The Effect of Investment Horizons on Risk, Return and End-of-Period Wealth for Major Asset Classes in Canada

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Abstract
The objective of this paper is to investigate whether the current practice among financial planners of recommending stocks at an early age and progressively moving into cash or bonds as retirement approaches would be appropriate. We computed returns, risks and end-of-period wealth distributions of various Canadian asset classes at increasing horizons between 1957 and 2003, based on the bootstrapping technique. Results show that investment outcomes at short horizons can be quite different from outcomes at longer horizons. Evidence is provided in favour of time diversification, while the current market practice of life cycle investing is not fully supported as stocks continue to exhibit more favourable risk-return payoffs than other asset classes, even at shorter time intervals.

JEL Classifications: G11, G23.

Keywords: Time Diversification, Investment Horizons, End-of-Period Wealth, Relative Performance

Résumé
Cet article se propose d'étudier le bien-fondé de la pratique actuelle qui consiste à recommander des actions aux investisseurs dans leur jeunesse et l'argent liquide ou les obligations lorsqu'ils approchent l'âge de la retraite. Grâce à la technique de bootstrapping, nous calculons les retours sur investissement, les risques et la distribution de richesse en fin de période pour plusieurs types d'actifs canadiens à horizons divers entre 1957 et 2003. Les résultats présentent des différences importantes entre les investissements à court terme et les investissements à long terme. Les données disponibles soutiennent l'idée de la diversification temporelle et réfutent partiellement la pratique actuelle du cycle de vie d'investissement. De fait, les actions comportent toujours un profil risques-bénéfices plus favorable que les autres types d'actifs, même pour des intervalles de temps réduits.

Mots clés : diversification temporelle, période de calcul, fin de la période de fortune, performance relative

The purpose of this study is to provide research, evidence, and answers with regard to the following question: How does the investment horizon affect investors' portfolio performance? To this end, the specific questions we examined are as follows:

1. For different asset classes, how does the holding period of return and risk, measured by the standard deviation of returns, change as the investment horizon is gradually increased?
2. How does asset class portfolio efficiency measured by the coefficient of variation and the Sharpe ratio change as the horizon lengthens? Does this have implications for an optimal investment horizon when investing in a particular asset class?
3. What is the distribution of ending period wealth when investing in different asset classes as the investment horizon lengthens, and how does the probability of ending up with a shortfall in wealth change as the investment horizon is increased in each asset class?

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4. As the investment horizon lengthens, what is the probability of one asset class outperforming another (i.e., stocks outperforming bonds)? What does this imply for the preferences of investors to invest in one asset class versus another?

The need for research to answer these questions has become increasingly important primarily due to fundamental changes that are taking place in the retirement planning industry. For example, corporate pension funds, traditionally structured as defined benefit plans that assured contributors of a predefined benefit at the time of retirement, are rapidly changing their structure to defined contribution plans (DCP) where decisions relating to investments, asset allocations and risk management are thrust upon the plan contributors.

Long term investment planning requires an understanding of the implications of investing over long horizons, particularly in respect to the conceptualization and measurement of risk. Yet, even among professionals there exists a considerable divergence of opinions regarding the implications of investment horizon on risk. For example, Olsen and Khaki (1998) suggest that the lack of closure on this topic is perhaps due to the profession's failure to accept a common definition of risk. They argue that investors should not only look at the conventional measures of risk, such as standard deviation of returns, but also view risk in terms of loss functions and the possibility of realizing returns below target levels.[1]

The usual argument advanced in life cycle investment recommendations is that people should not jeopardize their pension funds as they approach retirement and should therefore switch towards less risky assets such as cash or government bonds. This is inconsistent with most investment models as the probability distribution of terminal wealth is the same regardless of when risk is taken. Merton (1969, 1971), for example, formulated models taking into account that an investor's portfolio allocation is not influenced by his time horizon. Merton's conclusions do not support current practice of switching from stocks into cash and bonds at the onset of retirement. Equity exposure will never be zero in Merton's models and hence the current practice of investing for retirement would not be optimal and would reduce the value of retirement funds. Might it be possible that financial planners and DCP trustees choose solutions that at the same time limit the chance of being accused of improper efforts to minimize their own risk at the expense of their clients'/members' pension fund value at retirement?

The empirical literature on the aspect of long horizon risk and return analysis is scarce, possibly due to the limited span of historical data available for analysis especially outside the US. To overcome the data limitation in examining long horizon investment decisions, some recent US-based studies have adopted resampling techniques such as the bootstrap to extend the span of actual datasets (e.g., Hickman, Hunter, Byrd, Beck & Terpening, 2001). Nevertheless, financial markets outside the US, of which Canada is an example, have not been subjected to such analysis.

