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Do stocks outperform Treasury bills?[☆]

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ABSTRACT

The majority of common stocks that have appeared in the Center for Research in Security Prices (CRSP) database since 1926 have lifetime buy-and-hold returns less than one-month Treasuries. When stated in terms of lifetime dollar wealth creation, the best-performing 4% of listed companies explain the net gain for the entire US stock market since 1926, as other stocks collectively matched Treasury bills. These results highlight the important role of positive skewness in the distribution of individual stock returns, attributable to skewness in monthly returns and to the effects of compounding. The results help to explain why poorly diversified active strategies most often underperform market averages.

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1. 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 to low risk investments, such as government obligations, has been extensively documented, for the US stock market as well as for many other countries. In fact, the degree to which stock markets outperform is so large that there is wide spread reference to the "equity premium puzzle."[1]

The evidence that stock market returns exceed returns to government obligations in the long run is based on broadly diversified stock market portfolios. In this paper, I instead focus attention on returns to individual common stocks. I show that most individual US common stocks provide buy-and-hold returns that fall short of those earned on one-month US Treasury bills over the same horizons, implying that the positive mean excess returns observed for broad equity portfolios are attributable to relatively few stocks.[2]

I rely on the Center for Research in Securities Prices (CRSP) monthly stock return database, which contains all

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[1] Mehra and Prescott (1985) first drew attention to the magnitude of the equity premium for the broad US stock market. Dozens of papers have since sought to explain the premium.

[2] Since first circulating this paper, I have become aware of blog posts that show findings with a similar, though 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.

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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 the same month. In fact, less than half of monthly CRSP common stock returns are positive. When focusing on stocks' full lifetimes (from the beginning of the sample in 1926, or first appearance in CRSP, through the 2016 end of the 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 matched horizon. 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%.

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 90 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 shown by Banz (1981) it might have 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 over the full 90 years in 96% of the simulations. The single-stock strategy underperformed the one-month Treasury bill over the 1926–2016 period in 73% of the simulations.

The fact that the overall stock market generates long-term returns large enough 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 distribution of individual stock returns is positively skewed. Simply put, large positive returns to a few stocks offset the modest or negative returns to more typical stocks. The positive skewness in long horizon returns is attributable both to skewness in the distribution of monthly individual stock returns and to the fact that the compounding of random returns induces skewness.

This paper is not the first to study skewness in stock returns. Since at least Simkowitz and Beedles (1978) it has been recognized that individual stock returns are positively skewed, and that skewness declines as portfolios are diversified. The model of Krauss and Litzenberger (1976) implies a negative return premium for the coskewness of stock returns with market returns, while the models of Barberis and Huang (2008) and Brunnermeier et al. (2007) imply a negative return premium for firm-specific skewness. Evidence broadly consistent with these models is provided by Harvey and Siddique (2000), Mitton and Vorkink (2007), Conrad et al. (2013), and Amaya et al. (2016). However, the existing literature focuses on skewness in short horizon returns and has not emphasized either the magnitude or the consequences of skewness in longer horizon returns.

Perhaps the most striking illustration of the degree to which long-term return performance is concentrated in relatively few stocks arises when measuring aggregate wealth creation in the US public stock markets. I define wealth creation as the accumulation of market value in excess of the value that would have been obtained if the invested capital had 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, measured as of December 2016. However, just five firms (Exxon Mobile, Apple, Microsoft, General Electric, and International Business Machines) account for 10% of the total wealth creation. The 90 top-performing companies, slightly more than one-third of 1% of the companies that have listed common stock, collectively account for over half of the wealth creation. The 1092 top-performing companies, slightly more than 4% of the total, account for all of the net wealth creation. That is, the remaining 96% of companies whose common stock has appeared in the CRSP data collectively generate lifetime dollar gains that matched gains on one-month Treasury bills.

At first glance, the finding that most stocks generate negative lifetime excess (relative to Treasury bills) returns is difficult to reconcile with models that presume investors to be risk averse, since those models imply a positive anticipated mean excess return. Note, however, that implications of standard asset pricing models are with regard to stocks' mean excess 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 time series excess return and highlight the practical importance of positive skewness in the distribution of individual stock returns. While, as I show, monthly stock returns are positively skewed, the skewness increases with the time horizon over which returns are measured due to the effects of compounding.

These results complement recent time series evidence regarding the stock market risk premium. Savor and Wilson (2013) show that approximately 60% of the cumulative stock market excess return accrues on the relatively few days where macroeconomic announcements are made. Related, Lucca and Moench (2016) show that half of the excess return in US 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 also 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 et al. (1998) and Heaton et al. (2017), positive skewness in returns helps to explain why active strategies, which tend to be poorly diversified, underperform relative to market-wide benchmarks more than half of the time. These results imply that it may be useful to reassess standard methods of evaluating investment management performance.

The focus on the mean and variance of portfolio returns, and on the Sharpe ratio as a measure of investment performance, is often justified by the assumption that returns are reasonably approximated by the normal distribution. While this assumption may be reasonable at short horizons, the results here highlight strong positive skewness in longer-horizon returns. They thereby potentially justify the selection of less diversified portfolios by investors with long investment horizons who particularly value positive return skewness, i.e., the possibility of large positive outcomes, despite the knowledge that a typical undiversified portfolio is more likely to underperform the overall market. Further, the results highlight the potentially large gains from active stock selection if a decision maker has a comparative advantage in identifying in advance the stocks that will generate extreme positive returns.

I find that the percentage of stocks that generate lifetime returns less than those on Treasury bills is larger for stocks that entered the CRSP database in recent decades. This finding is consistent with evidence reported by Fama and French (2004), who show a surge in new listings after about 1980 that included increased numbers of risky stocks with high asset growth but low profitability, and low ex post survival rates. The recent evidence also supports the implications of Noe and Parker (2005) that the Internet economy will be associated with "winner take all" outcomes, characterized by highly skewed returns, and the findings of Grullon et al. (2018) showing increased industry concentration accompanied by abnormally high returns to successful firms in recent years.

