Do Stocks Outperform Treasury Bills?*

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Abstract

Most common stocks do not outperform Treasury Bills. Fifty eight percent of common stocks have holding period returns less than those on one-month Treasuries over their full lifetimes on CRSP. 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 stocks. These results highlight the important role of positive skewness in the cross-sectional distribution of stock returns. The skewness in long-horizon returns reflects both that monthly returns are positively skewed and the fact that compounding returns itself induces positive skewness. The results also help to explain why active strategies, which tend to be poorly diversified, most often underperform.

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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 low risk investments is so large that the magnitude of the observed stock market return premium is widely referred to as the "equity premium puzzle."[2]

In this paper, I document that most common stocks provide returns that fall short of those earned on one-month Treasury Bills.[3] I rely on the 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 2015, only 47.7% are larger than the one-month Treasury rate. In fact, less than half of monthly CRSP common stock returns are positive. When focusing on lifetime returns (from the beginning of sample or first appearance in CRSP through the end of sample or delisting from CRSP, and including delisting returns when appropriate), just 42.1% of common stocks have a holding period return

[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. 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.
[3] 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/2015/05/21/the-risks-of-owning-an-individual-stock/ and "The capitalism distribution" at http://www.theivyportfolio.com/wp-content/uploads/2008/12/thecapitalismdistribution.pdf.

that exceeds the return to holding one-month Treasury Bills over the same horizon, and more than half deliver negative lifetime returns.

Individual common stocks tend to have rather short lives. The median time that a stock is listed on the CRSP database between 1926 and 2015 is just over seven 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 2015 would have generated a 90-year holding period 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.[4] The single-stock strategy outperformed the one-month Treasury bill over the 1926 to 2015 period in only twenty eight percent of the simulations.

The fact that the overall stock market generates puzzling high long term returns while the majority of individual stocks fail to even match T-bills can be attributed to the fact that the cross-sectional distribution of stock returns is positively skewed.[5] Simply put, large positive returns

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[4] 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).

[5] 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 stocks 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 (2015).

are more frequent than large negative returns. The importance of positive skewness in the cross-sectional return distribution increases for longer holding periods, due to the effects of compounding.

Perhaps the most striking illustration of the importance of individual stock skewness to stock market performance arises when measuring aggregate stock market wealth creation. I calculate that the approximately 26,000 stocks that have appeared in the CRSP database since 1926 are collectively responsible for lifetime shareholder wealth creation of nearly $32 trillion dollars, measured as of December 2015. However, the eighty six top-performing stocks, less than one third of one percent of the total, collectively account for over half of the wealth creation. The 1,000 top performing stocks, less than four percent of the total, account for all of the wealth creation. That is, the other ninety six percent of stocks that have appeared on CRSP collectively generated lifetime dollar returns that only 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.[6] The Capital Asset Pricing Model (CAPM) in particular implies that each individual stock's expected return premium is the stock's beta times the positive expected market-wide premium. Given positive betas, each stock's expected return premium should be positive.

Note, however, that implications of standard asset pricing models, including the CAPM, are with regard to stocks' *mean* excess return, while the fact that the majority of common stock returns are less than the treasury rate reveals that the *median* excess return is negative. The

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

CAPM in particular relies on the assumption that stock returns are normally distributed, in which case mean and median returns are equal.

The evidence reported here is at indeed at odds with the CAPM, but the conflict arises from the fact that the median stock return is less than the mean return. As such, these results challenge the notion that individual stocks most often generate a positive return premium. The results highlight the importance of skewness in the cross-sectional distribution of stock returns. As I show in Section V of this paper, the skewness arises both from the fact that monthly returns are positively skewed and from the possibly underappreciated fact that compounding introduces skewness into the multi-period holding return distribution, even if single period returns are symmetric.

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. Lucca and Moench (2015) 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. Related, Cieslak, Morse, and Vissing-Jorgensen (2016) document that the entire equity premium since 1994 has accrued in even weeks after 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, the results help to understand why active strategies, which tend to be poorly diversified, most often lead to underperformance.[7] At the same time, the results potentially justify a focus on less diversified portfolios by those investors who particularly value the possibility of "lottery-like" outcomes, despite the knowledge that the poorly-diversified portfolio will more likely underperform.

II. The Distribution of Holding Period Returns

I study returns, inclusive of dividends, for all CRSP common stocks (share codes 10, 11, and 12) from July 1926 to December 2015.[8] The starting date is the earliest for which one-month Treasury bill data is available from Kenneth French's website. The data includes 25,782 distinct CRSP permanent numbers (PERMNOs), which I refer to as stocks.[9] I include in all calculations the CRSP delisting return for those firms that delist prior to the end of 2015. When studying periods longer than one month I create holding period returns by linking monthly gross (one plus) returns. Holding period returns capture the experience of a hypothetical investor who reinvests dividends but does not otherwise alter her position after the initial purchase of shares.[10]

a. Monthly Returns

Panel A of Table 1A reports some summary statistics for the 3,524,849 monthly common stock returns contained in the CRSP database from July 1926 to December 2015. The data confirms that the mean return premium is positive, as the average monthly return is 1.13%,

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[7] A similar observation is made by Heaton, Polson, and Witte (2016).

[8] 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 a negative mean monthly return. Their inclusion would therefore strengthen the conclusions drawn here.

[9] 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."

[10] However, holding period returns do not capture the investment experience of firms' investors in aggregate, who 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.

compared to an average one-month Treasury bill rate of 0.38%. 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 6.72. Second, monthly returns are highly variable, with a standard deviation of 18.0%. Third, and most important, only a minority, 47.7%, of CRSP monthly stock returns exceed the one-month Treasury return in the same month. In fact, less than half (48.3%) of monthly stock returns are positive.

When I weight the results by beginning-of-month market capitalization, I obtain that 53.3% of the market value of stocks in a given month deliver a return that exceeds the one month Treasury return, while 54.5% of the market value of stocks in a given month deliver a return that is positive. These results imply that smaller capitalization stocks are more likely to have returns that fall below the benchmarks of zero or the Treasury bill rate, a result explored more fully in Section III.d below.

The results contained in Table 1A pertain to the pooled distribution of all 3.52 million monthly common stock returns in the database, applying equal weight to each. When I focus on the time series of monthly returns for each stock, and then compute the mean across stocks, I find that the mean standard deviation of monthly returns is 18.79%, while the mean skewness of monthly returns is 1.026. The fact that the cross-sectional mean skewness is less than the skewness in the pooled distribution reflects in part differences in mean returns across securities. When I compute the time series average of the monthly cross-sectional standard deviation and skewness, I find that the mean cross-sectional standard deviation of monthly returns is 13.51%, while the mean cross-sectional skewness of monthly returns is 2.495. These results confirm that the high volatility and positive skewness of monthly common stock returns are observed on average both in the time series of individual firms and in the cross section of individual months.

b. Annual and Decade Returns

Panels B and C of Table 2 report summary statistics for CRSP common stock returns computed on a calendar year and decade basis, respectively. Decades are non-overlapping, and are defined as 1926 to 1935, 1936 to 1945, 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.[11] For each stock, I compute the simple sum of returns for the calendar interval, and also holding period 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 returns for each stock over each interval.[12] (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 will be positive more often than the geometric return, reflecting that 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) holding period returns (to a maximum of 500%). The frequency distribution of annual returns (each rounded to the nearest 1%) 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 holding period returns can be observed, in part because numerous returns exceed 100%, while, due to limited liability, no returns are less than

[11] 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.

