DO STOCKS OUTPERFORM TREASURY BILLS?

EVIDENCE FROM A SWEDISH SETTING

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Do stocks outperform Treasury bills? : Evidence from a Swedish setting

Abstract:

Most Swedish stocks listed since 1983 post lifetime buy-and-hold returns that are less than one-month Swedish Treasury bills. In terms of risk-adjusted returns for the same time horizon, individual Swedish stocks vastly underperform value-weighted benchmarks when measured with a Sharpe ratio. These results further illustrate the role which skewness plays in determining the heterogeneous nature of stock return distributions. Much of the observed long-term skewness can be attributed to the compounding effect. The results explain the importance of being well diversified as underdiversification over a lifetime almost always leads to a complete loss of the invested principal.

Keywords:

Individual stocks, Treasury bills, Skewness, Buy-and-hold returns, Diversification, Risk-adjusted returns

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1. Introduction

It is a well-documented fact that the stock market tends to outperform government bonds in the long run when evaluated on raw returns. Why then, would we pose the question: Do individual Swedish stocks outperform Swedish one-month Treasury bills? The answer lies in the cornerstone of modern portfolio theory; namely, diversification. Bessembinder (2018) provides evidence that most individual U.S. common stocks yield buy-and-hold returns lower than those of one-month U.S. Treasury bills. This study broadens the geographical range and further underscores the significance of diversification by examining individual Swedish stocks. It highlights their relative underperformance compared to Swedish one-month Treasury bills. The underperformance implies that most of the positive mean excess returns that are observed for a sufficiently diversified portfolio can be accredited to comparatively few stocks. However, in portfolio theory, the raw excess return of a portfolio is not of interest without information regarding the risk profile of said portfolio. As such, this study further investigates the risk-adjusted returns of Swedish stocks over the same time period.

We observe that out of all individual Swedish stocks spanning from January 1983 to December 2022, only 47.58% outperformed Treasury bills on a monthly basis and only 46.92% were positive. If we extend the timeline to include the whole lifetime of the stocks in the sample, we find that 39.35%, or slightly below two fifths of the stocks outperformed Treasury bills. Worth noting is that more than half of the stocks posted a negative return over their lifetime with the most common outcome being a 100% loss. On a risk-adjusted basis, over the full lifetime of the stocks, only 11.19% of stocks outperformed a value-weighted benchmark, which further shows the underperformance of individual stocks vis-á-vis various benchmarks.

Understanding the longevity of individual stocks is crucial to evaluate their performance over the longer horizons presented in this study as it can unlock new caveats. One critical observation is that a considerable portion of stocks might render a return of -100% over long durations, effectively erasing their value. In fact, the average lifetime of a stock before delisting is around 7.88 years. This poses challenges in evaluating the true long-term performance of individual stocks. To tackle this issue and gain deeper insights into the real return distribution over 40 years, we resort to a bootstrap simulation. The main goal is to inspect whether a strategy of holding individual stocks selected at random each month would cumulatively over 40 years generate returns that would beat a plethora of benchmarks such as one-month Treasury bills, a value-weighted portfolio, etc. We observe that over the 40-year period, only 18.28% of simulations holding a one-stock portfolio outperform the alternative of just buying and holding one-month Treasury bills over the same period. The simulations for a more diversified 100-stock portfolio instead find that 100% of the portfolios outperform

Treasury bills during the same period reinforcing the importance of portfolio diversification.

Expanding the discussion to Sharpe ratios adds an additional layer of insight as it gives a measure of the risk-adjusted returns. On an annual basis, only a select few individual stocks exhibit Sharpe ratios several magnitudes greater than the majority, indicating substantial variations in risk-adjusted performance. The general underperformance of individual stocks' risk-adjusted returns compared to a value-weighted market portfolio gives further support to the importance of diversification. Similar to the raw returns, the risk-adjusted section is complemented with a bootstrap simulation to investigate the Sharpe ratios over the full 40 years. Here, we can once again see that the relative performance vis-á-vis a value-weighted benchmark improves as more stocks are added to the portfolio, which again underlines the importance of diversification. Additionally, over the full lifetime, at least four fifths of a single stock portfolio have a positive Sharpe ratio, whereas 100% of portfolios with 5 or more stocks have a positive Sharpe ratio. This then means that holding for a longer period of time, and also holding a more diversified portfolio will almost ensure that the investor is compensated for risk.

In the subsequent sections, we delve into the cross-sectional heterogeneity of stocks, examining the traits that differentiate top performers from the bottom performers on the basis of raw performance. The results of this analysis carry significant implications for investment strategies, portfolio construction, and the importance of diversification. Additionally, the small stock effect is investigated by sorting the performance based on market cap. Smaller stocks are found to have a lower median buy-and-hold return on a monthly basis compared with larger stocks. However, the mean buy-and-hold return is higher for smaller stocks compared with larger. This is in support of the "small-firm-effect" by which smaller firms should have a higher return than larger firms to compensate for the additional risks. Since asset pricing literature often focuses on mean returns, the finding that smaller firms have a lower median does not have to be a contradiction to this well-known phenomenon.

2. Literature review

The idea to compare stock returns with Treasury bills over a long horizon is not new. To the extent of our knowledge, Bessembinder (2018) is the first to comprehensively show that over a long time horizon, less than half of the stocks listed on the U.S stock market generated a positive lifetime buy-and-hold return and an even smaller minority have lifetime buy-and-hold returns greater than a one-month Treasury bill over the same period. As such, Bessembinder finds that only a small minority of stocks stand for the overall market outperformance and aims to explain why poorly diversified active strategies routinely underperform relative to market-wide benchmarks. Bessembinder also highlights the extreme skewness in stocks over a longer time period in the U.S stock market, which is an important aspect in explaining the underperformance of stocks. Fang, Marshall, Nguyen and Visaltanachoti. (2021) expand on this and look at the stock performance vis-à-vis Treasury bills in an international setting. They find that a minority of stocks in 55 countries outperform a global Treasury bill index.

Furthermore, this outperformance by a minority is one of the main reasons leading to skewness in the stock market. In traditional finance theory, the mean-variance framework operates under the assumption of a normal distribution of returns. However, the assumption of normality often fails to capture the true distributional characteristics of stock returns, as they can exhibit skewness that deviate from a standard normal distribution. Simkowitz and Beedles (1978) highlights the importance of skewness, the third moment of distribution. Since the assumption of normality might not always hold in real-world scenarios, Simkowitz and Beedles find the effect that diversification has on portfolio skewness. They find that the direct effect of adding one additional asset on a portfolio's skewness is not linear, but dependent on the skewness of the asset returns and the correlation structure in the portfolio.

Further, Mitton and Vorkink (2007) develop a model for investor asset holdings in a single-period setting. Here, they assume that investors have a heterogenous preference for skewness, which they find support for in empirical data. One key finding is that underdiversified investors have a larger likelihood of holding a portfolio with high positive return skewness compared to diversified investors. This means that the payoff profile of underdiversified investors resembles a lottery-like distribution, where there are higher chances of extreme positive returns but also an increased likelihood of underperformance. Such a skewness preference may indicate a behavioural bias where underdiversified investors are attracted to the potential for outsized gains, even if it is irrational to do so from mean-variance trade-off perspective.

Additionally, Sharpe (1994) discusses a measure for the performance of funds which he calls reward-to-variability ratio, better known as the Sharpe ratio. The ratio is commonly used to find the risk-adjusted return, where risk is proxied by variability. The

Sharpe ratio can be calculated both based on historical data (ex post) or based on expectations of future returns (ex ante).

We believe our report contributes to the existing literature two-fold. Firstly, since the data is based on Swedish data, this provides a geographical perspective that has not, to our knowledge, been thoroughly explored. This is of particular interest as Swedish investors have been shown to be underdiversified in a report by Euroclear (2023). By the end of 2022, 37.6% of retail investors had a single-stock portfolio. The average number of stocks held is 5.27, which is an increase from previous years but still far from ideal. This could suggest that retail investors in Sweden also have a proclivity for lottery-like returns, as described by Mitton and Vorkink. Secondly, we perform a risk-adjusted analysis using Sharpe ratios to see if the same relationships we discover still hold under risk-adjusted conditions. This is of particular interest for portfolio managers, as the risk-adjusted return is a key metric in evaluating the performance of investment portfolios.