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 large gains on a few investments. The evidence here shows that such a payoff distribution is not only confined to pre-Initial Public Offering investments but also characterizes the structure of longer term returns to investments in public equity, particularly smaller firms and firms listed in recent decades.

2. How can excess returns to most stocks be negative if investors are risk averse?

I show in the subsequent sections of this paper 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 US stock markets can be attributed to a relatively few successful stocks. However, these results are not necessarily inconsistent with models implying that risk-averse stock investors require an expected return premium. Asset pricing models typically focus on mean returns, while the evidence here highlights that the median stock return is negative. The distinction between the positive mean and negative median stock return arises due to positive skewness in the return distribution.

2.1. Skewness in single-period returns

To better understand how the majority of excess stock returns can be negative, consider as a benchmark the case in which single-period excess stock returns are distributed lognormally. 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 simply return, $\mathrm{E}(R)$, is $\exp(\mu+0.5\sigma^2) - 1$. In contrast, the median excess simple return is $\exp(\mu) - 1$, which is less than the mean return for all $\sigma > 0$. The lognormal distribution does not have a distinct skewness parameter. However, the skewness of simple returns is positive, is monotone increasing in, and depends only on, σ.[3]

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

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

Stated alternatively, the lognormality assumption implies that more than half of single-period excess simple returns will be negative if the excess return variance is sufficiently large relative to the mean excess simple 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 monthly return standard deviation, σ, exceeds 12.62%.

2.2. 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 lognormal distribution, the skewness of multi-period simple returns increases with the number of periods, because the return standard deviation (which in turn solely determines the skewness of simple returns) 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. To my knowledge, this point was first demonstrated by Arditti and Levy (1975).[4] More recently, Fama and French (2018) rely on bootstrap simulations to estimate probability distributions for buy-and-hold returns to

[3] See, for example, http://www.itl.nist.gov/div898/handbook/eda/section3/eda3669.htm.

[4] Ensthaler et al. (2018) 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."

Table 1
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. Results reported are computed across 2.5 million non-overlapping annual returns, 500,000 non-overlapping five-year returns, and 250,000 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	0.188	0.385	0.579	0.779	0.997	1.222	1.471	1.724	2.014	2.306
5	0.000	0.460	0.959	1.549	2.322	3.314	4.570	8.352	9.440	15.196	23.814
10	0.000	0.667	1.478	2.618	4.655	8.550	11.058	23.849	61.148	42.597	53.323
	Panel B: Median buy-and-hold return										
1	6.17%	5.94%	5.24%	4.11%	2.46%	0.48%	−1.94%	−4.83%	−8.02%	−11.71%	−15.55%
5	34.89%	33.30%	28.76%	21.42%	11.57%	0.36%	−12.18%	−25.19%	−37.98%	−50.32%	−61.04%
10	81.94%	77.72%	65.60%	47.33%	24.32%	0.14%	−23.48%	−44.56%	−61.98%	−75.74%	−85.28%
	Panel C: Percentage of buy-and-hold returns that are positive										
1	100.00%	79.77%	64.39%	57.69%	53.49%	50.56%	48.14%	46.00%	44.12%	42.31%	40.73%
5	100.00%	96.82%	79.27%	66.12%	56.99%	50.18%	44.55%	39.66%	35.37%	31.37%	27.93%
10	100.00%	99.57%	87.49%	72.09%	59.68%	50.05%	42.06%	35.24%	29.47%	24.20%	20.02%
	Panel D: Ninety-ninth percentile buy-and-hold return										
1	6.2%	24.2%	44.6%	67.1%	92.1%	120.1%	150.8%	184.8%	221.5%	261.5%	304.7%
5	34.9%	90.5%	163.1%	255.2%	366.5%	498.8%	655.1%	819.3%	1017.9%	1205.5%	1414.7%
10	81.9%	194.8%	355.9%	577.2%	839.2%	1168.8%	1525.0%	1915.3%	2258.9%	2485.7%	2726.6%

the value-weighted US stock market at various horizons. Based on the full 1926–2016 sample, they estimate the skewness of the value-weighted market return to be 6.11 at the 30-year horizon, compared to 0.16 at the monthly horizon.

To illustrate the effect of compounding with the simplest possible example, consider the case in which single-period stock returns conform to a symmetric zero-mean binomial distribution. In particular, returns are either 20% or −20%, with equal probability. 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 with a standardized skewness coefficient of 0.412. Note also that the median (−4%) return is less than the zero mean, and the probability of observing a negative two-period return is 75%.

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. I therefore rely on simulations to illustrate the effects of compounding on multi-period buy-and-hold returns when single-period returns are normal.

By drawing from a constant distribution, 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 0 to 20%. For each standard deviation, I simulate returns for 250,000 ten-year periods (2.5 million one-year periods). Results, reported in Table 1, are computed across these simulation outcomes.

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%. 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 1 displays the results of compounding riskless returns of 0.5% per month, as a benchmark. Given the assumptions of independent and identical draws, these benchmarks also represent the expected or mean buy-and-hold return at each horizon for all standard deviations.

