skewness induced is larger. At the ten-year horizon the median buy-and-hold return declines from 81.94% when there is no risk to 0.14% when σ = 10% per month and, remarkably, to -85.45% when σ = 20% per month.

The effects of the skewness induced by compounding can also be observed in the percentage of simulated buy-and-hold returns that exceed zero, as demonstrated in Panel C of Table 5. When monthly returns are riskless all buy-and-hold returns exceed zero. When returns are risky but σ is low, the percentage of returns that are positive is less than one hundred, but increases with investment horizon, as the positive mean return (0.5% per month in the simulations) is more important than the skewness induced by compounding. For example, when σ = .04 per month, the percentage of buy-and-hold returns that are positive increases from 64.37% at a one-year horizon to 87.42% at a ten-year horizon. However, when risk is high the effects of the skewness induced by compounding are more important than the accumulated effect of the positive mean, and the percentage of buy-and-hold returns that are positive decreases with

horizon. For example, when σ = 16% per month the percentage of buy-and-hold returns that are positive decreases from 44.13% at a one-year horizon to 29.41% at a ten-year horizon.

The implication of this simulation is that the compounding of successive random returns alone can explain many of the striking results reported in this paper. Even if monthly returns are independent draws from a zero-skew normal distribution, buy-and-hold returns over multiple periods are positively skewed. This positive skewness causes the median buy-and-hold return to be less than the mean, and more so at longer horizons. The low median return is offset by the small possibility of extreme positive returns.[40] If the volatility of monthly returns is large enough (slightly more than 10%, given the normality assumption and the 0.5% monthly mean), then median buy-and-hold returns are negative, even though mean holding periods are positive. Also, since the simulations rely on independent draws, they show that a few very large long run returns should be anticipated even in the absence of any momentum in individual stock returns.

To summarize, the evidence that most stocks generate holding-period returns that are less than those earned on Treasury bills is not necessarily inconsistent with theories implying that investors require a positive risk premium. Asset pricing theories typically focus on *mean* returns, while the evidence here emphasizes *median* returns. Return skewness, which for most probability distributions implies that the mean return exceeds the median, can arise because single-period returns are skewed (as in the case of the log normal distribution). However, the compounding of random returns induces positive skewness in multi-period buy-and-hold returns, even if single period returns are symmetric.

VI. Conclusions

[40] These simulation results regarding simple returns are in line with the implications of Martin (2012), who shows that risk-adjusted gross (one plus) returns converge almost surely to zero at long horizons, even though the mean risk-adjusted gross return is always one in equilibrium.

While the overall stock market outperforms Treasury bills in the long run, most individual common stocks do not. Of the nearly 26,000 common stocks that have appeared on CRSP from 1926 to 2016, less than half generated a positive lifetime buy-and-hold return (inclusive of reinvested dividends), and only 42.6% have a lifetime buy-and-hold return greater than the one-month Treasury bill over the same time interval. The positive performance of the overall market is attributable to large returns generated by relatively few stocks. Rates of underperformance are highest for small capitalization stocks, for stocks that have entered the database in recent decades, and for stocks that were initially listed on exchanges other than the NYSE.

When stated in terms of lifetime dollar wealth creation to shareholders in aggregate, approximately one third of one percent of the firms that have issued common stocks contained in the CRSP database account for half of the net stock market gains, and slightly more than four percent of the firms account for all of the net stock market gains. The other ninety six percent of firms that have issued stock collectively matched Treasury-Bill returns over their lifetimes.

These results highlight the practical importance of positive skewness in the cross-sectional distribution of returns. This skewness arises both from the fact that monthly returns are skewed, and from the possibly underappreciated fact that the compounding of random returns introduces positive skewness into the multi-period return distribution, even if single period returns are symmetric. Researchers often assume that returns conform at least approximately to the normal distribution. However, even if returns are distributed normally at one return horizon, e.g. monthly, they are positively skewed at any longer horizon.

These results reaffirm the importance of portfolio diversification, particularly for those investors who view performance in terms of the mean and variance of portfolio returns. In addition to the points made in a typical textbook analysis, the results here focus attention on the

likelihood that poorly diversified portfolios will underperform because they omit the relatively few stocks that generate large positive returns. Actively managed portfolios tend to be poorly diversified. For example, Kacperczyk, Sialm, and Zheng (2005) document that actively managed equity mutual funds hold a median of only 65 stocks. The results therefore help to explain why active portfolio strategies *most often* underperform their benchmarks. Underperformance rates that exceed 50% are often attributed to transaction costs, fees, and/or behavioral biases that amount to a sort of negative skill. The results here show that underperformance can be anticipated more often than not for active managers with poorly diversified portfolios, even in the absence of costs, fees, or perverse skill. These results may require the reassessment of standard methods of evaluating investment manager performance.

The results here show that individual stocks and portfolios containing relatively few stocks have positively skewed returns, particularly over multiple-month horizons. Arrow (1971) shows that investors whose absolute risk aversion is non-increasing in wealth will exhibit a preference for positive return skewness. Since diversification tends to eliminate skewness, these investors may rationally choose to hold portfolios that are not well-diversified. Patton (2004) shows that even considering the relatively modest skewness of equity portfolio returns can significantly improve investor utility. While a full assessment of optimal individual stock portfolios over a variety of possible investment horizons is beyond the scope of this paper, Patton's results are suggestive that improvements in investor utility from considering parameters beyond the mean and standard deviations when selecting stock portfolios may be substantial.

The literature on skewness preference does rely on any ability to systematically identify those stocks that will outperform in the future. The results here show that the returns to active stock selection can be very large, *if* the investor is either fortunate or skilled enough to select stocks that go on to earn extreme positive returns. Of course, the key question of whether an

investor can reliably identify such “home run” stocks, or can identify a manager with the skill to do so, remains.

