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Dynamic Portfolio Theory & Management

**Using Active Asset
Allocation to Improve
Profits
and Reduce Risk**

Richard E. Oberuc

Finally, a book that provides a fully-explained procedure for determining when, why and how much to change your asset allocations as market conditions change. This book goes well beyond the concepts fostered by Harry Markowitz in his invention of Modern Portfolio Theory (MPT). The basic difficulty with MPT has been the generation of the required estimates of future performance and risk. Unfortunately most users of MPT use simple trend-following procedures to predict the needed future performance statistics. This has led to less than satisfying results since trends seldom persist. Dynamic Portfolio Theory and Management sidesteps the requirement to specify these vexing estimates by assuming past and future performance is controlled by a set of time-varying macroeconomic and market factors.

Finding the most effective set of influential factors is an important key. By applying the research of scores of leading market authorities, Oberuc develops a hierarchical consensus regarding factors such as dividend yields, unemployment, capacity utilization and a host of other factors considered useful in determining future investment performance. The evaluation of these most important factors is independently provided for stocks, bonds, interest rates and hedge funds.

The book shows how to integrate the most effective of these factors into a brand new portfolio optimization model devised by the author. The model structure is completely detailed in the book in a revolutionary system of equations called DynaPorte™. The DynaPorte system finds optimal asset allocation control equations that respond to changes in the influential factors in order to target the highest possible returns or to minimize risk. The effects of practical considerations such as allocation limits, transaction costs and dynamic leveraging are specifically considered.

The book documents how an investor with access to the provided procedures could have easily avoided the losses stemming from the 2000 stock market downturn. The procedures would have shifted allocations to other investments offering reasonable and safe investment growth. All that was needed was a fresh look at the factors that influence markets and a revolutionary methodology for altering investment portfolios.

0-07-142669-8 • \$55.00 • 256pp. • hardcover

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About the Author

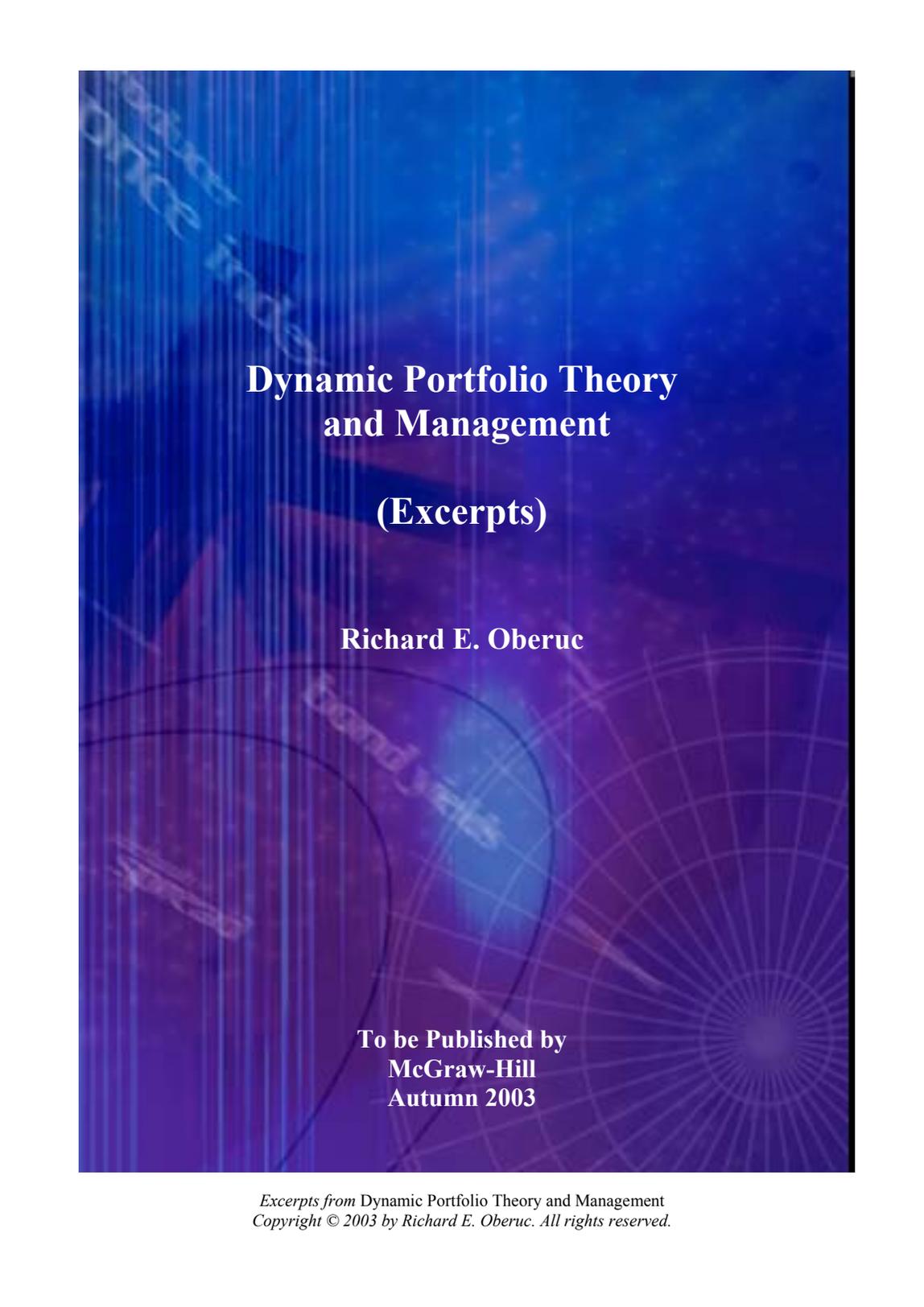
Richard Oberuc is Chairman of the Foundation for Managed Derivatives Research, whose sponsors include Morgan Stanley, Goldman Sachs, John W. Henry & Company, and Merrill Lynch among others. He is also founder and owner of Burlington Hall Asset Management. Mr. Oberuc has been in the financial industry for more than 25 years and has spent much time developing asset allocations systems including LaPorte and DynaPorte.