[12] The geometric mean for a sample of n returns is the nth root of one plus the holding period return, less one.

-100%.[13]

The frequency distribution of decade holding period returns in Figure 1B also reveals positive skewness.[14] Unlike annual returns, where the most frequent observation is zero, the most frequently-observed decade holding period return (rounded to the nearest 5%) is -100%.[15] Zero returns at the decade horizon are only slightly more frequent than small positive or negative returns. On balance, the frequency distribution of decade holding period returns is notably asymmetric, with the most frequent outcomes near -100% and many outcomes greater than 100%.

The statistics on Panels B and C of Table 1A verify that that holding period returns across multiple months are positively skewed. The standardized skewness coefficient is 19.92 for annual returns and 14.21 for decade returns. Note also that mean holding period returns substantially exceed median returns. The mean annual holding period return is 14.72%, while the median is 5.08%. The divergence is more notable for the decade horizon, where the mean holding period return is 118.6%, compared to a median of just 14.9%.

The mean decade holding period return of 118.6% 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 holding period return. At the decade horizon, 73.2% of arithmetic mean returns are positive, while only 55.7% of holding period returns are positive. The fact that the standardized skewness of annual holding period returns greatly exceeds that of the sum of annual

[13] A total of 20,805 (6.6% of all annual return observations) holding period returns exceed 100%. Of these, 828 exceed 500% and are not displayed on Figure 1A. The maximum annual holding period return was 11,060%.
[14] A total of 16,026 (29.7% of all decade return observations) holding period returns exceed 100%. Of these, 3,504 exceed 500% and are not displayed on Figure 1A. The maximum decade holding period return was 22,825%.
[15] The data contains only 375 occurrences where a stock has a delisting return of exactly -100%. More often a final (delisting) share price is small but positive, implying a holding return through the delisting date slightly better than -100%.

returns (19.92 vs. 1.25) emphasizes the important role of compounding in generating skewness over multiple periods.

At the annual horizon, a slight majority (51.4%) of stocks generate holding period returns that exceed the holding period return on one-month Treasury Bills. Notably, at the decade horizon, a minority (49.2%) of stocks outperform Treasury Bills.

The effects of right skewness in the distribution of holding period returns can also be observed when comparing individual stocks to market-wide benchmarks. At the decade horizon, only 37.4% of stocks have holding period returns that exceed the holding period return to the value-weighted portfolio of all common stocks, and just 33.9% outperform the holding period 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 (0.48% per month) at the annual horizon than at the decade (0.31% per month) horizon. Notably, the distribution of geometric returns across stocks is positively skewed at the annual horizon (skewness statistic of 6.43) but is negatively skewed at the decade horizon (skewness statistic of -3.12). 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 holding period 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 holding period returns can be fully attributed to a combination of positive skewness in monthly returns and the effects of compounding.

c. Lifetime Returns

In Panel D of Table 1A, I report on lifetime returns to CRSP common stocks. For each stock, the lifetime return spans from July 1926 or the original listing date to December 2015 or the delisting date, inclusive of the delisting return.

While over seventy one percent of individual stocks have a positive arithmetic average return over their full life, only a minority (49.2%) of CRSP common stocks have a positive lifetime holding period return, and the median lifetime return is -3.67%. This result highlights that arithmetic mean returns tend to overstate actual performance. While over 71% of CRSP common stocks show a positive arithmetic mean return over their lifetimes, less than half generate a positive holding period return.

The distribution of lifetime holding period returns is also highly positively skewed. The standardized skewness coefficient is 154.2. In contrast to the negative median lifetime holding period return, the cross-sectional mean lifetime return is over 16,000 percent.[16] Also reflective of the positive skewness, only 599 stocks, or 2.3% of the total, have lifetime holding period returns that exceed the cross-sectional mean lifetime return.

Geometric returns over stocks' full lives are negatively skewed (skewness coefficient -4.05) in the cross section. As discussed above, negative skewness in the distribution of geometric returns, which are stated on a per-month basis, implies that the very strong positive skewness in lifetime holding period returns is attributable to skewness in monthly returns in combination with the effects of compounding.

Perhaps most notably, only 42.1% of CRSP common stocks have lifetime holding period returns that exceed the holding period return on one-month Treasury Bills over the same time

[16] The maximum lifetime holding period return is 202.96 million percent, by the firm now known as Altria Group, Inc.

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 right skewness in the stock return distribution can also be illustrated by comparing the holding period returns of individual stocks to the holding period returns earned on the equal and value-weighted portfolios of all common stocks. As shown on Panel D of Table 1A, only 30.6% of individual common stocks generated lifetime holding period returns that exceed the performance of the value weighted portfolio over the same intervals, and only 26.2% outperformed the equal-weighted portfolio.

d. The potential role of firm leverage

The evidence reported on Table 1A shows that positive skewness is an empirically important feature of stock returns. Black and Scholes (1973) observed that the equity claim in a leveraged firm can be viewed as a call option, with a positively-skewed payoff distribution. To assess whether the positive skewness in stock returns can be attributed to leverage, I examine the distribution of returns to those CRSP common stocks identified by Strebulaev and Yang (2013) as "zero leverage" or "almost zero leverage" firms.[17] Their identification is on an annual basis, and covers the 1962 to 2009 period.

Table 1B 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

[17] 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%.

annual returns. The results on Table 1B indicate that unlevered firms on average deliver strong stock market returns. For example, the mean annual holding period return for unlevered firms is 27.23%, compared to 14.72% for the entire sample (Table 1A).

Most important, the results on Table 1B indicate that the distribution of returns to unlevered firms is also positively skewed. At the monthly horizon the skewness of unlevered firm returns is 4.365, compared to 6.718 (Panel A of Table 1A) for the entire sample. At the annual horizon the skewness of holding period returns to unlevered firms is 23.958, which actually exceeds the skewness of annual holding period returns for the full sample, which is 19.922 (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.

e. Return Distributions Delineated by Firm Size and by Share Price

In Table 2A I report a number of statistics regarding holding period returns to common stocks, when firms are stratified based on market capitalization, for monthly (Panel A), calendar year (Panel B), and non-overlapping decade (Panel C) horizons.[18] Each stock is assigned to a 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 2 show a distinct pattern by which small stocks more frequently deliver returns that are less than benchmark returns. At the decade horizon, only 43.1% of stocks in the smallest decile have holding period returns that are positive, and only

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

37.4% have holding period returns that exceed those of the one-month Treasury bill. In contrast, 80.0% of stocks in the largest decile have positive decade holding period returns, and 69.6% outperform the one-month Treasury Bill. Only 31.0% of smallest-decile stocks have decade holding period returns that exceed the return to the value-weighted market over the same period, and only 28.6% 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 holding period returns for the smallest decile of stocks is 13.14, which far exceeds that of the largest decile of stocks, which is 3.62.

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 holding period returns that exceed matched holding period return to the value-weighted market is 48.9% at the monthly horizon, 46.6% at the annual horizon, and 44.2% at the decade horizon.

