Asset Choice And Time Diversification Benefits

Amit K. Sinha, (Email: mfsinha@isugw.indstate.edu), Indiana State University
Megan Y. Sun, (E-mail: megan.sun@uwrf.edu), University of Wisconsin, River Falls

ABSTRACT

The issue of time diversification has been controversial. While some findings support time diversification, others do not. For example, Hodges, Taylor and Yoder (1997) find bonds outperform stocks, but Mukherji (2002) finds stocks provide time diversification benefits. This paper investigates whether the differences in the findings of Hodges, Taylor and Yoder (1997) and Mukherji (2002) stem from methodological variation. Results indicate that the differences in the procedure used to estimate the holding period returns may in fact be the reason for the difference in findings. Using a procedure to estimate holding period returns that is similar to Hodges, Taylor and Yoder (1997), and a performance measure that is similar to Mukherji (2002), we do not find that stocks provide time diversification benefits.

INTRODUCTION

With over twenty-five trillion dollars[1] invested in stocks and bonds, the decision to invest in stock or bonds, is perhaps a significant decision an investor has to make. Although, stocks and bonds provide investors with two distinct avenues for investment, the decision to choose one over the other is not as simple as it may appear. For example, although stocks are more risky than bonds in the one period context (Howe and Mistic, 2003), Levy (1978) and Reichenstein (1986), argue that if benefits of time diversification are considered stocks may be better investments than bond. This article investigates this issue further, and specifically attempts to explain the apparently contradictory findings of Hodges, Taylor and Yoder (henceforth HTY) (1997) who find bonds to outperform stocks, and Mukherji (2002) who finds stocks to provide time diversification benefits.

There are two major methodological differences between HTY and Mukherji (2002). While HTY resample historical returns to generate independent returns for longer holding periods, Mukherji (2002) uses rolling overlapping window periods to estimate the holding period returns. HTY use the risk premium per unit of standard deviation[2] to investigate time diversification benefits, while Mukherji (2002) uses downside risk per unit of return. Thus, answering the question of whether or not the difference in the findings of HTY and Mukherji (2002) is just methodological is the prime objective of this article.

Using monthly returns for stocks and bonds for the period between January 1926 and December 2003, we investigate whether time diversification benefits exist in returns per unit of downside risk using the resampling techniques used by HTY. Results indicate that findings of Mukherji (2002) may just be a methodological issue, as we do not find that stocks dominate bonds, even when downside risk is used to study benefits of holding stocks over long periods of time.

The remainder of this study is organized as follows. In the next session (session 2), we discuss the related literature. In section 3, we describe the data and methodology. In section 4, we present the empirical results. Finally, in section 5, we conclude the paper with a summary of the evidence.

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[1] Reilly and Brown (2003) point out that in 2000 US bonds and equities accounted for 43.5% of the 63.8 trillion dollar world securities market.
[2] Risk premium per unit of standard deviation is the same as the Sharpe Ratio.

LITERATURE REVIEW

As early as the late seventies, Bernstein (1976) and Lloyd and Haney (1980) are among the first to introduce the concept of "time diversification". They find that the standard deviation of the assets' returns decreases as the holding period lengthens, and argue that time is also an important factor in reducing a portfolio's risk. Lloyd and Modani (1983) reconfirm time diversification by showing that portfolios with larger proportions of common stocks have higher returns and lower risk. Later, McEnally (1985) shows that when risk is measured by standard deviation of the average of annualized returns, risk declines as the horizon lengthens. However, when risk measure is measured by standard deviation of total holding period returns, risk uniformly increases with horizon length. He concludes that time diversification is not the surest route to lower risk. Kritzman (1994) argues that although investors are less likely to lose money over a long horizon than over a short one, the magnitude of one's potential loss increases with the duration of the investment horizon. However, he points out that though time does not diversify risk, there are several reasons why investors might still condition their risk exposure on their time horizon.

Ever since then, the concept of "time diversification" has been studied and challenged both theoretically and empirically. With a few exceptions, theorists mostly argue that, given serially uncorrelated returns, holding a risky asset over longer periods of time will not reduce its inherent riskiness. This argument is supported by references to economic models of risk aversion, such as mean-variance optimization, expected utility theory, option pricing theory, etc.