To order the book at a very substantial discount, visit the DynaPorte web site at

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**Dynamic Portfolio Theory
and Management**

(Excerpts)

Richard E. Oberuc

**To be Published by
McGraw-Hill
Autumn 2003**

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Advantages/Disadvantages of Mean Absolute Deviation

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Preface

Over a half-century has elapsed since the dawn of Modern Portfolio Theory (MPT). During this time a wealth of techniques have evolved to aid the investor in creating rational portfolios of multiple investments. The Markowitz mean-variance model has become a universally understood technique within the investment world for generating the trade off of changes in risk for changes in expected return called the efficient frontier. Despite the acceptance of MPT and its derivatives, there is still a nagging feeling that the value of the results obtained from MPT is limited by the uncertainty of the inputs required to implement the model. How should the needed expected returns, standard deviations and correlation matrix be obtained? Ten skilled financial analysts charged with determining the required inputs for an identical list of investments will in all likelihood generate ten different sets of assumed inputs. This will, of course, lead to ten different asset allocation results using the same MPT model. The problem is no longer how to estimate the optimal asset allocations. Harry Markowitz gave us the solution to that problem in the 1950s. The problem is how to determine the required inputs. Selecting a slice of history and using the average values of the investment performance for that time period, is a poor way to predict future performance. The linkage between long-term past investment performance and short-term future performance is weak at best. Something more effective is required.

There are two purposes for *Dynamic Portfolio Theory*. The first is to investigate a fundamental procedure to obtain more accurate estimates of future investment performance. This ultimately involves the determination of the factors that have an influence on investment returns, with special emphasis on the traditional markets of stocks, bonds and interest rates. Chapters 3, 4, and 5 evaluate many factors considered by leading financial investigators to be fundamentally related to the performance of these three traditional markets. Some of these factors are found to be truly useful and others not quite so useful. In addition, a number of new factors are considered, some of which are found to be effective when combined with the more commonly applied factors. Additionally, for the world of alternative investments, factors influencing the performance of hedge funds are evaluated in Chapter 6. Many individual investors will find that Chapters 3-6 are all they will need from this book. Simply knowing what factors to monitor will provide enough insight to confidently reduce allocations to those assets heading toward lower performance and increase allocations to those headed up.

The second purpose of this book is to present a new asset allocation model that sidesteps the need for determining expected returns, standard deviations and the correlation matrix in the first place. This new model called DynaPorte links the asset allocations directly to

Modern Portfolio Theory (MPT) is one of those established quantitative techniques. Specifically, the Markowitz mean-variance model has an established record of being applied to the asset allocation process. For fifty years, it has offered valuable insights and tractable solutions to the single-period asset allocation problem.

This book means to extend the thinking behind the Markowitz model and other static asset allocation models to allow for practical asset allocation in a fundamental, dynamic framework. This new framework, called DynaPorte, is fundamental because it employs macro-economic and market-related factors to determine their impact on changing asset allocations. DynaPorte's structure is considered dynamic because the model allows an indefinite number of discrete historical time periods to be used to optimize the model fit. Once a model is established, an additional indefinite number of future time periods can be used for producing out-of-sample forecasts.

In order to set the DynaPorte methodology in context, it is worthwhile to review the status of Modern Portfolio Theory for static models. The status of current approaches to dynamic portfolio models will be covered in Chapter 9 on Multi-Period Portfolio Theory.

1. The Markowitz Mean-Variance Model

Before Modern Portfolio Theory (MPT), the classical equity investment tool was the dividend discount model as typified by John Burr Williams (1938). This is a one-dimensional tool that only considers the expected return of an investment. There is no structure for dealing with risk. Carried to its logical conclusion, the dividend discount model could lead an investor to place all capital in the single equity with the largest string of expected dividends. If we were certain about the future performance of investments, this would be a correct solution. Since we cannot be certain about future performance, this one-dimensional approach is a formula for financial disaster.

The inauguration of Modern Portfolio Theory came with the insight of Harry Markowitz (1959,1991) that an investor should not simply seek the single highest performing investment. An investor should create a portfolio of multiple investments. Each investment can be viewed as having a return that cannot be known with certainty. The return is a random variable with an expected value and an associated level of uncertainty or risk. Markowitz showed how to calculate the return and risk of any composite portfolio in terms of the individual investment return values, the risk values and the asset allocation weights given to the investments. His final insight was that there is a way to determine optimal asset allocation weights in order to target some desirable portfolio performance characteristic.

Figure 3.4 shows the resulting actual versus fit comparison on a monthly basis.



Figure 3.4

The standard errors of the coefficients shown in Table 3.16 have been adjusted as was done for Table 3.15 to account for overlapping time intervals.

There must be other factors that could further decrease the unexplained error of this model. What is required is a better understanding of the fundamental nature of the marketplace as well as the psychological reactions of investors to market circumstances. Further evaluation of the dividend discount model is likely to introduce additional factors that make logical sense and are borne out by empirical studies.

To gain some perspective on the degree of the fit ($R^2 = .607$) between the factors shown in Table 3.16 and the 12 month stock returns, Table 3.17 shows R^2 for similar multi-factor 12 month stock models developed in other investigations. All of the original investigators included in Table 3.1 are considered for this evaluation. Only those utilizing multi-factor models, using regression analysis based on 12 month forecasted returns, that are not cross-sectional models across multiple stocks and had a reported R^2 are included in Table 3.17.

