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Optimal Portfolios for Different Holding Periods and Target Returns

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Abstract

This paper examines the allocations of U.S. financial assets in optimal portfolios that minimize the proportion of downside risk, measured by deviations from target returns, to mean real terminal value. T-bills dominate the optimal portfolio only for short-term investors with a low target. Intermediate government bonds are the major investment for short-term investors with a medium target and for medium-term investors with low or medium targets. For a high target, stocks are the primary component of the optimal portfolio. For medium and high targets over a long holding period, the optimal portfolio consists solely of small stocks. © 2003 Academy of Financial Services. All rights reserved.

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1. Introduction

Financial planners generally recommend greater exposure to stocks for longer investment horizons, suggesting that stocks become less risky as the holding period increases. Lloyd and Haney (1980) show that lengthening the investment period reduces the standard deviation of returns on stocks more than increasing the number of stocks in the portfolio does. Lloyd and Modani (1983) find that stocks have a higher standard deviation of returns than bonds and

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bills for holding periods up to 9 years, but stocks have the lowest standard deviation of returns for periods exceeding 24 years. Lee (1990) observes that the proportion of the optimal mean-variance efficient portfolio invested in stocks increases with the investment horizon.

Some studies have provided empirical evidence against the benefit of time diversification. McEnally (1985) finds that the volatility of total returns on stocks increases with the holding period. Levy and Gunthorpe (1993) demonstrate that the standard deviation of the holding-period return on stocks rises faster than the mean return as the holding period increases, and suggest that mean-variance investors should invest primarily in intermediate government bonds. Levy and Spector (1996), however, show that investors with a log-wealth utility function should invest solely in equities, with more than 90% in small stocks, and investors with myopic utility functions and reasonable degrees of risk-aversion values should invest primarily in equities. Hickman et al. (2001) point out that most of the greater long-term variability of riskier assets consists of uncertainty about the extent to which riskier assets will outperform safer assets. Their study indicates that long-term investors who do not invest in risky assets face severe penalties in the value of terminal wealth.

The empirical evidence against the benefit of time diversification can be contested on the grounds that investors are more concerned about downside risk than about overall volatility, and with deviations from target returns rather than from mean returns of different investments. Several surveys show that investors consider downside risk more relevant than overall volatility (Payne, 1973; Investment Company Institute, 1996; Olsen, 1997). Academics have also suggested that investment decisions should be based on downside risk measures relative to target returns. Markowitz (1959) indicates that measuring risk by semivariance, instead of variance, produces better portfolios. Harlow (1991) demonstrates that, because returns are not normally distributed, optimal portfolios based on downside risk have better risk-return characteristics than those based on variance. Fishburn (1977) presents a general model that measures risk as deviations below a fixed target, and Kahneman and Tversky (1979) indicate that investor utility depends on returns compared to a target return. Mukherji (2002) finds that stocks provide greater real wealth and lower downside risk relative to minimum targets, compared to bonds and bills, over long holding periods.

Research on time diversification has generally focused on the relative performance of different asset classes over time. Most investors, however, hold portfolios rather than a single asset. This study uses 1,000 random samples drawn from 900 months of U.S. data to examine the composition of optimal portfolios of financial assets for different holding periods and target returns. The optimal portfolios minimize the proportion of downside risk to mean real terminal value for each holding period. The results show that the stock allocations of optimal portfolios increase with the target return as well as with the holding period. For a high target return, stocks are the primary component of the optimal portfolio. For medium and high target returns over a long holding period, the optimal portfolio consists solely of small stocks.

2. Data and methodology

Inflation-adjusted total monthly returns of the following six U.S. asset classes are obtained from Ibbotson Associates (2001) for the period 1926–2000:

1. 30-day U.S. treasury bills
2. Intermediate-term government bonds
3. Long-term government bonds
4. Long-term corporate bonds
5. Large-company stocks
6. Small-company stocks

Because the 900 months of available data contain only 75 nonoverlapping annual returns, fifteen 5-year returns, and five 15-year returns, 1,000 independent 1-year, 5-year, and 15-year returns are constructed using random sampling with replacement. For example, for the 15-year returns, 180 months are randomly sampled with replacement 1,000 times, and the real returns of the six asset classes are obtained for each month sampled. The sampling procedure is similar to that of Hickman et al. (2001). The real values of investments at the end of 1, 5, and 15 years are calculated by compounding 12, 60, and 180 real monthly returns, respectively. The real value of a $1 investment at the end of n months (V_n) is:

$$V_n = {}_{t=1}{}^{n}\Pi(1 + r_t)$$

where r_t is the real rate of return on the investment in month t, and π denotes the product.