In Table 2B I report results that parallel those compiled in Table 2A, except that stocks are assigned to decile portfolios based on share price at the beginning of the return measurement interval (or at the time of initial appearance in the data), rather than market capitalization. Outcomes for low-priced stocks are in many ways even more notable than for small stocks. For example, only 31.5% of monthly returns to stocks in the lowest share price decile exceed one month Treasury bill rates, as compared to 59.1% of monthly returns to stocks in the highest share price decile. At the decade horizon, only 29.7% of holding period returns to stocks in the lowest share price decile exceed the holding period return to one-month Treasury bills, compared to 65.1% of stocks in the highest share price decile.

III. Individual Stocks over the Full Ninety Years

The CRSP data I employ includes returns pertaining to ninety calendar years, spanning 1926 to 2015. In section III, I report data on lifetime returns to CRSP common stocks, showing that the majority fail to outperform one-month Treasury bills over their lifetime. However, for the large majority of 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 84 months, or slightly over seven years. The 90th percentile life span is 326 months, or just over 27 years.

To obtain evidence regarding the long term performance of individual stocks that spans the full ninety years, I adopt a bootstrap procedure. In particular, for each month from July 1926 to December 2015 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, the accumulated return on the value-weighted portfolio of all common stocks, and the accumulated return to the equal-weighted portfolio of all common stocks over the same calendar interval. I repeat the procedure 10,000 times, to obtain a bootstrap distribution of possible returns to single stock strategies. 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 firms over long horizons.

Panel A of Table 3 reports the mean and median holding period return, as well as the skewness, for the one-month Treasury bill as well as the equal and value-weighted portfolios of all CRSP common stocks, for annual, decade, and lifetime (90 year) horizons.[19] Since we only observe one actual history, these series contain only time series variation, and the 90-year series contains a single outcome. Panel B of Table 3 reports mean and median holding period returns for each time horizon, computed across the 10,000 bootstrap simulations.

The results reveal that single stock strategies would have been profitable on average (ignoring transaction costs). The mean holding return to the single stock strategy is 16.6% at a one year horizon, 265.0% at a decade horizon, and 526,325% at the 90-year horizon. However, the right skewness in the distribution of bootstrapped single stock strategies is extreme – the standardized skewness coefficient is 7.04 at the annual horizon, 41.0 at the decade horizon, and 44.3 at the 90-year horizon, implying that these mean returns greatly exceeded typical returns.

Despite the positive mean returns, most single stock portfolios performed poorly, especially at the 90-year horizon. While a slight majority (50.9%) of single stock strategies generated a positive 90-year holding return, the median 90-year return is only 13.1%, compared to a 90-year holding period return on Treasury bills of 1,923%. Only 27.6% of single stock strategies produced a holding period 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 3.8% of single stock strategies produced a holding period return greater than the value-weighted market, and only 1.2% beat the equal-weighted market over the full 90-year horizon. These observations, which again reflect the substantial positive skewness in the

[19] The skewness of annual value-weighted market returns is negative. Albuquerque (2012) presents evidence that negative skewness in market returns can be reconciled with positive skewness in individual stock returns by heterogeneity in information announcement dates across stocks.

distribution of stock returns, may help to explain the result that most active managers, who tend to be poorly diversified, most often underperform the broad stock market.

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

The results reported here show that most individual common stocks have generated holding period returns that are less than the holding period 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 low risk 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, holding period 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 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.[20] For these reasons, a high holding period return need not imply large wealth creation for investors in aggregate, and vice versa.

Consider, as a case in point, General Motors Corporation (PERMNO 12079), which delisted in June 2009 following a Chapter 11 bankruptcy filing.[21] Its delisting share price was $0.61, down from $93 less than a decade earlier and from $23 a little over two years earlier. Had the delisting share price been zero instead of sixty one cents, GM's lifetime holding period 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 these funds were collectively available to

[20] Dichev (2007) focuses attention on these shortcomings in holding period returns, and reports on what he terms "dollar weighted" returns, for aggregate stock markets in several countries. In particular, he computes for each market the internal rate of return to investors, when considering aggregate distributions to and from shareholders.
[21] A new General Motors stock emerged from the bankruptcy filing and completed an IPO in November 2010.

be invested elsewhere 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 holding period returns that underperform Treasury bills, I create a measure of dollar wealth creation for each of the 25,782 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 return R_f, (assumed for expositional simplicity to be constant over time) and a risky 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 riskless bond account. Separate from the dividend, the investor 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 at time t, with W_t, = B_t, + I_t.

The value of the investor's position in the riskless bond evolves according to

$B_t = B_{t-1}(1+R_f) + I_{t-1}*R_{dt} – F_t$, 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

$W_t = B_{t-1}(1+R_f) + I_{t-1}*(1+R_t)$, and we can state:

$$W_t - W_{t-1}*(1+R_f) = I_{t-1}*(R_t - R_f).$$ [22] (1)

Expression (1) states that the investor's actual wealth at time t, as compared to the wealth that would have been obtained had her prior period wealth been invested 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.

Applying expression (1) iteratively leads to the following expression:

$$W_T - W_0*(1+R_f)^T =$$

$$I_0*(R_1 - R_f)(1+R_f)^{T-1} + I_1*(R_2 - R_f)(1+R_f)^{T-2} + \ldots + I_{T-1}*(R_T - R_f). \quad (2)$$

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, or equivalently as the wealth created by investing funds in the risky asset rather than the Treasury bill. The second line of expression (2) shows that the dollar amount of wealth creation attributable to the investment in the risky asset can be computed as the sum of the future values (using the risk free rate to compound forward) of the period by period wealth creation specified by the right side of expression (1).[23,24]

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[22] 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.

[23] 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 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 a specific point in time.

[24] Expression (2) is also equivalent to calculating wealth creation as the date T value of the stock's outstanding shares less the date T value (using the treasury rate) of all cash flows (positive in the case of stock issuances, negative in the case of dividends and share repurchases) from investors to the firm prior to date T.

I implement expression (3) 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. Compounding is accomplished by linking actual one-month Treasury rates from each month t to December 2015. The results indicate that the 25,782 individual common stocks that have appeared in the CRSP data since July 1926 have collectively created over $31.8 trillion in wealth for investors, measured as of December 2015.

Table 4 reports lifetime wealth creation for the thirty individual stocks that created the most wealth. Individual stocks are identified by CRSP PERMNO and by the most recent name associated with the PERMNO. The largest amount of wealth creation attributable to any stock is $939.8 billion, by Exxon Mobil Corporation. The second largest wealth creation is attributable to Apple, Inc., which created $677.4 billion in shareholder wealth, despite a CRSP life of only 420 months (compared to 1,073 months for Exxon Mobil and other firms that were present for the full sample.) General Electric ($597.5 billion), Microsoft ($567.7 billion), International Business Machines ($487.3 billion), Altria Group ($448.1 billion), General Motors ($394.1 billion), Johnson and Johnson ($383.7 billion), Walmart Stores ($337.7 billion), and Proctor and Gamble ($335.8 billion) comprise the rest of the top ten stocks in terms of lifetime value creation.

In addition to lifetime wealth creation, Table 4 identifies the lifetime cumulative gross return (measured by linking individual monthly returns over the life of the stock) and the geometric mean excess monthly return (the geometric mean monthly return for the stock over its life, less the geometric mean monthly Treasury bill return over the same interval). The largest cumulative gross return was 202.9 million percent, earned by Altria Group (which includes among its holdings Phillip Morris USA). Altria Group's geometric mean monthly return over its 1,073 month life exceeded the geometric mean Treasury bill return by 1.08%. By comparison, Exxon Mobile Corporation (which had the largest dollar wealth creation) had an excess geometric mean return of 0.66% per month, and Microsoft had an excess geometric mean return of 1.62% per month.