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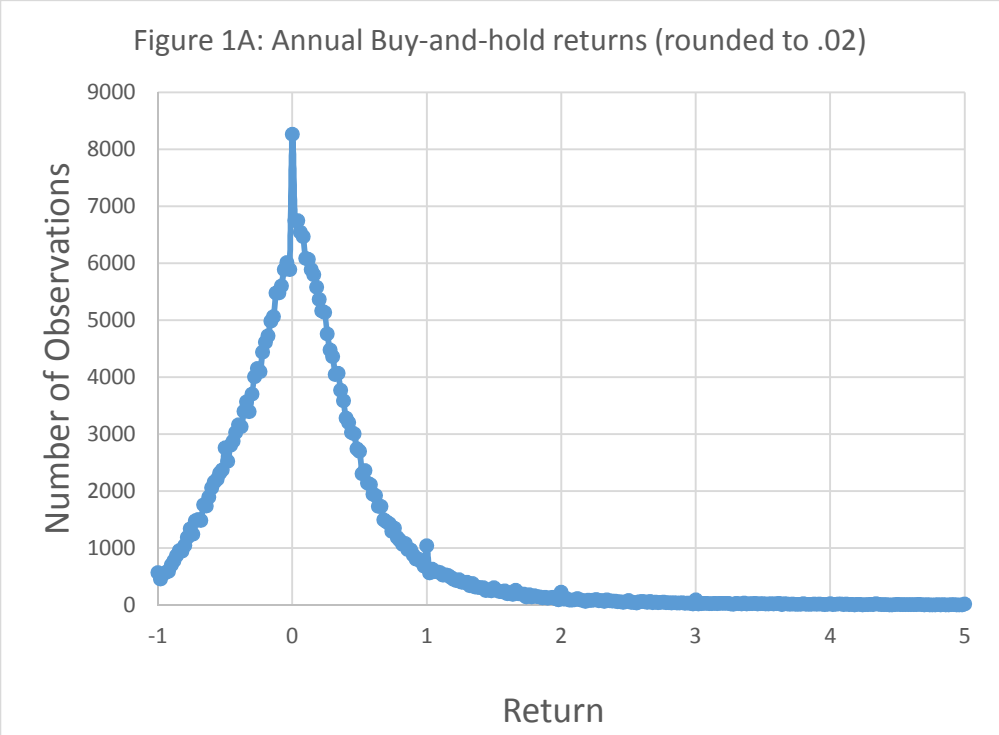
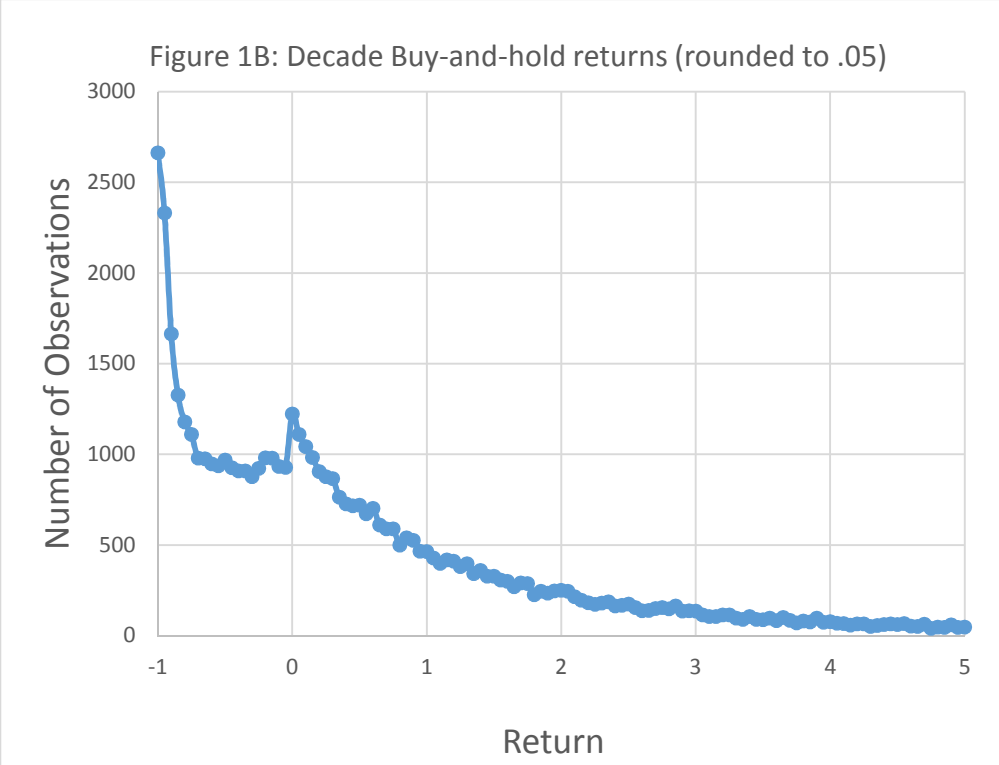
Figure 1: Frequency Distributions of Buy-and-hold returns.

Displayed are frequencies of buy-and-hold returns, to the indicated maximum. The data includes CRSP common stocks from 1926 to 2016. In cases where stocks list or delist with a calendar period the return is computed for portion of the period where data is available.