R^2 for Multi-Factor 12 Month Stock Return Models

Investigators	Begin Data	End Data	Years of Data	12 Month Bond Model R^2
Cuttler, Poterba and Summers (1991)	1926	1985	60	0.077
Domain and Reichenstein	1942	1994	53	0.200
Durell	1987	1994	7	0.640
Fama and French	1927	1987	61	0.070
Kirby	1927	1987	61	0.084
Average				0.248

Table 3.17

3. Term Spread

Investigators	Begin Data	End Data	Years of Data	Sign of Coefficient	Degree of Significance
Booth and Booth	1954	1992	39	+	*
Cutler, Poterba and Summers (US)	1926	1988	63	+	**
Domain and Reichenstein	1942	1994	53	+	*
Elder	1966	1991	24	+	***
Fama and Bliss	1964	1985	22	+	**
Fama and French	1927	1987	61	+	**
Ilmanen (June 1995)	1978	1993	16	+	Low
Ilmanen (August 1995)	1965	1995	31	+	*
Jensen, Mercer and Johnson	1954	1992	39	+	*
Kirby	1927	1987	61	+	***
Lamont	1947	1994	48	+	**
Consensus				+	**

Table 4.2

The term spread is the most frequently proposed factor for predicting future bond returns. The term spread is normally defined as the difference between a long-term bond yield and a short-term interest bearing instrument yield, although other maturity differences are sometime employed. Most of the researchers shown in Table 4.2 use the yield difference between long-term (10 or 20 years) government bonds and the 30-day treasury bill rate as the measure for the term spread of interest rates. In several instances, the long-term yield is based on the Moody's Aaa bond portfolio. In a few cases, the short-term yield is based on the one year treasury bond.

It is possible that the term spread measures nothing more than a tendency for interest rates to return to their long-term average as pointed out by Fama and Bliss (1987). For example, if the long-term yield is exceptionally high and begins to drop, the owner of a long-term bond will find that the price of this bond will increase because it carries a higher yield than similar bonds currently available. Conversely, if the long-term yield is exceptionally low, then the owner of a bond purchased at the previous low yield will find the price of this bond will drop as interest rates rise. The existing low-yield bond will not be as valuable since new bonds will obtain higher yields. Therefore, the simple process of interest rates returning to their long-term mean could explain the apparent impact of a term spread on bond returns.

Fama and French (1989) suggest another explanation for the importance of terms spreads. The term spread can be considered as the risk premium associated with bearing the duration risk of an investment held for an extended period. This duration risk could have an impact on the return of stocks or bonds.

Market Timing Methods and Results

*It is circumstance and proper timing that give an action
its character and make it either good or bad.*

Plato. From Plutarch, Lives. (444-400 B.C.)

Time-varying asset allocation is motivated by return enhancement or by risk avoidance or some combination of the two concepts. Otherwise a static portfolio with the most acceptable reward and risk expectations would be implemented and never revised. In the urgent world of investing there is always some pressure to consider modifying the portfolio allocations as the investment climate changes. Whether motivated by a sudden lowering of interest rates by the Fed, an oil production announcement by OPEC or a surge in reported industrial capacity utilization, there are frequent temptations to consider portfolio alteration.

Any investor considering the adoption of a model to change allocations frequently should have an interest in the maximum potential for better portfolio performance. There are many questions to be resolved. For example, how does the frequency of portfolio revisions affect the outcome? How does the number of investments considered in the portfolio alter performance? What is the influence of transaction costs? How does the prediction accuracy affect the potential return? How does the size of allocation changes influence the results? What types of timing models hold some promise for increasing return over buy-and-hold? How successful have models or actual money managers been at altering portfolios and against what benchmark? This chapter addresses some of these issues in order to evaluate the potential reward for market timing.

1. Market Timing versus Dynamic Asset Allocation

Before we attempt to answer any of the open questions, let us address the difference between *market timing* and *dynamic asset allocation*. Unfortunately, some consider the words *market timing* to carry a bad connotation, as if it were only conducted by unsuccessful or disreputable investment managers. But the concept of market timing is just a tool. How it is applied or misapplied is another matter. We are interested in whether there is likely profitability in a system that alters asset allocations on a regular basis.

1. Multi-Period Models with Predictable Returns

The point of departure for multi-period portfolio optimization is to assume that returns at each period of the horizon are not constant but vary conditionally with a set of exogenous factors in accordance with some model. Let us apply the name *Multi-Period Portfolio Theory* or MPPT to this body of knowledge concerning conditional multi-period portfolio optimization.

The specific model of interest for what follows is to assume that the returns, or the asset allocations themselves, are a linear function of a set of macroeconomic factors. Since 1980 an avalanche of research has shown that many types of investments have returns that can be related to previous values of macroeconomic factors. For a review of this research see Chapters 3-6 on stocks, bonds, interest rates and hedge funds.

Another concept common to these models is the budget constraint between one time period and the next. This equation calculates the change in wealth between the two time periods as a function of the allocations to the investments and the state variables. This change in wealth considers both the periodic rate of return on the underlying investments as well as the periodic capital consumption of a portion of the portfolio.

Assuming

The investor's wealth at time t	W_t
The capital consumption occurring during time t is	C_t
The return of investment j at time t is	r_{jt}
The portfolio allocation given to investment j during time t is	x_{jt}

Considering both portfolio growth and capital consumption, the value of the investor's portfolio at the end of time $t+1$ is

$$W_{t+1} = (W_t - C_t) \sum_{j=1}^n (x_{jt} r_{jt}) \quad (9.1)$$

When investment returns are not independent and identically distributed (i.i.d.) over the investment horizon, the asset allocations at each point in time can be calculated as a function of macroeconomic factors in order to maximize the resulting terminal wealth. Investors who are able to anticipate the level of future returns may alter their current allocations to be better positioned to take advantage of the returns to come. The difference in asset allocations between a dynamic and myopic portfolio policy is referred to as *hedging demand*. This process is termed the hedging demand because it may lead to ignoring the single-period (myopic) optimal allocations in order to hedge against future changes in investment opportunities.

1. Model Objectives

In Chapter 9, we mention a number of approaches to multi-period investment models. In many of these cases the mathematical statement of the problem is challenging, the solution methodologies are difficult and many simplifying assumptions must be made. The number of investments that can be treated is frequently very small and the number of controlling factors is limited. In addition to these problems, the impact of skewed performance distributions can cause difficulties with many solution methodologies. With all of these difficulties in mind, the following model objectives are proposed.