Panel A of Table 1 demonstrates the effect of compounding on the skewness of buy-and-hold returns, showing that the skewness of buy-and-hold returns is positive at all multi-period horizons as long as returns are not riskless. The skewness in long-horizon returns increases with the number of months over which returns are compounded and with the standard deviation of monthly returns, σ. When risk is modest ($\sigma = 0.02$), the skewness of buy-and-hold returns ranges from 0.188 at the one-year horizon to 0.667 at the ten-year horizon. When risk is high ($\sigma = 0.20$) the skewness of buy-and-hold returns is 2.306 at the one-year horizon, 23.814 at the five-year horizon, and 53.323 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 1. At a one-year horizon, the median buy-and-hold return declines monotonically from 6.17% when there is no risk, to 0.48% when the standard deviation of monthly returns is 10%, and to −15.55% when the standard deviation of monthly returns is 20%. The effect of compounding is more dramatic at longer horizons, because the skewness 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 $\sigma = 10\%$ per month and, remarkably, to −85.28% when $\sigma = 20\%$ 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 1. When returns are risky but σ is low, the percentage of returns that are positive is less than 100, 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 $\sigma = 0.04$ per month, the percentage of buy-and-hold returns that are positive increases from 64.39% at a one-year horizon to 87.49% 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 $\sigma = 16\%$ per month, the percentage of buy-and-hold returns that are positive decreases from 44.12% at a one-year horizon to 29.47% at a ten-year horizon.

Of course, the mean return at each horizon remains fixed even as volatility is changed. The decline in the median return at each horizon as return volatility increases is offset by a small possibility of increasingly large returns. Panel D of Table 1 reports the 99th percentile return obtained across simulations at each horizon, for each return standard deviation. For example, at the ten-year horizon the 99th percentile buy-and-hold return increases from 195% when $\sigma = 2\%$ to 1,169% when $\sigma = 10\%$ and to 2,727% when $\sigma = 20\%$.

This simulation illustrates that the compounding of successive random returns induces skewness into multiple-period buy-and-hold returns, even if single-period returns are drawn from a zero-skew normal distribution. That is, even if returns are distributed normally at a short horizon, they are not distributed normally, but rather are positively skewed, at any longer horizon. 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.[5] 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 extreme positive long run returns should be anticipated, even in the absence of any momentum in individual stock returns.

To summarize, the simulations verify that a finding 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 can arise because simple single-period returns are skewed (as in the case of the lognormal distribution). Further, the compounding of random returns induces positive skewness in multi-period buy-and-hold returns, even if single-period returns are symmetric.

3. The distribution of buy-and-hold returns for CRSP common stocks

I next report on actual buy-and-hold returns to individual CRSP common stocks at the monthly, annual, decade, and lifetime horizons. I study all CRSP common stocks (share codes 10, 11, and 12) from July 1926 to December 2016, and focus on returns inclusive of reinvested dividends.[6] The starting date is the earliest for which one-month Treasury bill data are available from Kenneth French's website. The data include 25,967 distinct CRSP permanent numbers (PERMNOs), which I refer to as stocks.[7] 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. These 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.

3.1. Monthly returns

Panel A of Table 2A reports summary statistics for the pooled distribution of 3,575,216 monthly common stock returns contained in the CRSP database from July 1926 to December 2016, as well as matched Treasury bill returns. The data confirm that the mean excess return is positive, as the average monthly return is 1.13%, compared to an average one-month Treasury bill return during the same month of 0.37%. Several additional observations regarding monthly common stock returns are noteworthy. First, monthly returns are positively skewed, with a skewness coefficient equal to 6.96. Second, monthly returns to

[5] Though these simulation results do not consider the role of risk aversion, they are consistent with the intuition obtained from Martin (2012), who models risk-adjusted returns. In particular, he shows that risk-adjusted returns obtained from a class of asset pricing models converge to −100% at long horizons with probability approaching one, even though the mean risk-adjusted return is zero at all horizons.

[6] The sample excludes 57 common stocks for which CRSP data on shares outstanding are always equal to zero. These stocks were listed for between 1 and 19 months, and 39 of the 57 stocks had 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 were yet available.

[7] 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 typically differ across share classes. However, when considering lifetime wealth creation in Section 5, I aggregate wealth creation across share classes.

Table 2A
CRSP common stock returns at various horizons.
Included are all CRSP common stocks (SHARE TYPE CODE 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. T-bill refers to the one-month Treasury-bill return. A Treasury-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. The VW Mkt return is the capitalization-weighted average return for all stocks during each period, while the EW Mkt return is the equal-weighted average return across all stocks each period. SD denotes standard deviation.

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%	

individual stocks are highly variable, with a standard deviation of 18.1%. The simulations in the preceding section imply that compounding will induce substantial skewness in multi-period returns given volatility of this magnitude. Third, and most notable, only a minority, 47.8%, of CRSP 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.[8]

The results contained in Table 2A pertain to the pooled distribution of all monthly common stock returns in the database and therefore reflect both time series and cross-sectional variation. I also compute the skewness of the return distribution separately for each calendar month. The estimated skewness coefficient is positive for 1005 of the 1086 months, and the time series mean of the monthly skewness coefficients is 2.56. Thus, the data show that positive skewness is pervasive in CRSP monthly individual common stock returns.[9]

[8] 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.

[9] To assess whether the positive skewness in stock returns can be attributed to financial leverage, I examine returns to those CRSP common

It may be of interest to assess in future research the extent to which the positive skewness in monthly returns reflects the fact that monthly returns can be obtained by compounding shorter-horizon returns. Alternatively, the skewness can reflect fundamental explanations. For example, positive skewness in monthly returns might be associated with skewness in earnings or cash flow shocks, or could be attributable to firm-specific technological breakthroughs, such as patent grants or favorable clinical trial outcomes. In addition, limited liability, which ensures that no return is less than −100%, plays a role.

3.2. Annual and decade returns

Panels B and C of Table 2A 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 90.5 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 stock and matched Treasury bill return over the portion of the calendar interval that the stock was included in the CRSP data, as the alternative of including only those stocks that were listed for the full calendar interval would introduce survivorship bias.

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 returns for each stock over each interval.[10] (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.)