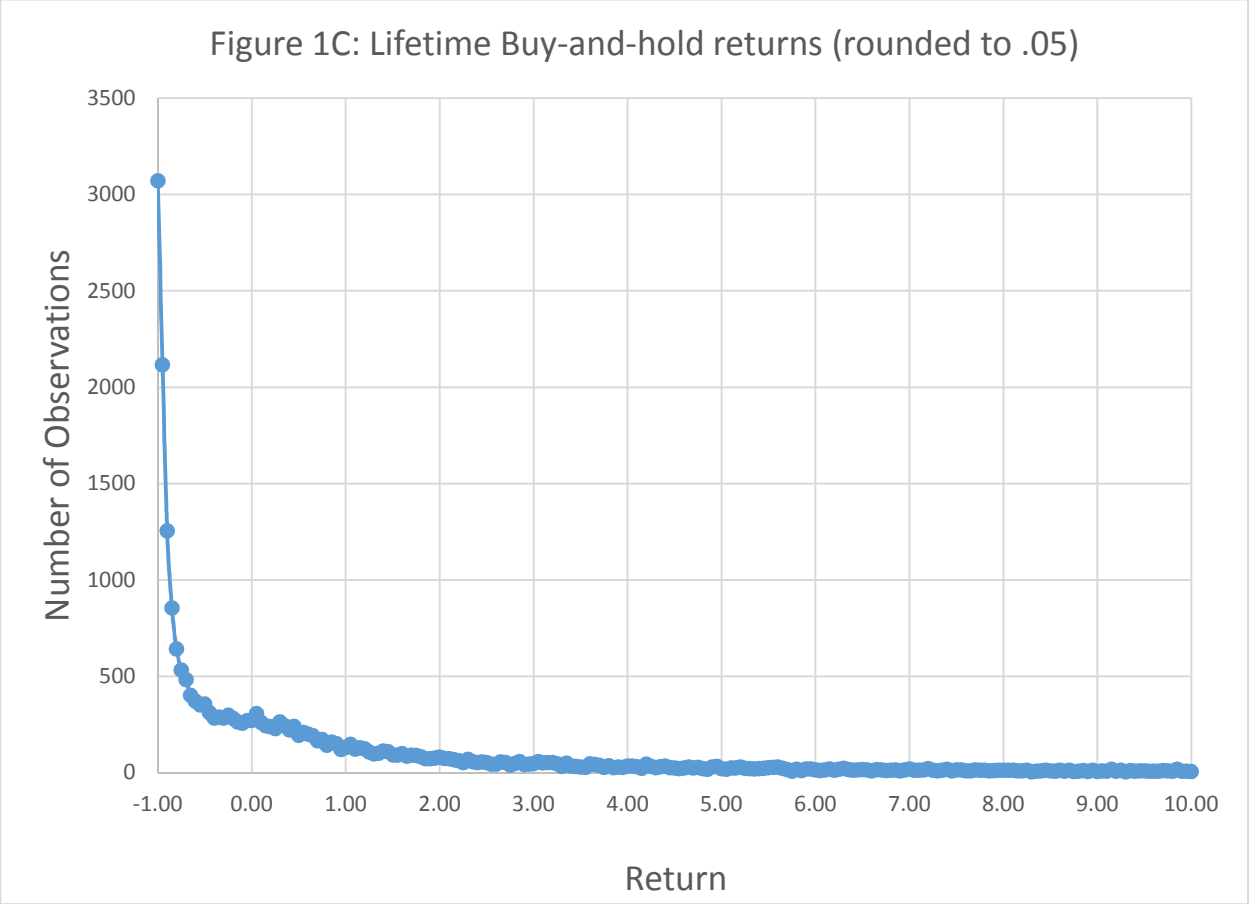
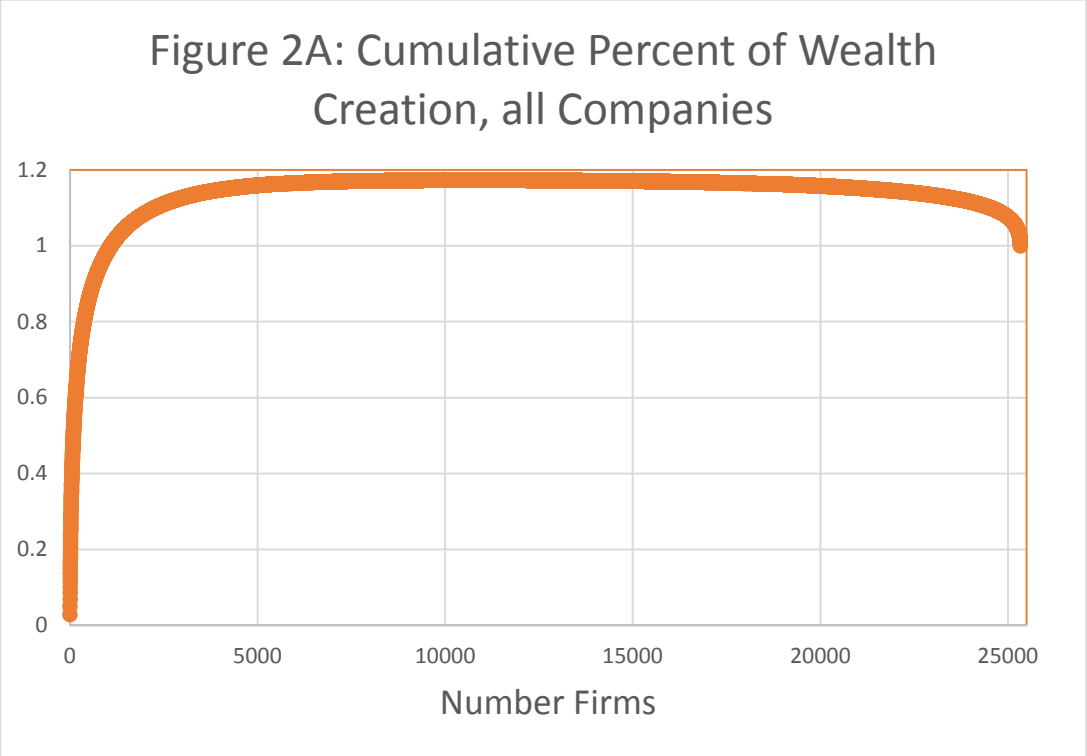


Figure 1C: Lifetime Buy-and-hold returns (rounded to .05)
Number of Observations
3500
3000
2500
2000
1500
1000
500
0
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
Return

Figures 2A and 2B. Cumulative Percentages of Stock Market Wealth Creation.