The option-based approach is initiated by Bodie (1995), where risk is defined as the cost of insurance against earning less than the risk free rate over the holding period. Bodie criticizes time diversification as a fallacy in his 1995 paper. Following this option pricing approach, Merrill and Thorley (1996), however, provide evidence that longer time horizons reduce the risk of equity investments by analyzing financially engineered securities that guarantee a minimum return. They find that when risk is measured by the fair cost of insuring a minimum return, it is lower for longer horizons. Zou (1997) argues that risk as measured by the cost of insuring a minimum rate of return is not a monotonic function of the portfolio's time horizon. He concludes that there is no uniform answer to the issue of time diversification. In a response to Merrill and Thorley (1996), Oldenkamp and Vorst (1997) attack the effectiveness of using an option-pricing model to identify a time diversification benefit. Rather, they simulate the probability distribution of returns and find that investments with a longer time horizon have higher standard deviations, though with higher expected returns. Hence, equity investments are not necessarily safer for longer time horizons than for short time horizons.

Besides the option based approach, some other theorists resort to utility function maximization to challenge the time diversification concept. Milevsky (1999) uses optimization theory to maximize a Safety-First (downside risk-aversion) utility function and asserts that investors with the above utility function are invariant to the time horizon and also asserts that longer time horizons do not reduce risks. Hansson and Persson (2000) use a nonparametric bootstrap approach on a mean-variance-efficient portfolio framework. They find that the weights for stocks in an efficient portfolio are significantly larger for long investment horizons than for a one-year horizon and that an investor can gain from time diversification. Using both US and UK data, Strong and Taylor (2001) also lend their support to time diversification using a mean-variance utility function optimization. Gollier (2002) proposes to apply a new theoretical model to the notion of time diversification. He shows that time diversification occurs when investors have no liquidity constraint, while the existence of liquidity constraints reduces the time diversification benefit.

While theorists apply different models to test time diversification, empirical studies on this issue mainly focus on resampling historical data. Empirical tests on time diversification involve calculating returns and risks in longer time horizons, but given the short history of the financial market, these tests are weakened by a shortage of independent return observations. However, by assuming that past stock and bond market performance repeats itself, thousands (even millions) of independent observations can be obtained by resampling the observed distribution of asset returns[3]. For example, based on annual returns from 1926 to 1993, HTY resample the return distribution and

[3] More important, it does not require making distribution assumptions of asset returns.

yield a large number of independent holding returns for a period from 1 year to 30 years. HTY then use the Sharpe Ratio to evaluate performance and find that stocks do not provide time diversification benefits.

Mukherji (2002) introduces downside risk while investigating time diversification. Mukherji (2002) investigates downside risk by estimating the coefficient of downside risk, which he estimates by dividing the downside deviation by the mean value of returns. When downside risk is used as the risk measure, stocks dominate bonds over the long horizon, and investors are better off investing in stocks to achieve time diversification benefits. However, Mukherji (2002) uses rolling overlapping window periods to estimate the holding period returns. The question remains whether time diversification benefits exist if an alternate method, like resampling, is used to obtain a time series of holding period returns.

Thus the two major differences between HTY and Mukherji (2002) are: (i) the technique used to estimate holding period returns[4], and (ii) the measures used to evaluate performance. The question arises whether the findings of Mukherji (2002) change if one uses a measure similar to that used by Mukherji (2002), while using the technique used by HTY to estimate holding period returns.

DATA AND METHODOLOGY

The data consisting of monthly returns for small and large stocks, long term corporate and long term government bonds, and treasury bills was obtained from Ibbotson Associates (2004) for the period from January 1926 to December 2003.

Resampling Methodology

The resampling procedure adopted in this study is similar to HTY. Similar to HTY and Mukherji (2002), we study small stocks, large stocks, long-term corporate bonds, and long-term government bonds. The holding period return is estimated using the following three step procedure:

Step 1: For a given holding period of *n* years, *n x 12* returns are randomly selected from 936 historical monthly returns.

Step 2: *n*-year holding period return is generated by using the following formula:

$$HPR_n = \prod_{i=1}^{nx12} (1 + R_i) - 1 \tag{1}$$

where HPR_n = *n*-year holding period return

R_i = monthly return observations for period I

n = number of years in the holding period

The holding period return differs from HTY and Mukherji (2002) who use $\mathrm{HPR_n} = \prod_{i=1}^{n} (1 + \mathrm{R_i})$. Our measure is a proper representation of the holding period return, while their measures are a proper representation of the future wealth at the end of the holding period.