Fig. 1 displays the frequency distribution of annual (Fig. 1A) and decade (Fig. 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%.[11]

The frequency distribution of decade buy-and-hold returns in Fig. 1B also reveals substantial positive skewness.[12] Unlike annual returns, where the most frequent observation is zero, the most frequently observed decade

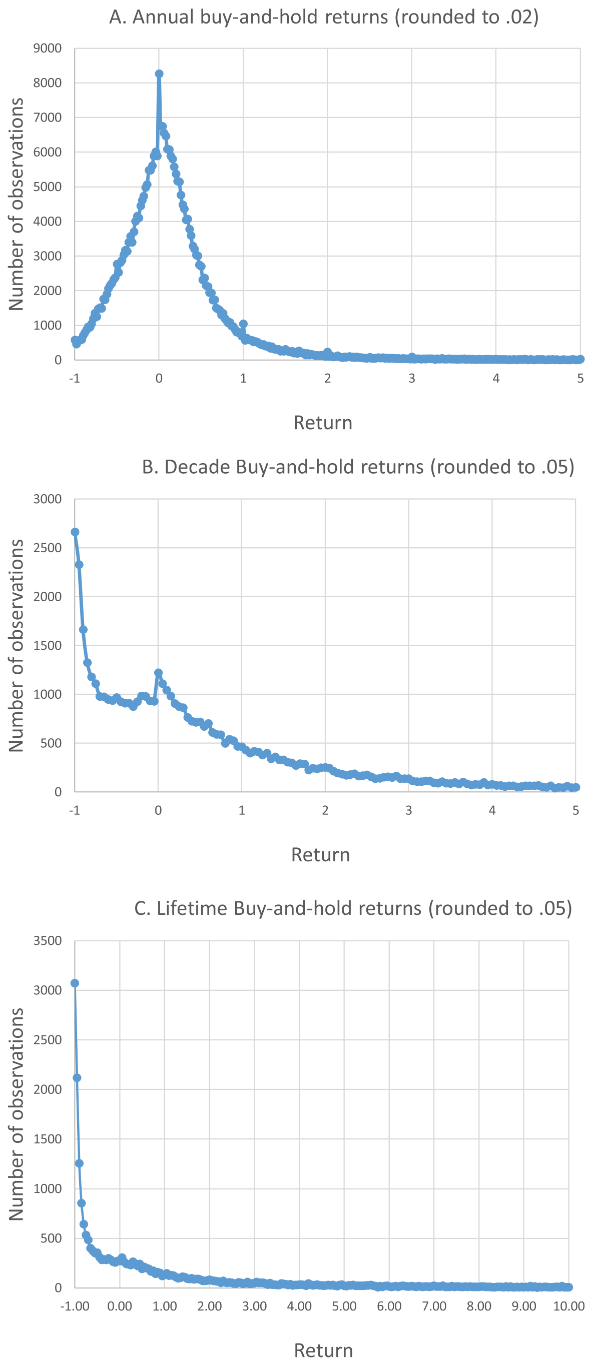

Fig. 1. Frequency distributions of buy-and-hold returns. Displayed are frequencies of buy-and-hold returns, to the indicated maximum. The data include all CRSP common stocks (SHARE TYPE CODE 10, 11, or 12) from 1926 to 2016. In cases where stocks list or delist within a calendar period, the return is computed for portion of the period where data are available.

stocks identified by Strebulaev and Yang (2013) as "zero-leverage" or "almost zero-leverage" firms. The skewness of monthly and annual returns for this subsample is quite similar to that of the full sample, implying that financial leverage plays little or no role. I thank Ilya Strebulaev and Baozhong Yang for identifying the zero-leverage firms.

[10] The geometric mean for a sample of n returns is the nth root of one plus the buy-and-hold return, less one.

[11] 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 Fig. 1A. The maximum annual buy-and-hold return was 11,060%.

[12] A total of 16,010 (29.1% of all decade return observations) buy-and-hold returns exceed 100%. Of these, 3242 exceed 500% and are not

buy-and-hold return (rounded to the nearest 5%) is –100%.[13] 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 from a simple benchmark, such as the normal distribution, is notable.

The statistics on Panels B and C of Table 2A verify that that annual and decade buy-and-hold returns are strongly positively skewed. Consistent with the simulation results in the prior section, the skewness of longer horizon returns exceeds that of monthly returns. The standardized skewness coefficient is 19.85 for annual returns and 16.32 for decade returns, compared to 6.96 for monthly returns. The skewness of decade returns is so sufficiently large that only a minority (49.5%) of stocks outperform Treasury bills at this horizon.

Also reflecting the effects of skewness, 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 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 effects of positive skewness in the distribution of buy-and-hold returns can also be observed when comparing individual stocks returns to returns on 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. Notably, the distribution of geometric returns across stocks is positively skewed at the annual horizon (skewness statistic of 5.79). However, geometric returns are negatively skewed at the decade horizon (skewness statistic of –3.13). Since each stock's decade buy-and-hold return can be obtained by compounding the stock's geometric return, the results verify that the positive skewness in decade buy-and-hold return arises due to compounding.

It is informative to compare the properties of actual buy-and-hold returns, as reported on Table 2A, to those of the simulated returns reported on Table 1. Focusing on the decade horizon, the actual skewness of buy-and-hold returns to CRSP stocks is 19.85. By comparison, the skewness of the simulated buy-and-hold returns at the decade horizon, when the standard deviation of monthly returns is 18% (in line with the actual monthly return data), is 42.60. That is, the skewness in actual returns, which is responsible for the potentially surprising result that most common stocks generate decade returns lower than those earned on Treasury bills, is less in the actual data as compared to benchmarks obtained based on independent and identical draws from normal monthly returns. Further, the skewness of decade buy-and-hold returns is less than that of annual buy-and-hold returns, a result also inconsistent with the simulation results obtained when compounding independent returns. These results are suggestive that serial dependence in the actual return data is important in determining the degree of return skewness in longer horizon returns.