The downside variance (DV) of an investment, relative to the minimum target value (TV), is computed as:

$$DV = {}_{V<TV}\Sigma(TV - V_h)^2/(H-1)$$

where V_h is the real value of the investment at the end of holding period h, and H is the total number of holding periods used to calculate the DV. The downside deviation (DD) is the square root of the downside variance. The coefficient of downside deviation (CDD) is the DD divided by the mean real value of the investment.

Results are examined for low, medium, and high target values, reflecting compounded real annual returns of 2%, 5%, and 8%, and for short, medium, and long holding periods of 1, 5, and 15 years. Because the annual inflation rate averages 3.17% during the study period, the real annual target returns represent low, medium, and high nominal annual target returns that are slightly higher than 5%, 8%, and 11%, respectively. For each holding period–target return combination, asset allocations are determined for the optimal portfolio, which minimizes the CDD, subject to the following constraints:

1. The proportion of each asset in the portfolio is greater than or equal to zero.
2. The total proportion of all the assets in the portfolio equals 100%.
3. The terminal value of the portfolio provides a real annual return that is equal to or greater than the target rate of return.

These constraints imply that short sales are not allowed, the portfolio is fully invested in the six asset classes examined, and the target return is achieved or exceeded. The optimal allocations are obtained with the Microsoft Excel 2000 Solver program, which uses the Generalized Reduced Gradient algorithm developed by Lasdon and Waren (1978). The target cell is the CDD, which is set equal to the minimum value, the changing cells are the proportions invested in the six asset classes, and the constraints are as indicated above.

Table 1
Real values of $1 invested in different asset classes over various holding periods

	Treasury bills	Intermediate-term government bonds	Long-term government bonds	Long-term corporate bonds	Large company stocks	Small company stocks
Panel A. 1-Year holding period						
Mean	1.0071	1.0235	1.0278	1.0297	1.0985	1.1408
Median	1.0084	1.0217	1.0232	1.0243	1.0812	1.1015
Maximum	1.0837	1.2859	1.4683	1.4544	2.6158	4.0953
Minimum	0.9217	0.8857	0.8239	0.8036	0.5330	0.3638
Range	0.1620	0.4001	0.6444	0.6508	2.0828	3.7315
Standard deviation	0.0192	0.0507	0.0842	0.0754	0.2163	0.3443
Coefficient of variation	0.0191	0.0495	0.0819	0.0732	0.1969	0.3018
Panel B. 5-Year holding period						
Mean	1.0369	1.1197	1.1401	1.1455	1.5963	1.9534
Median	1.0382	1.1136	1.1160	1.1269	1.4567	1.5953
Maximum	1.1639	1.6142	2.0580	1.9276	8.2172	22.5842
Minimum	0.8580	0.8018	0.6563	0.7683	0.2713	0.2066
Range	0.3059	0.8124	1.4017	1.1592	7.9458	22.3776
Standard deviation	0.0437	0.1235	0.2118	0.1856	0.7855	1.5743
Coefficient of variation	0.0421	0.1103	0.1858	0.1620	0.4921	0.8059
Panel C. 15-Year holding period						
Mean	1.1173	1.4096	1.4934	1.5265	4.1810	7.2996
Median	1.1193	1.3831	1.4161	1.4661	3.0095	3.8859
Maximum	1.3334	2.5056	3.7689	3.5122	57.7005	360.0965
Minimum	0.9122	0.8085	0.5861	0.6198	0.2659	0.1185
Range	0.4212	1.6970	3.1828	2.8923	57.4344	359.9779
Standard deviation	0.0768	0.2659	0.4984	0.4421	4.0649	15.1003
Coefficient of variation	0.0687	0.1886	0.3338	0.2896	0.9722	2.0687