Handle a Reasonably Large Number of Investments

The investments in the portfolio should be considered to be investment classes rather than individual securities. The DynaPorte methodology is not suited to determining allocations to hundreds of stocks. The methodology is better suited to determining allocations to tens of asset classes. This is true because macroeconomic factors have a stronger relationship with asset classes than they do with individual securities. The difference in performance between two individual securities in the same asset class is related to differences in company specifics, not to macroeconomic factors. Using the DynaPorte formulation, up to 20 or 30 asset classes might be the largest allocation problem that can be solved in a practical amount of time, although larger problems are feasible.

Make The Allocations a Function of Macroeconomic Factors

Instead of making the portfolio returns, standard deviations and the correlation coefficients be functions of influential factors, the idea is to make the asset allocations be direct linear functions of these factors. This approach of making the asset allocations a linear function of the influential factors has been incorporated in other asset allocation formulations including Brandt (1999) and Campbell, Chan and Viceira (2001). These other formulations deal with more complex problems and are not linear programming structures, but they support the concept of using linear functions of exogenous factors to represent time varying asset allocations.

Using this procedure avoids the two-stage process of determining the performance expectations from the influential factors and then using these expectations to generate the asset allocations. It also avoids the problem of building a consistent set of expectations based on the factors. A correlation matrix in which each covariance term is independently developed based on a factor model while remaining consistent with each other covariance term could prove difficult. For implementations of the mean-variance model with linear return functions of influential factors, see Perold (1984) and Robertsson (2000). In the formulation that follows, making the allocation to each investment be a function of a set of macroeconomic factors does not turn out to present any consistency problem.

Allocation Summation Constraint

For each time period t the sum of allocations across each of the j investments must equal that period's leverage ratio, LEV_t . In an unleveraged situation, the sum of the allocations would simply be 1.

$$\sum_{j=1}^N AA_{jt} = LEV_t \quad (10.9)$$

Although it is not a part of the formulation of the model, combining equations (10.3) and (10.9) produces the following two useful results.

$$\sum_{j=1}^N A_j = C \quad (10.10)$$

and for each factor k

$$\sum_{j=1}^N B_{kj} = D_k \quad (10.11)$$

Equation (10.11) indicates that a change in the allocation to investment j due to the change in factor k must be offset by changes in the allocations to one or more other investments. The sum of all changes in allocation due to a change in factor k must be zero across all investments if there is no change in leverage.

Average Portfolio Return Constraint Over All Time Periods

The average portfolio return over all time periods R_{avg} is the simple average of the portfolio returns for each time period R_t . Since there are M time periods, the average portfolio return is:

$$R_{avg} = 1/M \sum_{t=1}^M R_t \quad (10.12)$$

When minimizing the objective function (10.2), the value of R_{avg} is a specified value within the range of feasible average portfolio returns.

Asset Allocation Upper Bounds

The asset allocation upper bound for each investment j must be less than or equal to the same maximum proportion of the leverage ratio for each time period t . The upper bounds are not constants. They are constants $amax_j$ multiplied times the leverage ratio LEV_t in effect for the time period t .

$$AA_{jt} \leq amax_j LEV_t \quad (10.13)$$

The resulting dynamic allocation to stocks is shown in Figure 11.3.

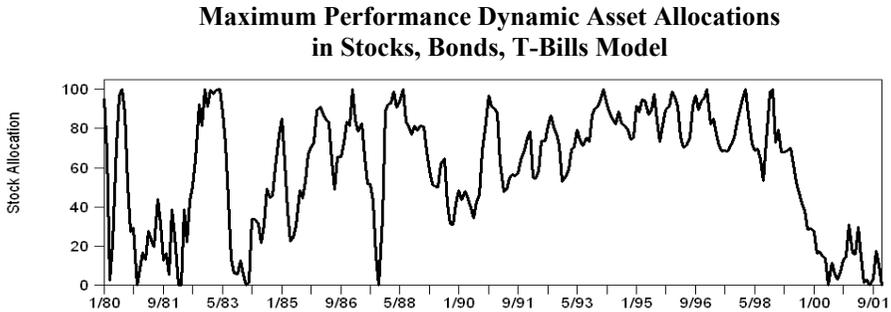


Figure 11.3

The allocations given to stocks as shown in Figure 11.3 are similar, but not identical, to the stock allocations shown in Table 11.1. The statistical performance of the dynamic asset allocation model with these changing allocations is shown on the last line of Table 11.5 along with the 100% buy-and-hold investments and the performance of the dynamic Stock, T-bill model for comparison.

Statistical Performance of Dynamic Stocks, Bonds, T-Bills Model

Investments	Leverage Ratio	Max Min	Monthly Arith Average	Annual Geo Average	Annual Arith Std-Dev	Max Draw-down	Annual Sharpe Ratio	Average Deviation Below 0
100% Stocks	1.0	None	1.2688	14.9694	15.4011	30.4919	0.5438	1.1538
100% Government Bonds	1.0	None	0.9057	10.7827	10.9256	19.2140	0.3833	0.7890
100% T-Bills	1.0	None	0.5339	6.5948	0.7817	0.0	N/A	0
Dynamic Stocks, T-Bills	1.0	Max	1.5059	19.1071	9.7022	7.9711	1.2896	0.4083
Dynamic Stocks, Bonds, T-Bills	1.0	Max	1.6018	20.2378	11.5479	10.6956	1.1814	0.6435

Table 11.5

The maximum-performance dynamic model of Stocks, Bonds and T-bills increases the excess return over 100% stocks by another 1.13% to a total excess return of 5.27%. While this increase in return suffers a little more risk compared to the Stock, T-bills model, the new model still has much lower risk levels than 100% stocks. Nonetheless, the stocks/bonds portfolio grows to a significantly higher level of terminal wealth than the stocks/T-bills portfolio as shown in Figure 11.4.