The figures display the cumulative percentage of U.S. stock market wealth creation since 1926 and measured as of the end of 2016 attributable to individual stocks, when companies are sorted from largest to smallest wealth creation. Figure 2A includes all 25,332 companies with common stock in the CRSP database, while Figure 2B includes only the 1,100 largest wealth creating companies.



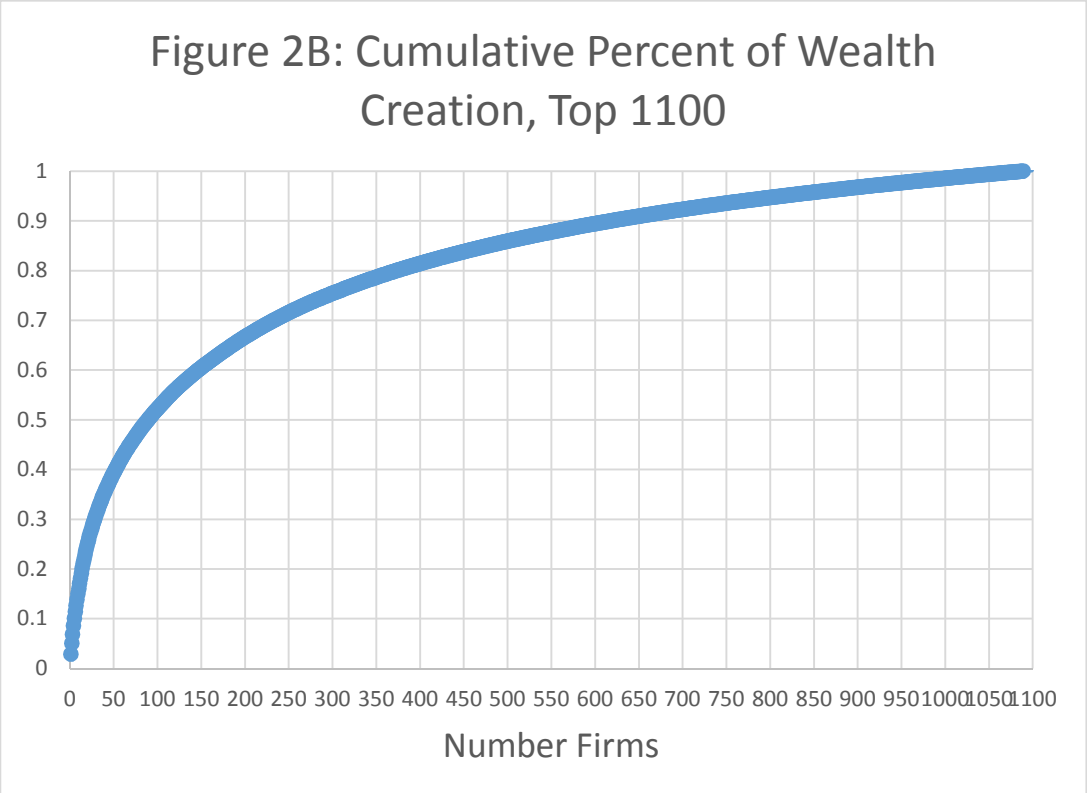


Table 1A: CRSP Common Stock Returns at Various Horizons

Included are all CRSP common stocks (shrcd 10, 11, or 12) from September 1926 to December 2016. Annual returns refer to calendar years. Decade returns are non-overlapping. Returns pertain to shorter intervals if the stock is listed or delisted within the calendar period. Lifetime returns span from September 1926 or a stocks first appearance on CRSP to the stocks delisting or December 2016. Delisting returns are included. A T-Bill return is matched to each stock for each time horizon. The geometric return for q months is the q^{th} root of one plus the buy-and-hold return, less one.

Panel A: Individual Stocks, Monthly Horizon (N = 3,575,216)

Variable	Mean	Median	SD	Skewness	% Positive
Buy-and-Hold Return, T-Bill	0.0037	0.0039	0.003	0.621	92.5%
Buy-and-Hold Return, Stock	0.0113	0.0000	0.181	6.955	48.4%
	% > T-bill	% > VW Mkt Return		% > EW Mkt Return	
Buy-and-Hold Return, Stock	47.8%	46.3%		45.9%	

Panel B: Individual Stocks, Annual Horizon (N = 320,336)

Variable	Mean	Median	SD	Skewness	% Positive
Sum Stock Return	0.1263	0.1185	0.617	1.417	62.7%
Buy-and-Hold Return, T-Bill	0.0429	0.0446	0.032	0.646	96.6%
Buy-and-Hold Return, Stock	0.1474	0.0523	0.819	19.848	55.7%
Geometric Return, Stock	-0.0024	0.0049	0.077	5.791	55.7%
	% > T-bill	% > VW Mkt Return		% > EW Mkt Return	
Buy-and-Hold Return, Stock	51.6%	44.4%		42.5%	

Panel C: Individual Stocks, Decade Horizon (N = 55,028)