3.3. Lifetime returns

In Panel D of Table 2A, I report on lifetime returns to CRSP common stocks. Fig. 1C displays the frequency distribution of lifetime buy-and-hold returns (rounded to the nearest 5%, to a maximum of 1000%) For each stock, the lifetime return spans from July 1926, or the month that the 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 buy-and-hold return is –2.29%. This result highlights that arithmetic mean returns overstate actual performance for buy-and-hold investors.

The distribution of lifetime buy-and-hold returns is 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%. 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. The maximum lifetime buy-and-hold return is 244.3 million %, by the firm now known as Altria Group. As can be observed on Fig. 1C, the most frequent or modal lifetime return is a loss of essentially 100% (rounded to the nearest 5%). A total of 3071 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. An answer to the question posed in 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

displayed on Fig. 1A. The maximum decade buy-and-hold return was 25,260%.

[13] The data contain only 375 occurrences where a stock has a delisting return of exactly –100%. CRSP obtains a final delisting price for delisted 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, and the computed lifetime return for such a stock is often close to, but not exactly, –100%. For purposes of my computations, the –100% 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.

Table 2B

Lifetime Buy-and-Hold Returns, by final listing status. Reported are lifetime returns to CRSP common stocks, based on final listing status. The geometric return for q months is the *q*th root of one plus the buy-and-hold return, less one. T-bill refers to the one-month Treasury-bill return. A Treasury-bill return is matched to each stock for each time horizon. The VW Mkt return is the capitalization-weighted average return for all stocks during each period, while the EW Mkt return is the equal-weighted average return across all stocks each period. SD denotes standard deviation. 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 ($N=4138$)					
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: Stocks delisted by exchange ($N=9187$)					
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%	

periods is 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 2A, only 30.8% of individual common stocks generated lifetime buy-and-hold returns that exceed the performance of the value-weighted portfolio over the matched time intervals and only 26.1% outperformed the equal-weighted portfolio.

3.4. 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 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 2B reports on lifetime returns to common stocks, delineated by the three delisting categories.

Not surprisingly, the 4138 stocks in the Still Trading group (Panel A of Table 2B) 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 also exceed the buy-and-hold return on one-month Treasury bills (60.1%) over the same periods. For these stocks as well, return 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 2B 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% of stocks outperformed

Table 3A
The distribution of stock buy-and-hold returns, by firm 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. T-bill refers to the one-month Treasury-bill return. The VW Mkt return is the capitalization-weighted average return for all stocks during each month, while the EW Mkt return is the equal-weighted average return across all stocks each month.

Panel A: Individual stocks, monthly horizon							
Group (Market cap)	Mean	Median	Skewness	% > 0 (%)	% > T-bill (%)	% > VW Mkt return (%)	% > EWMkt 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

one-month Treasury bills over their lifetimes. For these stocks, the return skewness coefficient is 60.5, the median lifetime return of 103% is substantially less than the mean lifetime return of 3825%, and less than half of the stocks outperformed the value-weighted portfolio return over their lifetimes.

A total of 9187 stocks were delisted by their trading exchange (Panel C of Table 2B).[14] The median lifetime buy-and-hold return for these stocks was −91.95%; only 9.8% generated a positive lifetime buy-and-hold return, and only 6.8% outperformed one-month Treasury bills over their lives. 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 2B 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 is intuitive and potentially reassuring, it is of limited applicability unless one can predict in advance the category in which a given stock will eventually be found.

3.5. Return distributions by firm size, and decade of initial appearance

In Table 3A, 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

[14] The specific reason for delisting by an exchange is not always reported in the CRSP database. Among those where a reason is reported, 1071 stocks were delisted because “price fell below acceptable level”; 1378 were delisted because of “insufficient capital, surplus, and/or equity; 1004 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.”

Table 3B

Lifetime Buy-and-hold returns to individual stocks, by decade of initial appearance. 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. Delisting returns are included. T-bill refers to the one-month Treasury-bill return. The VW Mkt return is the capitalization-weighted average return for all stocks during each month, while the EW Mkt return is the equal-weighted average return across all stocks each month.

Initial Decade	*N*	Mean	Median	Skewness	% > 0 (%)	% > T-bill (%)	% > VW Mkt return (%)	% > EW Mkt return (%)
1926–1936	920	4624.72	5.9903	29.188	72.5	67.4	31.7	10.9
1937–1946	251	897.36	29.5849	6.778	91.2	86.5	43.4	20.7
1947–1956	247	402.04	13.8533	7.952	91.1	87.0	40.9	26.7
1957–1966	1599	67.66	1.3975	12.130	74.0	61.5	44.8	29.1
1967–1976	4548	25.43	0.5888	17.689	60.7	46.9	42.6	29.4
1977–1986	5151	7.97	−0.5258	40.517	39.2	31.7	20.9	23.3
1987–1996	6860	2.87	−0.2539	15.758	45.2	39.6	26.3	25.8
1997–2006	4153	0.91	−0.4578	38.807	40.2	37.2	29.4	24.7
2007–2016	2238	0.19	−0.1134	6.488	45.3	45.0	32.9	34.0

decade (Panel C) horizons. 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 10% of the stocks in the database as of the month prior to the interval over which the return is measured. I omit results for lifetime returns, since market capitalization at original listing is not very informative regarding a firm's longer term market capitalization.

Despite the fact that small firms deliver higher mean monthly returns as compared to large, the data reported on Table 3A show a distinct pattern by which small stocks display more return skewness and a higher frequency of underperformance relative to benchmarks. This result is anticipated based on the simulations reported in the prior section, as the higher return volatilities typical for small stocks imply that compounding will impart more skewness. For example, the standardized skewness of the decade buy-and-hold returns for the smallest decile of stocks is 12.55, while that for the largest decile of stocks is 6.96. As a consequence, 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.