3. Empirical results

Table 1 provides descriptive statistics for the six asset classes examined over different holding periods. The mean real terminal value of $1 invested for a year varies between $1.01 for T-bills and $1.14 for small stocks. Over 15 years, the range of mean values is much wider, from $1.12 for T-bills to $7.30 for small stocks. The ranges between the maximum and minimum values of each asset also increase with time; for example, between the 1- and 15-year periods, the range increases from $0.16 to $0.42 for T-bills and from $3.73 to $359.98 for small stocks. The standard deviation of the real terminal value of each asset increases with the holding period, with the largest increase for small stocks and the smallest increase for T-bills. Between the 1- and 15-year holding periods, the standard deviation increases by multiples of 4 for bills, 5 to 6 for bonds, 19 for large stocks, and 44 for small stocks. Therefore, if risk is measured by the standard deviation of terminal value, then there is a much greater increase in the risk of stocks, compared to bonds and bills, as the holding period increases from 1 to 15 years. However, the increase in the mean value is highest for small stocks, followed by large stocks, bonds, and bills. As a result, between the 1- and 15-year holding periods, the coefficient of variation increases by a multiple of about 4 for bills and bonds, 5 for large stocks, and 7 for small stocks. Over 15 years, the mean value

Table 2
Mean values, downside deviations (DD), and coefficients of downside deviation (CDD) of different asset classes for different target returns over various holding periods

	Mean value	DD and CDD for real annual target returns of:					
		2.00%		5.00%		8.00%	
		DD	CDD	DD	CDD	DD	CDD
Panel A. 1-Year holding period							
Treasury bills	1.0071	0.0221	0.0219	0.0470	0.0467	0.0754	0.0749
Intermediate-term government bonds	1.0235	0.0324	0.0317	0.0514	0.0503	0.0743	0.0726
Long-term government bonds	1.0278	0.0521	0.0507	0.0705	0.0686	0.0913	0.0889
Long-term corporate bonds	1.0297	0.0449	0.0436	0.0631	0.0613	0.0842	0.0818
Large company stocks	1.0985	0.0965	0.0878	0.1115	0.1015	0.1279	0.1164
Small company stocks	1.1408	0.1368	0.1199	0.1523	0.1335	0.1686	0.1478
Panel B. 5-Year holding period							
Treasury bills	1.0369	0.0799	0.0771	0.2435	0.2348	0.4349	0.4194
Intermediate-term government bonds	1.1197	0.0735	0.0657	0.1964	0.1754	0.3709	0.3312
Long-term government bonds	1.1401	0.1134	0.0994	0.2291	0.2010	0.3881	0.3404
Long-term corporate bonds	1.1455	0.0968	0.0845	0.2110	0.1842	0.3716	0.3244
Large company stocks	1.5963	0.1540	0.0964	0.2352	0.1473	0.3436	0.2153
Small company stocks	1.9534	0.2287	0.1171	0.3147	0.1611	0.4227	0.2164
Panel C. 15-Year holding period							
Treasury bills	1.1173	0.2412	0.2159	0.9651	0.8638	2.0573	1.8412
Intermediate-term government bonds	1.4096	0.1385	0.0983	0.7200	0.5108	1.7833	1.2651
Long-term government bonds	1.4934	0.2175	0.1456	0.7480	0.5009	1.7518	1.1730
Long-term corporate bonds	1.5265	0.1710	0.1120	0.6919	0.4533	1.7047	1.1168
Large company stocks	4.1810	0.1886	0.0451	0.4918	0.1176	1.1116	0.2659
Small company stocks	7.2996	0.2969	0.0407	0.6276	0.0860	1.2268	0.1681

exceeds the median by 39% for large stocks and 88% for small stocks, indicating that the values of these assets, particularly small stocks, are positively skewed and most of their variability is on the upside. For bills, however, the mean and median values are almost identical, and for bonds the means are only 2% to 5% higher than the medians.

It may not be appropriate to use the coefficient of variation to compare the risk-return tradeoffs of different asset classes because the risk measure in the numerator, standard deviation, suffers from two flaws:

1. It measures deviations around the means of individual asset classes, which vary widely. For example, at the end of 15 years, the mean value is $1.12 for T-bills and $7.30 for small stocks. For practical relevance, the risk of different asset classes should be measured relative to target values of investors.
2. It includes upside deviations, whereas investors are concerned only about DDs.