[4] Mukherji (2002) does not employ the resampling technique. He generates returns based on rolling overlapping holding periods. According to Howe and Mistic (2003), due to the overlapping, the returns generated by Mukherji (2002) are no longer independent, which casts doubt upon his final conclusions.

Step 3: For each holding period, ranging from 1 to 30 years, this process is repeated 5,000 times resulting in 5,000 holding period returns for each horizon.

Risk Measure and Performance Measure

Another issue raised by time diversification studies is the choice of risk measure and corresponding performance measure. HTY use the standard deviation as the risk measure and Sharpe ratio (Sharpe 1966, 1994) as the performance measure.

The Sharpe ratio is estimated as follows:

$$S_p = \frac{\overline{R}_p - \overline{R}_f}{\sigma_p} \tag{2}$$

where S_p = Sharpe ratio of the portfolio for the holding period

$\overline{R}_p$ = average holding period return of the portfolio for each horizon

$\overline{R}_f$ = risk-free holding period return for each horizon

σ_p = standard deviation of holding period returns

In Sharpe ratio, standard deviation of returns is used as the risk measure. However, as the investment horizon lengthens, it is not clear if standard deviation is the best measure of risk. Olsen (1997) shows that CFA (Chartered Financial Analysts) charter holders rank the potential of obtaining below target returns as the greatest investment risk. Hence, downside deviation rather than standard deviation should be used in order to measure downside risk. Downside deviation is calculated as the lower partial variance of returns as in Mukherji (2002) and Howe and Mistic (2003). Correspondingly, a performance measure that considers potential for below target returns might be better suited to evaluate the performance of long horizon returns. The Sortino ratio is one such measure (Sortino and Lee, 1994).

The Sortino ratio is reward-to-risk measure based on a minimum acceptable rate of return (MAR) for an individual investor, and is scaled by the downside risk, instead of total risk as is the case with the Sharpe ratio. The Sortino ratio is estimated by:

$$\text{Sortino Ratio} = \frac{(\text{HPR} - R_{\text{MAR}})}{DD_{\text{MAR}}} \tag{3}$$

where HPR = holding period returns

R_{MAR} = minimum acceptable returns (target returns) for the holding period

DD_{MAR} = the downside deviation and is measured as lower partial variance, a traditional semi-variance measure:

$$DD_{\text{MAR}} = \left(\frac{\left(\sum_{i=1}^{N} (L_i)^2 \right)}{N} \right)^{1/2} \tag{4}$$

where $L_i = R_i - R_{MAR}$ (If $R_i - R_{MAR} < 0$) or 0 (If $R_i - R_{MAR} > 0$).

N = number of periods

R_i = return for period i.

The Sortino ratio is in fact the reciprocal of the coefficient of downside risk, as defined and used by Mukherji (2002). The coefficient of downside deviation is obtained by dividing the downside deviation by the mean value of excess returns, indicating the downside risk per unit of return. A greater value indicates a higher risk of yielding below target return per unit of return.

$$\text{Coefficient of Downside Deviation} = \frac{1}{\text{Sortino}} = \frac{DD_{MAR}}{HPR - R_{MAR}} \tag{5}$$

This study uses downside risk as the risk measure and Sortino ratio as the performance measure, rather than using the coefficient of downside deviation.

Risk on Holding Period Returns

As demonstrated by Kochman and Goodwin (2001, 2002), there are two ways to calculate the standard deviation of returns in longer horizons. The first approach is to calculate the standard deviation of the average of annual returns during the overall holding period, while the second is to calculate the standard deviation of total holding period returns. Past research shows that when the first approach is used, standard deviation (risk) is a decreasing function of time, while when the second approach is used, risk increases over time. HTY point out that the reward to risk performance measure is valid only if the intended investment horizon is equal to the holding period of returns used to compute the ratio. This study therefore calculates the risk using total holding period returns rather than the average of annual returns during the holding period as in Mukherji (2002).