Variable	Mean	Median	SD	Skewness	% Positive
Sum Stock Return	0.7352	0.6912	1.460	0.476	73.9%
Buy-and-Hold Return, T-Bill	0.3090	0.1876	0.340	1.774	99.9%
Buy-and-Hold Return, Stock	1.0678	0.1605	4.146	16.320	56.3%
Geometric Return, Stock	-0.0110	0.0033	0.063	-3.131	56.3%
	% > T-bill	% > VW Mkt Return		% > EW Mkt Return	
Buy-and-Hold Return, Stock	49.5%	37.3%		33.6%	

Panel D: Individual Stocks, Lifetime Horizon (N = 25,967)

Variable	Mean	Median	SD	Skewness	% Positive
Sum Stock Return	1.5580	1.0477	2.821	1.195	71.7%
Buy-and-Hold Return, T-Bill	1.1276	0.3483	2.278	4.120	99.8%
Buy-and-Hold Return, Stock	187.4705	-0.0229	15376.460	154.815	49.5%
Geometric Return, Stock	-0.0196	-0.0003	0.063	-4.428	49.5%
	% > T-bill	% > VW Mkt Return		% > EW Mkt Return	
Buy-and-Hold Return, Stock	42.6%	30.8%		26.1%	

Table 1B: Lifetime Buy-and-Hold Returns, By Listing Status

Reported are lifetime returns to CRSP common stocks, based on listing status. The geometric return for q months is the q^{th} root of one plus the buy-and-hold return, less one. Panel A pertains to stocks that were not delisted (CRSP dlstcd with 1 as first digit), Panel B pertains to firms that departed the database due to merger, exchange, or liquidation (CRSP dlstcd with 2, 3, or 4 as first digit), and Panel C refers to firms removed from listing by the relevant exchange (CRSP dlstcd with 5 as first digit). The delisting code is missing for 82 stocks.

Panel A: Stocks that Did Not Delist (N = 4,138)

Variable	Mean	Median	SD	Skewness	% Positive
Sum Stock Return	3.0287	2.1637	3.427	1.060	84.9%
Buy-and-Hold Return, Stock	1060.2100	0.6486	38491.400	61.902	64.1%
Geometric Return, Stock	-0.0014	0.0049	0.027	-1.414	64.1%
	% > T-bill		% > VW Mkt Return	% > EW Mkt Return	
Buy-and-Hold Return, Stock	60.1%		39.4%	34.1%	

Panel B: Stocks That Merged, Exchanged, or Liquidated (N = 12,560)

Variable	Mean	Median	SD	Skewness	% Positive
Sum Stock Return	2.2860	1.6734	2.346	1.386	91.4%
Buy-and-Hold Return, Stock	38.2482	1.0279	702.232	60.455	73.8%
Geometric Return, Stock	0.0055	0.0076	0.027	-3.987	73.8%
	% > T-bill		% > VW Mkt Return	% > EW Mkt Return	
Buy-and-Hold Return, Stock	63.0%		46.8%	39.4%	

Panel C: Delisted Stocks (N = 9,187)

Variable	Mean	Median	SD	Skewness	% Positive
Sum Stock Return	-0.1046	-0.4857	2.272	1.753	38.7%
Buy-and-Hold Return, Stock	-0.0080	-0.9195	20.365	54.991	9.8%
Geometric Return, Stock	-0.0625	-0.0407	0.085	-3.589	9.8%
	% > T-bill		% > VW Mkt Return	% > EW Mkt Return	
Buy-and-Hold Return, Stock	6.8%		5.0%	4.3%	

Table 1C: Buy-and-Hold Returns to Unlevered Firms

Reported are monthly and annual returns to those CRSP common stocks identified by Strebulaev and Yang (2013) as "zero-leverage" or "almost zero leverage" firms. Includes unlevered CRSP common stocks over the 1962 to 2009 period. Annual buy-and-hold returns refer to calendar years, or a portion thereof if the stock is listed or delisted within the year. Delisting returns are included. The geometric return for q months is the q^{th} root of one plus the buy-and-hold return, less one.

Panel A: Individual Stocks, Monthly Horizon (N = 293,295)

Variable	Mean	Median	SD	Skewness	% Positive
Buy-and-Hold Return, Stock	0.0194	0.0040	0.192	4.365	50.7%
	% > T-bill		% > VW Mkt Return		% > EW Mkt Return
Buy-and-Hold Return, Stock	50.0%		48.3%		48.1%

Panel B: Individual Stocks, Annual Horizon (N = 25,567)

Variable	Mean	Median	SD	Skewness	% Positive
Sum Stock Return	0.2220	0.1718	0.672	1.502	64.1%
Buy-and-Hold Return, Stock	0.2723	0.0783	1.231	23.958	55.9%
Geometric Return, Stock	0.0057	0.0067	0.064	1.112	55.9%
	% > T-bill		% > VW Mkt Return		% > EW Mkt Return
Buy-and-Hold Return, Stock	52.0%		46.4%		45.4%

Table 2A: The Distribution of Stock Buy-and-Hold Returns, by Size Group

Stocks are assigned to market capitalization deciles as of the end of the prior month (Panel A), year (Panel B) or decade (Panel C). Annual and Decade buy-and-hold returns pertain to shorter intervals if the stock is listed or delisted within the calendar period. Delisting returns are included.