Table 2 shows the mean values, DDs, and CDDs of the six asset classes for different target returns and holding periods. Over one year, T-bills have the lowest CDD, followed by intermediate government bonds, for 2% and 5% target returns; intermediate government bonds have the lowest CDD, followed by T-bills, for an 8% target. Small stocks have the highest CDD and large stocks have the second-highest CDD for all the target returns. When the holding period increases to five years, the results begin to vary. Intermediate government

bonds have the lowest, and T-bills have the second-lowest CDD for a 2% target, whereas large stocks have the lowest, and small stocks have the second-lowest CDD for 5% and 8% targets. T-bills have the highest CDD for 5% and 8% targets. Over 15 years, small stocks have the lowest CDD, large stocks have the second-lowest CDD, and T-bills have the highest CDD, for all the target returns.

These results show that the downside risk-return characteristics of asset classes change dramatically with the holding period. T-bills provide the best risk-return tradeoff in the short term, but are a poor investment over the long term. Stocks have the worst risk-return characteristics in the short term, but are the best investment for the long term. Therefore, assets that are considered risky by traditional risk measures, such as standard deviation and range, offer the best risk-return tradeoff over long periods, when risk is measured by DDs below target returns. Furthermore, these results reflect both higher returns and lower risk of stocks, compared to bonds and bills, for medium to high target returns over long periods. Over 15 years, small stocks have the highest mean value and second-lowest DD, whereas large stocks have the second-highest mean value and lowest DD, for 5% and 8% target returns.

These findings suggest that among individual asset classes, the best risk-return tradeoffs are offered by T-bills in short periods for low and medium targets, intermediate government bonds in short periods for high targets and in medium periods for low targets, large stocks in medium periods for medium and high targets, and small stocks over long periods for all targets. The asset allocations of optimal portfolios will, however, be influenced by the correlations between the individual asset classes.

Table 3 shows the correlations between real terminal values of the asset classes over short, medium, and long terms. There are strong correlations, ranging between 0.80 and 0.86, among the three bonds, over all periods. Large and small stocks also have strong correlations of 0.75 to 0.83 in the three terms. Intermediate government bonds and T-bills have moderate correlations of 0.47 to 0.52 in the three periods. These correlations suggest that including more than one type of bond, or combining large stocks with small stocks, or intermediate government bonds with T-bills, will not provide much diversification benefit over any period.

Table 4 presents the asset allocations of the optimal portfolios, which minimize the CDDs. For short-term investors with a 2% target return, the optimal portfolio consists of 66% T-bills, 26% intermediate government bonds, 4% large stocks, and 3% small stocks. The optimal allocation changes to 68% intermediate government bonds, 4% long corporate bonds, 16% large stocks, and 12% small stocks for a 5% target return, and to 8% intermediate government bonds, 36% long corporate bonds, 26% large stocks, and 29% small stocks for an 8% target return. Thus, short-term investors can load up on the risk-free security only if they are willing to accept a low return. As the target return increases, investors have to invest in intermediate government bonds, corporate bonds and stocks to improve the risk-return tradeoff.

For medium-term investors with a low target return, the optimal portfolio comprises 39% T-bills, 47% intermediate government bonds, 10% large stocks, and 3% small stocks. For a medium target return, the allocations are 65% intermediate government bonds, 24% large stocks, and 12% small stocks. The high target return is best achieved with 17% in long corporate bonds, 47% in large stocks, and 36% in small stocks.

Table 3
Correlations between real terminal values of different asset classes over various holding periods

	TB	ITGB	LTGB	LTCB	LCS	SCS
Panel A. 1-Year holding period						
Treasury bills (TB)	1.00					
Intermediate-term government bonds (ITGB)	0.49	1.00				
Long-term government bonds (LTGB)	0.34	0.85	1.00			
Long-term corporate bonds (LTCB)	0.33	0.80	0.86	1.00		
Large company stocks (LCS)	0.06	0.14	0.19	0.22	1.00	
Small company stocks (SCS)	0.01	0.07	0.09	0.15	0.83	1.00
Panel B. 5-Year holding period						
Treasury bills (TB)	1.00					
Intermediate-term government bonds (ITGB)	0.47	1.00				
Long-term government bonds (LTGB)	0.32	0.85	1.00			
Long-term corporate bonds (LTCB)	0.33	0.82	0.85	1.00		
Large company stocks (LCS)	0.09	0.22	0.25	0.29	1.00	
Small company stocks (SCS)	0.03	0.14	0.15	0.20	0.82	1.00
Panel C. 15-Year holding period						
Treasury bills (TB)	1.00					
Intermediate-term government bonds (ITGB)	0.52	1.00				
Long-term government bonds (LTGB)	0.38	0.85	1.00			
Long-term corporate bonds (LTCB)	0.38	0.82	0.86	1.00		
Large company stocks (LCS)	0.06	0.12	0.16	0.21	1.00	
Small company stocks (SCS)	0.01	0.04	0.08	0.13	0.75	1.00

For long-term investors with a low target return, the optimal allocation is 58% intermediate government bonds, 14% large stocks, and 28% small stocks. For medium and high target returns, the optimal portfolio of long-term investors is fully invested in small stocks.