EMPIRICAL RESULTS

Table I presents the mean holding period returns of all four types of assets over various holding horizons. The table reveals that in all cases, the mean holding period return increases as the holding period lengthens. The mean return for small stocks increases from 12.6% for a 1-year holding period to 13,319% for a 30-year holding period. The corresponding mean returns for large stocks are 12.3% and 3,447% for a 1-year and 30-year holding horizon. The mean returns for long-term corporate bonds are 6.3% and 498% respectively and for long-term government bonds are 5.7% and 421% respectively for a 1-year and 30-year holding period. Small stocks have the highest average holding period return, and long-term government bonds have the lowest average holding period return, with large stocks and long-term corporate bonds ranking second and third in between.

Table I: Means for Portfolios of Small Stocks, Large Stocks, Long-Term Corporate Bonds, and Long-Term Government Bonds

Holding Period (Years)	Small Stocks	Large Stocks	Corporate Bonds	Government Bonds
1	0.179	0.123	0.063	0.057
2	0.392	0.275	0.124	0.105
3	0.610	0.434	0.191	0.181
4	0.872	0.593	0.271	0.243
5	1.247	0.811	0.341	0.315
6	1.554	1.028	0.435	0.391
7	2.068	1.233	0.506	0.504
8	2.402	1.612	0.620	0.569
9	3.127	1.857	0.708	0.649
10	3.998	2.178	0.804	0.744
11	5.007	2.868	0.940	0.865
12	6.148	3.096	1.032	0.961
13	7.784	3.687	1.173	1.046
14	9.005	4.225	1.315	1.191
15	10.476	5.071	1.436	1.312
16	11.194	5.648	1.607	1.394
17	14.976	6.212	1.768	1.607
18	16.597	7.533	1.903	1.716
19	21.139	9.021	2.043	1.820
20	24.130	9.372	2.312	2.048
21	31.968	10.902	2.480	2.228
22	33.516	11.990	2.739	2.429
23	41.341	13.974	2.881	2.638
24	39.285	16.000	3.203	2.734
25	52.612	17.634	3.471	2.983
26	57.375	19.947	3.669	3.308
27	72.225	21.897	4.027	3.568
28	120.241	27.809	4.285	3.768
29	94.205	30.961	4.600	3.987
30	133.319	34.471	4.988	4.206

As average holding period return increases with the length of the horizon, total risk -- as measured by the standard deviation of the total holding period return -- also increases with the length of the holding period, as seen in Table II. For a 1-year and 30-year holding period, the standard deviation for small stocks grows from 33.5% to 44,984%. The corresponding standard deviations of corporate bonds are 7.6% and 226% respectively. When ranking the standard deviation of holding period returns across assets, small stocks rank first, large stocks score second and corporate bonds score third. Long-term government bonds rank last on the list. Combining Tables I and II, we find that while small stocks have the greatest holding period returns, they also have the greatest volatility

Table II: Total Risk (Standard Deviation) for Portfolios of Small Stocks, Large Stocks, Long-Term Corporate Bonds, And Long-Term Government Bonds