There are distinct differences between the Canadian and US markets. It is widely believed that the Canadian historical investment experience is very different from that of the US, where most of the studies on long term horizon performance are based (Gluskin 2006). The differential taxation of investment income in Canada versus that of the US and the heavier dependence of the Canadian market on commodities could play a role in this regard. Given that investment income is taxed more heavily in Canada, investors should expect higher before-tax returns from Canadian than US investments as they look at after-tax returns when making investment decisions. This is particularly true as in the long run foreign exchange differentials should not play an important role in determining returns. As a result, US holding period returns should behave differently than Canadian holding period returns, especially over long term horizons. Moreover, as Canadian equity markets are dominated by the financial and commodity sectors, a portfolio that looks like the Canadian market is not likely to be diversified.[2]

Hence, diversification is more essential in Canada than the US (Damsell 2006). The heavier weighting of the Canadian markets towards commodity stocks than their US counterparts should imply flatter long term performance of Canadian versus US equity markets vis-à-vis such markets' short term performance. Because commodity stocks belong to companies that over a typical cycle will produce low returns on capital and deficient stock market performance (DeCloet, 2006), if one stays invested for the long term and does not try to time the market, average returns will be about zero as there is not much growth in such stocks over the long run. As a result, active managers have beaten the index more often in Canada than in the US (Gluskin, 2006).[3] On the other hand, the US market is based more on growth-oriented stocks and, as a result, one may expect higher long-term returns. However, the risk of the US market can be higher as well. Given these two contradictory expectations, it would be informative to compare the Canadian and US markets to determine which is more efficient.

The limited diversification of the Canadian market in conjunction with the foreign content limitations (to which Canadian RRSP and pension fund portfolios are subjected) and the home bias demonstrated by Canadian investors make this study all the more important. For example, Ackert, Church, Tompkins and Zhang (2005) found that Canadian investors have a greater familiarity with local and domestic securities than foreign and non-local firms and, as a result, they invest more in such securities.

Moreover, Canadian results point towards the need to incorporate the autocorrelation structure of this study's asset classes in the resampling techniques used to extend the dataset. This is in contrast with US based studies, such as Hickman et al. (2001), who report that generally the autocorrelation coefficient levels of the asset classes they examined were low enough to obviate the need to incorporate correlation structures in their resampling procedures. Finally, unlike others investigating a similar question, our study is not based on simulations (e.g., Butler and Domian, 1991), but rather on actual return data that we bootstrap.

We find that investment outcomes at short horizons can be quite different from outcomes at longer horizons. While the current market practice of life cycle investing is not fully supported as stocks continue to exhibit more favourable risk-return payoffs than other asset classes (even at shorter time intervals), evidence is provided in favour of time diversification. Moreover, we find that the probability of a shortfall in end-of-period wealth decreases as the holding period lengthens. We also find that higher risk asset classes outperform lower risk asset classes and have higher end-of-period wealth for longer holding periods. Also, investing in higher risk asset classes will increase benefits monotonically as the time horizon increases.

Our study is the most comprehensive to examine horizon period returns in the Canadian markets. It should be useful to other studies of Canadian markets that examine asset allocation strategies designed to prevent people from outliving their money. Some studies need distributions of actual asset returns at various horizons to run simulations in order to determine probabilities of shortfall (e.g., Milevsky, Ho, and Robinson, 1997; Ho, Milevsky, and Robinson, 1994a; and Ho, Milevsky and Robinson, 1994b). Due to a lack of empirical data of the sort we analyzed in our study, these prior studies used return approximations from a variety of different sources. This is likely to have limited the consistency and generalizability of their findings and conclusions. Nevertheless, their conclusions are consistent with our own as they too found that traditional advice from financial planners on life cycle investing is not always correct. Finally, our results are consistent with Barberis (2000, p. 225) who found that "even after incorporating parameter uncertainty, there is enough predictability in returns to make investors allocate substantially more on stocks, the longer their horizon". They are also consistent with Cochrane (1999), who showed that stock prices exhibit negative serial correlation or mean reversion, which contributes to time diversification resulting in conclusions consistent with our own.

The remainder of our paper is structured as follows: The next section discusses the data and return computations. The following section highlights the method we employed, and the subsequent presents the results. The final section summarizes the findings and concludes the paper.