As noted, Exxon Mobil was responsible for lifetime wealth creation of $939.8 billion. Thus, Exxon Mobile alone was responsible for 2.96% of the $31.8 trillion in total wealth creation by CRSP common stocks over the 1926 to 2015 period. Apple Corporation was responsible for an additional 2.13% of total stock market wealth creation. The right column of Table 4 displays the cumulative percentage of total 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 thirty firms together accounted for 31.2% of the total stock market's wealth creation.

Figure 2A displays the cumulative percentage of the total stock market wealth creation attributable to the 25,782 individual common stocks in the CRSP database, when firms are ranked from highest to lowest wealth creation. The curve on Figure 2A 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 14,946 (58.0% of total) stocks with negative lifetime wealth creation.

Figure 2B displays the same data as Figure 2A, but is confined to the 1,000 stocks with the largest lifetime wealth creation. Strikingly, the curve on Figure 2B passes through 50% at just 86 stocks and passes through 75% at 282 stocks. That is, just 0.33% of all CRSP common stocks account for half of the cumulative wealth creation in the U.S. stock market from 1926 to 2015, and 1.09% of the stocks account for three quarters of the wealth creation.

The curve on Figure 2B reaches 100% at 983 stocks, which is 3.81% of the 25,782 stocks in the sample. The striking implication is that less than four percent of the common stocks contained in the CRSP database collectively account for all of the wealth creation in the U.S.

stock market since 1926. The remaining 96.19% of common stocks collectively generated dollar gains that matched those that would have been earned had the invested capital earned the same rates as one-month U.S. Treasury bills.[25,26]

It should be noted that there are at least five considerations that collectively contribute to the fact that wealth creation in the U.S. stock market is concentrated in relatively few stocks. First, some stocks have long lives while others have short lives. As noted, the median life of a CRSP common stock is just over seven years, while, not surprisingly, the stocks with the greatest wealth creation generally have much longer lives. Second, firm size varies widely, and a given excess return equates to larger wealth creation for stocks with greater market capitalization. Third, pure randomness contributes. Even if the cross-sectional distribution of holding period returns was symmetric, some stocks would have high ex post returns and some would have low returns. Fourth, monthly returns are positively skewed. Finally, the compounding of returns over multiple periods itself induces additional positive skewness in the distribution of returns, as discussed more fully in the following section.

These explanations are not independent, and potentially reinforce each other. In particular, stocks 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 fact that all of the dollar wealth creation in the U.S. market is attributable to less than four percent of stocks is striking.

[25] Beyond the best-performing 983, an additional 9,853 stocks (38.2%) of stocks created positive wealth over their lifetimes. The wealth creation of these stocks was just offset by the wealth destruction of the remaining 14,946 (58.0% of total) stocks, so that the top 983 stocks created the same wealth as the overall market.

[26] 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.

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 are attributable to the empirical fact that the median stock return is negative, even while the mean stock return is positive. I will now argue that negative median stock returns should be anticipated as the norm rather than an aberration, especially 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.[27]

In particular, let R denote a simple excess return for a single period. If $r \equiv \ln(1 + R)$ is distributed normally with mean μ and standard deviation σ, then R is distributed log normally. The expected excess return, E(R) is $\exp(\mu + 0.5\sigma^2) - 1$. In contrast, the median excess return is $\exp(\mu) - 1$. Clearly the median excess return is less than the mean excess return for all $\sigma > 0$, and the divergence of the mean from the median becomes larger if there is more return volatility. Further, the skewness of excess returns in this case is positive an increasing in σ.[28]

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

[28] The expression for the standardized skewness of a log normal variable depends monotonically on the standard deviation, σ, and implies positive skewness for all $\sigma > 0$. See, for example, http://www.itl.nist.gov/div898/handbook/eda/section3/eda3669.htm.

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 excess return is also negative. This occurs if

$$\sigma^2 > 2*\ln[1 + E(R)]. \tag{1}$$

Stated alternatively, the log normality assumption implies that more than half of single period excess returns will be negative for any stock where the excess return variance, σ^2, exceeds twice the continuously compounded equivalent of the mean excess return. This is attributable to the fact that greater return variance implies greater positive skewness and a greater divergence of the mean from the median in the case of log normal variables.

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 return monthly return if the standard deviation, σ, exceeds 12.6%. By comparison, the full sample standard deviation of monthly CRSP common stock returns about is 18%. 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.

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 the log normal distribution, the positive skewness of multi-period returns increases with the number of periods, as the return standard deviation (which in turn solely determines skewness) is proportional to the square root of the number of periods.

It appears to be less widely appreciated that the compounding of returns over multiple periods will typically impart positive skewness to longer horizon returns, *even if the distribution* *of single-period returns is symmetric*. To my knowledge, this point was first demonstrated by Arditti and Levy (1975).[29]

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 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.[30]

It is sometimes assumed that single-period stock returns are distributed normally, and this assumption often underlies the focus on mean-variance efficiency as a criterion for portfolio selection. The normal return assumption is potentially more plausible for diversified portfolios than for individual stocks, as it has been shown (Simkowitz and Beedles, 1978 and Albuquerque, 2013) that diversification tends to eliminate skewness from portfolio returns.

It is known that the product of normally distributed variables is not normally distributed. To my knowledge, the statistical properties of multiple-period holding returns generated by the multiplicative linking of gross returns that are successive draws from the normal distribution has not been carefully explored.[31] I therefore rely on simulations to assess the effects of compounding on the median holding period return and the skewness of holding period returns,

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[29] 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."

[30] 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.

[31] 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.

when single-period returns are distributed normally. In particular, I construct simulated monthly returns as random draws from normal distributions, and compute multi-period holding 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.

In the actual CRSP data, the standard deviation of monthly returns to the value-weighted portfolio of all from 1926 to 2015 is 5.5%, while that for the equal-weighted portfolio is 7.4%. When I compute the standard deviation of monthly returns to the individual common stocks in the CRSP database over their full lifetimes, the cross-sectional average standard deviation is 18.8%. 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. In this case there is no skewness in returns. All holding period returns are positive, and are equal to 6.17% for twelve months, 34.89% for five years, and 81.94% for ten years.

Panel A of Table 5 demonstrates the effect of compounding on the skewness of holding period returns. Even though each single period return is drawn from a zero-skew normal distribution, the skewness of holding period returns is positive at all horizons. 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 holding period 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 holding period 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 causes the median holding period return to be less than the mean return, as demonstrated in Panel B of Table 5. At a one year horizon, the median holding period 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 holding period 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 holding period returns that exceed zero, as demonstrated in Panel C of Table 5 When monthly returns are riskless all holding period 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 holding period 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 compounding of the positive mean, and the percentage of holding period returns that are positive decreases with horizon. For example, when σ = 16% per month the percentage of holding period 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 compounding alone can explain many of the striking results reported in this paper. Even if monthly returns are drawn from a zero-skew normal distribution, holding period returns over multiple periods are positively skewed. This positive skewness causes the median holding period return to be less than the mean, and more so at longer horizons. 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 holding period returns are negative, implying that the majority of individual stock returns are negative, even though mean holding periods are positive.

To summarize, the evidence that most stocks generate holding-period returns that are less than would have been 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, skewness of single period returns is not required. Compounding induces positive skewness in multi-period holding returns, even if single period returns are symmetric.

