LONG-RUN INVESTMENT DECISION IN THE TAIWAN EXCHANGE MARKET

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ABSTRACT

Whether an investor should hold more risky assets in the long run is an issue of allocation. However, the comparison of performance between different investment horizons is not an allocation issue, but rather at timing issue. Therefore, we employ Markovian moving block bootstrap to examine the performance differences between risky portfolios and diversified portfolios over different investment horizons. The results show that Sharpe ratio estimates for all of the stock portfolios increase first and then decrease as the investment horizon lengthens. Second, the size effect only holds in the short run, but not in the long run. Third, the performances of some examined portfolios outperform that of the market portfolio in the long run, indicating an investor may be better off holding some risky assets over longer investment horizon. Fourth, balanced- and bond-fund portfolios outperform the market portfolio when the investment horizons are over 15 years, suggesting that investors can benefit from investing into these types of mutual funds in the long run.

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INTRODUCTION

Numerous researchers examine whether investors should hold more risky assets in long-run investment horizons. The benefit from holding more risky assets as investment horizon lengthens is often called time diversification.[1] Tobin (1965) pioneered the work on the effect of various investment horizons on portfolio allocations. Levy (1972) discovered that the Sharpe ratio tends to change with different holding periods.

The supporters of the time diversification, suggest investors should put more of their money in risky assets in the long run. Lee (1990) showed that investment horizon is irrelevant only when asset prices follow a random walk. Levy and Spector (1996) employed a myopic utility function to conduct optimum asset allocation under different degrees of risk averse and different investment horizons, and found that the weight of risky asset should increase as investment horizon lengthens. Merrill and Thorley (1996) and Levy and Cohen (1998) also proved that lengthening the holding period could reduce risk using option theory. Strong and Taylor (2001) applied stochastic dominance and suggested that investors should hold more risky asset under 10-year investment horizons. Buter and Domian (1991) and Hansson and Persson (2000) reached the same conclusion by bootstrap methodology.

The opponents however, think that investors are less likely to lose money over a long horizon however, the magnitude of the loss increases with the holding period. Samuelson (1969, 1990, 1994) and Merton (1971) concluded that the optimum asset allocation is not indifferent to investment horizon, implying that investors are better served by holding a diversified portfolio in the long-run horizon. Furthermore, Gressis, Philippatos, and Hayya (1976), Gunthorpe and Levy (1994), and Levy and Gunthorpe (1993) demonstrated that the proportion of safe assets should be increased with longer investment horizons. The work of Hodges, Taylor, and Yoder (1997) reached the same conclusion that the Sharpe ratio of bonds outperforms those of stocks with long-run investment horizons, suggesting that investors should not increase the proportion of risky asset in the long run.

In order to solve the problem of time diversification, some of those studies evaluated performance with different investment horizons and explored whether the performance were improved with longer investment horizon. On the other hand, other works explored whether the optimal holding of risky asset should increase as investment horizon lengthens by use of mean-variance optimization. The comparison of the performance between different investment horizons is not a problem of allocation, but timing.

However, whether an investor should hold more risky assets in the long run is an issue of allocation. As a result, comparing the performance between different investment horizons may not solve the problem of time diversification. Furthermore, it is also difficult for an investor to invest according to the suggestion of mean-variance optimization. Therefore, we compare the performance between risky portfolios and diversified portfolios over different investment horizons in Taiwan markets. To date, few studies examined time diversification in the Taiwan exchange market. The studies of time diversification also don't consider the time diversification of mutual funds. The motivation of this study is to examine whether investors can benefit from holding more risky assets in the Taiwan exchange market under a long-run investment horizon. Specifically, we investigate whether investors are better off holding risky portfolios or diversified portfolio in the long run. We also compare the performance of different kinds of mutual funds in the long-run investment horizon.

In order to analyze whether investors should hold more risky assets or just diversified portfolios in the long run, we examine five size-sorted and five portfolios sorted on book-to-market ratio to risky assets, and market portfolio to a diversified portfolio. Then we can compare the effect of the investment horizon on shortfall risks and Sharpe ratios of risky and diversified portfolios. We also compare these two measures for three different types of mutual funds. The shortfall risk and the Sharpe ratio are employed because they have been extensively used to evaluate portfolio risk and performance, and we can compare our result to other works.