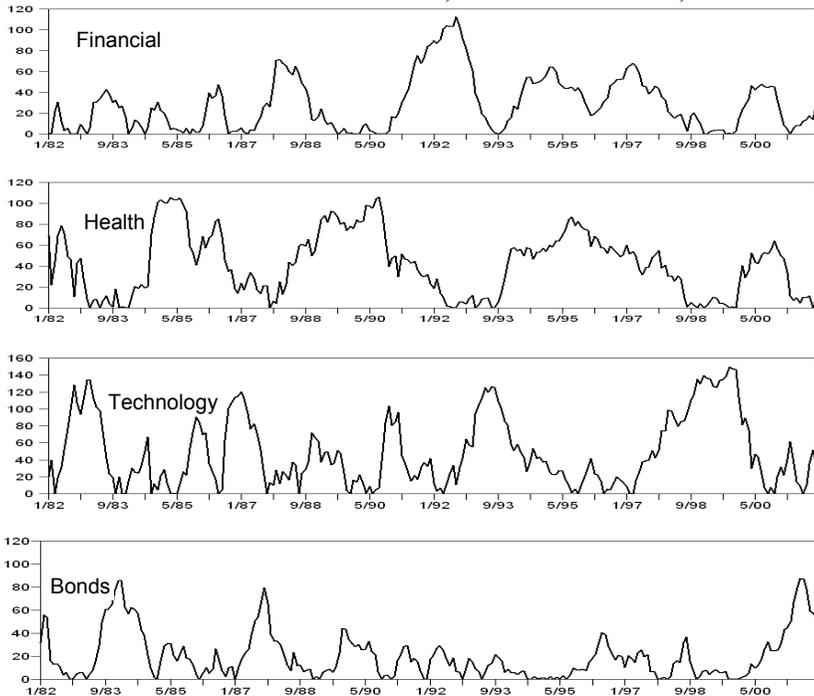
Maximum Performance of a Dynamic Four Stock Sectors, Government Bonds, T-Bills Model

Investments	Leverage Ratio	Max Min	Monthly Arith Average	Annual Geo Average	Annual Arith Std-Dev	Max Draw-down	Annual Sharpe Ratio	Average Deviation Below 0
100% Financial Services	1.0	None	1.5507	17.9496	19.8014	46.9274	0.5734	1.5796
100% Health Care	1.0	None	1.7071	20.3394	19.1016	34.7716	0.7196	1.3413
100% Technology	1.0	None	1.6463	15.7138	31.7550	74.0865	0.2872	2.6586
100% Utility	1.0	None	1.1891	14.2175	13.4181	43.7506	0.5681	0.9808
100% Government Bonds	1.0	None	0.7555	9.3231	4.9063	7.3296	0.5561	0.2654
100% T-Bills	1.0	None	0.5250	6.4833	0.6682	0	N/A	0
Dynamic Stocks, Bonds, T-Bills	1.0	Max	2.7168	35.8720	18.1381	11.7268	1.6141	0.7634
Dynamic Stocks, Bonds, T-Bills	1.5	Max	3.7355	50.2909	27.0251	17.5203	1.6169	1.2198

Table 11.14

The dynamic allocations undergo large changes over the course of this 20-year interval. Figure 11.11 shows that each one of the investments has several peaks of high allocations. The technology fund has several intervals of large allocations including a very long interval during the late 1990s. All of the equity funds are then suppressed during 2001 as the majority of the allocation is given to bonds.

Dynamic Allocations in Four Stock Sectors, Government Bonds, T-Bills Model



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**To be Published October 2003
by McGraw-Hill**

(Excerpts)

**To be Published by
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The resulting dynamic allocation to stocks is shown in Figure 11.3.

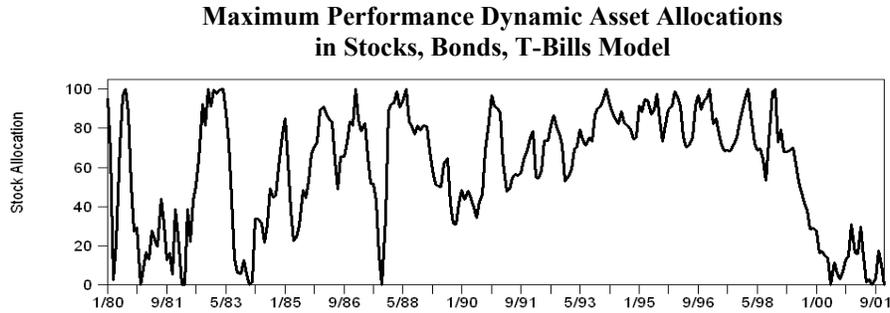


Figure 11.3

The allocations given to stocks as shown in Figure 11.3 are similar, but not identical, to the stock allocations shown in Table 11.1. The statistical performance of the dynamic asset allocation model with these changing allocations is shown on the last line of Table 11.5 along with the 100% buy-and-hold investments and the performance of the dynamic Stock, T-bill model for comparison.

Statistical Performance of Dynamic Stocks, Bonds, T-Bills Model

Investments	Leverage Ratio	Max Min	Monthly Arith Average	Annual Geo Average	Annual Arith Std-Dev	Max Draw-down	Annual Sharpe Ratio	Average Deviation Below 0
100% Stocks	1.0	None	1.2688	14.9694	15.4011	30.4919	0.5438	1.1538
100% Government Bonds	1.0	None	0.9057	10.7827	10.9256	19.2140	0.3833	0.7890
100% T-Bills	1.0	None	0.5339	6.5948	0.7817	0.0	N/A	0
Dynamic Stocks, T-Bills	1.0	Max	1.5059	19.1071	9.7022	7.9711	1.2896	0.4083
Dynamic Stocks, Bonds, T-Bills	1.0	Max	1.6018	20.2378	11.5479	10.6956	1.1814	0.6435

Table 11.5

The maximum-performance dynamic model of Stocks, Bonds and T-bills increases the excess return over 100% stocks by another 1.13% to a total excess return of 5.27%. While this increase in return suffers a little more risk compared to the Stock, T-bills model, the new model still has much lower risk levels than 100% stocks. Nonetheless, the stocks/bonds portfolio grows to a significantly higher level of terminal wealth than the stocks/T-bills portfolio as shown in Figure 11.4.