These results indicate that T-bills dominate the portfolio only for short-term investors with a low target. Intermediate government bonds are the major investment for short-term investors with a medium target, and for medium-term investors with low or medium targets. The stock allocations of optimal portfolios increase with the target return as well as with the holding period. For a high target return, stocks are the primary component of the optimal portfolio. For medium and high target returns over a long holding period, the optimal portfolio consists solely of small stocks.

These findings contrast with those of Levy and Gunthorpe (1993), who report that for mean-variance investors, intermediate government bonds dominate the optimal portfolio for all holding periods, and the proportion of these bonds in the portfolio increases with the holding period. In a mean-DD framework, stocks are the primary component of the optimal portfolio for high target returns, and the optimal portfolio comprises only small stocks for medium and high target returns over long periods.

Table 5 shows the downside risk-return characteristics of the optimum portfolios. The target returns of 2%, 5%, and 8% are binding constraints only for the 1-year period. The actual compounded real annual rates of return of the optimal portfolios range between 3.06% and 10.49% for the 5-year period, and from 8.61% to 14.17% for the 15-year period. Thus, these optimal portfolios offer returns that are substantially higher than the targets, especially over the long term. The DD of the optimal portfolio consistently increases with the target

Table 4
Asset allocations of portfolios with minimum coefficients of downside deviation (DD) for different target returns over various holding periods

	Asset allocations for real annual target returns of:		
	2%	5%	8%
Panel A. 1-Year holding period			
Treasury bills	66.26%	0.00%	0.00%
Intermediate-term government bonds	25.88%	68.39%	8.35%
Long-term government bonds	0.00%	0.00%	0.00%
Long-term corporate bonds	0.00%	3.64%	35.89%
Large company stocks	4.42%	15.50%	26.33%
Small company stocks	3.44%	12.47%	29.43%
Panel B. 5-Year holding period			
Treasury bills	39.26%	0.00%	0.00%
Intermediate-term government bonds	47.47%	64.83%	0.00%
Long-term government bonds	0.00%	0.00%	0.00%
Long-term corporate bonds	0.00%	0.00%	17.15%
Large company stocks	9.85%	23.53%	47.05%
Small company stocks	3.41%	11.64%	35.80%
Panel C. 15-Year holding period			
Treasury bills	0.00%	0.00%	0.00%
Intermediate-term government bonds	57.95%	0.00%	0.00%
Long-term government bonds	0.00%	0.00%	0.00%
Long-term corporate bonds	0.00%	0.00%	0.00%
Large company stocks	13.88%	0.00%	0.00%
Small company stocks	28.17%	100.00%	100.00%

return and with the holding period. The CDD rises with the target return, for each holding period. For each target return, the CDD increases as the holding period rises from 1 to 5 years, but it falls as the holding period increases from 5 to 15 years.

Table 5
Downside risk-real return characteristics of portfolios with minimum coefficients of downside deviation (DD) for different target returns over various holding periods

	Portfolio characteristics for real annual target returns of:		
	2%	5%	8%
Panel A. 1-Year holding period			
Mean value	1.0200	1.0500	1.0800
Compounded annual return	0.0200	0.0500	0.0800
Downside deviation	0.0215	0.0549	0.0992
Coefficient of downside deviation	0.0210	0.0523	0.0919
Panel B. 5-Year Holding Period			
Mean value	1.1626	1.3289	1.6468
Compounded annual return	0.0306	0.0585	0.1049
Downside deviation	0.0540	0.1639	0.3379
Coefficient of downside deviation	0.0464	0.1233	0.2052
Panel C. 15-Year holding period			
Mean value	3.4535	7.2996	7.2996
Compounded annual return	0.0861	0.1417	0.1417
Downside deviation	0.1132	0.6276	1.2268
Coefficient of downside deviation	0.0328	0.0860	0.1681

Table 6
Asset allocations of portfolios with minimum coefficients of downside deviation (DD) and minimum downside deviations (DD) for different target returns over 5- and 15-year holding periods