To keep the serial dependence of returns within each generated block, the Markovian moving block bootstrap procedure of Graflund (2001) is applied. The bootstrap procedure has been used extensively in the context of time diversification, e.g., Butler and Domian (1991), Hodges, Taylor, and Yoder (1997), among others. However, their simple bootstrap approach may destroy the serial dependence of returns. As a result, Hanson and Persson (2000) applied a block bootstrap procedure, which was developed by Carlstein (1986), to examine time diversification. Nevertheless, the block bootstrap procedure may also neglect the serial correlation between successive generated blocks.

Our results show that all the shortfall risks of the examined portfolios decline with longer holding periods. Second, the Sharpe ratios of all size-sorted portfolios and the market portfolio rise at first and then fall as investment horizon lengthens, just as predicted by Lin and Chou (2003). The results of comparing the Sharpe ratio between five size-sorted portfolios with the market portfolio are mixed. However, the performance of the small-size portfolio only outperforms those of the market and large-size portfolio in the short-run investment horizon. In other words, the size effect only holds in the short run, but not in the long run. The finding may result from the fact that small firms may not survive in the long run. Third, the Sharpe ratios of book-to-market sorted portfolios show that second, third, and fourth book-to-market portfolios outperform the market portfolio consistently. Therefore, some risky portfolios may outperform a diversified portfolio in the long run.

Fourth, the Sharpe ratios of equity-fund and balanced-fund portfolios also rise at first and then fall, but the performance of the bond-fund rises consistently. Moreover, when investment horizons are more than 15 years, the equity-fund and balanced-fund are inferior to the bond-fund. Nevertheless, the performance of the market portfolio outperforms those of the fund portfolios until the investment horizon is 10-years, indicating that the volatility of the market portfolio is much larger than that of fund portfolios as the investment horizon increases over 10-years. Finally, although all of the performances of the examined fund portfolios increase as investment horizon lengthens, the market portfolio outperforms all of the examined fund portfolios when we use a downside risk measure, the semi-variance.

The nest section is literature review. Section 3 and 4 outlines the proposed method and data. Section 5 provides an analysis of the empirical results. Finally, some concluding remarks are provided.

LITERATURE REVIEW

Markowitz (1952) pioneered the foundation for asset allocation theory. He concludes that the optimal asset allocation should lie on the efficient frontier estimated from mean-variance optimization. However, Markowitz's model considers only one period. Merton (1969) extends the myopia model into continuous-time. Samuelson (1969, 1990, and 1994) showed that the optimal asset allocation is independent of the investment horizon. His arguments are conditioned on the following assumptions: (1) investors have constant relative risk aversion, (2) asset price follows random walk pattern and return is normal distribution, and (3) other income isn't considered.

However, the work of Lloyd and Haney (1980) doesn't coincide with the argument of Samuelson. Lloyd and Haney pointed out that the volatility of a portfolio's value can be reduced by lengthening the holing period. This is the concept of time diversification. Kritzman (1994) provided a clear presentation of the principle of time diversification and its application. Many academicians and practitioners have found the results supporting the reality of time diversification. Strong and Taylor (2001) and Alles and Athanassakos (2006) found that shortfall risk falls as the investment horizon lengthens. Using mean-variance optimization, Levy and Spector (1996) and Hansson and Persson (2000) concluded that the weights investing in stocks in an efficient portfolio were significantly larger for long-run investment horizons than a one-year horizon. Nevertheless, Bodie (1995) showed that investors can buy a put option to insure themselves against obtaining returns below a threshold level. Then, the price of the put option can be seen as a risk measurement. Bodie found that the put price increases as the investment horizon lengthens. Taylor and Brown (1996) contradicted the Bodie's assumption that the volatility of long-term equity's returns are constant. Releasing the assumption of constant volatility of equity's return, the results of Levy and Cohen (1998) supported time diversification.

In addition to the application of risk evaluation and option pricing, many researchers compared performance between different investment horizons. For example, Hodges, Taylor, and Yoder (1997, 2003) and Best, Hodges, and Yoder (2007) applied bootstrap method and utilize the Sharpe ratio and Treynor ratio as the performance measurement. Stochastic dominance was also applied by Strong and Taylor (2001), among others. However, they didn't reach the same conclusion.