3. Methodology

3.1. Data

To compare the buy-and-hold return of one-month Treasury bills and Swedish stocks, we extract data from the Riksbank (Swedish central bank) data archives and EIKON Refinitiv respectively. We take the one-month Treasury bill data from the first month it is available (January 1983) until December of 2022 for a time span of 40 years. The buy-and-hold return for a Treasury bill will simply be its ultimo yield, i.e. the last yield recorded for the month since there will be no buying or selling for this hypothetical investor during the month. As such, price fluctuations of the bond will not affect the buy-and-hold return as the buyer simply gets the full face value at maturity in addition to accumulated interest. For EIKON Refinitiv we filter by Swedish stocks, listed on the Stockholm Stock Exchange, with currency in SEK, include major listings, and lastly only primary quotes. Further we collect data spanning the range January 1983 to December 2022 in monthly intervals so that the stock returns are comparable with those of the one-month Treasury bills. Market capitalisation data is sourced from EIKON using the same filters as the stock return data. To ensure consistency in our dataset, we excluded months where there was a mismatch between the market capitalisation and stock return data. Specifically, months with market capitalisation data but without corresponding stock return data, or vice versa, were excluded.

EIKON is known for having data quality issues, and as such, we have conducted some additional data cleaning outside of the initial filters described above. More specifically, we use the guidelines proposed by Schmidt, von Arx, Schrimpf, Wagner and Ziegler (2011) and set all returns over 990% to missing values as this is found to increase the accuracy and comparability of the results.

3.2. Outcomes due to delisting

We note that a significant number of stocks will withdraw from the database before the terminal date of our horizon. As EIKON does not provide a delisting return for Swedish stocks we choose to include a cut-off point at the last month before stocks exhibit at least three consecutive months of 0% returns, as the price data remains static after the delisting date. This decision was made based on the rationale that it is relatively unlikely for a stock to remain stagnant over a three-month period unless there are underlying reasons, such as potential delisting. However, we acknowledge that this is an arbitrary choice and could inadvertently exclude stocks that, for other unrelated reasons, exhibit three consecutive months of 0% returns. The robustness of this choice will be evaluated later in the paper. The choice of including the delisted stocks in the dataset as opposed to removing them completely is made to reduce potential survivorship bias. We assume that the price of the stock should already reflect approximately the returns generated due to delisting outcomes some months prior to the actual event of delisting.

We are aware that this choice also slightly compromises the objectivity of our data and introduces delisting biases as described by Shumway (1997). As such, other methods of mitigating biases in the data could be explored. Shumway and Warther (1999) determine an arbitrary corrected return as a substitute for stocks that meet our delisting criteria, assuming we liken the returns by stocks in the first couple of deciles in Table 3A to those of the *Pink Sheets* and assuming missing returns are on average large and negative this could be a viable alternative. Piotroski (2000) assumes that all the delisting returns are zero, while Sloan (1996) sets the delisting return to -100%. While there is no "one-size fits all" way to deal with missing delisting returns, we choose to follow the example of Piotroski (2000) as it requires making less hard assumptions as opposed to emulating Sloan (1996) or Shumway et al. (1999).

3.3. Skewness

As previously discussed, researchers such as Simkowitz and Beedles (1978), Mitton and Vorkink (2007) have investigated skewness in relation to the stock market. Most importantly for this paper, Bessembinder (2018) shows that skewness is one of the contributing factors to the underperformance of stocks relative to other benchmarks in the U.S markets. As such, it should not come as a surprise that only a minority of stocks found in EIKON's Swedish database outperform the lowest tenor Treasury bill in terms of lifetime returns.

Bessembinder (2018) also points out that the results do not have to be inconsistent with the ideas of risk-return trade-offs. This is because asset pricing models focus on mean returns, meaning that investors will demand a higher mean of excess returns to compensate for increased risk. However, a positive mean and negative median stock return can arise due to positive skewness. The larger the skewness, the more pronounced the difference between the mean and median. Therefore, it is not irrational for risk-tolerant investors to tolerate negative median returns if the mean returns are sufficiently high, offsetting the increased risk. This perspective aligns with standard asset pricing theories, which prioritize mean returns over medians in evaluating investment risks and rewards.

3.3.1. Skewness in single-period returns

To demonstrate how skewness affects the mean and median return in a single period, consider a benchmark where the single-period excess stock returns are distributed lognormally. Similarly, to Bessembinder (2018), let the variable *X* represent the excess return for one period that is lognormally distributed. Let *y* be:

$$y = ln(1 + x) \tag{1}$$

Now, assume that y is normally distributed and has mean μ and standard deviation σ. The expected excess return, *E(X)*, can be expressed as:

$$e^{\mu+0.5\sigma^2} \tag{2}$$

On the other hand, the median excess return will be described by:

$$e^{\mu-1} \tag{3}$$

As such, whenever $\sigma > 0$, the mean value will always exceed the median. The lognormal distribution does not have a specific skewness function; however, it is positive, and an increasing function dependent on σ alone. Assuming that the lognormality distribution holds, this means that as the standard deviation increases, the skewness of the excess return also increases, leading to a more pronounced right tail. In practical terms, this suggests that when there is greater volatility, there is a higher likelihood of observing extremely large returns, despite most returns being centred around a lower value.

Due to our definitions, we can also see that the mean excess log return can be expressed as:

$$\mu = ln\big(1 + E(X)\big) - 0.5\sigma^2 \tag{4}$$

If μ is negative, then the median excess return will always be negative per definition. This occurs when:

$$\sigma^2 > 2 \times ln\big(1 + E(X)\big) \tag{5}$$

If the lognormality assumption holds, then this implies that more than half of the one-period excess returns will be negative if the excess return variance is sufficiently large. In other words, if the above equation holds, more than half of the one-period excess returns will be negative. As an example, if the expected simple excess return is 0.5%, and the lognormal distribution applies, then the median excess monthly return will be negative if the monthly return variance σ^2 exceeds approx. 0.01, or alternatively stated if the monthly return standard deviation σ exceeds approx. 10%.

3.3.2. Skewness in multi-period returns

As discussed by Bessembinder (2018), intuition dictates that skewness in single-period returns should imply that it is present for returns compounded over multiple periods. Since the skewness of a lognormal distribution is a positive increasing function of σ, if one draws independently from a lognormal distribution, the skewness will simply increase. This is because the standard deviation is proportional to the square root of the number of elapsed periods which is strictly increasing.

However, if we leave the case with already skewed single-period returns and look at the compounding of random returns over multiple periods that are symmetrically distributed, i.e. no skewness, it is less intuitive that this could still give rise to skewness.

Bessembinder (2018) also shows the effect of compounding on normally distributed single-period stock returns. The assumption of normal distribution in single periods is often done in portfolio theory as a normal distribution implies that the only necessary statistics to describe the risk and return characteristics of a portfolio are the mean and variance. As such, we have conducted a simulation with the same specifications as Bessembinder to illustrate the effects of compounding on multi-period buy-and-hold when drawing from normally distributed single-period returns.

The returns are drawn from a constant distribution and are thus assumed to be independent and identically distributed across time. The monthly mean is set to 0.5%, and the standard deviations, σ, are set in intervals of 2 between 0 to 20%. For each standard deviation, the returns are simulated for 2.5 million one-year periods, 500 000 five-year periods and 250 000 ten-year periods. The results of the simulation can be seen in Table 1.

Table 1. Simulations similar to Bessembinder (2018). Illustration of skewness in multi-period returns assuming normally distributed single-period returns. Monthly returns are randomly generated from a normal distribution with a mean of 0.5% and standard deviation as shown. Buy-and-hold returns are calculated by combining monthly returns for the given horizon. Results are calculated with 2.5 million non-overlapping annual returns, 500 000 non-overlapping five-year returns and 250 000 non-overlapping ten-year returns.