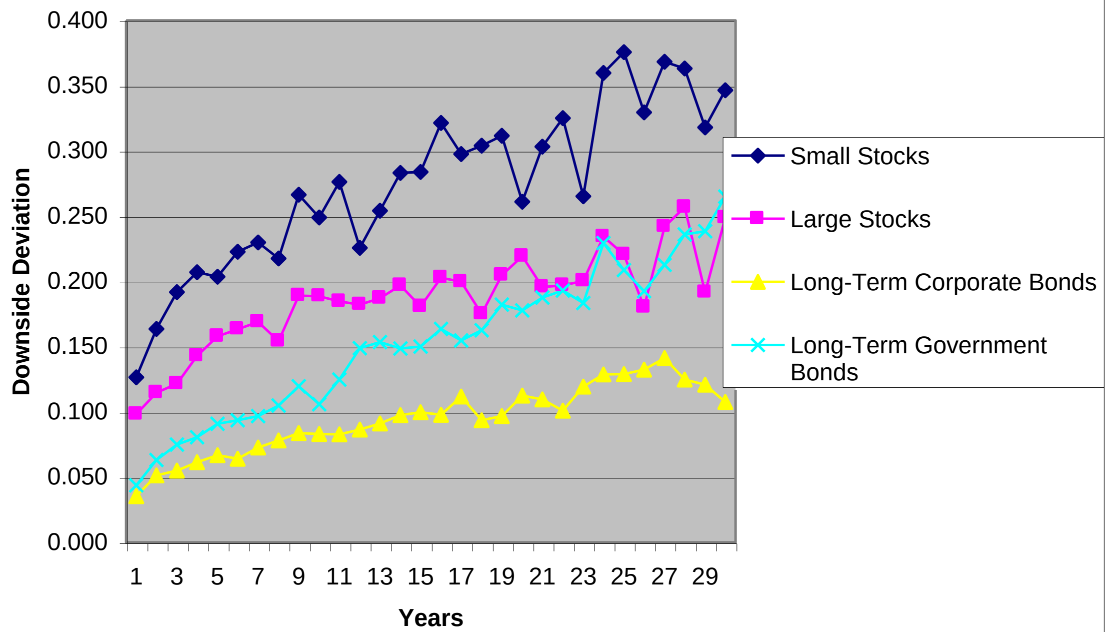
Holding Period (Years)	Small Stocks	Large Stocks	Corporate Bonds	Government Bonds
1	0.335	0.222	0.076	0.081
2	0.596	0.354	0.112	0.116
3	0.846	0.473	0.140	0.170
4	1.090	0.661	0.172	0.196
5	1.721	0.825	0.206	0.233
6	2.001	1.039	0.230	0.270
7	2.769	1.196	0.277	0.325
8	3.042	1.567	0.316	0.361
9	4.892	1.722	0.368	0.401
10	7.223	1.983	0.402	0.424
11	7.753	2.899	0.453	0.502
12	8.527	3.230	0.485	0.560
13	12.687	4.022	0.551	0.606
14	13.100	4.458	0.625	0.687
15	17.455	5.914	0.668	0.732
16	22.417	6.523	0.740	0.754
17	36.633	6.515	0.815	0.858
18	28.747	8.466	0.878	0.942
19	47.823	13.979	0.921	0.964
20	47.552	11.137	1.051	1.078
21	109.061	13.067	1.096	1.197
22	80.364	13.797	1.232	1.307
23	127.520	17.197	1.286	1.476
24	78.078	22.122	1.521	1.504
25	114.879	26.937	1.592	1.651
26	145.972	26.199	1.719	1.752
27	144.428	28.223	1.798	1.854
28	902.100	40.717	2.003	2.102
29	210.453	60.245	2.186	2.202
30	449.842	51.002	2.266	2.204

As mentioned above, the greatest concern for investors in investing on a long-term basis is not the risk of volatility but the risk of obtaining lower than target returns. Following Mukherji (2002) and Howe and Mistic (2003), we further explore the pattern of the downside risk measured by the risk of yielding below target returns. Using returns on T-bills as the target, we report the downside risk in Table III and graph the results in Figure 1. Table III shows that the downside risk for each portfolio increases as the holding period is lengthened. The downside risks for small stocks is 12.6% for a 1-year holding period, and increases to 34.6% for a 30-year holding period. Correspondingly, the downside risks for large stocks are 9.8% and 24.9% respectively for a 1-year and 30-year holding period. The downside risks for long-term corporate bonds are much smaller, estimated at 3.5% and 10.7% respectively for a 1-year and 30-year holding period. Interestingly, the downside risk for long-term government bonds is higher than that of long-term corporate bonds. As the time horizon increases, the downside risk for long-term government bonds becomes closer or at times, higher than the downside risk of large stocks. Ranking the downside risk across assets, we find that small stocks have the greatest downside risk and hence the greatest possibility of yielding a return lower than T-bills. Large stocks rank second in terms of downside risk among the four types of assets. Long-term government bonds rank third, while long-term corporate bonds have the lowest downside risk.