The mean-variance optimization is employed by most researchers to examine the optimal asset allocation in the long-run investment horizon, including, e.g., Levy and Spector (1996), Gressis, Philippatos, and Hayya (1976), Krizman and Rich (1988), Gunthorpe and Levy (1994), and Levy and Gunthorpe (1993), among others. However, the results were also different between academicians. Shortfall risk is the probability of the return on an examined asset falling below a threshold value, and has been used to study the effect of long-run investment horizon. Most studies found that the shortfall risk decreased as the investment horizons lengthen, e.g., Kritzman (1994), Thorley (1995), and Butler and Domain (1991), among others. However, Milevsky (1999) showed that although shortfall risk decreases with investment horizon, the portfolio asset allocation proportions remain invariant.

According to the works of Kritzman (1994), Thorley (1995), and Kritzman and Rich (1998), the basic differences between academicians and practitioners are risk definition and return's process. The volatility of asset returns and shortfall risk decline as the investment horizons increases. However, the volatility of end-wealth increases when the investment horizons lengthen. Likewise, if risky asset's process follows mean-reversion, then investors would benefit from investing in risky asset for the long run. On the contrary, return with a random walk pattern would deteriorate the investor's end-wealth. Without the coincidence of risk measurement and asset process, the debate of time diversification may be continued.

METHODOLOGY

We apply Markovian moving block bootstrap, which was developed by Graflund (2001), to examine whether time diversification holds in the Taiwan exchange market. While the origin version of Graflund only considered variance as governing the probability of switching between states, Sanfilippo (2003) extended the model to contain two transition governed pieces of information: the variance and expected return. Based on the works of Graflund (2001) and Sanfilippo (2003), the detailed algorithm of the Markovian moving block bootstrap is as follows:

Step 1: Determine the block length, *b* and compute the number of blocks *T/b*, where *T* is sample size.

Step 2: Compute expected return, which is predicted by the historical average return μ_i, and standard deviation σ_i. Meanwhile, find the maximum of both expected return and standard deviation, $(\mu_{\max}, \sigma_{\max})$, and Minimum $(\mu_{\min}, \sigma_{\min})$.

Step 3: Set $N = 1$, and draw a block *i*.

Step 4: Draw a block j, and compute $\mu_{ij} = (1 - \frac{|\mu_i - \mu_j|}{\mu_{man} - \mu_{\min}})$ and $v_{ij} = (1 - \frac{|\sigma_i - \sigma_j|}{\sigma_{man} - \sigma_{\min}})$. Draw a random number c from uniform distribution between zero and one. If $c < \mu_{i,j}$ and $c < \upsilon_{i,j}$, then accept block j, and $N = N + 1$; otherwise redraw another block j.

Step 5: Take block *j* as block *i*, and go to step 4. Repeat until investment horizon is equal to *Nb*.

In this paper, we set the block length as 6 months,[2] and generate a total of 5,000 holding period returns for different investment horizons. With the sample, we can calculate the performance for each investment horizon. To compare our result to other works, we use the Sharpe ratio to evaluate portfolio performance, which is a ratio of the expected excess return to the expected standard deviation. Based on the studies of downside risk, see, e.g., Ang, Chen, and Xing (2006) and Sortino and Meer (1991), we also consider the downside risk version of the Sharpe ratio. The downside risk version of Sharpe ratio is defined as the ratio of a portfolio's expected excess return to the square root of semi-variance, i.e., semi-standard deviation. We also use the risk-free rate as a benchmark to compute shortfall risk for each portfolio.

DATA

We rank all firms in the Taiwan Stock Exchange (TSE) and Taiwan Over-The-Counter Exchange (OTC) by their market capitalization (size) and book-to-market ratio (book/market) respectively at the end of June in each year. We classify all the stocks into five size and five book/market portfolios. We then hold these portfolios for one year and compute their value weighted continuous monthly returns. We examine the data span from July 1981 to December 2006, including 1227 firms. We compute the value weighted monthly return of all the stocks in the TSE and OTC as the proxy of the market portfolio. The risk-free rate is taken from the one-month deposit rate of the First Commercial Bank. We also group and compute the sample average return for all of the equity funds, balanced funds, and bond funds. The sample periods are from January 1992 to December 2006, which consists of 260, 93, and 108 funds for equity, balanced, and bond-funds, respectively. All the data come from Taiwan Economic Journal.