Standard deviation	0%	2%	4%	6%	8%	10%	12%	14%	16%	18%	20%
Horizon (Years)			Panel A: Skewness of buy-and-hold returns								
1	0.000	0.188	0.383	0.579	0.781	0.998	1.230	1.463	1.727	2.023	2.316
5	0.000	0.458	0.961	1.552	2.264	3.291	4.497	6.719	9.214	18.354	18.290
10	0.000	0.655	1.449	2.438	4.564	6.406	13.692	23.165	40.416	65.336	74.434
			Panel B: Median of buy-and-hold returns %								
1	6.168	5.934	5.253	4.080	2.506	0.451	-1.992	-4.808	-8.048	-11.710	-15.666
5	34.885	33.370	28.651	21.370	11.598	0.347	-12.334	-25.460	-37.883	-50.111	-61.079
10	81.940	77.589	65.541	46.809	23.936	0.113	-23.638	-44.341	-62.488	-75.695	-85.473
			Panel C: Positive buy-and-hold returns %								
1	100.0	79.77	64.45	57.61	53.54	50.51	48.09	46.00	44.11	42.33	40.64
5	100.0	96.84	79.26	66.13	57.05	50.18	44.47	39.56	35.35	31.50	28.01
10	100.0	99.60	87.57	71.92	59.65	50.04	42.03	35.34	29.35	24.34	20.03
			Panel D: Ninety-ninth percentile buy-and-hold return %								
1	6.17	24.24	44.57	67.19	92.20	120.22	150.99	184.17	221.73	261.48	304.34
5	34.89	90.67	162.54	254.52	365.74	500.94	658.21	820.45	1022.87	1227.37	1424.22
10	81.94	193.65	352.88	569.49	835.51	1166.40	1527.68	1861.10	2259.16	2527.37	2669.88

The results for the lower standard deviations are more relevant for a well-diversified portfolio while the higher standard deviations are more relevant for single stock portfolios. Panel A demonstrates that similar to a single period, the skewness is positive and an increasing function dependent on σ. Additionally, when looking at Panel B, one can observe that when the skewness is increasing, the median decreases and moves further away from the mean. Note that the mean can be observed as the median when the standard deviation is 0%. Also, in Panel C, the number of positive buy-and-hold returns decreases with the increase of skewness. It can also be observed that when σ is low, the positive buy-and-hold percentage is increasing with the time horizon, but as the σ increases, the positive buy-and-hold percentage decreases as the horizon increases. Since the mean return is not affected by σ, one can see in Panel D that the decrease in the median as the risk goes up is offset by a small probability of earning large returns.

The chief point of the simulation is to show that the compounding of single-period returns can introduce skewness, even if the single-period returns are symmetrical. This skewness causes the median of the buy-and-hold returns to decrease as the risk increases. However, this decreased median is offset by the slight possibility of earning massive positive returns. The simulations further support the finding that most individual stocks generate buy-and-hold returns less than those earned by Treasury bills.

3.4. Sharpe ratio

While the raw return of stocks is important for all intents and purposes, what is often neglected is the Sharpe ratio which is indicative of the return for a given level of risk. The Sharpe ratio is important to us for ascertaining what level of returns could be reasonably expected for a skilled fund manager to achieve for a single stock, eliminating certain risky stocks that performed exceptionally well but that are extremely risky.

More specifically, we have calculated the ex post Sharpe ratio which entail using actual historical returns of the stock rather than the expected return of a stock. We denote the difference D_t as the difference between excess returns $R_{Pt} - R_{Ft}$:

$$D_t = R_{Pt} - R_{Ft} \tag{6}$$

Where R_{Pt} is the portfolio or individual stock return, and R_{Ft} is the one month Treasury bill. As such $\bar{D}$ (D-bar) is defined as the average of D_t from the period t=1 to T:

$$\bar{D} = \frac{1}{T}\sum_{t=1}^{T} D_t \tag{7}$$

Sigma$_D$ is the standard deviation over the period:

$$\sigma_D = \sqrt{\frac{\sum_{t=1}^{T}(D_t - \bar{D})^2}{T-1}} \tag{8}$$

We thus define the ex-post Sharpe ratio S_h:

$$S_h = \frac{\overline{D}}{\sigma_D} \tag{9}$$

3.4.1. Single period ex post Sharpe ratio

The Sharpe ratio both ex post and ex ante are not independent of the convention which it is measured. Assuming the *Rp – Rf* over *T* periods is measured by summing the respective *D* that have no serial correlation we consider the following assumptions:

$$\overline{d_T} = T d_1 \tag{10}$$

$$\sigma_{d_T}^2 = T \sigma_{d_1}^2 \tag{11}$$

$$\sigma_{d_T} = \sqrt{T} \sigma_{d_1} \tag{12}$$

Which imply that the following relationship holds:

$$S_T = \sqrt{T} S_1 \tag{13}$$

In reality this situation most likely does not take place naturally over multiple periods, as such we need to more closely ascertain a method to deal with Sharpe ratios under circumstances where the differential returns might be serially correlated.

3.4.2. Multi-period ex post Sharpe ratio

When computing multi-period returns, we consider the same principles that underpin why skewness can arise in multiple periods even when no skewness is present in a single period. Alternatively stated, when we compute multi-period returns, compounding is an inevitable part of this process. Therefore, even if the single-period ex post Sharpe ratios does not contain serial correlation, a multi-period might. A step which is taken to mitigate this effect, is simply annualising the data. Using equations 10 and 11 before we compute the Sharpe ratio allow us to meaningfully compare the risk level across horizons. Since we are annualising the data, we will simply set *T* equal to 12.

4. Results and discussion

We focus on buy-and-hold returns of individual EIKON stocks across four different time horizons: monthly, annual, decade and lifetime from January of 1983 to December of 2022. EIKON adjusts prices for corporate actions such as stock splits, dividends, and rights offerings for comparability over a longer horizon.

Table 2. EIKON Refinitiv stock returns at various horizons. All Swedish common stocks from EIKON from January 1983 to December 2022 are included. Annual returns use calendar year convention, decade returns are non-overlapping. If a stock is listed or delisted within a calendar period, they naturally encapsulate a shorter time interval. Lifetime horizon begins in January 1983, or a stock's debut in EIKON until December 2022, or a stocks delisting. "T-bill" refers to the return of a Swedish one-month Treasury bill and it is matched to each stock for each time horizon. Sum stock return is the arithmetic sum of all returns. 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 weighted average return for all stocks within a timeframe based on market capitalisation, whereas the EW Mkt return is the equal-weighted average return across all stocks within a timeframe.

Panel A: Individual stocks, monthly horizon (N=148,862)					
Variable	Mean	Median	SD	Skewness	Positive %
Buy-and-hold return, T-bill	0.004	0.003	0.004	0.776	82.08
Buy-and-hold return, Stock	0.009	0.000	0.199	8.597	46.92
	% > T-bill	% > VW Mkt return		% > EW Mkt return	
Buy-and-hold return, Stock	47.58		43.42		45.29
Panel B: Individual stocks, annual horizon (N=13,451)					
Variable	Mean	Median	SD	Skewness	Positive %
Sum stock return	0.099	0.078	0.667	2.068	58.25
Buy-and-hold return, T-bill	0.030	0.014	0.042	1.432	69.68
Buy-and-hold return, Stock	0.117	0.009	0.983	30.323	51.32
Geometric return, Stock	-0.004	0.001	0.052	-0.754	51.32
	% > T-bill	% > VW Mkt return		% > EW Mkt return	
Buy-and-hold return, Stock	48.55		41.46		41.59
Panel C: Individual stocks, decade horizon (N=2327)					
Variable	Mean	Median	SD	Skewness	Positive %
Sum stock return	0.587	0.469	1.598	0.707	65.26
Buy-and-hold return, T-bill	0.229	0.088	0.413	3.066	72.02
Buy-and-hold return, Stock	1.023	-0.102	5.022	12.798	46.67
Geometric return, Stock	-0.003	-0.001	0.015	-1.039	46.67
	% > T-bill	% > VW Mkt return		% > EW Mkt return	
Buy-and-hold return, Stock	39.37		26.80		27.11
Panel D: Individual stocks, lifetime horizon (N=1573)					
Variable	Mean	Median	SD	Skewness	Positive %
Sum stock return	0.844	0.500	2.098	1.032	64.53
Buy-and-hold return, T-bill	0.357	0.077	7.826	4.146	77.75
Buy-and-hold return, Stock	3.483	-0.202	25.055	15.210	43.87

Geometric return, Stock	-0.002	-0.004	0.049	-3.232	43.87
	% > T-bill		% > VW Mkt return		% > EW Mkt return
Buy-and-hold return, Stock	39.35		43.05		43.49

Note: Standard deviation is abbreviated to SD, value-weighted is abbreviated to VW, equal-weighted is abbreviated to EW and Treasury bill is abbreviated to T-bill.