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.[15]

In Table 3B, I report on lifetime buy-and-hold returns, delineated by the decade of the stock's initial appearance in the CRSP database. A number of the results obtained here can be understood in terms of the data presented by Fama and French (2004). They show a jump in the number of newly listed CRSP common stocks during the 1980–2001 period as compared to preceding years. The cross-section of profitability for newly listed firms became significantly more negatively skewed after 1980, while the cross-section of asset growth became more positively skewed. They attribute these changes to an increase in the supply of equity capital that allowed the listing on the public equity markets of additional firms with more distant expected payoffs. Although they did not report on mean returns or return standard deviations, they show a sharp decline in survival rates for newly listed firms after 1980.

The data in Table 3B show that a total of 920 stocks entered the CRSP common stock database up to 1936. These included stocks already listed at the initiation of CRSP coverage, as well as new listings during the first decade. Only 490 stocks entered the database over the following 20 years, through 1956, followed by 1599 new stocks during the 1957–1966 decade. A total of 4548 stocks were added to the database between 1967 and 1976, including 2828 that entered during 1972, when Nasdaq stocks were first included in the CRSP data. As shown by Fama and French (2004), the rate of new stock appearances accelerated thereafter. In particular, the CRSP database includes 5151 new stocks during the 1977–1986 decade, 6860 between 1987 and 1996, and 4153 during the 1997–2006 period. During the most recent 2007–2016 decade, only 2238 stocks entered the database.

The data reported on Table 3B show that positive skewness is present in lifetime 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

[15] While mean returns are not the main focus of this paper, it is of interest to observe that the "small-firm effect" by which small firms have greater mean returns than large firms can be observed in monthly returns and in buy-and-hold annual returns but not in buy-and-hold decade returns. In particular, the mean decade buy-and-hold return to large stocks on Table 3A is 152%, compared to 96% for small stocks.

stocks that appeared between 1977 and 1986 to 44.8% of stocks that first appeared during the 1957–1966 decade.

The observation that most stocks underperform Treasury bills in the full CRSP dataset 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 attributable to changes in the type of firms brought to the public equity markets in recent decades. Fama and French (2004) show an increase in new listings characterized by negative earnings and strong asset growth, while Fink et al. (2010) show that the firms brought to market in recent decades have tended to be younger.

In combination, the results reported here show that skewness in individual stock returns 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 and stocks that entered the CRSP database since the mid-1960s.

4. Individual stocks and portfolios over the full 90 years

The CRSP dataset includes returns pertaining to ninety calendar years, spanning 1926–2016. However, for most stocks the lifetime return pertains to a period much shorter than the full 90-year sample. In fact, just 36 stocks were present in the database for the full 90 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 90th 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 90 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 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 90-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 4, 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 1-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.

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 90-year buy-and-hold return on Treasury bills of 1928%. 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 (i.e., 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, 25, 50, and 100 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 4, verify that 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 25 stock portfolios. The skewness of annual returns is actually negative (−0.09 and −0.21, respectively) for 50 and 100 stock portfolios. Albuquerque (2012) shows that negative skewness in diversified portfolio returns can arise due to heterogeneity in information announcement dates across stocks. On balance, the simulations verify that the positive skewness in the distribution of shorter-horizon individual stock returns is eliminated by diversification. Note, though, that the skewness of longer-horizon returns remains positive even for the more diversified portfolios.

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 25 stocks, and 93.1% with 100 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

Table 4
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 1-, 10-, and 90-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. Mean, Med, Skew refer to the mean, median, and standardized skewness computed across the 20,000 outcomes.

	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 5-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 25-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 50-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 100-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%		

relative to value-weighted benchmarks such as the S&P 500. For 25 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 active managers, who tend to be poorly diversified, underperform the broad stock market more than half of the time.

5. Aggregate value creation in the US 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 US Treasuries over the same time periods. Stated alternatively, the fact that the overall stock market has outperformed Treasuries is attributable to large returns earned by relatively few stocks.

I next turn to the question of just how concentrated is the creation of value in the US public stock markets. To do so, I measure net value creation for the overall stock market and for each individual firm, from the perspective of shareholders in aggregate. The buy-and-hold returns considered in many studies of stock market performance (and in this paper to this point) measure the experience of a hypothetical investor who reinvests dividends, but otherwise makes no transactions after the initial purchase of shares. As Dichev (2007) notes, the experience of this hypothetical investor does not reflect 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. 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 (GM), which delisted in June 2009 following a Chapter 11 bankruptcy filing.[16] The delisting share price for its main class of common stock was $0.61, compared to $93 less than a decade earlier. Had the delisting share price been $0 instead of $0.61, 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

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

to its bankruptcy and also repurchased shares on multiple occasions. These funds were collectively available to investors for other purposes, even after 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 degree of concentration in stock market performance from the viewpoint of shareholders in aggregate, 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 $I_t = I_{t-1}{}^*(1 + R_{ct}) + F_t$, 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:

$$W_t - W_{t-1} * \left(1 + R_{ft}\right) = I_{t-1} * (R_t - R_{f_t}). \qquad (2)$$

Note that F_t and R_{dt} have been eliminated from expression (2); dividends, repurchases, and new equity investments matter only indirectly, through their effect on the magnitude of subsequent period's net investment, I. Expression (2) simply states that the investor's actual wealth at time t, in excess of that which would have been attained had she invested her $t-1$ wealth entirely in risk free bonds, is the product of the dollar investment in the risky asset times the asset's excess return.