Table 1 presents some summary statistics on the stock and fund portfolios. Panel A shows the average returns, standard deviations, Sharpe ratios, number of firms, and average market values for the five size-sorted portfolios, market portfolios, and the risk-free rate. Before risk adjustment, the size effect

Table 1: Summary Statistics on the Stock and Mutual Fund Portfolios

Panel A: Size Portfolios

	Size					Market Portfolio	Risk-free Rate
	Smallest	**2**	**3**	**4**	**Largest**		
Average	4.613	3.299	2.985	2.392	2.782	3.005	0.398
Standard Deviation	13.521	11.940	11.372	10.269	9.593	9.383	0.194
Sharpe Ratio	0.312	0.243	0.227	0.194	0.249	0.278	N/A
Number of firms	11-246	11-246	11-245	11-245	11-245	55-1227	N/A
Average Market value	1076	2510	4517	8626	50009	N/A	N/A

Panel B: Book-to-Market Ratio Portfolios

	Book-to-Market Ratio					Market Portfolio	Risk-free Rate
	Smallest	**2**	**3**	**4**	**Largest**		
Average	3.568	2.284	2.489	2.398	2.889	3.005	0.398
Standard Deviation	14.213	10.779	10.203	9.537	10.659	9.383	0.194
Sharpe Ratio	0.223	0.175	0.205	0.210	0.234	0.278	N/A
Number of firms	11-246	11-246	11-245	11-245	11-245	55-1227	N/A
Average book/market	0.822	1.634	2.105	2.810	7.267	N/A	N/A

Panel C: Mutual Fund Portfolios

	Equity-type	Balanced-type	Bond-type	Market Portfolio	Risk-free Rate
Average	0.795	0.730	0.371	2.000	0.315
Standard Deviation	6.863	4.570	0.716	7.983	1.829
Sharpe Ratio	0.070	0.091	0.078	0.211	N/A
Number of funds	15-260	4-93	2-108	N/A	N/A

We classify all the stocks into five size and five book/market portfolios by ranking all firms in the Taiwan Stock Exchange and Taiwan Over-The-Counter Exchange by their market capitalization and book-to-market ratio respectively at the end of each June. The data span from July 1981 to December 2006. We also group and compute the sample average return for all of the equity funds, balanced funds, and bond funds. The sample period is from January 1992 to December 2006. The average returns and standard deviations are represented as percentages. The numbers of stocks and funds are reported from smallest number to largest number, and average market values are represented in millions of NT. dollars. The symbol of N/A denotes not available.

still holds. The average return of the smallest size portfolio reaches 4.61%, while the average return of the fourth sized portfolio is only 2.39%, and is the lowest average return. The average returns of the market and risk-free asset are 3.01% and 0.4%, respectively. The highest average return also has the highest volatility. The standard deviation of the smallest size portfolio is more than the other size-sorted and market portfolios. The standard deviation of the market portfolio is lower than those of the five size-sorted portfolios. The Sharpe ratio shows the existence of size effect after risk adjustment, where the smallest portfolio has the largest value of 0.312. From 1981 to 2006, there are 11 to 246 firms contained in each size portfolio, with an average market size of 1076 million (in NT dollar) for the smallest to 50,009 million for the largest portfolio.

Panel B displays the same statistics for the book/market portfolios. The largest book/market portfolio doesn't reward the highest return. On the contrary, the smallest book/market portfolio produces the highest average return, 3.57%. The fourth book/market portfolio reported the lowest return. A high return is also accompanied by a high volatility. The smallest book/market portfolio has a standard deviation of 14.21%, which is the highest among the other book/market portfolios. Except the smallest book/market portfolio, the other four portfolios show the book/market effect, that the largest portfolio has the largest Sharpe ratio. Some statistics for fund portfolios are shown in Panel C. The average return and standard deviation of equity-fund are larger than those of balanced- and bond-fund portfolios. Moreover, all of the fund returns are lower than those of the market portfolio. The estimates of the Sharpe ratio tell us that all of the funds did not outperform the market.

EMPIRICAL RESULTS

A:Size-Sorted Portfolios

Shortfall risk (SFR) is the probability of the examined portfolio's return falls below a threshold value, which is represented by the risk-free rate in this paper. Table 2 displays point estimates of the SFR for the five size-sorted portfolios with different investment horizons. All of the estimates decline as the investment horizons lengthen, which are same as in other studies, e.g., Strong and Taylor (2001). The estimated SFR of the smallest size portfolio decrease faster than the other size-sorted portfolios and market portfolio, and reaches zero for holding periods up to 10 years. The estimated SFR of the largest size portfolio is the lowest among the other four size portfolios, while the SFR of market portfolio lies in the middle of the five size portfolios.