4.1. Monthly performance

Panel A from Table 2 displays summary statistics for the pooled distribution of 148 862 monthly stock returns in the EIKON database from January 1983 to December 2022 in addition to matching Treasury bill returns. Observable is the fact that mean stock buy-and-hold return for this horizon is positive at 0.90% compared to mean Treasury bill returns which read 0.40%. There are several noteworthy findings here, firstly the skewness coefficient being positive and reading 8.597 indicating that monthly returns are extremely positively skewed. Secondly, similarly to Bessembinder (2018) we find that individual stocks vary a lot shown by a standard deviation of 19.90%.

As Table 1 illustrates, it is implied that for compounding over multiple periods with a volatility of this magnitude, significant skewness will be present. Most importantly is the fact that only 46.92% of stocks posted a positive return whilst 47.58% outperformed Treasury bills suggesting that Treasury bills had a negative return at some point in time. Upon closer examination of our data, we find that the return generated by Treasury bills were negative for almost one fifth of our entire time horizon. This has heavy implications for why our results contradict the intuition of what a risk-free financial instrument such as a government bond should return.

4.2. Annual and decade performance

Panels B and C from Table 2 display summary statistics for EIKON stocks calculated using a standard calendar year and decade convention respectively. The database used ranges from January 1983 to December 2022. The non-overlapping decades are defined as January 1983 to December 1992, January 1993 to December 2002, January 2003 to December 2012, and January 2013 to December 2022.

For each stock we calculated the simple arithmetic sum of returns to determine if the mean is positive or negative and the buy-and-hold return to determine the magnitude of the gains or losses borne by an investor implementing a strategy of only buying and holding (reinvesting only dividends). We also compute the geometric mean of the monthly returns for each stock over each interval which we henceforth refer to as the geometric return to avoid confusion.

Figures 1A and 1B show the distribution of frequency for annual and decade returns (rounded to the nearest 2% and 5%) respectively up to a cut-off of 500%. Annually this shows the zero mark as the apex frequency wise for returns. However, for the decade horizon we observe that the most common outcome is around a -95% return closely followed by a -100% return. For Figure 1B despite observing a clear trend of a downward trending slope we can still see that for certain points of return that the frequency spikes significantly. The distributions for both show significant positive skewness. Consistent with the simulations from Table 1, Panel B and C in Table 2 show that there is significant skewness in both the annual and decade data.

Further evidence of skewness can be found when comparing the mean buy-and-hold return with the median. Annually, the mean buy-and-hold return is 11.70% while the median is 0.90%. The difference is made even clearer on the decade horizon, where the mean buy-and-hold return is 102.30% while the median comes in at a negative -10.20%. If we also look at the mean sum of returns (57.10%), this is lower than the mean buy-and-hold return. However, the sum of returns is positive 64.68% of the time while only 46.67% of buy-and-hold returns are positive. This implies that there is a large right tail in the distribution of the returns.

Additionally, one can also compare the different returns to market-wide benchmarks. From an annual perspective, around 41.46% of stock returns exceed the return of a value-weighted portfolio of all common stocks and 41.59% of stocks outperform an equal-weighted benchmark. From a decade perspective, merely 26.80% of stocks outperform the value-weighted benchmark while 27.11% outperform an equal-weighted one. The benchmark outperformance indicates that there are only a few stocks that are responsible for the benchmark returns, which further demonstrates the effect of positive skewness.

As can be seen in Table 2, Panel B, the annual horizon has a negatively skewed distribution of geometric returns. Since the skewness of annual buy-and-hold returns are positive at 30.323, this implies that the skewness from annual returns arise due to compounding. This is because a stock's annual buy-and-hold return can simply be obtained by compounding the stock's annual geometric return. Because this is negative, but compounding turns the sign positive, this further supports that compounding over multiple periods can give rise to skewness. The same conclusion can be drawn based on decade geometric returns and buy-and-hold data.

If we compare the results obtained from actual data as reported in Table 2 to the data presented in Table 1, we can see that there are some discrepancies. Simulated skewness of buy-and-hold returns at the decade horizon when the standard deviation is 20% is 74.434, which can be compared with the actual skewness of 12.798. Note that monthly standard deviation of 20% is similar to the actual data, which has monthly standard deviation of 19.90%. The skewness of the annual horizon is also higher than the decade horizon, which also goes against the simulation. This shows that the skewness in the actual data is significantly lower than what the simulation implies, they are based on independent draws from a constant distribution. The outcomes suggest the great significance of serial correlation in the actual return data when determining the skewness of returns over longer time horizons.

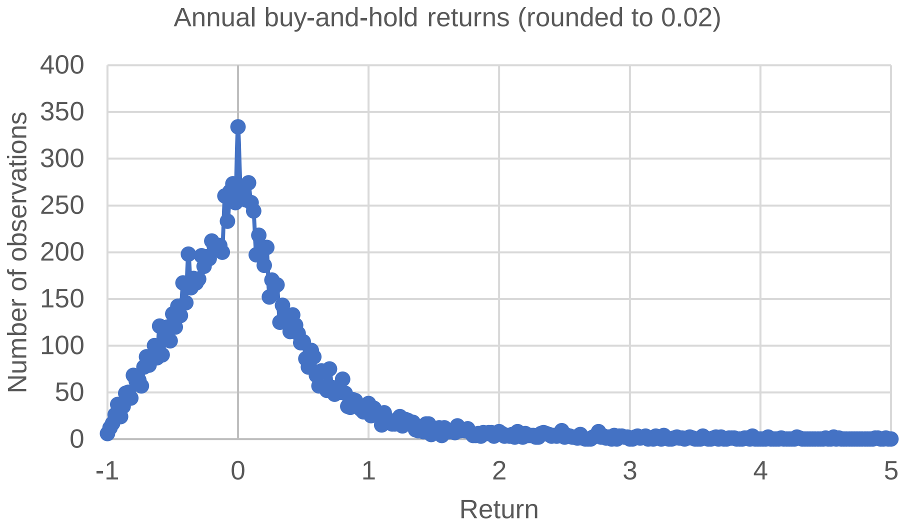

Figure 1A. Panel data from January 1983 to December 2022 showing frequency distribution of annual buy-and-hold returns of all Swedish individual stocks listed in EIKON rounded to 0.02. The buy-and-hold returns for an annual horizon are calculated to a maximum of 500%. If a stock lists or delists within the yearly period, the return is computed for portion of the year where data is available. Return is presented on the X-axis in decimal format and number of observations is presented on the Y-axis as an integer.

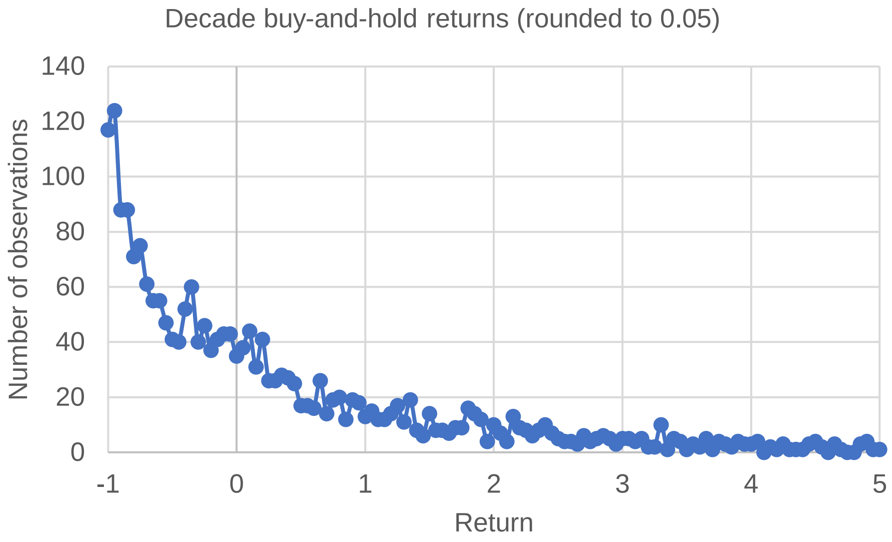

Figure 1B. Panel data from January 1983 to December 2022 showing frequency distribution of non-overlapping decade buy-and-hold returns of all Swedish individual stocks listed in EIKON rounded to 0.05. The buy-and-hold returns for a decade horizon are calculated to a maximum of 500%. If a stock lists or delists within the decade period, the return is computed for portion of the decade where data is available. Return is presented on the X-axis in decimal format and number of observations is presented on the Y-axis as an integer.