	Asset allocations of portfolios with:			
	5-Year holding period		15-Year holding period	
	Min. CDD	Min. DD	Min. CDD	Min. DD
Panel A. Real annual target return: 2%				
Treasury bills	39.26%	51.49%	0.00%	0.00%
Intermediate-term government bonds	47.47%	38.02%	57.95%	83.27%
Long-term government bonds	0.00%	0.00%	0.00%	0.00%
Long-term corporate bonds	0.00%	0.00%	0.00%	0.00%
Large company stocks	9.85%	8.21%	13.88%	12.33%
Small company stocks	3.41%	2.28%	28.17%	4.40%
Panel B. Real annual target return: 5%				
Treasury bills	0.00%	0.00%	0.00%	0.00%
Intermediate-term government bonds	64.83%	72.72%	0.00%	32.41%
Long-term government bonds	0.00%	0.00%	0.00%	0.00%
Long-term corporate bonds	0.00%	0.00%	0.00%	21.16%
Large company stocks	23.53%	19.85%	0.00%	37.87%
Small company stocks	11.64%	7.43%	100.00%	8.55%
Panel C. Real annual target return: 8%				
Treasury bills	0.00%	0.00%	0.00%	0.00%
Intermediate-term government bonds	0.00%	27.31%	0.00%	0.00%
Long-term government bonds	0.00%	0.00%	0.00%	1.80%
Long-term corporate bonds	17.15%	14.83%	0.00%	3.62%
Large company stocks	47.05%	38.24%	0.00%	76.22%
Small company stocks	35.80%	19.62%	100.00%	18.36%

Some investors may simply want to minimize the downside risk, rather than minimizing the CDD. For the benefit of such investors, the tests were repeated, changing the objective function to minimizing DD. The portfolio allocations for this objective are identical to those that minimize the CDD for the one-year period. There are some differences in the 5- and 15-year periods, shown in Table 6.

For the 5-year period, with a 2% target return, the allocation in the optimal portfolio increases by 12% for T-bills and decreases by 9% for intermediate government bonds, 2% for large stocks, and 1% for small stocks. With a 5% target return, the optimal allocation rises by 8% for intermediate government bonds, while it falls by 4% each for large and small stocks. For an 8% target return, the optimal proportion increases by 27% for intermediate government bonds and declines by 2% for corporate bonds, 9% for large stocks, and 16% for small stocks.

Over 15 years, for a 2% target return, the optimal allocation rises by 25% for intermediate government bonds, while it falls by 2% for large stocks and 24% for small stocks. With a 5% target return, the optimal proportion increases by 32% for intermediate government bonds, 21% for corporate bonds, and 38% for large stocks, declining by 91% for small stocks. For an 8% target return, the optimal allocation rises by 2% for long government bonds, 4% for long corporate bonds and 76% for large stocks, decreasing by 82% for small stocks.

Thus, in the short term, the optimal allocations are identical for investors minimizing DD

and those minimizing the CDD. For medium and long periods, investors minimizing downside risk have higher allocations in safer assets than investors minimizing the proportion of downside risk to mean value. However, both groups of investors increase allocations to riskier assets for higher target returns and longer holding periods. For an 8% target return over 15 years, the optimal stock allocation is 95% for investors minimizing DD and 100% for those minimizing the CDD. Notably, for both the 5- and 15-year periods, for all target returns, the stock allocations of investors minimizing downside risk contain more large stocks than small stocks. The most striking difference between the optimal portfolios of investors minimizing DD and those minimizing the CDD is for the 8% target return over 15 years. Whereas the former have 100% in small stocks, the latter have 76% in large stocks and 18% in small stocks.

4. Conclusions

This study examines the allocations of U.S. financial assets in optimal portfolios that minimize the proportion of downside risk to mean real terminal value, where downside risk is measured by deviations from target returns. The results show that T-bills dominate the optimal portfolio only for short-term investors with a low target return. Intermediate government bonds are the major investment for short-term investors with a medium target and for medium-term investors with low or medium targets. The stock allocations of optimal portfolios increase with the target return as well as with the holding period. For a high target return, stocks are the primary component of the optimal portfolio. For medium and high target returns over a long holding period, the optimal portfolio consists solely of small stocks. These findings are particularly relevant for financial planning, which is commonly based on a target return required to fulfill investment objectives over a period.

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