Table 2: Shortfall Risks for Five Size-Sorted Portfolios

Investment Horizon (Years)	Size					Market Portfolio
	Smallest	2	3	4	Largest	
1	0.158	0.285	0.282	0.308	0.253	0.258
2	0.075	0.175	0.180	0.221	0.157	0.184
3	0.035	0.131	0.137	0.179	0.112	0.131
4	0.026	0.102	0.110	0.147	0.087	0.117
5	0.011	0.068	0.076	0.111	0.063	0.090
6	0.005	0.049	0.056	0.091	0.044	0.068
7	0.004	0.036	0.047	0.073	0.033	0.050
8	0.001	0.030	0.033	0.057	0.024	0.047
9	0.001	0.025	0.032	0.054	0.022	0.033
10	0	0.018	0.025	0.045	0.016	0.025
15	0	0.004	0.007	0.018	0.004	0.012
20	0	0.001	0.002	0.006	0.001	0.004

We use the risk-free rate as a benchmark and calculate all of the shortfall risk estimates by Markovian moving block bootstrap, where we set the block length to be 6 months, and generate a total of 5,000 holding period returns for each investment horizon.

The Sharpe ratios of the five size-sorted portfolios and the market portfolio, which are reported in Panel A of Table 3, rise firstly and then fall as the investment horizon lengthens, just as the work of Best, Hodges, and Yoder (2007). However, the pattern of decrease is not monotonous with the holding period. The results imply that, although the holding return increases with the investment horizon, the magnitude of the volatility increases much more. When the investment horizon is one year, the Sharpe ratio of the smallest size portfolio is the largest among the five size-sorted portfolios and the market portfolio. This is in accord with the size effect. However, when investment horizon increases, the Sharpe ratios of the smallest portfolios decrease faster than those of the other size-sorted portfolios. The result is also similar to the work of Hodges, Taylor, and Yoder (1997). We can see that when we lengthen the investment horizon, the larger a portfolio is, the more performance it has. The result suggests that when we want to invest in the long run, it would be better to allocate more money to larger size firms. Nevertheless, the results of comparing the Sharpe ratio between risky portfolios with diversified portfolio are mixed.

We also use downside risk, which is represented by the square root of semi-variance, to calculate the Sharpe ratio. Panel B of Table 3 lists the results. All of the estimates are higher than those of Panel A as expected, because semi-variance is lower than the traditional variance. The pattern of the calculated Sharpe ratio is different from that of Panel A. The estimates reach the highest values with three- to eight-year investment horizons respectively, and then decline as the investment horizon increases. When the investment horizon reaches 4 years, the Sharpe ratio of the largest size portfolio dominates the other size portfolios. Again, the size effect disappears when the investors take investment horizon into account. Moreover, the performance of largest size portfolio is superior to that of market portfolio for all the holding periods. However, the smallest and middle portfolios outperform the market portfolio as investment horizons are within two and three years, but are dominated by the market portfolio when investment horizons are more than two and three years, respectively. The results imply that time diversification only exists in some portfolios, but not in all portfolios.

Table 3: Sharpe Ratios for Five Size-Sorted Portfolios

Panel A: Sharpe Ratios Calculated by Standard Deviation

Investment Horizon (Years)	Size					Market Portfolio
	Smallest	2	3	4	Largest	
1	0.6457	0.5662	0.4958	0.4613	0.5283	0.5685
2	0.6483	0.6337	0.5925	0.5754	0.6242	0.6213
3	0.5563	0.5778	0.6054	0.6287	0.6461	0.6860
4	0.4376	0.4180	0.4474	0.5177	0.5873	0.5958
5	0.3747	0.4325	0.3508	0.3918	0.4463	0.4107
6	0.3537	0.3602	0.3928	0.4598	0.5272	0.5147
7	0.3497	0.3157	0.2563	0.3333	0.4249	0.4376
8	0.3072	0.3528	0.3800	0.4380	0.4394	0.2907
9	0.2437	0.3091	0.3300	0.3679	0.4550	0.4206
10	0.2485	0.3119	0.3525	0.3865	0.4499	0.3292
15	0.0892	0.1348	0.1897	0.2701	0.2731	0.2423
20	0.0932	0.1284	0.1582	0.1906	0.1793	0.1754