VI. Conclusions

While the overall stock market outperforms Treasury bills, most individual common stocks do not. Of the nearly 26,000 common stocks that have appeared on CRSP since 1926, less than half generated a positive holding period return, and only 42% have a holding period return higher 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. When stated in terms of lifetime dollar wealth creation, one third of one percent of common stocks account for half of the overall stock market gains, and less than four percent of common stocks account for all of the stock market gains. The other ninety six percent of stocks 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 compounding introduces positive skewness into the multi-period return distribution even if single period returns are symmetric.

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 fact that poorly diversified portfolios may underperform because they omit the relatively few stocks that generate large positive returns. The results also help to explain why active portfolio strategies, which tend to be poorly diversified, most often underperform their benchmarks. Underperformance is typically 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.

At the same time, a preference for positive skewness in portfolio returns is not necessarily irrational, and it is known that diversification tends to eliminate skewness from portfolio returns. The results reported here also highlight the fact that poorly diversified portfolios *occasionally* deliver very large returns. As such, the results can justify a decision to not diversify by those investors who particularly value positive skewness in the distribution of possible investment returns, even in light of the knowledge that the undiversified portfolio will more likely underperform.

References

Ariditti, Fred, and Haim Levy, "Portfolio Efficiency Analysis in Three Moments: The Multiperiod Case" *Journal of Finance*, 30 (1975), 797-809.

Albuquerque, Rui, "Skewness in Stock Returns: Reconciling the Evidence on Firm Versus Aggregate Returns" *Review of Financial Studies*, 25 (2012), 1631-1673.

Amaya, Diego, Peter Christoffersen, Kris Jacobs, and Aureilio Vasquez, "Does Realized Skewness Predict the Cross-Section of Equity Returns?" *Journal of Financial Economics*, 118 (2015), 135-167.

Asparouhova, Elena, Hendrik Bessembinder, and Iva Kalcheva, "Noisy Prices and Inference Regarding Returns", *Journal of Finance*, 68 (2013): 665-714.

Banz, Ralf, "The Relationship between Return and Market Value of Common Stocks", *Journal of Financial Economics*, 9, (1981): 3-18.

Black, Fischer, and Myron Scholes, "The Pricing of Options and Corporate Liabilities", Journal of Political Economy, 81 (1973), 637-654.

Cieslak, Anna, Adair Morse, and Annette Vissing-Jorgensen, "Stock Returns and the FOMC Cycle, (2016), working paper.

Conrad, Jennifer, Robert Dittmar, and Eric Ghysels, "Ex Ante Skewness and Expected Stock Returns" *Journal of Finance*, 68 (2013), 85-124.

Dichev, Ilia, "What are Stock Investors' Actual Historical Returns? Evidence from Dollar-Weighted Returns", *American Economic Review*, 97 (2007), 386-401.

Mehra, Rajnish, and Edward C. Prescott, "The Equity Premium: A Puzzle." *Journal of Monetary Economics,* 15 (1985): 145–61.

Ensthaler, Ludwig, Olga Nottmeyer, Georg Weizsacker, and Christian Zankiewicz, "Hidden Skewness: On the Difficulty of Multiplicative Compounding under Random Shocks", *Management Science*, (2017), forthcoming.

Harvey, Campbell and Akhtar Siddique, "Conditional Skewness in Asset Pricing Tests", *Journal of Finance*, 55 (2000), 1263-1295.

Heaton, J.B., Nick Poulson, and Jan Hendrik Witte, "Why Indexing Works", working paper, 2016, available at). Available at SSRN: https://ssrn.com/abstract=2673262.

Kraus, Alan and Robert Litzenberger, "Skewness Preference and the Valuation of Risky Assets", *Journal of Finance*, 31 (1976), 1085-1100.

Kumar, Alok, "Who Gambles in the Stock Market?", *Journal of Finance,* 64 (2009), 1889-1933.

Lucca, David and Emanuel Moench, “The Pre-FOMC Announcement Drift”, *Journal of Finance*, 70 (2015), 329-371.

Mitton, Todd and Keith Vorkink, “Equilibrium Underdiversification and the Preference for Skewness”, *Review of Financial Studies*, 20 (2007), 1255-1288.

Rubinstein, Mark, “The Valuation of Uncertain Income Streams and the Pricing of Options,” *The Bell Journal of Economics*, 7 (1976): 407-425.

Savor, Pavel and Mungo Wilson, “How Much do Investors Care about Macroeconomic Risk: Evidence from Scheduled Macroeconomic Announcements” *Journal of Financial and Quantitative Analysis*, 48 (2013): 343-375.

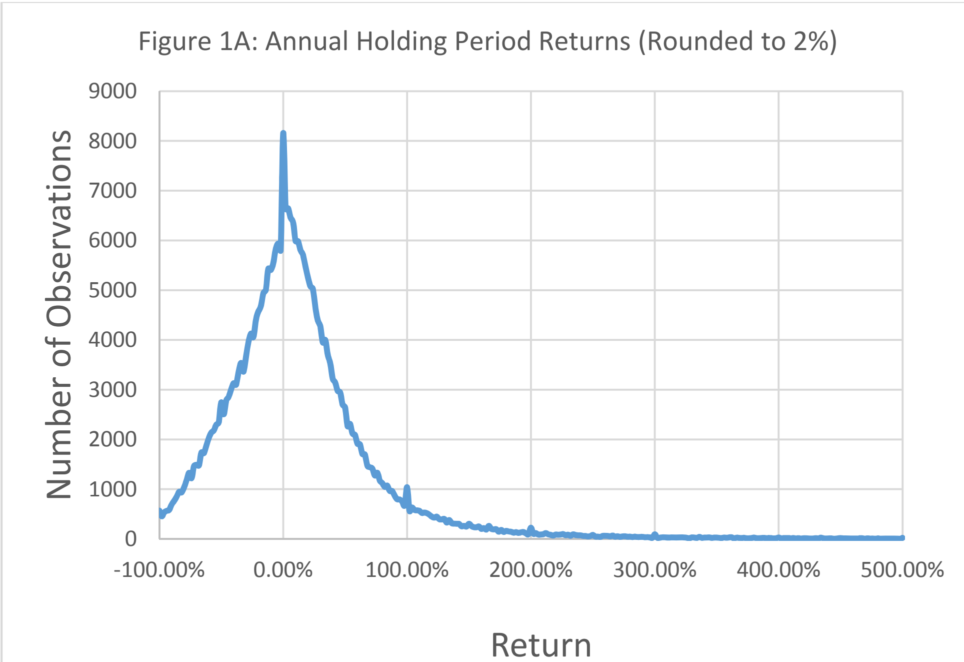
Seijas-Macias, Antonio, and Amilcar Oliveira, “An Approach to Distribution of the Product of Two Normal Variables” *Discussiones Mathematicae, Probability and Statistics*, 32 (2012), 87-99.