Panel A: Individual Stocks, Monthly horizon

Group (Market Cap)	Mean	Median	Skewness	% > 0	% > T-bill	% > VW Mkt Return	% > EW Mkt Return
1	0.0244	0.0000	8.389	40.3%	40.2%	43.7%	43.4%
2	0.0095	0.0000	3.694	43.2%	43.0%	43.6%	43.2%
3	0.0087	0.0000	4.668	45.1%	44.8%	44.2%	44.0%
4	0.0093	0.0000	4.471	46.8%	46.4%	45.1%	44.8%
5	0.0098	0.0000	6.194	48.2%	47.7%	45.8%	45.5%
6	0.0102	0.0000	1.809	49.6%	49.0%	46.6%	46.2%
7	0.0105	0.0038	1.330	50.9%	50.1%	47.4%	47.0%
8	0.0108	0.0066	1.305	52.2%	51.3%	48.3%	47.9%
9	0.0105	0.0080	0.814	53.5%	52.3%	48.9%	48.3%
10	0.0096	0.0084	0.492	54.4%	52.8%	48.9%	48.6%

Panel B: Individual Stocks, Annual Horizon

Group (Market Cap)	Mean	Median	Skewness	% > 0	% > T-bill	% > VW Mkt Return	% > EW Mkt Return
1	0.2387	0.0000	16.827	47.9%	45.0%	41.6%	40.0%
2	0.1667	0.0000	29.293	49.7%	46.4%	41.0%	40.1%
3	0.1390	0.0143	5.255	51.5%	48.0%	42.1%	40.5%
4	0.1396	0.0260	8.769	52.7%	49.1%	43.1%	41.8%
5	0.1344	0.0444	3.936	54.8%	51.1%	44.6%	42.8%
6	0.1362	0.0570	4.234	56.0%	52.0%	45.4%	43.0%
7	0.1296	0.0672	3.031	57.5%	53.3%	45.8%	43.8%
8	0.1339	0.0852	3.728	60.1%	55.7%	47.0%	44.4%
9	0.1332	0.0949	4.176	62.5%	57.4%	47.5%	44.9%
10	0.1230	0.0989	10.778	65.0%	58.7%	46.7%	44.3%

Panel C: Individual Stocks, Decade Horizon

Group (Market Cap)	Mean	Median	Skewness	% > 0	% > T-bill	% > VW Mkt Return	% > EW Mkt Return
1	0.9654	-0.1929	12.552	42.4%	36.6%	29.7%	28.0%
2	0.9976	-0.0843	23.335	47.1%	40.8%	31.7%	29.8%
3	0.9098	-0.0492	11.420	48.3%	42.7%	34.0%	31.2%
4	0.8929	0.0636	8.805	52.6%	46.4%	36.5%	33.3%
5	1.0026	0.0917	9.416	54.2%	47.8%	37.1%	34.0%
6	1.0443	0.1498	10.299	56.3%	49.7%	38.3%	35.0%
7	1.0713	0.2596	7.102	60.2%	53.4%	39.6%	36.0%
8	1.2946	0.4422	5.263	66.5%	58.6%	44.6%	38.4%
9	1.2908	0.5464	10.472	70.0%	61.3%	42.7%	36.2%
10	1.5254	0.9788	6.956	81.3%	70.5%	44.7%	36.3%

Table 2B: Lifetime Buy-and-hold returns to Individual Stocks, by Decade of Initial Appearance and Initial Listing Exchange

Buy-and-hold returns are computed from the date of a stocks initial appearance in the CRSP database through its delisting or the end of the sample at December 31, 2016.

Panel A: By Decade of initial appearance in the CRSP database

Initial Decade	N	Mean	Median	Skewness	% > 0	% > T-bill	% > VW Mkt Return	% > EW Mkt Return
1926-1936	920	4624.7200	5.9903	29.188	72.5%	67.4%	31.7%	10.9%
1937-1946	251	897.3600	29.5849	6.778	91.2%	86.5%	43.4%	20.7%
1947-1956	247	402.0400	13.8533	7.952	91.1%	87.0%	40.9%	26.7%
1957-1966	1599	67.6600	1.3975	12.130	74.0%	61.5%	44.8%	29.1%
1967-1976	4548	25.4300	0.5888	17.689	60.7%	46.9%	42.6%	29.4%
1977-1986	5151	7.9700	-0.5258	40.517	39.2%	31.7%	20.9%	23.3%
1987-1996	6860	2.8700	-0.2539	15.758	45.2%	39.6%	26.3%	25.8%
1997-2006	4153	0.9100	-0.4578	38.807	40.2%	37.2%	29.4%	24.7%
2007-2016	2238	0.1900	-0.1134	6.488	45.3%	45.0%	32.9%	34.0%

Panel B: By Listing Exchange at time of initial appearance in the CRSP database

Exchange Code	N	Mean	Median	Skewness	% > 0	% > T-bill	% > VW Mkt Return	% > EW Mkt Return
NYSE	4249	1092.6800	1.2482	62.640	71.6%	65.3%	40.2%	29.2%
AMEX	3175	24.8600	0.1670	17.474	55.0%	44.3%	33.5%	26.3%
Nasdaq	18531	7.9000	-0.3035	36.079	43.6%	37.2%	28.2%	25.3%
Others	12	-0.0400	-0.2896	0.332	41.7%	41.7%	41.7%	41.7%

Table 3: Returns to Bootstrapped Stock Portfolios,

July 1926 to December 2016

The indicated numbers of stocks are selected at random for each month, value-weighted portfolio returns are computed each month for the selected stocks, and these returns are linked over one, ten, and ninety-year horizons. The procedure is repeated 20,000 times. Each linked return is compared to zero, to the actual holding return on one-month Treasury Bills, and to the actual holding return to the value-weighted portfolio of all stocks in the database.