Panel B: Sharpe Ratios Calculated by Semi-Standard Deviation

Investment Horizon (Years)	Size					Market Portfolio
	Smallest	2	3	4	Largest	
1	1.4806	1.2512	1.2148	1.1110	1.2568	1.1848
2	1.6599	1.4957	1.4721	1.3788	1.5307	1.4685
3	1.6792	1.5760	1.5718	1.5012	1.6374	1.6226
4	1.6398	1.5709	1.5876	1.5538	1.6867	1.6404
5	1.5782	1.5628	1.5769	1.5793	1.6980	1.6578
6	1.5306	1.5319	1.5812	1.6066	1.7107	1.6649
7	1.4945	1.5030	1.5576	1.6066	1.7035	1.6399
8	1.4380	1.4773	1.5469	1.6077	1.6925	1.6161
9	1.3795	1.4256	1.4967	1.5685	1.6585	1.6128
10	1.3547	1.4092	1.4828	1.5513	1.6374	1.5711
15	1.2222	1.2719	1.3354	1.4406	1.4716	1.4091
20	1.1711	1.2037	1.2744	1.3763	1.4078	1.3444

We calculate all of the estimates of the Sharpe ratio by Markovian moving block bootstrap, where we set the block length to be 6 months, and generate a total of 5,000 holding period return for each investment horizon.

B: Book-to-Market Ratio Portfolios

The estimated SFR of five book/market portfolios, which are shown in Table 4, are similar to those of size-sorted portfolios. All of the estimates decrease as the investment horizon lengthens. The smallest book/market portfolio has the smallest SFR, while the second book/market portfolio reports the largest SFR. The SFR of market portfolio is not lower than those of book/market portfolios.

Table 4: Shortfall Risks for Five Book/Market Portfolios

Investment Horizon (Years)	Book-to-Market Ratio					Market Portfolio
	Smallest	2	3	4	Largest	
1	0.2802	0.3262	0.3036	0.3010	0.3128	0.2576
2	0.1998	0.2606	0.2238	0.2306	0.2554	0.1840
3	0.1334	0.2138	0.1736	0.1868	0.2178	0.1308
4	0.1156	0.1914	0.1564	0.1706	0.2078	0.1172
5	0.0856	0.1730	0.1316	0.1442	0.1774	0.0902
6	0.0646	0.1534	0.1108	0.1158	0.1482	0.0678
7	0.0550	0.1398	0.0960	0.0958	0.1310	0.0502
8	0.0460	0.1208	0.0830	0.0912	0.1164	0.0474
9	0.0356	0.1014	0.0642	0.0698	0.0952	0.0334
10	0.0276	0.0932	0.0562	0.0654	0.0902	0.0246
15	0.0114	0.0578	0.0294	0.0334	0.0534	0.0124
20	0.0028	0.0308	0.0132	0.0138	0.0272	0.0038

We use risk-free rate as benchmark and calculate all of the shortfall risk's estimates by Markovian moving block bootstrap, where we set the block length to be 6 months, and generate a total of 5,000 holding period return for each investment horizon.

Panel A of Table 5 displays the Sharpe ratios of five book/market portfolios and market portfolios with different investment horizons. The Sharpe ratios rise firstly and reach the largest value with investment horizons up to two or three years, and then decline. The decline is not monotonous as the investment horizon lengthens. This pattern is also similar to the results of size portfolios. Therefore, no matter how we construct the portfolios, the Sharpe ratios first rise and then fall as investment horizon lengthens, a finding consistent with Lin and Chou (2003). The Sharpe ratio of the second book/market portfolio outperforms that of market portfolio at investment horizon up to two-year. Moreover, third and fourth portfolios outperform market portfolio for all of the examined holding periods.

The Sharpe ratios calculated by semi-standard deviation are displayed in Panel B. The results are different from those of Panel A. All of the estimates reach the largest value in five- to nine-year investment horizon, and then decline with non-monotonously as the investment horizon lengthens. The second, third, and fourth book/market portfolios also outperform market portfolio as the examined investment horizons are over eight, seven, and seven years, respectively. As a result, investors may benefit from holding some specific risky portfolios, but not all risky portfolios, instead of diversified portfolio in the long-run investment horizon.

C: Mutual Fund Portfolios

Table 6 summarizes the results of estimating shortfall risk for the three mutual fund portfolios. The estimates also decline as the investment horizon lengthens. When the investment horizon increases to 20 years, the shortfall risk of equity-fund portfolio still remains 35%, while the estimate of market portfolio has dropped to 2.3%. The bond-fund portfolio has the smallest shortfall risk among the three fund portfolios. On the contrary, the equity-fund portfolio has the largest estimate. The results confirm the fact that equity's risk is larger than the bonds. However, the shortfall risk of market portfolio is lower than the bonds, indicating that market portfolio is much more efficient than the bonds.