Sample Data and Return Computations

Data from January 1957 to December 2003 were obtained from the Canadian Financial Markets Research Centre (CFMRC) data base. This data source includes stock index (Canadian Universe Equally Weighted [EW] and Value Weighted [VW]) total return data, as well as rates of returns on indices of Long Term Government of Canada Bonds ([TBONDS] over 10 years) and 91-day Treasury Bills (TBILLS).

The CFMRC Equal Weighted Index return is the average monthly return for all domestic common equities in the CFMRC database. The CFMRC VW Index return is the market value weighted average monthly return for all domestic common equities in the CFMRC database. A security's market weight is defined as its market value at the beginning of the current month (shares outstanding multiplied by closing price on the last trading day in the previous month) divided by the market value of all securities included in the index. Returns used in the above indexes are fully adjusted for distributions.[4] The 91-day T-Bill return is defined as the return on a 91 day T-bill purchased at the end of last month and sold at the end of the current month. Long Term Government of Canada (GOC) Bond Return is defined as the return on a long term GOC bond with an approximate term to maturity of 17 years purchased at the end of last month and sold at the end of the current month. More on the descriptions of these series and their construction can be found in Hatch and White (1988).These rates of returns are discrete monthly returns. In carrying out our tests, we converted these returns into continuously compounded returns.

The summary statistics of the sample data are reported in Table 1. A comparison of the mean and the standard deviation of annualized monthly returns of the series confirm the standard risk-return trade-off that would be expected across these asset classes. The end-of-period wealth is computed as the ending value of an investment of $1 in each asset class with monthly compounding.

Table 1
*Summary Results Based on Annualized Returns**

Sample Data from January 1957 to December 2003 (Number of Observations = 564)			
Return series	Mean	Standard deviation	End-of-period wealth
EW	0.1628	0.1955	92.8498
VW	0.0939	0.1593	53.9879
TBONDS	0.0748	0.0887	43.2303
TBILLS	0.0652	0.0104	37.6473

* Returns and standard deviations are the annualized measures of the monthly returns and standard deviations.

Note:
EW Continuously compounded returns of the CFMRC equal weighted index.
VW Continuously compounded returns of the CFMRC value weighted index.
TBONDS Continuously compounded returns of the Long Term Government Bond index.
TBILLS Continuously compounded returns of the T-Bill index.

Method

To reach the objectives, we undertook a comparative assessment of the returns, risks, and end-of-period wealth distributions of investments in major Canadian asset classes (e.g., large stocks, small stocks, long term government of Canada bonds and Treasury bills) for different investment horizons. To this end, we used the historical index series for each of the above asset classes, computed holding period returns for a series of investment horizons, and then bootstrapped these returns to get the respective distributions of returns and end-of-period wealth for each horizon. From these distributions, we then examined the means, standard deviations, efficiency of performance measures (such as the coefficient of variation and the Sharpe ratio[5]), as well as the end-of-period wealth outcomes of the various investment horizons.

Second, we examined the comparative efficiency of investing in different asset classes. We did this by computing the return differentials between pairs of asset classes at different holding periods, applying a similar method. The incremental risk-return profile at different horizons indicate the relative benefits of investing in different asset allocation strategies (i.e., large and small stocks versus government of Canada bonds; large and small stocks versus T-bills; and government of Canada bonds versus T-bills) at different investment horizons.

Resampling Technique and Computation of Holding Period Returns

The holding period returns for the chosen asset classes were computed for holding periods of 1, 5, 10, 15 and 20 years. If we had computed holding periods as one would normally do by starting at the beginning of each data series and working our way towards the end of the series, holding period returns would overlap but the calendar order of returns within the holding periods would be maintained and, hence, the autocorrelation structure of the returns would be preserved. There are shortcomings with computing such overlapping holding period returns. First, the holding period return observations are not independent. Second, the results will be influenced by the initial values of the investing periods, so that the results cannot be generalized. Third, there will be increasingly fewer observations as the holding period lengthens.

To overcome these limitations and provide a sufficient number of nonoverlapping holding periods needed to generate a distribution of returns (especially with long holding periods such as 15 or 20 years), we extended the dataset by resampling the available sample data using a bootstrap approach.[6] Samuelson (1963) and Bodie (1995) argue that time diversification is driven by the nonindependence or mean reversion of stock returns. This implies that in the absence of mean reversion there would be no time diversification benefits. The approach followed in this section corrects for the independence assumption to see whether with this improvement in methodology a reduction in risk is still achieved when the independence assumption is maintained.