4.3. Lifetime performance

Panel D from Table 2 reports on lifetime returns for EIKON stocks whilst Figure 1C shows the distribution of frequency for the lifetime horizon (rounded to the nearest 5%) capped at 1000%. Each stock's lifetime return encapsulates January 1983 or the month which the stock first appears in the database until December 2022 or the month it gets delisted. Lifetime returns for such stocks do not include the delisting return, evident from the discussion in Section 3.2.

From Figure 1C we observe that the most common outcome across 1573 stocks over forty years is a -100% return. From Panel D in Table 2 we also find that 64.53% of stocks yielded positive arithmetic mean returns over their entire lifetime while only 43.87% of individual stocks posted positive returns when looking at their buy-and-hold return over the same period, which illustrates a large right-tail and positive skewness.

Looking at outperformance rate vis-à-vis the buy-and-hold return of a one-month Treasury bill, only 39.35% outperformed over the same period. As such, a preliminary answer to the question that is the title of this paper would simply be: no, most individual Swedish stocks do not outperform Treasury bills. This is also true for all time horizons, as the percentage of stocks that outperform Treasury bills never exceeds 50%.

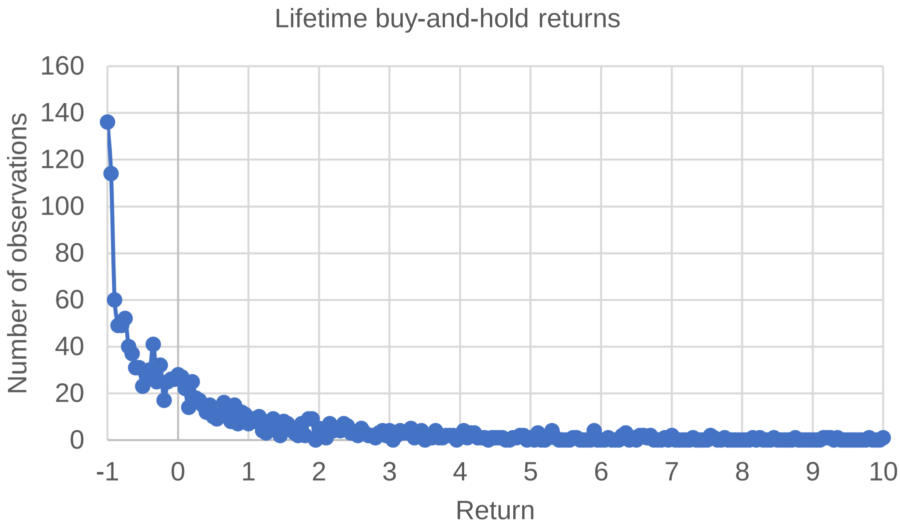

Figure 1C. Panel data from January 1983 to December 2022 showing frequency distribution of non-overlapping lifetime buy-and-hold returns of all Swedish individual stocks listed in EIKON rounded to 0.05. The buy-and-hold returns for a decade horizon are calculated to a maximum of 1000%. If a stock lists or delists within the 40 years, the return is computed for portion of the lifetime where data is available. Return is presented on the X-axis in decimal format and number of observations is presented on the Y-axis as an integer.

4.4. Distributions by firm size

To closer examine the small firm effect we have grouped the stocks that appear in our database by market capitalisation in Table 3A. They are subsequently classified based on monthly, yearly and decade time horizons. We assign each stock to a group based on its market capitalisation at the end of the prior month, year or decade for the corresponding interval of returns. We exclude the lifetime horizon due to the initial market capitalisation being largely irrelevant to the return which will be achieved throughout the firm's entire lifetime.

Similarly, to Bessembinder (2018) we find that small firms generate higher mean returns than large firms as shown in Table 3A Panel A and B for the monthly and yearly horizons. However, worth noting is the fact that at the same time it also illustrates a pattern of stocks belonging to the smaller deciles exhibiting extreme levels of skewness in the context of stock returns as well as, underperforming benchmarks at a much higher rate vis-à-vis their larger counterparts. Similar to Bessembinder, we find that for the decade horizon, the mean seems to be increasing with the decile group.

Now, while small stocks show a higher return variability, and large stocks have lower skewness, the positive skewness still shows itself through the fact that large individual stocks still fail to match the overall market benchmarks, with monthly outperformance for the tenth decile vis-á-vis the value-weighted benchmark being 45.60%, annual being 48.44%, and decade being 43.97%.

Table 3A. The distribution of stock buy-and-hold returns, by firm market capitalisation. Stocks are assigned to market capitalisation deciles as per the end of the corresponding prior month (Panel A), year (Panel B) or decade (Panel C) for a given stock. For annual and decade stocks, there is the possibility of a stock delisting, and it is subsequently included for a shorter time period than what is encapsulated by the calendar convention. T-bill refers to the return given by Swedish one-month Treasury bills. The VW Mkt return is the capitalisation weighted average return for all stocks during each month. The EW Mkt return is the equally weighted average return for all stocks during each month.

Panel A: Individual stocks, monthly horizon							
Group	Mean	Median	Skewness	% > 0	% > T-bill	% > VW	% > EW
1	0.027	-0.015	8.123	41.34	42.79	42.28	43.64
2	0.003	-0.017	6.437	41.45	42.87	40.84	41.64
3	0.006	-0.010	7.104	43.08	44.52	41.13	42.87
4	0.005	-0.007	2.875	44.32	45.87	42.20	43.36
5	0.005	-0.003	2.650	46.13	47.07	43.13	44.70
6	0.007	0.000	1.650	47.00	48.01	43.50	45.71
7	0.009	0.000	2.136	49.00	49.01	43.94	46.17
8	0.010	0.005	0.985	51.37	51.39	45.91	47.86
9	0.010	0.007	0.810	52.65	52.37	46.04	48.58
10	0.008	0.007	0.214	53.20	52.31	45.60	48.86
Panel B: Individual stocks, annual horizon							
Group	Mean	Median	Skewness	% > 0	% > T-bill	% > VW	% > EW
1	0.233	-0.149	21.042	40.77	41.70	36.86	37.40
2	0.069	-0.086	17.957	44.25	43.06	37.61	38.26
3	0.117	-0.028	3.383	48.15	47.41	40.37	41.17
4	0.109	-0.000	2.090	49.77	46.81	39.50	40.85
5	0.090	0.009	1.987	50.98	50.12	40.92	40.63
6	0.128	0.019	3.641	52.06	50.84	44.75	45.05
7	0.145	0.082	1.994	58.12	52.59	45.13	46.63
8	0.142	0.076	9.929	57.97	54.65	44.98	45.88
9	0.131	0.087	1.153	62.31	57.24	47.66	46.53
10	0.128	0.101	3.040	62.98	59.09	48.44	47.04
Panel C: Individual stocks, decade horizon							
Group	Mean	Median	Skewness	% > 0	% > T-bill	% > VW	% > EW
1	0.552	-0.522	4.431	30.17	22.61	14.43	13.33
2	0.621	-0.555	5.661	30.43	26.10	17.13	17.56
3	0.494	-0.313	3.952	39.13	33.99	22.72	24.36
4	1.163	-0.250	11.279	42.61	34.47	24.76	24.62
5	1.505	-0.255	11.171	40.87	34.59	23.18	25.11
6	0.977	-0.047	9.978	47.39	39.68	24.51	25.43
7	1.002	-0.021	4.473	48.70	43.84	31.10	30.45
8	1.374	0.241	3.932	59.13	50.65	35.26	36.35
9	1.388	0.235	7.386	57.83	50.73	34.21	35.54
10	1.267	0.545	4.876	71.00	59.32	43.97	41.66

Note: Standard deviation is abbreviated to SD, value-weighted is abbreviated to VW, equal-weighted is abbreviated to EW and Treasury bill is abbreviated to T-bill.