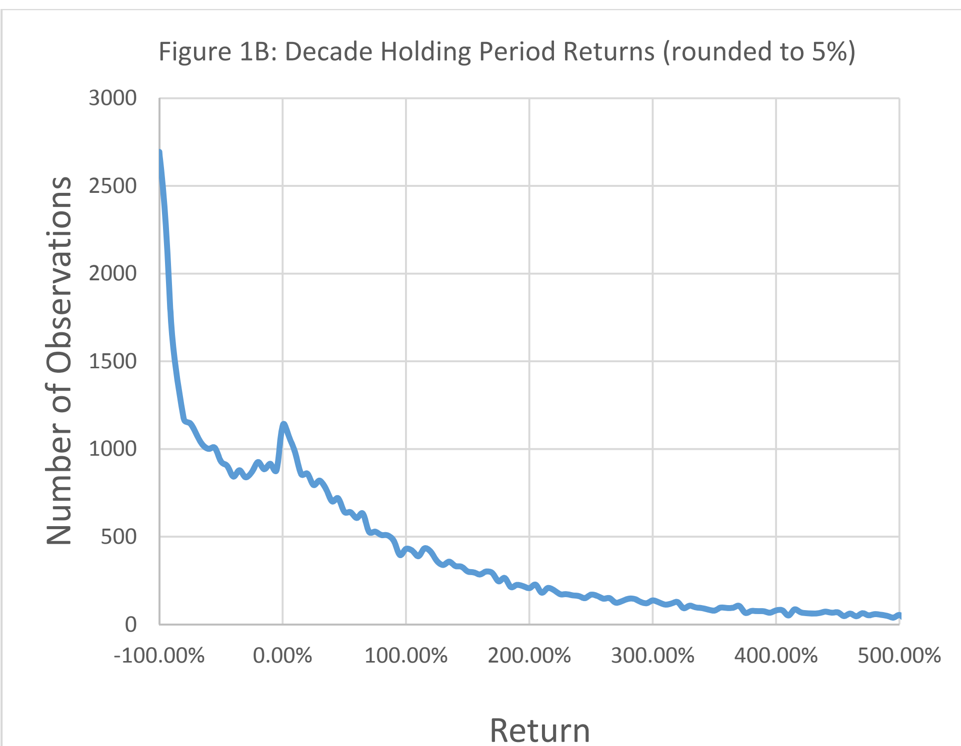
Simkowitz, Michael, and William Beedles, “Diversification in a Three-Moment World”, *Journal of Financial and Quantitative Analysis,* 13 (1978), 927-941.

Strebulaev, Ilya, and Baozhong Yang, “The mystery of zero-leverage firms”, *Journal of Financial Economics*, 109 (2013), 1-23.

Figure 1: Frequency Distributions of Holding Period Returns.

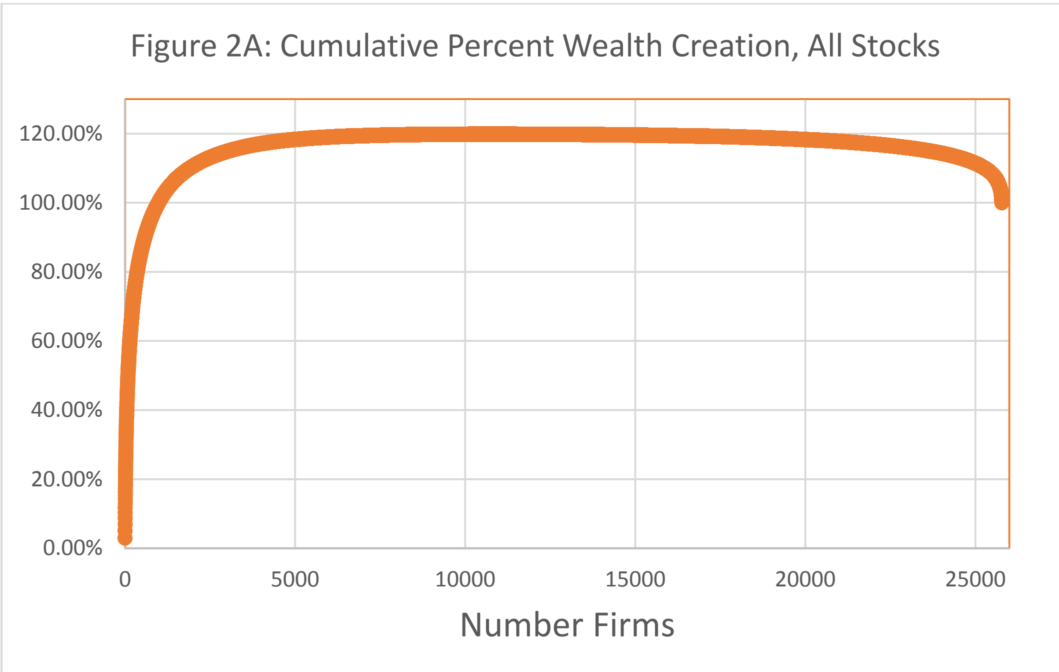
Displayed are frequencies of holding period returns, to a maximum of 500%. The data includes all CRSP common stocks from 1926 to 2015. In cases where stocks list or delist with a calendar period the return is computed for portion of the period where data is available.





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 2015 attributable to individual stocks, when stocks are sorted from largest to smallest wealth creation. Figure 2A includes all 25,782 CRSP stocks, while Figure 2B includes only the 250 largest wealth creating stocks.



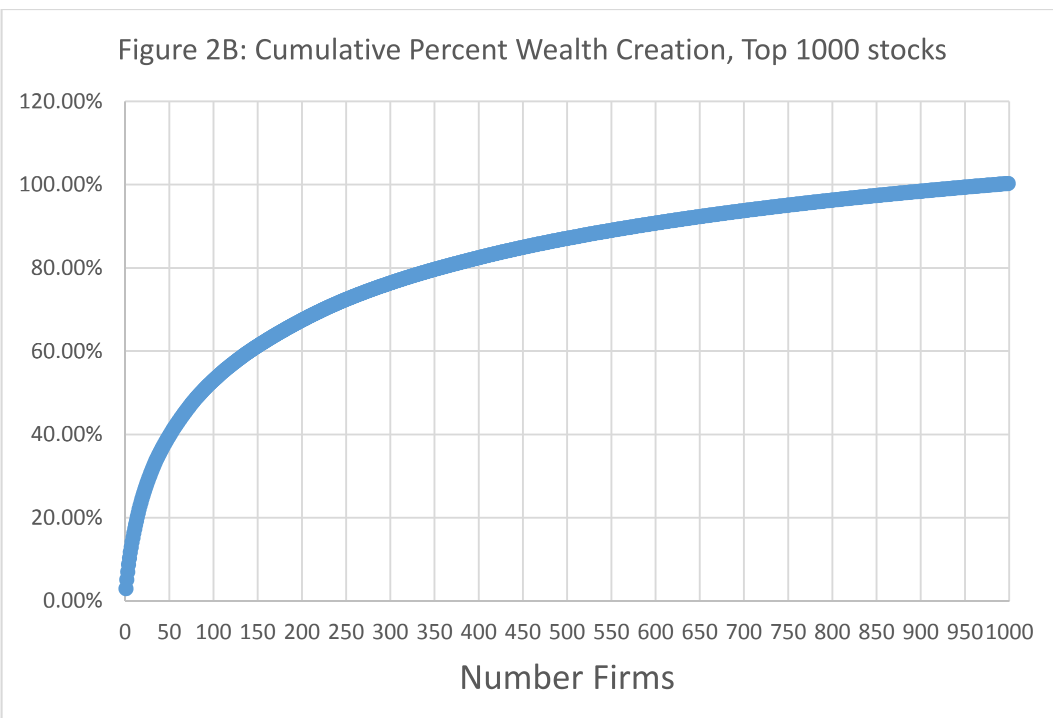


Table 1A: CRSP Common Stock Returns at Various Horizons

The data includes all CRSP common stock (shrcd 10, 11, or 12) returns from September 1926 to December 2015. Annual returns refer to calendar years. Decade returns are non-overlapping, referring to 1926 to 1935, 1936 to 1945, etc. Holding period 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 2015. Delisting returns are included. The geometric return for q months is the q^{th} root of one plus the holding period return, less one.