Table III: Downside Risk (Downside Deviation) for Portfolios of Small Stocks, Large Stocks, Long-Term Corporate Bonds, and Long-Term Government Bonds

Holding Period (Years)	Small Stocks	Large Stocks	Corporate Bonds	Government Bonds
1	0.126	0.098	0.035	0.044
2	0.164	0.115	0.051	0.063
3	0.192	0.121	0.055	0.075
4	0.207	0.143	0.061	0.081
5	0.204	0.158	0.067	0.091
6	0.223	0.163	0.064	0.094
7	0.230	0.169	0.073	0.097
8	0.217	0.154	0.078	0.105
9	0.266	0.189	0.084	0.120
10	0.249	0.189	0.083	0.106
11	0.276	0.185	0.083	0.125
12	0.226	0.182	0.086	0.149
13	0.254	0.187	0.091	0.154
14	0.283	0.197	0.097	0.148
15	0.284	0.181	0.100	0.150
16	0.321	0.203	0.098	0.164
17	0.298	0.200	0.112	0.155
18	0.304	0.175	0.094	0.163
19	0.311	0.205	0.097	0.182
20	0.261	0.219	0.112	0.178
21	0.303	0.196	0.110	0.188
22	0.325	0.197	0.101	0.193
23	0.265	0.200	0.119	0.184
24	0.360	0.234	0.129	0.229
25	0.376	0.221	0.129	0.209
26	0.330	0.180	0.132	0.193
27	0.368	0.242	0.141	0.213
28	0.363	0.257	0.125	0.236
29	0.318	0.192	0.121	0.238
30	0.346	0.249	0.108	0.265

Figure 1: Downside Risk for Holding Periods from 1 to 30 Years



Our finding regarding the downside risk contradicts that of Mukherji (2002) who claims that the downside risk decreases as holding period lengthens and downside risk for stocks is lower than that for bonds. Since Mukherji (2002) generates holding period returns by rolling overlapping holding periods, a methodology that has not generated independent returns, his conclusions are no longer reliable. Therefore, according to the findings in this study, stocks have a greater risk of yielding below target returns and hence there is no evidence of time diversification of stocks over bonds.

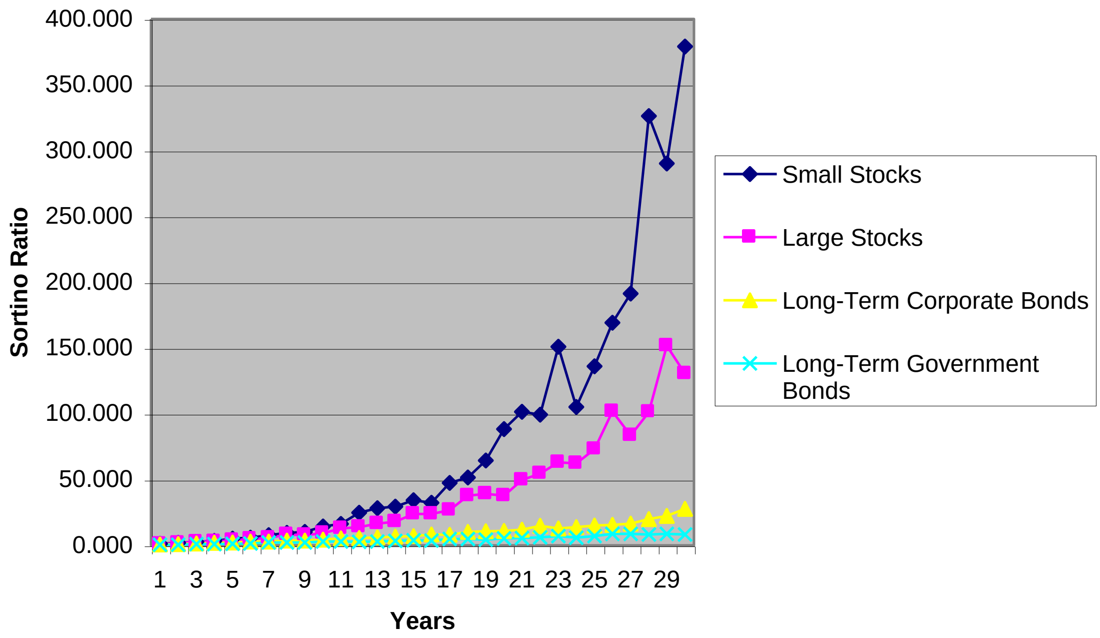
Table IV presents the reward-to-downside-risk ratios (Sortino ratio) for all four assets and Figure 2 graphs the ratio. The Sortino ratio increases as the holding period extends. The Sortino ratio for small stocks starts at 1.12 for a 1-year holding period and finishes at 378.99 for a 30-year holding period. Similarly, for the 1-year and 30-year holding period, the Sortino ratio for large stocks grows from 0.87 to 130.45. The magnitude of change of Sortino ratio for long-term corporate bonds and long-term government bonds for a 1-year and 30-year holding period are not as dramatic as those for small stocks and large stocks. The Sortino ratio for long-term corporate bonds increases from 0.73 to 27.67, while the Sortino ratio for long-term government bonds grows from 0.45 to 8.27 from a 1-year to 30-year holding period. Comparing the Sortino ratios at different holding horizons across all four types of assets, we find that small stocks have the highest Sortino ratio, while long-term government bonds have the lowest Sortino ratio. In other words, the compensation for bearing one unit of downside risk is greatest for small stocks and least for long-term government bonds, with large stocks and long-term corporate bonds ranking in between. Since Sortino ratio is essentially the reciprocal of the coefficient of downside risk as defined by Mukherji (2002), our finding here on Sortino ratio is in fact consistent with the finding of Mukherji (2002) on coefficient of downside risk.