Panel A of Table 7 shows the Sharpe ratios for the three fund portfolios based on traditional standard deviation. The estimates of equity-fund and balanced-fund firstly rise and reach the highest value in the investment horizon of 10 and 15 years respectively, and then fall with longer investment horizon. However, the Sharpe ratios of bond-fund increase as the investment horizon lengthens. The balanced-fund has the largest Sharpe ratios within 15-year investment horizons. When the investment horizons are over 15 years, bond-fund outperforms the other two fund portfolios. All of the Sharpe ratios of the three fund portfolios are lower than the estimates of market portfolio within 10-year investment horizons. However, when the investment horizons are over 10 years, the performance of

Table 5: Sharpe Ratios for Five Book/Market Portfolios

Panel A: Sharpe Ratios Calculated by Standard Deviation

Investment Horizon (Years)	Book-to-Market ratio					Market Portfolio
	Smallest	2	3	4	Largest	
1	0.5853	0.5307	0.5770	0.6000	0.4152	0.5685
2	0.6823	0.6729	0.6988	0.7294	0.4195	0.6213
3	0.7251	0.7143	0.7385	0.7841	0.4468	0.6860
4	0.5789	0.6892	0.7329	0.7523	0.3438	0.5958
5	0.6033	0.6907	0.6719	0.7416	0.2178	0.4107
6	0.5275	0.6877	0.6456	0.7423	0.2861	0.5147
7	0.5526	0.6243	0.5730	0.6651	0.2520	0.4376
8	0.4984	0.6519	0.5940	0.6528	0.0960	0.2907
9	0.4594	0.6175	0.6139	0.6733	0.2068	0.4206
10	0.3590	0.5489	0.4881	0.5926	0.1710	0.3292
15	0.3049	0.4095	0.3592	0.4385	0.1156	0.2423
20	0.1161	0.1202	0.2062	0.3523	0.1141	0.1754

Panel B: Sharpe Ratios Calculated by Semi-Standard Deviation

Investment Horizon (Years)	Book-to-Market ratio					Market Portfolio
	Smallest	2	3	4	Largest	
1	1.1780	0.8830	1.0082	0.9789	1.0429	1.1848
2	1.4546	1.1933	1.3127	1.2987	1.2728	1.4685
3	1.6197	1.3873	1.5057	1.4852	1.3911	1.6226
4	1.6229	1.4613	1.5701	1.5507	1.4173	1.6404
5	1.6623	1.5451	1.6226	1.6148	1.4356	1.6578
6	1.6536	1.5782	1.6592	1.6648	1.4433	1.6649
7	1.6169	1.6106	1.6673	1.6782	1.4215	1.6399
8	1.6113	1.6254	1.6666	1.6847	1.3852	1.6161
9	1.5566	1.6224	1.6638	1.6917	1.4066	1.6128
10	1.5325	1.6086	1.6193	1.6597	1.3820	1.5711
15	1.4002	1.5334	1.5288	1.5623	1.2437	1.4091
20	1.2806	1.4280	1.4306	1.4806	1.2242	1.3444

We calculate all of the estimates of the Sharpe ratio by Markovian moving block bootstrap, where we set the block length to be 6 months, and generate a total of 5,000 holding period return for each investment horizon.

Table 6: Shortfall Risk for Three Fund Portfolios

Investment Horizon (Years)	Equity-fund	Balanced-fund	Bond-fund	Market Portfolio
1	0.453	0.450	0.289	0.302
2	0.439	0.416	0.305	0.241
3	0.433	0.399	0.323	0.210
4	0.424	0.383	0.326	0.179
5	0.421	0.360	0.315	0.146
6	0.412	0.363	0.315	0.135
7	0.402	0.338	0.292	0.115
8	0.410	0.330	0.296	0.100
9	0.400	0.327	0.278	0.089
10	0.385	0.305	0.286	0.083
15	0.367	0.271	0.235	0.039
20	0.349	0.246	0.202	0.023

We use risk-free rate as benchmark and calculate all of the shortfall risk's estimates by Markovian moving block bootstrap, where we set the block length to be 6 months, and generate a total of 5,000 holding period return for each investment horizon.