	1 Year Horizon			10 Year Horizon			Life (90 Year) Horizon		
	Mean	Med	Skew	Mean	Med	Skew	Mean	Med	Skew
				Bootstrapped Single Stock Positions					
Holding Return	0.1656	0.0406	6.99	2.4538	0.2772	65.03	9498.26	0.095	96.45
% > 0	53.59%			56.18%			50.76%		
% > T-Bill	50.79%			47.77%			27.45%		
% > VW Mkt	42.86%			29.38%			3.97%		
				Bootstrapped Five Stock Portfolios, Value Weighted					
Holding Return	0.1316	0.1072	1.08	1.9180	1.2364	9.03	8954.97	949.36	47.24
% > 0	64.33%			83.60%			99.94%		
% > T-Bill	59.98%			72.29%			96.48%		
% > VW Mkt	47.20%			40.77%			22.68%		
				Bootstrapped Twenty Five Stock Portfolios, Value Weighted					
Holding Return	0.1226	0.1252	0.10	1.8188	1.3977	1.64	6355.47	3174.56	10.02
% > 0	70.00%			95.96%			100.00%		
% > T-Bill	64.94%			86.86%			100.00%		
% > VW Mkt	48.69%			45.37%			36.81%		
				Bootstrapped Fifty Stock Portfolios, Value Weighted					
Holding Return	0.1208	0.1290	-0.09	1.7980	1.4009	1.15	5860.71	3843.32	4.40
% > 0	71.21%			98.38%			100.00%		
% > T-Bill	66.19%			90.70%			100.00%		
% > VW Mkt	49.10%			46.70%			40.94%		
				Bootstrapped One Hundred Stock Portfolios, Value Weighted					
Holding Return	0.1195	0.1318	-0.21	1.7805	1.3760	0.90	5441.81	4217.49	2.95
% > 0	72.00%			99.57%			100.00%		
% > T-Bill	67.09%			93.08%			100.00%		
% > VW Mkt	49.28%			47.54%			43.29%		

Table 4: Lifetime Wealth Creation

This table reports lifetime wealth creation to shareholders in aggregate. Wealth creation is measured by text equation (2), and refers to accumulated December 2016 value in excess of the outcome that would have been obtained if the invested capital had earned one-month Treasury bill returns. Results are reported for the 50 firms with the greatest wealth creation among all companies with common stock in the CRSP database since July 1926. The company name displayed is that associated with the Permco for the most recent CRSP record. Also reported is the compound annual return, inclusive of reinvested dividends. For firms with multiple share classes wealth creation is summed across classes, while the return pertains to the share class that existed for the longest period of time.

PERMCO	Company Name (most recent)	Lifetime Wealth Creation ($ Millions)	% of Total	Cumulative % of Total	PERMNO	Annualized Return	Start Month	End Month	Life (Months)
20678	EXXON MOBIL CORP	1,002,144	2.88%	2.88%	11850	11.94%	Jul-26	Dec-16	1086
7	APPLE INC	745,675	2.14%	5.02%	14593	16.27%	Jan-81	Dec-16	432
8048	MICROSOFT CORP	629,804	1.81%	6.83%	10107	25.02%	Apr-86	Dec-16	369
20792	GENERAL ELECTRIC CO	608,115	1.75%	8.57%	12060	10.67%	Jul-26	Dec-16	1086
20990	INTERNATIONAL BUSINESS MACHS COR	520,240	1.49%	10.07%	12490	13.78%	Jul-26	Dec-16	1086
21398	ALTRIA GROUP INC	470,183	1.35%	11.42%	13901	17.65%	Jul-26	Dec-16	1086
21018	JOHNSON & JOHNSON	426,210	1.22%	12.64%	22111	15.53%	Oct-44	Dec-16	867
20799	GENERAL MOTORS CORP	425,318	1.22%	13.86%	12079	5.04%	Jul-26	Jun-09	996
20440	CHEVRON CORP NEW	390,427	1.12%	14.98%	14541	11.03%	Jul-26	Dec-16	1086
21880	WAL MART STORES INC	368,214	1.06%	16.04%	55976	18.44%	Dec-72	Dec-16	529
45483	ALPHABET INC	365,285	1.05%	17.09%	90319	24.86%	Sep-04	Dec-16	148
540	BERKSHIRE HATHAWAY INC DEL	355,864	1.02%	18.11%	17778	22.61%	Nov-76	Dec-16	482
21446	PROCTER & GAMBLE CO	354,971	1.02%	19.13%	18163	10.45%	Sep-29	Dec-16	1048
15473	AMAZON COM INC	335,100	0.96%	20.09%	84788	37.35%	Jun-97	Dec-16	235
20468	COCA COLA CO	326,085	0.94%	21.03%	11308	13.05%	Jul-26	Dec-16	1086
20606	DU PONT E I DE NEMOURS & CO	307,976	0.88%	21.91%	11703	10.57%	Jul-26	Dec-16	1086
20103	A T & T CORP	297,240	0.85%	22.77%	10401	7.81%	Jul-26	Nov-05	953
21188	MERCK & CO INC NEW	286,671	0.82%	23.59%	22752	13.79%	Jun-46	Dec-16	847
21305	WELLS FARGO & CO NEW	261,343	0.75%	24.34%	38703	13.26%	Jan-63	Dec-16	648
2367	INTEL CORP	259,252	0.74%	25.09%	59328	17.70%	Jan-73	Dec-16	528