4.5. Distributions by performance

To examine the performance of a "skilled" investor versus a "poor" investor, the stocks have been grouped based on their buy-and-hold returns. They are presented on a monthly, annual and decade horizon in Table 3B. As can be seen, there is heterogeneity in the cross-section which is expected given the large positive skewness.

The fact that selecting a stock from the top quintile would essentially outperform all benchmarks is nothing unexpected. What piques our interest, however, is the fact that for the fourth quintile of stocks, all else held equal starts to outperform the relevant benchmarks to a much lesser extent as the horizon increases. This indicates that as the horizon increases, more and more of the broader market returns can be attributed to fewer of the top performing stocks, which is why diversification becomes such an important factor to consider when constructing portfolios. This finding also implies that whilst hedge fund managers quite often outperform benchmarks in the short term, it might be harder to do so over a decade. This is because on a monthly basis, both the fourth and fifth quintile have more than four fifths of buy-and-hold returns outperforming the benchmarks. However, on a longer horizon such as the decade horizon, it is almost entirely stocks belonging to the fifth decile that outperform benchmarks. As such, over a longer time period, the selection pool becomes smaller which makes it more difficult for an active manager to select the correct stocks.

Table 3B. The distribution of stock buy-and-hold returns, by current month's performance. Stocks are assigned to quintiles as per the performance the current month (Panel A), year (Panel B) or decade (Panel C) for a given stocks. For annual and decade stocks, there is the possibility of a stock delisting, and it is subsequently included for a shorter time period than what is encapsulated by the calendar convention. T-bill refers to the return given by Swedish one-month Treasury bills. The VW return is the capitalisation weighted average return for all stocks during each month. The EW return is the equally weighted average return for all stocks during each month.

Panel A: Individual stocks, monthly horizon							
Group	Mean	Median	Skewness	% > 0	% > T-bill	% > VW	% > EW
1	-0.167	-0.136	-1.746	0.42	0.83	0.00	0.00
2	-0.053	-0.044	-1.065	10.57	13.80	2.24	0.10
3	-0.004	0.000	-0.455	47.50	49.21	29.34	31.52
4	0.049	0.047	0.677	79.64	80.03	87.23	96.24
5	0.222	0.154	10.375	97.41	97.01	99.61	100.00
Panel B: Individual stocks, annual horizon							
Group	Mean	Median	Skewness	% > 0	% > T-bill	% > VW	% > EW
1	-0.501	-0.498	0.230	2.85	2.51	0.00	0.00
2	-0.182	-0.157	-0.023	16.67	19.56	0.00	0.00

3	0.016	0.038	0.114	59.22	53.15	23.58	16.01
4	0.240	0.235	0.333	81.95	74.06	83.82	91.99
5	1.014	0.729	22.737	96.04	93.77	100.00	100.00
Panel C: Individual stocks, decade horizon							
Group	Mean	Median	Skewness	% > 0	% > T-bill	% > VW	% > EW
1	-0.912	-0.929	0.705	0.00	0.00	0.00	0.00
2	-0.591	-0.603	0.251	0.00	0.00	0.00	0.00
3	-0.095	-0.101	-0.017	33.62	16.73	0.00	0.00
4	0.764	0.700	0.503	100.00	82.04	34.14	35.69
5	5.960	3.150	7.266	100.00	98.53	100.00	100.00

Note: Standard deviation is abbreviated to SD, value-weighted is abbreviated to VW, equal-weighted is abbreviated to EW and Treasury bill is abbreviated to T-bill.

4.6. Risk-adjusted performance

To find the risk-adjusted return of stocks, which takes the stock variability into account, the annualised Sharpe ratio of stocks have been presented in Table 4 on a yearly, decade and lifetime basis. Only a select few stocks outperform the market-based benchmarks in terms of Sharpe ratios. Looking at Table 4 we can see a trend; that the average mean of the Sharpe ratio worsens for individual stocks as the horizon gets longer, however, most notably we see the rate of outperformance versus VW Mkt Sharpe ratio diminishing.

The findings echo those of modern portfolio theory in the sense that it is due to the inherent nature of how VW portfolios are constructed that makes these types of portfolios better optimised in terms of mean-variance as opposed to random individual stocks. This is since increasing the number of stocks tends to lower the portfolio's overall standard deviation, or risk, without necessarily reducing its expected return. In essence, this diversification strategy in VW portfolios effectively balances risk and return, a cornerstone concept in modern investment theory. Since the Sharpe ratio is a measure of the return to variability, this implies that a VW-portfolio should vastly outperform individual stocks relative to raw returns in terms of percentages. This supports our discussion regarding the raw returns, as this shows that on a risk-adjusted basis, diversification is important to maximise Sharpe.

Also worth noting is the fact that individual stocks have a positive Sharpe ratio across all our horizons the majority of the time. Now, this may seem slightly surprising, as more than half of the stocks are returning raw returns less than Treasury bills on all time horizons. It then seems counterintuitive that more than half of the Sharpe ratios are positive as Sharpe is based on the excess return, which is the difference of the raw returns of stocks, and in our case, Treasury bills. Since the Sharpe ratio is calculated based on mean excess returns (see equation 9), this implies that there exist few periods of exceptionally high returns that drag up the mean excess return, i.e. $\overline{D}$. Standard deviation cannot be negative, which means that this mean excess return decides the sign of the Sharpe ratio. This is in line with our previous discussion, which finds that buy-and-hold returns are extremely positively skewed.

Additionally, there seems to be a negative trend when observing the mean and median Sharpe ratio over time. The median lifetime Sharpe ratio is 0.133, while the yearly median is 0.183. A possible reason for this could be that the standard deviation of stock return increases as the time horizon increases. This can be observed in Table 2 Panel B and D, where the annual standard deviation for historical raw returns is 98.30%, while the lifetime standard deviation is several magnitudes higher at 2500.05%. Because Sharpe ratio is decreasing in standard deviation, this implies that Sharpe should also be decreasing as time increases. As such, the findings of the ex-post risk-adjusted performance echoes the findings of the raw performance, i.e. it highlights the importance of diversification due to skewness of stock returns.

Table 4. Ex post Sharpe ratios at various horizons. All Swedish common stocks from EIKON from January 1983 to December 2022 are included. Annual Sharpe ratios use calendar year convention, decade returns are non-overlapping. If a stock is listed or delisted within a calendar period, they naturally encapsulate a shorter time interval. Lifetime horizon begins in January 1983, or a stock's debut in EIKON until December 2022, or a stocks delisting. SR refers to the Sharpe ratio. The VW Mkt SR is the Sharpe ratio of the weighted average return for all stocks within a timeframe based on market capitalisation, whereas the EW Mkt SR is the Sharpe ratio of the equal-weighted average return across all stocks within a timeframe.

Panel A: Individual stocks, annual horizon (N=13451)					
Variable	Mean	Median	SD	Skewness	Positive %
Sharpe Ratio, Stock	0.359	0.183	30.680	113.887	55.57
	% > VW Mkt SR		% > EW Mkt SR		
Sharpe Ratio, Stock	26.44		36.19		
Panel B: Individual stocks, decade horizon (N=2327)					
Variable	Mean	Median	SD	Skewness	Positive %
Sharpe Ratio, Stock	0.030	0.156	0.886	-3.216	61.32
	% > VW SR		% > EW SR		
Sharpe Ratio, Stock	12.50		26.69		
Panel C: Individual stocks, lifetime horizon (N=1573)					
Variable	Mean	Median	SD	Skewness	Positive %
Sharpe Ratio, Stock	-0.015	0.133	0.876	-3.146	60.24
	% > VW SR		% > EW SR		
Sharpe Ratio, Stock	11.19		34.84		

Note: Standard deviation is abbreviated to SD, value-weighted Sharpe ratio is abbreviated to VW SR, equal-weighted Sharpe ratio is abbreviated to EW SR.