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- 9. Multi-Period Portfolio Theory
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- 11. DynaPorte Model Examples
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 - Review of the DynaPorte Dynamic Model Performance

Allocation Summation Constraint

For each time period t the sum of allocations across each of the j investments must equal that period's leverage ratio, LEV_t . In an unleveraged situation, the sum of the allocations would simply be 1.

$$\sum_{j=1}^N AA_{jt} = LEV_t \quad (10.9)$$

Although it is not a part of the formulation of the model, combining equations (10.3) and (10.9) produces the following two useful results.

$$\sum_{j=1}^N A_j = C \quad (10.10)$$

and for each factor k

$$B \sum_{j=1}^N D_k \quad (10.11)$$

Equation (10.11) indicates that a change in the allocation to investment j due to the change in factor k must be offset by changes in the allocations to one or more other investments. The sum of all changes in allocation due to a change in factor k must be zero across all investments if there is no change in leverage.

Average Portfolio Return Constraint Over All Time Periods

The average portfolio return over all time periods R_{avg} is the simple average of the portfolio returns for each time period R_t . Since there are M time periods, the average portfolio return is:

$$R_{avg} = 1/M \sum_{t=1}^M R_t \quad (10.12)$$

When minimizing the objective function (10.2), the value of R_{avg} is a specified value within the range of feasible average portfolio returns.

Asset Allocation Upper Bounds

The asset allocation upper bound for each investment j must be less than or equal to the same maximum proportion of the leverage ratio for each time period t . The upper bounds are not constants. They are constants $amax_j$ multiplied times the leverage ratio LEV_t in effect for the time period t .

$$AA_{jt} \leq amax_j LEV_t \quad (10.13)$$

12. Mean Absolute Deviation

Advantages/Disadvantages of Least Squares

Advantages/Disadvantages of Mean Absolute Deviation

Do MAD and LS Obtain Similar Model Coefficients?

Does MAD Produce Better Forecasts than Least Squares?

Should we Prefer MAD to LS?

1. Model Objectives

In Chapter 9, we mention a number of approaches to multi-period investment models. In many of these cases the mathematical statement of the problem is challenging, the solution methodologies are difficult and many simplifying assumptions must be made. The number of investments that can be treated is frequently very small and the number of controlling factors is limited. In addition to these problems, the impact of skewed performance distributions can cause difficulties with many solution methodologies. With all of these difficulties in mind, the following model objectives are proposed.

Handle a Reasonably Large Number of Investments

The investments in the portfolio should be considered to be investment classes rather than individual securities. The DynaPorte methodology is not suited to determining allocations to hundreds of stocks. The methodology is better suited to determining allocations to tens of asset classes. This is true because macroeconomic factors have a stronger relationship with asset classes than they do with individual securities. The difference in performance between two individual securities in the same asset class is related to differences in company specifics, not to macroeconomic factors. Using the DynaPorte formulation, up to 20 or 30 asset classes might be the largest allocation problem that can be solved in a practical amount of time, although larger problems are feasible.

Make The Allocations a Function of Macroeconomic Factors

Instead of making the portfolio returns, standard deviations and the correlation coefficients be functions of influential factors, the idea is to make the asset allocations be direct linear functions of these factors. This approach of making the asset allocations a linear function of the influential factors has been incorporated in other asset allocation formulations including Brandt (1999) and Campbell, Chan and Viceira (2001). These other formulations deal with more complex problems and are not linear programming structures, but they support the concept of using linear functions of exogenous factors to represent time varying asset allocations.

Using this procedure avoids the two-stage process of determining the performance expectations from the influential factors and then using these expectations to generate the asset allocations. It also avoids the problem of building a consistent set of expectations based on the factors. A correlation matrix in which each covariance term is independently developed based on a factor model while remaining consistent with each other covariance term could prove difficult. For implementations of the mean-variance model with linear return functions of influential factors, see Perold (1984) and Robertsson (2000). In the formulation that follows, making the allocation to each investment be a function of a set of macroeconomic factors does not turn out to present any consistency problem.

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Preface

Over a half-century has elapsed since the dawn of Modern Portfolio Theory (MPT). During this time a wealth of techniques have evolved to aid the investor in creating rational portfolios of multiple investments. The Markowitz mean-variance model has become a universally understood technique within the investment world for generating the trade off of changes in risk for changes in expected return called the efficient frontier. Despite the acceptance of MPT and its derivatives, there is still a nagging feeling that the value of the results obtained from MPT is limited by the uncertainty of the inputs required to implement the model. How should the needed expected returns, standard deviations and correlation matrix be obtained? Ten skilled financial analysts charged with determining the required inputs for an identical list of investments will in all likelihood generate ten different sets of assumed inputs. This will, of course, lead to ten different asset allocation results using the same MPT model. The problem is no longer how to estimate the optimal asset allocations. Harry Markowitz gave us the solution to that problem in the 1950s. The problem is how to determine the required inputs. Selecting a slice of history and using the average values of the investment performance for that time period, is a poor way to predict future performance. The linkage between long-term past investment performance and short-term future performance is weak at best. Something more effective is required.

There are two purposes for *Dynamic Portfolio Theory*. The first is to investigate a fundamental procedure to obtain more accurate estimates of future investment performance. This ultimately involves the determination of the factors that have an influence on investment returns, with special emphasis on the traditional markets of stocks, bonds and interest rates. Chapters 3, 4, and 5 evaluate many factors considered by leading financial investigators to be fundamentally related to the performance of these three traditional markets. Some of these factors are found to be truly useful and others not quite so useful. In addition, a number of new factors are considered, some of which are found to be effective when combined with the more commonly applied factors. Additionally, for the world of alternative investments, factors influencing the performance of hedge funds are evaluated in Chapter 6. Many individual investors will find that Chapters 3-6 are all they will need from this book. Simply knowing what factors to monitor will provide enough insight to confidently reduce allocations to those assets heading toward lower performance and increase allocations to those headed up.

The second purpose of this book is to present a new asset allocation model that sidesteps the need for determining expected returns, standard deviations and the correlation matrix in the first place. This new model called DynaPorte links the asset allocations directly to

1. Multi-Period Models with Predictable Returns

The point of departure for multi-period portfolio optimization is to assume that returns at each period of the horizon are not constant but vary conditionally with a set of exogenous factors in accordance with some model. Let us apply the name *Multi-Period Portfolio Theory* or MPPT to this body of knowledge concerning conditional multi-period portfolio optimization.