Table 7: Sharpe Ratios for Three Fund Portfolios

Panel A: Sharpe Ratios Calculated by Standard Deviation

Investment Horizon (Years)	Equity-fund	Balanced-fund	Bond-fund	Market Portfolio
1	0.2177	0.2558	0.2011	0.5733
2	0.3063	0.3548	0.2702	0.7017
3	0.3375	0.3818	0.2874	0.7285
4	0.3867	0.4431	0.3275	0.7737
5	0.4037	0.4757	0.3724	0.7464
6	0.4132	0.4872	0.3857	0.7638
7	0.4312	0.5159	0.4359	0.7464
8	0.4349	0.5282	0.4448	0.6969
9	0.4024	0.5203	0.4774	0.5734
10	0.4618	0.5795	0.4830	0.6727
15	0.4495	0.6043	0.5937	0.5082
20	0.3488	0.5283	0.6923	0.3546

Panel B: Sharpe Ratios Calculated by Semi-Standard Deviation

Investment Horizon (Years)	Equity-fund	Balanced-fund	Bond-fund	Market Portfolio
1	0.3372	0.4191	0.3408	0.9457
2	0.5082	0.5924	0.4507	1.2494
3	0.5933	0.6615	0.4691	1.3911
4	0.7072	0.7829	0.5255	1.5164
5	0.7969	0.8773	0.5922	1.6046
6	0.8134	0.8983	0.6149	1.6336
7	0.9036	0.9894	0.6888	1.6662
8	0.9423	1.0338	0.7054	1.6801
9	0.9812	1.0709	0.7565	1.6583
10	1.0356	1.1308	0.7538	1.6766
15	1.1567	1.2837	0.9335	1.6060
20	1.2244	1.3647	1.0854	1.4944

We calculate all of the estimates of the Sharpe ratio by Markovian moving block bootstrap, where we set the block length to be 6 months, and generate a total of 5,000 holding period return for each investment horizon.

balanced- and bond-fund outperform the performance of market portfolio, implying that the time diversification hold in these two funds, but not in equity fund.

By comparison, Sharpe ratios calculated by semi-standard deviation, which are shown in Panel B, differ from those obtained by ordinary standard deviation. The Sharpe ratios of the three examined mutual funds increase monotonously as the investment horizon lengthens. The Sharpe ratio of market portfolio increases firstly, and decreases as the investment horizon is equal to eight years. Moreover, the market portfolio outperforms all of the three examined mutual funds. The results indicate that holding a mutual fund longer may produce higher Sharpe ratio, but it is better for an investor to hold a diversified portfolio in the long-run.

CONCLUSION

In order to analyze whether investors should hold more risky assets or just diversified portfolio in the long run, we compare the effect of the investment horizon on the Sharpe ratios of risky and diversified portfolios in the Taiwan securities markets. We examine five size-sorted and five book/market-sorted portfolios to risky assets, and market portfolio to a diversified portfolio. We also compare the Sharpe ratios of three-type mutual funds to market portfolio. We employ Markovian moving block bootstrap procedure of Graflund (2001) to keep the serial dependence of returns within each generated block.

Our results show that all the shortfall risks decline with longer holding period. Second, the Sharpe ratios of all size-sorted portfolios rise firstly and then fall as investment horizon lengthens. However, the performance of the small-size portfolio only outperforms those of market and large-size portfolio in the short-run investment horizon. In other words, the size effect in Taiwan only holds in the short run, but not in the long run. Third, the Sharpe ratios of book/market-sorted portfolios show that the third and fourth book/market portfolios outperform the market portfolio consistently. Therefore, some risky portfolios can outperform a diversified portfolio in the long run.

Fourth, the Sharpe ratios of equity-fund and balanced-fund portfolio also rise firstly and then fall, but the performance of bond-funds rise consistently. Moreover, when investment horizons are more than 15 years, the equity-fund and balanced-fund are inferior to the bond-fund. Nevertheless, the performance of the market portfolio outperforms those of the fund portfolios until investment horizon is 10-years, indicating that the volatility of the market portfolio is much larger than those of fund portfolios as the investment horizon extends over 10-years. Finally, although the performance of all examined fund portfolios increase as investment horizon lengthens, the market portfolio outperforms all of the examined fund portfolios when we use a downside risk measure, the semi-variance.

ENDNOTES

[1] See, for example, the work of Thorley (1995).
[2] We also consider the case of 12-month block length, whose results are similar to those of 6-month block. To save space, we leave the results upon the request

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