Panel A: Individual Stocks, Monthly Horizon (N = 3,524,849)

Variable	Mean	Median	SD	Skewness	% Positive
Holding Return, T-Bill	0.0038	0.0039	0.003	0.619	92.4%
Holding Return, Stock	0.0113	0.0000	0.180	6.718	48.3%
	% > T-bill	% > VW Mkt Return		% > EW Mkt Return	
Holding Return, Stock	47.7%	46.2%		45.9%	

Panel B: Individual Stocks, Annual Horizon (N = 315,880)

Variable	Mean	Median	SD	Skewness	% Positive
Sum Stock Return	0.1257	0.1173	0.617	1.352	62.6%
Holding Return, T-Bill	0.0435	0.0467	0.032	0.641	96.5%
Holding Return, Stock	0.1472	0.0508	0.820	19.922	55.5%
Geometric Return, Stock	-0.0023	0.0048	0.076	6.429	55.5%
	% > T-bill	% > VW Mkt Return		% > EW Mkt Return	
Holding Return, Stock	51.4%	44.3%		42.5%	

Panel C: Individual Stocks, Decade Horizon (N = 54,015)

Variable	Mean	Median	SD	Skewness	% Positive
Sum Stock Return	0.7349	0.6744	1.484	0.485	73.2%
Holding Return, T-Bill	0.3138	0.1884	0.336	1.753	99.9%
Holding Return, Stock	1.1855	0.1494	4.780	14.205	55.7%
Geometric Return, Stock	-0.0100	0.0031	0.063	-3.138	55.7%
	% > T-bill	% > VW Mkt Return		% > EW Mkt Return	
Holding Return, Stock	49.2%	37.4%		33.9%	

Panel D: Individual Stocks, Lifetime Horizon (N = 25,782)

Variable	Mean	Median	SD	Skewness	% Positive
Sum Stock Return	1.5395	1.0370	2.795	1.187	71.3%
Holding Return, T-Bill	1.1347	0.3516	2.282	4.103	99.8%
Holding Return, Stock	161.9077	-0.0367	12818.020	154.214	49.2%
Geometric Return, Stock	-0.0194	-0.0005	0.061	-4.047	49.2%
	% > T-bill	% > VW Mkt Return		% > EW Mkt Return	
Holding Return, Stock	42.1%	30.6%		26.2%	

Table 1B: 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 holding period 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 holding period return, less one.

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

Variable	Mean	Median	SD	Skewness	% Positive
Holding Return, T-Bill	0.0037	0.0039	0.002	0.877	98.2%
Holding Return, Stock	0.0194	0.0040	0.192	4.365	50.7%
	% > T-bill	% > VW Mkt Return		% > EW Mkt Return	
Holding 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%
Holding Return, T-Bill	0.0432	0.0467	0.026	0.864	98.7%
Holding 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	
Holding Return, Stock	52.0%	46.4%		45.4%	

Table 2A: The Distribution of Stock Holding Period 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 holding period 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	0.0245	0.0000	8.420	40.3%	40.2%	43.7%	43.5%
2	0.0095	0.0000	3.699	43.1%	42.9%	43.6%	43.2%
3	0.0086	0.0000	2.968	45.0%	44.6%	44.2%	43.9%
4	0.0092	0.0000	4.513	46.7%	46.2%	45.1%	44.7%
5	0.0096	0.0000	5.475	48.1%	47.6%	45.7%	45.5%
6	0.0101	0.0000	1.823	49.5%	48.9%	46.6%	46.2%
7	0.0104	0.0036	1.340	50.8%	50.0%	47.4%	46.9%
8	0.0107	0.0065	1.313	52.2%	51.2%	48.2%	47.9%
9	0.0105	0.0079	0.819	53.4%	52.3%	48.8%	48.4%
10	0.0096	0.0083	0.495	54.3%	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	0.2408	0.0000	16.903	47.9%	45.0%	41.7%	40.1%
2	0.1670	0.0000	29.517	49.6%	46.3%	41.0%	40.1%
3	0.1390	0.0132	5.065	51.4%	47.8%	42.0%	40.4%
4	0.1391	0.0247	8.752	52.6%	48.9%	43.0%	41.7%
5	0.1330	0.0427	3.837	54.5%	50.8%	44.4%	42.6%
6	0.1353	0.0548	4.246	55.8%	51.8%	45.1%	42.8%
7	0.1283	0.0654	3.041	57.3%	53.1%	45.6%	43.6%
8	0.1332	0.0840	3.737	59.9%	55.4%	46.9%	44.3%
9	0.1332	0.0946	4.172	62.4%	57.2%	47.5%	44.9%
10	0.1229	0.0982	10.785	64.9%	58.5%	46.6%	44.4%

Panel C: Individual Stocks, Decade Horizon

Group (Market Cap)	Mean	Median	Skewness	% > 0	% > T-bill	% > VW Mkt Return	% > EW Mkt Return
1	1.4164	-0.1905	13.144	43.1%	37.4%	31.0%	28.6%
2	1.0628	-0.1023	11.533	46.4%	40.8%	32.6%	30.6%
3	0.9900	-0.0551	14.417	47.9%	42.5%	33.8%	31.5%
4	1.0189	0.0393	16.431	51.7%	45.9%	36.2%	33.1%
5	1.0875	0.1064	10.464	54.2%	48.2%	37.5%	34.7%
6	1.1444	0.1385	10.583	55.5%	49.6%	38.6%	35.1%
7	1.2201	0.2319	6.794	58.5%	52.1%	39.9%	36.3%
8	1.3027	0.4181	5.015	65.4%	57.5%	43.0%	37.4%
9	1.3832	0.5627	6.311	70.1%	61.6%	43.0%	37.4%
10	1.5478	1.0027	3.624	80.0%	69.6%	44.2%	36.9%

Table 2B: The Distribution of Stock Holding Period Returns, by Price 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 holding period 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 (Price)	Mean	Median	Skewness	% > 0	% > T-bill	% > VW Mkt Return	% > EW Mkt Return
1	-0.0303	-0.0417	4.9168	31.5%	31.5%	34.9%	34.3%
2	0.0023	-0.0187	7.6029	39.2%	39.1%	39.7%	39.2%
3	0.0089	-0.0067	5.8689	42.8%	42.6%	42.1%	41.7%
4	0.0107	0.0000	4.9872	45.4%	45.1%	43.8%	43.5%
5	0.0127	0.0000	3.6685	48.0%	47.5%	45.4%	45.2%
6	0.0152	0.0031	3.0573	50.6%	49.9%	47.3%	46.9%
7	0.0179	0.0075	9.8116	52.8%	51.9%	49.1%	48.8%
8	0.0207	0.0109	11.0000	55.0%	53.9%	50.7%	50.5%
9	0.0241	0.0142	4.4568	57.4%	56.0%	53.0%	52.7%
10	0.0302	0.0190	13.1488	60.8%	59.1%	56.4%	55.9%