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

$$\begin{aligned} W_T - W_0 * FV_{0,T} = {} & I_0 * \left(R_1 - R_{f1}\right) FV_{1,T} \\ & + I_1 * \left(R_2 - R_{f2}\right) FV_{2,T} + \ldots \\ & + I_{T-2} * \left(R_{T-1} - R_{fT-1}\right) * FV_{T-1,T} \\ & + I_{T-1} * \left(R_T - R_{fT}\right). \end{aligned} \qquad (3)$$

The left side of expression (3) can be interpreted as the difference between the investor's actual final wealth and the final wealth the investor would have attained had she invested entirely in the risk-free asset. The right side of expression (3) 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 (2).[17]

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. The calculation extends from the first monthly return in the CRSP database to the last (including any delisting return). It therefore does not capture wealth created prior to the appearance of the stock in the monthly CRSP data. 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, Berkshire Hathaway, and GM, 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 sum the dollar outcomes from implementing expression (3) across PERMNOs for those firms with multiple classes of stock.[18]

Table 5 reports on lifetime wealth creation for the 50 individual firms that created the most wealth.[19] Firms are identified in the table based on CRSP PERMCO and the most recent name associated with the PERMCO 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.[20] For firms with multiple classes of common stock the return pertains to the class that was outstanding for the longest time period.

The largest amount of wealth creation attributable to any firm is \$1.002 trillion, by Exxon Mobil. The second

[17] Compounding at the risk-free rate reflects the fact that in this computation, the Treasury bill always comprises the opportunity cost on invested capital, or equivalently, the return on cash given off by the risky asset. 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 (3). 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.

[18] 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.

[19] A spreadsheet containing lifetime wealth creation data for all firms with common stock in the CRSP data can be downloaded from https://wpcarey.asu.edu/department-finance/faculty-research/do-stocks-outperform-treasury-bills.

[20] 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.

Table 5
Lifetime wealth creation.
This table reports lifetime wealth creation to shareholders in aggregate. Wealth creation is measured by text Eq. (3) 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 (identified by PERMNO) that existed for the longest period of time. The start and end months refer to the first and last months with return data for the PERMCO.

PERMCO	Company name (most recent)	Lifetime wealth creation ($ millions)	% of Total	cumulative % of total	PERMNO	Annualized return (%)	Start month	End month	Life in 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	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	WALMART 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	AT&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
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	3 M 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	AT&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	Aug-29	Dec-16	1049
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	HP 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

largest wealth creation is attributable to Apple, which created $745.7 billion in shareholder wealth, despite a CRSP life of only 433 months (compared to 1086 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), GM ($425.3 billion), Chevron ($390.4 billion), and Walmart ($368.2 billion) comprise the rest of the top ten firms in terms of lifetime wealth 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–

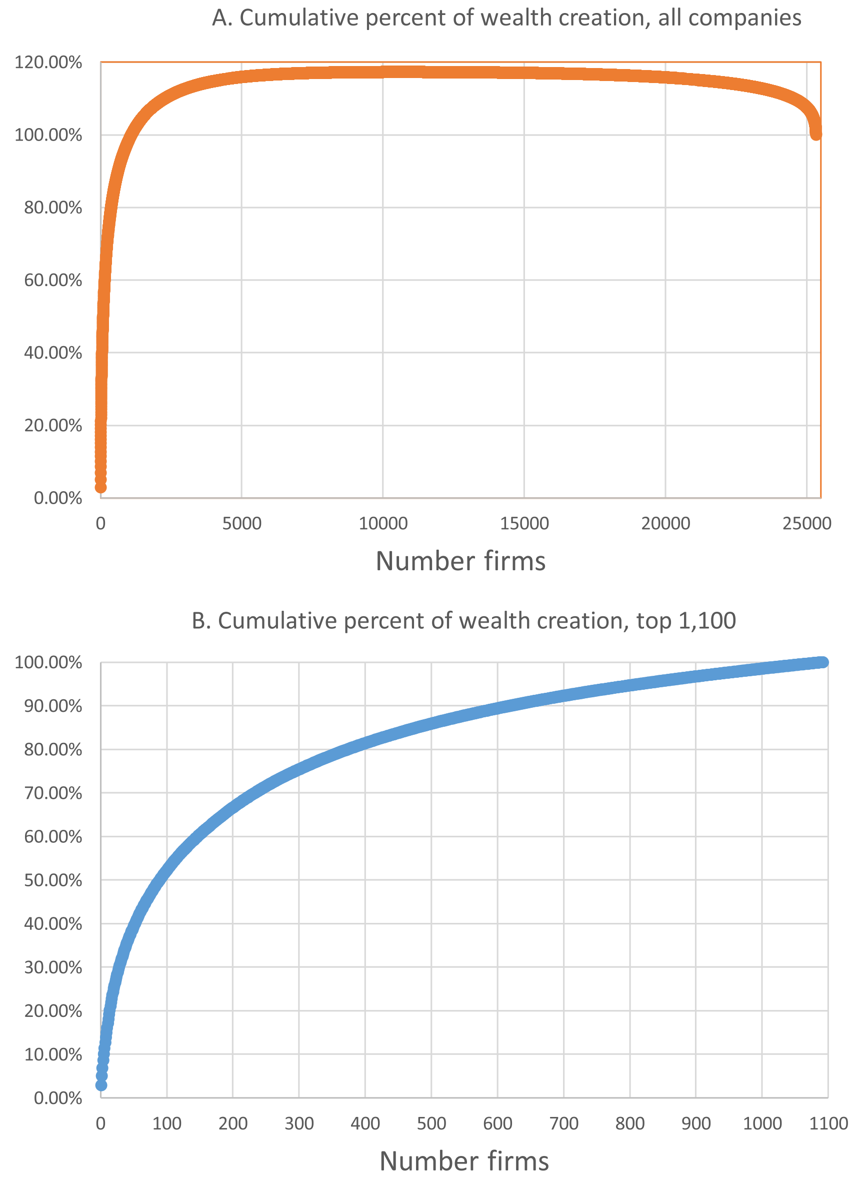

Fig. 2. Cumulative percentages of stock market wealth creation. The figures display the cumulative percentage of net US stock market wealth creation since 1926 and measured as of the end of 2016 attributable to individual stocks, when companies are sorted from largest to smallest wealth creation. Fig. 2A includes all 25,332 companies with common stock in the CRSP database, while Fig. 2B includes only the 1100 largest wealth creating companies.