4.7. Implications of diversification over 40 years

Since the average lifetime of a stock is only around 7.8 years, a bootstrap simulation is adopted to draw conclusions regarding individual stock performance over the full 40 years. From January 1983 to December 2022, one stock is selected at random and matched with a Treasury-bill and VW-portfolio. This procedure is repeated 5000 times to obtain a distribution of possible stock returns. Our findings in Table 5 show that on average, employing a single-stock strategy would have been profitable since the mean value is positive in all time horizons. This is however quite misleading as we also observe that the median return produced by such a strategy would lead to almost a complete loss of the invested capital over a 40-year horizon. Observing the high skewness of single portfolio returns, this suggests that a few extreme outliers serve to increase the mean value well above the median. However, one can also observe that skewness decreases with the number of stocks in the portfolio. This means that the median becomes closer to the mean value when more stocks are added into the portfolio, which suggests that diversification makes sure that the having more stocks in the portfolio captures some of the outliers that are responsible for the high mean return. Note that compared to Bessembinder (2018), the mean return of the single stock-portfolio is significantly lower than those of higher stock portfolios. Looking back at Table 3A, it can be seen that smaller stocks have a considerably lower mean return for Swedish stock market data compared to U.S data. Since these smaller stocks naturally have a lower weight in a value-weighted portfolio, this could then be a leading cause as to why the bootstrapped portfolios with more stocks are outperforming single-stock portfolios.

Consider also that the percentage over value-weighted market portfolio never goes above 50%. This is of particular interest as the returns of active managers are often measured relative to a value-weighted portfolio such as the S&P 500 or OMXS30. This means that skewness also helps to explain why active managers, who are often underdiversified, fail to outperform value-weighted benchmarks.

Further, we also find that the buy-and-hold return above zero and Treasury bills decrease with time for a single-stock portfolio. Particularly interesting is the fact that for the single-stock buy-and-hold strategy, only 36.40% of such simulations managed to attain a positive return over 40 years and only 18.28% of such strategies managed to beat one-month Treasury bills over the same period.

In addition, it is worth noting a mathematical phenomenon pertaining to how our bootstrapped portfolios are weighted might impact our results. To illustrate this effect, posit that for a sample of n stocks, you have a 30% chance of selecting an extremely skewed stock. Note that the probability can be both lower or higher in reality. We can extend the number of selections to 480 as is the case for our 40-year horizon and define the variables q: the probability of not selecting an extremely skewed stock and n:

number of stocks in the sample. Since there is resampling, we arrive at the expression $1-(1-(q/n))^{480}$ inserting the variables for what is relevant in our case we compute it to approximately 19.24% chance of selecting an extremely skewed data point for the single-stock portfolio. However, if we increase the number of stocks in our portfolio to five, the expression becomes: $1-(1-(q/n))^{480*5}$ which is computed to approximately 65.64%. As such, by diversifying more and adding more stocks to a portfolio, an investor would increase the probability of including a skewed stock, which should increase the raw expected returns of the portfolio.

These results are alarming as we previously established that almost two fifths of retail investors in Sweden only hold one-stock portfolios. It would require those select individuals to be quite lucky or skilled should they have any chance to boast positive returns let alone beat even a low-risk asset such as a Treasury bill over longer periods of time.

Table 5. Returns for bootstrapped portfolios from January 1983 to December 2022. The stocks are stratified based on number of stocks seen in panel title and are selected at random each month. Value-weighted portfolio returns are calculated each month for the chosen stocks, with these returns being compiled over 1-, 10-, and 40-year horizons. This procedure is repeated 2000 times and is capped to the 99th percentile due to several extreme outliers significantly impacting the results if included. Each compiled return is analysed against zero, the buy-and-hold return for Swedish one-month Treasury bills and the buy-and-hold return for the value-weighted portfolio of all stocks in the EIKON database that match our filter criteria. Mean, Med and Skew are the mean, median and skewness across all 2000 outcomes.

	1-Year horizon			10-Year horizon			Life (40-Year) horizon		
	Mean	Med	Skew	Mean	Med	Skew	Mean	Med	Skew
Bootstrapped single-stock positions									
Holding return	0.174	0.005	8.497	2.369	-0.250	50.844	61.188	-0.710	42.958
% > 0	50.34			43.30			36.40		
% > T-bill	46.65			32.30			18.28		
% > VW Mkt	34.27			11.10			0.80		
Bootstrapped 5-stock portfolios, value weighted									
Holding return	0.240	0.175	1.711	5.326	3.253	6.028	1162.128	363.355	16.198
% > 0	68.82			96.83			100.00		
% > T-bill	63.99			84.24			99.68		
% > VW Mkt	44.86			35.94			22.90		
Bootstrapped 25-stock portfolios, value weighted									
Holding return	0.231	0.197	0.860	5.151	4.079	2.806	1131.672	755.663	5.688
% > 0	75.43			99.98			100.00		
% > T-bill	70.47			97.36			100.00		
% > VW Mkt	47.37			41.98			33.14		
Bootstrapped 50-stock portfolios, value weighted									
Holding return	0.228	0.199	0.733	5.120	4.154	2.462	1080.644	843.551	2.892
% > 0	76.66			100.00			100.00		

% > T-bill	72.08			99.42			100.00		
% > VW Mkt	47.63			42.26			34.20		
Bootstrapped 100-stock portfolios, value weighted									
Holding return	0.228	0.201	0.666	5.169	4.229	2.082	1076.031	935.166	1.895
% > 0	77.34			100.00			100.00		
% > T-bill	73.12			99.97			100.00		
% > VW Mkt	48.02			43.44			36.68		

Note: Value-weighted is abbreviated to VW, and Treasury bill is abbreviated to T-bill.

4.8. Implications of risk-adjusted performance over 40 years

To continue the analysis over the full 40 years, but on a risk-adjusted basis, the Sharpe ratio is calculated for the bootstrapped portfolios. From Table 6 we observe that as the number of stocks in the portfolio increases, the mean and median Sharpe ratio improves. However, we also note that the mean and median Sharpe ratio significantly worsens as the time horizon increases. However, this discovery can be attributed to the fact that volatility is approximately proportionate to the square root of time due to the statistical properties of geometric Brownian motion.

Since adding more stocks to a portfolio will improve the expected return to variability, we observe that the rate of outperformance against the VW SR of the bootstrapped portfolio grows in tandem with the number of stocks in the portfolio. Consider that over time, the while the benchmark outperformance significantly decreases, the positive percentage increases significantly. For portfolios with more than one stock, 100% of the returns are above 0, which indicates that as the time horizon goes by, a diversified portfolio will compensate the investor for the extra risk. However, it is then worth realising that simply investing in the value-weighted benchmark would almost always outperform the bootstrapped portfolio returns for all time frames and number of stocks. This reinforces the importance of keeping a well-diversified portfolio and is another explanation to the poor performance of active managers over longer horizons.

A differing factor vis-à-vis the bootstrap in terms of raw returns is the fact that skewness for Sharpe ratios are not as pronounced and also negative as opposed to positive for raw returns. This finding serves to reinforce the implication that stocks which drag up the mean raw return might have a much smaller Sharpe ratio. In other words, the risk-adjusted return of stocks that are extremely skewed should be quite low since the risk involved in these stocks is extreme. Furthermore, the slight negative tilt we see in skewness for our portfolios in terms of Sharpe ratios particularly for the annual horizon might indicate that in the short-term, our simulated portfolios did not adequately provide compensation for the additional units of risk our hypothetical investor takes on.

Table 6. Ex post Sharpe ratios for bootstrapped portfolios from January 1983 to December 2022. The stocks are stratified based on number of stocks seen in panel title and are selected at random each month.

Value-weighted portfolio returns are calculated each month for the chosen stocks, with these returns being compiled over 1-, 10-, and 40-year horizons. This procedure is repeated 5000 times and is capped to returns of 990% at the highest as a significant number of outliers will impact the results if included. Each compiled return is analysed against zero i.e. have the same risk-adjusted return for Swedish one-month Treasury bills and the buy-and-hold return for the value-weighted portfolio of all stocks in the EIKON database that match our filter criteria. Mean, Med and Skew are the mean, median and skewness across all 2000 outcomes.