Panel B: Individual Stocks, Annual Horizon

Group (Price)	Mean	Median	Skewness	% > 0	% > T-bill	% > VW Mkt Return	% > EW Mkt Return
1	0.2212	-0.0909	14.4956	42.9%	40.6%	37.8%	36.5%
2	0.1496	-0.0500	5.9663	46.0%	43.2%	38.8%	37.4%
3	0.1364	-0.0050	37.7610	49.1%	45.8%	40.6%	39.2%
4	0.1326	0.0210	3.7786	52.2%	48.5%	42.8%	41.4%
5	0.1382	0.0517	4.0702	55.6%	51.7%	44.9%	43.6%
6	0.1397	0.0751	2.2981	58.6%	54.2%	46.7%	45.1%
7	0.1453	0.0871	3.7734	60.8%	55.9%	47.9%	45.4%
8	0.1417	0.0953	3.2515	62.5%	57.5%	48.1%	45.6%
9	0.1341	0.1011	3.5456	63.9%	58.4%	48.3%	45.4%
10	0.1337	0.1003	10.1426	64.6%	58.9%	47.6%	45.4%

Panel C: Individual Stocks, Decade Horizon

Group (Price)	Mean	Median	Skewness	% > 0	% > T-bill	% > VW Mkt Return	% > EW Mkt Return
1	1.0523	-0.3867	14.2062	34.9%	29.7%	24.2%	22.5%
2	1.1566	-0.3258	11.7604	39.4%	34.0%	27.6%	24.7%
3	1.0187	-0.1922	14.9743	43.4%	38.3%	29.8%	27.6%
4	1.0080	0.0133	7.5563	50.6%	44.7%	34.8%	33.0%
5	1.1174	0.1532	11.1436	56.4%	50.1%	39.6%	36.8%
6	1.1894	0.3047	6.2237	62.6%	56.1%	43.2%	39.7%
7	1.3030	0.4210	7.2035	65.6%	58.1%	44.8%	40.4%
8	1.3547	0.5078	7.1302	69.7%	61.7%	45.4%	39.7%
9	1.4650	0.6962	5.7426	72.0%	64.8%	45.4%	39.8%
10	1.4129	0.7898	3.8242	74.4%	65.1%	44.5%	37.0%

Table 3: Returns to Single Stock Strategies, July 1926 to December 2015

One stock is selected at random for each month, and these random returns are linked over one, ten, and ninety year horizons. The procedure is repeated 10,000 times. Each linked return is compared to zero, and to the actual holding period return on one month Treasury Bills, the value-weighted portfolio, and the equal-weighted portfolio over the same interval.

Panel A: Actual Holding Period Returns

	1 Year Horizon			10 Year Horizon			Life (90 Year) Horizon		
	Mean	Med	Skew	Mean	Med	Skew	Mean	Med	Skew
Value-Weighed Market	0.1172	0.1434	-0.424	1.729	1.4314	0.172	4233.51	4233.51	.
Equal-Weighed Market	0.1652	0.1752	0.536	2.6459	2.3265	1.569	33133.4	33133.4	.
One Month Treasury Bill	0.0344	0.0298	1.013	0.4465	0.3204	1.109	19.23	19.23	.

Panel B: Bootstrapped Single Stock Strategies

	1 Year Horizon			10 Year Horizon			Life (90 Year) Horizon		
	Mean	Med	Skew	Mean	Med	Skew	Mean	Med	Skew
Holding Return	0.1658	0.0403	7.035	2.65	0.3021	41.031	5263.25	0.1311	44.328
% > 0	53.59%			56.32%			50.86%		
% > T-Bill	50.74%			48.48%			27.58%		
% > VW Mkt	42.86%			29.83%			3.75%		
% > EW Mkt	40.56%			24.33%			1.23%		

Table 4: Lifetime Wealth Creation

This table reports lifetime wealth creation to shareholders in aggregate, as measured by text equation (3) based excess returns and prior-period market capitalization. Also reported is the lifetime gross holding period return from first appearance on CRSP to last, and the lifetime geometric mean excess return, measured as the geometric mean of lifetime monthly returns in excess of the geometric mean Treasury Bill return over the same life. Includes the 30 best performing stocks from all CRSP common stock returns from July 1926 to December 2015.

Permno	Name	Lifetime Dollar Wealth Creation (Millions)	Lifetime Gross Holding Return	Geometric Mean Excess Monthly Return	Life (Months)	Cumulative Percent of Market Wealth Creation
11850	EXXON MOBIL CORP	939,831	22,584.7	0.66%	1073	2.96%
14593	APPLE INC	677,411	202.5	0.91%	420	5.09%
12060	GENERAL ELECTRIC CO	597,545	9,221.7	0.57%	1073	6.96%
10107	MICROSOFT CORP	567,701	834.4	1.62%	357	8.75%
12490	INTERNATIONAL BUSINESS MACHS C	487,384	94,564.1	0.79%	1073	10.28%
13901	ALTRIA GROUP INC	448,051	2,029,630.4	1.08%	1073	11.69%
12079	GENERAL MOTORS CORP	394,132	59.0	0.11%	995	12.93%
22111	JOHNSON & JOHNSON	383,702	29,306.7	0.88%	855	14.14%
55976	WAL MART STORES INC	337,738	1,495.4	1.02%	517	15.20%
18163	PROCTER & GAMBLE CO	335,811	5,377.0	0.55%	1036	16.26%
14541	CHEVRON CORP NEW	330,406	9,454.3	0.58%	1073	17.29%
11308	COCA COLA CO	326,990	66,634.0	0.76%	1073	18.32%
10401	A T & T CORP	302,550	393.5	0.32%	952	19.27%
84788	AMAZON COM INC	300,228	450.6	2.60%	223	20.22%
11703	DU PONT E I DE NEMOURS	299,497	7,919.8	0.56%	1073	21.16%
90319	ALPHABET INC	276,539	15.2	1.91%	136	22.03%
22752	MERCK & CO INC NEW	265,694	7,917.8	0.74%	835	22.87%
38703	WELLS FARGO & CO NEW	250,843	797.0	0.66%	636	23.65%
59328	INTEL CORP	246,030	1,195.9	0.98%	516	24.43%
66181	HOME DEPOT INC	225,150	5,239.9	1.77%	411	25.14%
13856	PEPSICO INC	213,920	42,284.4	0.72%	1073	25.81%
17778	BERKSHIRE HATHAWAY INC	209,839	2,908.8	1.33%	470	26.47%
10104	ORACLE CORP	203,726	607.5	1.53%	357	27.11%
15966	MOBIL CORP	202,573	2,795.5	0.60%	875	27.75%
26403	DISNEY WALT CO	192,834	8,115.2	0.92%	697	28.35%
20482	ABBOTT LABORATORIES	189,642	28,206.7	0.79%	945	28.95%
22592	3M CO	180,706	7,492.6	0.73%	839	29.52%
19393	BRISTOL MYERS SQUIBB CO	177,167	34,848.4	0.78%	987	30.07%
43449	MCDONALDS CORP	172,186	3,709.3	0.99%	593	30.62%
21936	PFIZER INC	171,584	25,886.5	0.86%	863	31.16%

Table 5: Simulation Evidence Regarding Multiperiod 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. Holding period 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 Holding Period 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 Holding Period 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 Holding Period 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%