2016 period. Apple was responsible for an additional 2.14% of net stock market wealth creation. Table 5 also displays the cumulative percentage of US 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 five firms account for 10.07% of net stock market wealth creation, while the top 50 firms account for 39.29% of the net wealth creation.

Fig. 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 and reaches a maximum of 117.27%. This reflects that gross stock market wealth creation (obtained by summing wealth creation across all firms that generated positive wealth) was 17.27% larger than net wealth creation.

Fig. 2B displays the same data as Fig. 2A, but is confined to the 1,100 firms with the largest lifetime wealth creation. The curve on Fig. 2B passes through 50% at just 90 firms and passes through 75% at 295 firms. That is, just 0.36% of all firms whose common stock has been included in the CRSP data account for half of the cumulative net wealth creation in the US stock market from 1926 to 2016, and 1.16% of the firms account for three quarters of the net wealth creation.

The curve on Fig. 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 4% of the firms contained in the CRSP database collectively account for all of the net wealth creation in the US stock market since 1926. Beyond these best-performing firms, 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 the top 1092 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 US Treasury bill rates.[21]

It should be noted that it would have been impossible for this analysis to not find some amount of concentration in stock market wealth creation. Pure randomness contributes to ex post concentration. Further, some firms have long lives, while others have short lives. Firm size varies widely, and a given positive excess return implies more wealth creation for a large stock. In addition, monthly returns are positively skewed, and the compounding of returns over multiple periods induces additional positive skewness in the distribution of long horizon returns. 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 exit the market. Nevertheless, the degree of concentration in wealth creation is striking. It will be of interest to assess whether existing industrial organization models are consistent with the degree of concentration in wealth creation shown here.

6. Conclusion

While the overall US stock market has handily outperformed Treasury bills in the long run, most individual common stocks have 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 and, as would be anticipated based on the evidence in Fama and French (2004), for stocks that have entered the database in recent decades.

When stated in terms of lifetime dollar wealth creation to shareholders in aggregate, approximately one-third of 1% of the firms that issued common stocks contained in the CRSP database account for half of the net stock market gains, and slightly more than 4% of the firms account for all of the net stock market gains. The other 96% of firms that issued stock collectively matched one-month Treasury bill returns over their lifetimes. It will be of interest to assess whether this degree of concentration in long horizon wealth creation is consistent with existing industrial organization models of firm entry and exit, strategic interaction, and corporate performance.

These results highlight the practical importance of positive skewness in the distribution of returns. The skewness in long horizon returns is attributable in part to the fact that monthly returns are skewed. It also reflects the possibly underappreciated fact that the compounding of random returns induces positive skewness in the multi-period return distribution, and more so for stocks with more volatile returns. Researchers often assume that returns conform at least approximately to the normal distribution. However, even if returns were distributed normally at a one-period horizon, the effects of compounding imply positive skewness at any longer horizon. It will be of interest to assess the extent to which the positive skewness in monthly returns arises because monthly returns can be obtained by compounding shorter horizon returns, or reflects skewness in fundamental drivers of returns.

While the actual skewness in long horizon CRSP stock returns is strong, it is less than would be anticipated based only on the effects of compounding of independent and identical returns, as illustrated by the simulations reported in Section 2 of this paper. Of course, the actual return-generating process is much more complex than the assumptions incorporated in the simulation. The actual returns in this study pertain to nearly 26,000 different stocks over 90 years, and expected returns and return volatility can differ across stocks and over time. While the simulated returns do not allow for delistings, many actual stocks are delisted, for both positive (e.g., due to acquisition) or negative (e.g., share price below specified minimums) reasons. Further, the simulations assumed independent draws over time, while actual returns may reflect complex own and cross-autocorrelations at various horizons. Assessing the reasons that long horizon returns display less skewness than would be anticipated if multi-period returns were generated by independent draws from a normal distribution with constant parameters comprises an interesting avenue for future research.

The results presented here 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 possibility that poorly diversified portfolios will underperform because they omit the relatively few stocks that generate large positive returns. Actively managed portfolios tend to be concentrated. For example, Kacperczyk et al. (2006) show 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 benchmarks (such as the S&P 500 return) that are constructed as average returns across securities available for investment. Under-

[21] Of course, at any given time, investors could only choose among the stocks then listed (which reached a maximum of 7927), not among all 25,332 firms that issued common stock during the 1926–2016 sample. The 1092 firms that accounted for all of the net stock market wealth creation comprise 4.3% of the firms that appeared in the data but comprise 13.8% of the firm/months in the dataset. Similarly, the 90 firms that accounted for half of the net stock market wealth creation comprise only 0.36% of the firms that appeared in the data but comprise 1.68% of the firm/months in the dataset, and the five firms that accounted for 10% of the net stock market wealth creation comprise only 0.02% of the firms that have appeared in the data but 0.11% of the stock/months in the data.

performance 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 systematic behavioral biases. These results may require the reassessment of standard methods of evaluating investment manager performance such as the Sharpe ratio and Jensen's alpha.

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 portfolio return skewness. This preference does not rely on any assumed ability to identify stocks that are under or over-valued. Nevertheless, since diversification tends to reduce, or over shorter horizons eliminate, skewness, these investors can rationally choose to hold portfolios that are not fully diversified. Patton (2004) shows that considering even 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 deviation when selecting stock portfolios may be substantial.

The results in this paper imply that the returns to active stock selection can be very large, if the investor is either fortunate or skilled enough to select a concentrated portfolio containing stocks that go on to earn extreme positive returns. Of course, the key question of whether an investor can reliably identify in advance such "home run" stocks, or can identify a manager with the skill to do so, remains.

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