PERMCO	Company Name (most recent)	Lifetime Wealth Creation ($ Millions)	% of Total	Cumulative % of Total	PERMNO	Annualized Return	Start Month	End Month	Life (Months)
20436	JPMORGAN CHASE & CO	238,148	0.68%	25.77%	47896	9.97%	Apr-69	Dec-16	573
5085	HOME DEPOT INC	230,703	0.66%	26.43%	66181	27.63%	Oct-81	Dec-16	423
21384	PEPSICO INC	224,571	0.64%	27.08%	13856	12.58%	Jul-26	Dec-16	1086
8045	ORACLE CORP	214,245	0.62%	27.69%	10104	23.44%	Apr-86	Dec-16	369
21211	MOBIL CORP	202,461	0.58%	28.27%	15966	11.50%	Jan-27	Nov-99	875
21205	3M CO	200,357	0.58%	28.85%	22592	13.72%	Feb-46	Dec-16	851
20587	DISNEY WALT CO	191,954	0.55%	29.40%	26403	16.47%	Dec-57	Dec-16	709
54084	FACEBOOK INC	181,243	0.52%	29.92%	13407	34.47%	Jun-12	Dec-16	55
20017	ABBOTT LABORATORIES	181,152	0.52%	30.44%	20482	13.53%	Apr-37	Dec-16	957
21394	PFIZER INC	179,894	0.52%	30.96%	21936	15.02%	Feb-44	Dec-16	875
21177	MCDONALDS CORP	178,327	0.51%	31.47%	43449	17.85%	Aug-66	Dec-16	605
7267	UNITEDHEALTH GROUP INC	172,168	0.49%	31.96%	92655	24.75%	Nov-84	Dec-16	386
21645	A T & T INC	169,525	0.49%	32.45%	66093	11.93%	Mar-84	Dec-16	394
20191	AMOCO CORP	168,009	0.48%	32.93%	19553	13.10%	Sep-34	Dec-98	772
20288	VERIZON COMMUNICATIONS INC	165,102	0.47%	33.41%	65875	11.16%	Mar-84	Dec-16	394
21734	TEXACO INC	164,279	0.47%	33.88%	14736	11.58%	Jul-26	Oct-01	904
20331	BRISTOL MYERS SQUIBB CO	161,949	0.47%	34.34%	19393	13.20%	Oct-33	Dec-16	999
43613	COMCAST CORP NEW	146,959	0.42%	34.77%	89525	12.38%	Dec-02	Dec-16	169
21401	CONOCOPHILLIPS	143,849	0.41%	35.18%	13928	10.22%	Jul-26	Dec-16	1086
21886	WARNER LAMBERT CO	142,468	0.41%	35.59%	24678	19.40%	Jul-51	Jun-00	588
20315	BOEING CO	139,355	0.40%	35.99%	19561	15.60%	Oct-34	Dec-16	987
216	AMGEN INC	137,877	0.40%	36.39%	14008	21.01%	Jul-83	Dec-16	402
21576	SCHLUMBERGER LTD	134,186	0.39%	36.77%	14277	7.04%	Jul-26	Dec-16	1086
10486	CISCO SYSTEMS INC	131,295	0.38%	37.15%	76076	25.43%	Mar-90	Dec-16	322
52983	VISA INC	129,757	0.37%	37.52%	92611	21.06%	Apr-08	Dec-16	105
20908	H P INC	129,290	0.37%	37.89%	27828	9.85%	Apr-61	Dec-16	669
21832	UNITED TECHNOLOGIES CORP	126,168	0.36%	38.25%	17830	9.86%	May-29	Dec-16	1052
21810	UNION PACIFIC CORP	122,357	0.35%	38.60%	48725	13.55%	Aug-69	Dec-16	569
21592	SEARS ROEBUCK & CO	120,587	0.35%	38.95%	14322	10.86%	Jul-26	Mar-05	945
11300	GILEAD SCIENCES INC	118,600	0.34%	39.29%	77274	20.95%	Feb-92	Dec-16	299

Table 5: Simulation Evidence Regarding Multi-Period Returns, when Single-Period Returns are Distributed Normally

Monthly returns are random draws from a normal distribution with mean 0.5% and standard deviation as indicated. Buy-and-hold returns are created by linking monthly returns for the indicated horizon. The simulation included 12 million monthly returns for each standard deviation. Results reported are computed across 1 million non-overlapping annual returns, 200,000 non-overlapping five year returns, and 100,000 non-overlapping ten-year returns.

Standard Deviation of Monthly Returns	0.00%	2.00%	4.00%	6.00%	8.00%	10.00%	12.00%	14.00%	16.00%	18.00%	20.00%
Horizon (Years)	**Panel A: Skewness of Buy-and-hold returns**										
1	0.000	0.186	0.387	0.578	0.782	1.005	1.220	1.478	1.718	2.026	2.333
5	0.000	0.475	0.970	1.546	2.258	3.342	4.575	5.530	10.168	13.652	19.465
10	0.000	0.683	1.476	2.449	4.668	8.215	10.500	12.929	30.637	32.155	41.954
	Panel B: Median Buy-and-hold return										
1	6.17%	5.95%	5.20%	4.10%	2.47%	0.42%	-1.92%	-4.86%	-8.07%	-11.64%	-15.62%
5	34.89%	33.34%	28.72%	21.42%	11.52%	0.27%	-12.06%	-25.25%	-38.00%	-50.12%	-61.34%
10	81.94%	77.71%	65.25%	46.91%	23.81%	0.14%	-23.70%	-44.60%	-62.05%	-75.61%	-85.45%
	Panel C: Percentage of Buy-and-hold returns that are Positive										
1	100.00%	79.82%	64.37%	57.70%	53.53%	50.49%	48.15%	45.98%	44.13%	42.37%	40.66%
5	100.00%	96.86%	79.23%	66.09%	56.91%	50.13%	44.60%	39.69%	35.36%	31.49%	27.82%
10	100.00%	99.60%	87.42%	72.05%	59.55%	50.06%	41.95%	35.16%	29.41%	24.50%	19.91%