The specific model of interest for what follows is to assume that the returns, or the asset allocations themselves, are a linear function of a set of macroeconomic factors. Since 1980 an avalanche of research has shown that many types of investments have returns that can be related to previous values of macroeconomic factors. For a review of this research see Chapters 3-6 on stocks, bonds, interest rates and hedge funds.

Another concept common to these models is the budget constraint between one time period and the next. This equation calculates the change in wealth between the two time periods as a function of the allocations to the investments and the state variables. This change in wealth considers both the periodic rate of return on the underlying investments as well as the periodic capital consumption of a portion of the portfolio.

Assuming

The investor's wealth at time t	W_t
The capital consumption occurring during time t is	C_t
The return of investment j at time t is	r_{jt}
The portfolio allocation given to investment j during time t is	x_{jt}

Considering both portfolio growth and capital consumption, the value of the investor's portfolio at the end of time $t+1$ is

$$W_{t+1} = (W_t - C_t) \sum_{j=1}^n (x_{jt} r_{jt}) \quad (9.1)$$

When investment returns are not independent and identically distributed (i.i.d.) over the investment horizon, the asset allocations at each point in time can be calculated as a function of macroeconomic factors in order to maximize the resulting terminal wealth. Investors who are able to anticipate the level of future returns may alter their current allocations to be better positioned to take advantage of the returns to come. The difference in asset allocations between a dynamic and myopic portfolio policy is referred to as *hedging demand*. This process is termed the hedging demand because it may lead to ignoring the single-period (myopic) optimal allocations in order to hedge against future changes in investment opportunities.

Modern Portfolio Theory (MPT) is one of those established quantitative techniques. Specifically, the Markowitz mean-variance model has an established record of being applied to the asset allocation process. For fifty years, it has offered valuable insights and tractable solutions to the single-period asset allocation problem.

This book means to extend the thinking behind the Markowitz model and other static asset allocation models to allow for practical asset allocation in a fundamental, dynamic framework. This new framework, called DynaPorte, is fundamental because it employs macro-economic and market-related factors to determine their impact on changing asset allocations. DynaPorte's structure is considered dynamic because the model allows an indefinite number of discrete historical time periods to be used to optimize the model fit. Once a model is established, an additional indefinite number of future time periods can be used for producing out-of-sample forecasts.

In order to set the DynaPorte methodology in context, it is worthwhile to review the status of Modern Portfolio Theory for static models. The status of current approaches to dynamic portfolio models will be covered in Chapter 9 on Multi-Period Portfolio Theory.

1. The Markowitz Mean-Variance Model

Before Modern Portfolio Theory (MPT), the classical equity investment tool was the dividend discount model as typified by John Burr Williams (1938). This is a one-dimensional tool that only considers the expected return of an investment. There is no structure for dealing with risk. Carried to its logical conclusion, the dividend discount model could lead an investor to place all capital in the single equity with the largest string of expected dividends. If we were certain about the future performance of investments, this would be a correct solution. Since we cannot be certain about future performance, this one-dimensional approach is a formula for financial disaster.

The inauguration of Modern Portfolio Theory came with the insight of Harry Markowitz (1959,1991) that an investor should not simply seek the single highest performing investment. An investor should create a portfolio of multiple investments. Each investment can be viewed as having a return that cannot be known with certainty. The return is a random variable with an expected value and an associated level of uncertainty or risk. Markowitz showed how to calculate the return and risk of any composite portfolio in terms of the individual investment return values, the risk values and the asset allocation weights given to the investments. His final insight was that there is a way to determine optimal asset allocation weights in order to target some desirable portfolio performance characteristic.

Market Timing Methods and Results

*It is circumstance and proper timing that give an action
its character and make it either good or bad.*

Plato. From Plutarch, Lives. (444-400 B.C.)

Time-varying asset allocation is motivated by return enhancement or by risk avoidance or some combination of the two concepts. Otherwise a static portfolio with the most acceptable reward and risk expectations would be implemented and never revised. In the urgent world of investing there is always some pressure to consider modifying the portfolio allocations as the investment climate changes. Whether motivated by a sudden lowering of interest rates by the Fed, an oil production announcement by OPEC or a surge in reported industrial capacity utilization, there are frequent temptations to consider portfolio alteration.

Any investor considering the adoption of a model to change allocations frequently should have an interest in the maximum potential for better portfolio performance. There are many questions to be resolved. For example, how does the frequency of portfolio revisions affect the outcome? How does the number of investments considered in the portfolio alter performance? What is the influence of transaction costs? How does the prediction accuracy affect the potential return? How does the size of allocation changes influence the results? What types of timing models hold some promise for increasing return over buy-and-hold? How successful have models or actual money managers been at altering portfolios and against what benchmark? This chapter addresses some of these issues in order to evaluate the potential reward for market timing.

1. Market Timing versus Dynamic Asset Allocation

Before we attempt to answer any of the open questions, let us address the difference between *market timing* and *dynamic asset allocation*. Unfortunately, some consider the words *market timing* to carry a bad connotation, as if it were only conducted by unsuccessful or disreputable investment managers. But the concept of market timing is just a tool. How it is applied or misapplied is another matter. We are interested in whether there is likely profitability in a system that alters asset allocations on a regular basis.

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Figure 3.4 shows the resulting actual versus fit comparison on a monthly basis.



Figure 3.4

The standard errors of the coefficients shown in Table 3.16 have been adjusted as was done for Table 3.15 to account for overlapping time intervals.

There must be other factors that could further decrease the unexplained error of this model. What is required is a better understanding of the fundamental nature of the marketplace as well as the psychological reactions of investors to market circumstances. Further evaluation of the dividend discount model is likely to introduce additional factors that make logical sense and are borne out by empirical studies.

To gain some perspective on the degree of the fit ($R^2 = .607$) between the factors shown in Table 3.16 and the 12 month stock returns, Table 3.17 shows R^2 for similar multi-factor 12 month stock models developed in other investigations. All of the original investigators included in Table 3.1 are considered for this evaluation. Only those utilizing multi-factor models, using regression analysis based on 12 month forecasted returns, that are not cross-sectional models across multiple stocks and had a reported R^2 are included in Table 3.17.