Overall, this study documents that even though the holding period return is higher for stocks than for bonds, the downside risk for stocks is also higher than for bonds. Therefore, even though on a return per unit downside risk basis, stocks seem to be a better investment than bonds in the long run, there is no evidence that stocks dominate bonds in the return-downside risk plane. The empirical evidence presented here doesn't lend support to time diversification. On the contrary, it claims that time diversification does not exist.

Table IV: Sortino Ratio (Reward-to-Downside-Risk) for Portfolios of Small Stocks, Large Stocks, Long-Term Corporate Bonds, and Long-Term Government Bonds

Holding Period (Years)	Small Stocks	Large Stocks	Corporate Bonds	Government Bonds
1	1.122	0.875	0.732	0.454
2	1.931	1.737	0.921	0.460
3	2.572	2.609	1.345	0.856
4	3.445	3.041	1.826	1.048
5	5.130	3.858	2.071	1.243
6	5.873	4.790	2.943	1.544
7	7.729	5.570	2.939	2.185
8	9.476	8.231	3.557	2.169
9	10.260	7.742	3.751	2.135
10	14.266	9.185	4.311	2.820
11	16.309	12.822	5.321	2.923
12	24.781	13.940	5.506	2.722
13	28.224	16.444	6.164	2.828
14	29.434	18.023	6.568	3.477
15	34.320	23.974	7.016	3.827
16	32.320	23.882	8.217	3.603
17	47.396	26.767	8.068	4.783
18	51.517	37.638	10.277	4.769
19	64.631	39.119	10.685	4.457
20	88.322	37.768	10.900	5.411
21	101.574	49.724	11.968	5.650
22	99.238	54.561	14.761	6.110
23	150.896	63.090	13.013	7.130
24	105.239	62.271	13.859	5.732
25	136.004	73.054	15.151	7.027
26	169.205	101.840	15.609	8.853
27	191.409	83.523	16.456	8.762
28	326.159	101.255	19.856	8.313
29	290.182	151.654	22.282	8.725
30	378.989	130.447	27.671	8.278

Figure 2: Reward-to-Downside-Risk for Holding Periods from 1 to 30 Years



CONCLUSION

Recent discussions of time diversification have been surrounded by controversy. While HTY do not find time diversification to exist, Mukherji (2002) finds that investors may achieve time diversification by holding stocks. This study thus attempts to reconcile the differences between HTY and Mukherji (2002). Results indicate that the procedure used to estimate holding period returns and risk makes a big difference in the results of the study. For example, Mukherji (2002) uses downside risk and a rolling window approach to estimate returns, while HTY use the Sharpe Ratio and resampling to obtain independent holding period returns for long holding periods. In this paper, we use downside risk and resampling to investigate whether the results confirm Mukherji (2002) or HTY.

This study documents that small stocks have the greatest downside risk among the four asset types, with large stocks ranking second, long term corporate bonds ranking third, and long term government bonds ranking last. However, the reward-to-downside-risk (the Sortino ratio) ranks greatest for small stocks, second for large stocks, third for long-term corporate bonds, and lowest for long-term government bonds. Even though small stocks have the highest reward-to-downside risk ratio (Sortino ratio), they have greatest risks of missing the target returns, a finding contradictory to Mukherji (2002). This paper finds no evidence of dominance of stocks over bonds in longer holding horizons. Stocks are not necessarily safer and better investments than bonds over longer investment horizons.

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