	1-Year horizon			10-Year horizon			Life (40-Year) horizon		
	Mean	Med	Skew	Mean	Med	Skew	Mean	Med	Skew
Bootstrapped single-stock positions									
Sharpe ratio	0.185	0.444	-0.271	0.385	0.441	-0.252	0.135	0.143	-0.264
% > 0	53.91			65.35			82.80		
% > VW SR	35.12			0.10			0.00		
Bootstrapped 5-stock portfolios, value weighted									
Sharpe ratio	1.981	2.146	-0.165	1.591	1.602	-0.008	0.457	0.458	-0.020
% > 0	68.23			94.56			100.00		
% > VW SR	38.92			8.80			1.64		
Bootstrapped 25-stock portfolios, value weighted									
Sharpe ratio	2.842	2.935	-0.192	2.102	2.117	0.089	0.587	0.587	0.002
% > 0	73.66			99.69			100.00		
% > VW SR	46.34			20.98			12.50		
Bootstrapped 50-stock portfolios, value weighted									
Sharpe ratio	3.066	3.156	-0.225	2.234	2.287	0.029	0.619	0.620	0.012
% > 0	75.85			99.99			100.00		
% > VW SR	46.68			24.52			17.14		
Bootstrapped 100-stock portfolios, value weighted									
Sharpe ratio	3.236	3.315	-0.265	2.342	2.430	-0.073	0.644	0.645	-0.027
% > 0	75.60			100.00			100.00		
% > VW SR	47.44			28.92			22.80		

Note: Value-weighted Sharpe ratio is abbreviated to VW SR.

5. Robustness check

Firstly, we aim to assess the impact which the choice of cut-off point has on the results. To gauge the sensitivity of our results, we firstly compare the difference between using 2 months of consecutive 0% returns as a cut off versus using 3 months of consecutive 0% returns. Using 2 consecutive zeroes delists 67 more stocks than using 3 consecutive zeroes. When manually looking up all the 67 stocks that differ, it can be found that only 4 of those additional stocks have actually delisted. In other words, 63 of the stocks that were removed if they displayed 2 consecutive months of 0% returns have not been delisted but have displayed this behaviour for some other reason. As such, although the results differ remarkably when only removing 2 months of consecutive 0% returns, we believe that this can be attributed to biases that are introduced by removing 63 stocks that should still be in the dataset. As such, we believe that 3 months of consecutive 0% returns introduce less biases than 2 months, since it stands to reason that the likelihood of 2 consecutive months being for other reasons unrelated to delisting is higher.

Further, we compare the difference between using 3 months of consecutive 0% returns versus using 4 months of consecutive 0% returns. The 3 months of consecutive 0% returns remove 16 more stocks than the 4 months. Out of these, 14 stocks were incorrectly removed as they have not yet delisted but posted 3 months of consecutive 0% returns for other reasons. In Table 7, the difference in monthly buy-and-hold returns are presented when removing 4 months of consecutive zeroes versus 3 months of consecutive zeroes.

Table 7. Difference in mean, median, standard deviation, skewness and percentage positive of raw monthly buy-and-hold returns depending on the choice of cut-off point for delisted stocks. The mean, median, standard deviation, skewness and percentage positive of raw monthly buy-and-hold returns if the cut-off point is selected at 4 months is subtracted from the respective statistic but for a 3-month cut-off point. The differences (Δ) between them are presented.

Difference monthly Buy-and-hold return 4- vs 3 months					
Variable	ΔMean	ΔMedian	ΔSD	ΔSkewness	ΔPositive %
Buy-and-hold return, Stock	-0.0001	0.0000	-0.0006	-0.1504	-0.1528

As can be seen in Table 7, the monthly difference in mean is quite small. The difference with the median is also 0. The largest difference is in the skewness and the percentage positive. However, we believe that the magnitude of the change does not affect the validity of the main conclusions drawn in the paper. As such, we believe that the robustness of using 3 months of consecutive 0% returns as a cut-off point sufficient.

Another assumption made regarding the delisting of stocks was the delisting return. Setting the delisting return to -100% instead of simply leaving it at 0% gives more pronounced results. As expected, the mean and the median will decrease for almost all horizons, but more specifically for longer horizons. However, the same main conclusions that have been drawn in the paper can still be drawn even when setting the delisting return to -100%. In a way, when setting the returns to -100%, the importance of diversification is even evident as for example only 20% of stocks then exhibit a positive lifetime buy-and-hold returns.

For other negative delisting returns, such as the -55% suggested by Shumway and Warther (1999), the main conclusions will thus also be similar to that of setting the delisting return to either -100% or 0%. As such, we do not believe that the choice of delisting return has a significant effect on the results and discussion held in this paper. As there, to our knowledge, is no consensus on what delisting return to use, we consider the robustness of using a 0% delisting return as sufficient.

6. Conclusion

Despite observing that the Swedish stock market outperforms Treasuries in terms of raw returns, on the individual level most have not. In the period 1983 to 2022 a little less than half posted positive returns and even fewer managed to return more than one-month Treasuries. These results also imply that the outperformance of the stock market is down to a few extreme cases of outperformance from individual stocks. Furthermore, the rate of individual stock underperformance for the same time horizon was highest amongst the smallest decile of stocks.

The observation that a considerable number of individual stocks may incur a 100% loss over their lifetime highlights the challenges for active investors holding concentrated portfolios. The solution to this is simply to diversify, since a well-diversified portfolio, as evidenced by the simulation results, is highly likely to outperform less diversified strategies even over extended time horizons both on a normal and risk-adjusted basis.

We also find that as the time horizon increases, an even smaller proportion of stocks ranked by performance outperform all benchmarks. In other words, as the time horizon increases, only the top decile of returns seems to outperform benchmarks. This could further help to explain the underperformance of active managers relative to value-weighted benchmarks over longer periods of time, as the selection pool of stocks with high outperformance diminishes over time.

Considering the risk-adjusted performance of stocks, we find further support for our previous conclusions drawn based on raw returns. As we observe the simulation results of each time horizon in isolation, we find that as the number of stocks in the portfolio increases, the proportion of stocks that beat a value-weighted benchmark also increases. As such, when the portfolio becomes more diversified, the risk-adjusted return improves.

These insights can guide retail investors in making more informed decisions regarding individual stock investments and portfolio management. The findings imply that randomly holding a single stock is certainly not the way to go for unskilled investors, since even skilled investors have a hard time beating the returns of a diversified market portfolio under the same conditions. A suggestion for unskilled retail investors in Sweden would thus be to buy a well-diversified market portfolio as that seems to yield the best risk-adjusted returns.

7. References

Bessembinder, H. (2018). Do stocks outperform treasury bills? *Journal of Financial Economics*, *129*(3), 440–457. https://doi.org/10.1016/j.jfineco.2018.06.004

Euroclear. (2023). *Aktieägandet i Sverige 2022*. Retrieved 31 Oct 2023 from https://www.euroclear.com/sweden/sv/det-svenska-aktieagandet.html

Fang, J., Marshall, B. R., Nguyen, N. H., & Visaltanachoti, N. (2021). Do stocks outperform treasury bills in international markets? *Finance Research Letters*, *40*, 101710. https://doi.org/10.1016/j.frl.2020.101710

Mitton, T., & Vorkink, K. (2007). Equilibrium underdiversification and the preference for skewness. *Review of Financial Studies*, *20*(4), 1255–1288. https://doi.org/10.1093/revfin/hhm011

Piotroski, J. D. (2000). Value Investing: The Use of Historical Financial Statement Information to Separate Winners from Losers. *Journal of Accounting Research*, *38*, 1–41. https://doi.org/10.2307/2672906

Schmidt, P. S., von Arx, U., Schrimpf, A., Wagner, A. F., & Ziegler, A. (2011). On the construction of common size, value and momentum factors in international stock markets: A guide with applications. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1738315

Sharpe, W. F. (1994). The Sharpe ratio. The Journal of Portfolio Management, 21(1), 49–58. https://doi.org/10.3905/jpm.1994.409501

Shumway, T. (1997). The delisting bias in CRSP Data. *The Journal of Finance*, *52*(1), 327–340. https://doi.org/10.1111/j.1540-6261.1997.tb03818.x

Shumway, T., & Warther, V. A. (1999). The Delisting Bias in CRSP's Nasdaq Data and Its Implications for the Size Effect. *The Journal of Finance*, *54*(6), 2361–2379. http://www.jstor.org/stable/797998

Simkowitz, M. A., & Beedles, W. L. (1978). Diversification in a Three-Moment World. *The Journal of Financial and Quantitative Analysis*, *13*(5), 927–941. https://doi.org/10.2307/2330635

Sloan, R. G. (1996). Do Stock Prices Fully Reflect Information in Accruals and Cash Flows about Future Earnings? *The Accounting Review*, *71*(3), 289–315. http://www.jstor.org/stable/248290