R^2 for Multi-Factor 12 Month Stock Return Models

Investigators	Begin Data	End Data	Years of Data	12 Month Bond Model R^2
Cuttler, Poterba and Summers (1991)	1926	1985	60	0.077
Domain and Reichenstein	1942	1994	53	0.200
Durell	1987	1994	7	0.640
Fama and French	1927	1987	61	0.070
Kirby	1927	1987	61	0.084
Average				0.248

Table 3.17

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3. Term Spread

Investigators	Begin Data	End Data	Years of Data	Sign of Coefficient	Degree of Significance
Booth and Booth	1954	1992	39	+	*
Cutler, Poterba and Summers (US)	1926	1988	63	+	**
Domain and Reichenstein	1942	1994	53	+	*
Elder	1966	1991	24	+	***
Fama and Bliss	1964	1985	22	+	**
Fama and French	1927	1987	61	+	**
Ilmanen (June 1995)	1978	1993	16	+	Low
Ilmanen (August 1995)	1965	1995	31	+	*
Jensen, Mercer and Johnson	1954	1992	39	+	*
Kirby	1927	1987	61	+	***
Lamont	1947	1994	48	+	**
Consensus				+	**

Table 4.2

The term spread is the most frequently proposed factor for predicting future bond returns. The term spread is normally defined as the difference between a long-term bond yield and a short-term interest bearing instrument yield, although other maturity differences are sometime employed. Most of the researchers shown in Table 4.2 use the yield difference between long-term (10 or 20 years) government bonds and the 30-day treasury bill rate as the measure for the term spread of interest rates. In several instances, the long-term yield is based on the Moody's Aaa bond portfolio. In a few cases, the short-term yield is based on the one year treasury bond.

It is possible that the term spread measures nothing more than a tendency for interest rates to return to their long-term average as pointed out by Fama and Bliss (1987). For example, if the long-term yield is exceptionally high and begins to drop, the owner of a long-term bond will find that the price of this bond will increase because it carries a higher yield than similar bonds currently available. Conversely, if the long-term yield is exceptionally low, then the owner of a bond purchased at the previous low yield will find the price of this bond will drop as interest rates rise. The existing low-yield bond will not be as valuable since new bonds will obtain higher yields. Therefore, the simple process of interest rates returning to their long-term mean could explain the apparent impact of a term spread on bond returns.

Fama and French (1989) suggest another explanation for the importance of terms spreads. The term spread can be considered as the risk premium associated with bearing the duration risk of an investment held for an extended period. This duration risk could have an impact on the return of stocks or bonds.

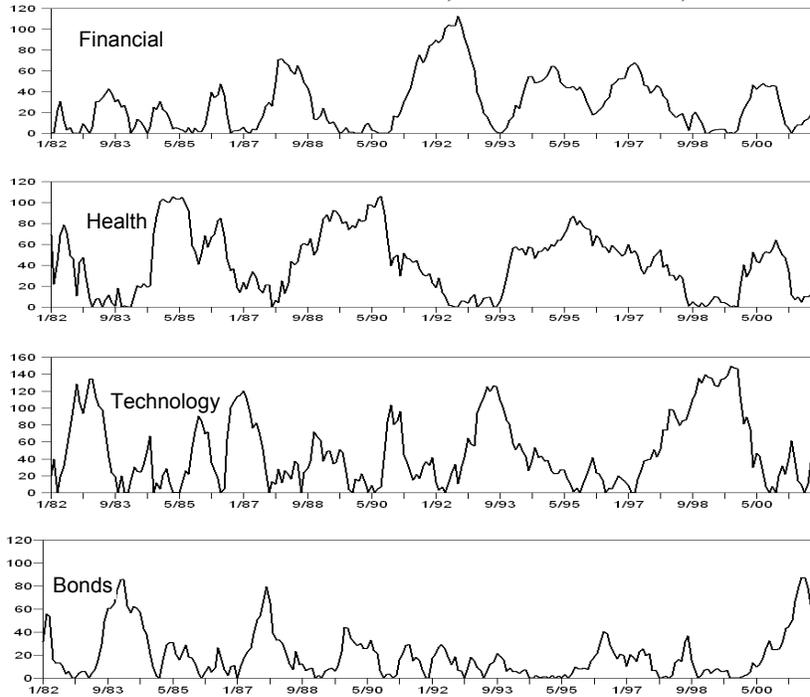
**Maximum Performance of a Dynamic
Four Stock Sectors, Government Bonds, T-Bills Model**

Investments	Leverage Ratio	Max Min	Monthly Arith Average	Annual Geo Average	Annual Arith Std-Dev	Max Draw-down	Annual Sharpe Ratio	Average Deviation Below 0
100% Financial Services	1.0	None	1.5507	17.9496	19.8014	46.9274	0.5734	1.5796
100% Health Care	1.0	None	1.7071	20.3394	19.1016	34.7716	0.7196	1.3413
100% Technology	1.0	None	1.6463	15.7138	31.7550	74.0865	0.2872	2.6586
100% Utility	1.0	None	1.1891	14.2175	13.4181	43.7506	0.5681	0.9808
100% Government Bonds	1.0	None	0.7555	9.3231	4.9063	7.3296	0.5561	0.2654
100% T-Bills	1.0	None	0.5250	6.4833	0.6682	0	N/A	0
Dynamic Stocks, Bonds, T-Bills	1.0	Max	2.7168	35.8720	18.1381	11.7268	1.6141	0.7634
Dynamic Stocks, Bonds, T-Bills	1.5	Max	3.7355	50.2909	27.0251	17.5203	1.6169	1.2198

Table 11.14

The dynamic allocations undergo large changes over the course of this 20-year interval. Figure 11.11 shows that each one of the investments has several peaks of high allocations. The technology fund has several intervals of large allocations including a very long interval during the late 1990s. All of the equity funds are then suppressed during 2001 as the majority of the allocation is given to bonds.

Dynamic Allocations in Four Stock Sectors, Government Bonds, T-Bills Model



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