To compute holding period returns with the bootstrap method, we started with the monthly continuously compounded returns for each series and randomly resampled the monthly returns with replacements until the number of observations needed to compute a hold-

Table 2
Autocorrelations of Return Series

(Monthly Data From January 1957 to December 2003)

	Lags							
	1	2	3	4	5	6	Ljung-Box Q statistic	Significance level
EW	0.232	0.016	0.070	-0.010	0.013	0.024	116.900	0.000
VW	0.082	-0.034	0.050	-0.015	0.046	0.041	65.650	0.030
TBONDS	0.090	-0.010	0.038	-0.040	0.000	0.000	56.100	0.170
TBILLS	0.892	0.862	0.820	0.799	0.785	0.760	9942.700	0.000

Note:
EW CFMRC equal weighted index continuously compounded return.
VW CFMRC value weighted index continuously compounded return.
TBONDS Long Term Government Bond index continuously compounded return.
TBILLS T-Bill index continuously compounded return.

ing period return was obtained. By repeating this process 1000 times, we obtained 1000 samples with randomly selected starting observations. Means and standard deviations of the 1000 holding period returns for each asset class and for each holding period were then calculated. To provide a relative measure of returns and risk, we calculated the coefficient of variation. The coefficient of variation measure for each investment horizon was computed as the mean of the continuously compounded returns of the 1000 bootstrapped samples for each holding period divided by the standard deviation of the 1000 holding period returns. Another measure of relative return and risk calculated is the Sharpe ratio. The Sharpe ratio is calculated similarly to the coefficient of variation except that the Sharpe ratio numerator includes an asset's mean excess holding period return over TBILLS.

To determine which computational method would be more efficient with our data, we had to understand the time series properties of the data. To this end, we estimated the autocorrelation structure of the return series for each of the asset classes examined in this study. Table 2 reports the findings. First lag autocorrelation coefficients were quite high in the case of the TBILLS and the EW series, with the Ljung-Box Q data statistically significant at the 1% level. The first lag autocorrelation coefficient was also statistically significant for the VW series at the 5% level. This autocorrelation coefficient was quite low and statistically insignificant for the TBONDS series. In general, however, these results suggested the need to incorporate the autocorrelation structure in the resampling techniques adopted to extend the dataset. These results are in contrast with US based studies, such as Hickman et al. (2001), who reported that, other than in TBILLS, the autocorrelation coefficient levels were low enough to obviate the need to incorporate correlation structures in their resampling procedures.

Further, to apply the proper method when return differentials were examined, we also had to examine the cross correlations between the series employed in this study. That is, unless the asset classes used are independent from each other, it would be inappropriate to directly compare their return distributions. As can be seen from Table 3, the cross correlation coefficients show that TBONDS versus TBILLS, EW versus TBONDS and EW versus VW are significantly correlated. This indicates that in the resampling procedures, a draw in a particular series must be matched by draws in the other series at the same point in time if the interseries relationships are to be preserved when the return differentials are analyzed. Moreover, these high cross correlations motivate the investigation of return differentials among asset classes.

In the next section, we provide our results using the bootstrap method. However, comparative results (not reported here but available from the authors upon request), were also obtained by computing returns, risk, and end-of-period wealth distributions using overlapping holding period returns.

Table 3
Cross Correlations of Series

(Monthly Data From January 1957 to December 2003)

	Lags				
	1	2	3	Ljung-Box Q statistic	Significance level
VW and TBONDS	0.098	0.080	0.079	55.490	0.180
TBONDS and TBILLS	0.116	0.117	0.100	344.970	0.000
EW and TBILLS	-0.020	-0.030	-0.030	17.580	0.990
EW and VW	0.210	0.010	0.070	91.510	0.000
EW and TBONDS	0.140	-0.190	-0.150	-0.030	0.000
VW and TBILLS	0.005	0.002	-0.010	0.120	0.980

Note:
EW Continuously compounded returns of the CFMRC equal weighted index.
VW Continuously compounded returns of the CFMRC value weighted index.
TBONDS Continuously compounded returns of the Long Term Government Bond index.
TBILLS Continuously compounded returns of the T-Bill index.

Results

Risk and Return Behaviour – Independent Returns

Table 4 reports holding period returns of the asset classes in question with returns calculated by resampling with the bootstrapping technique. In the resampling procedure, the number of monthly return observations were drawn independently to compute the holding period returns (e.g., 12 observations for a one year holding period), and the returns are summed to give the holding period return. This was repeated 1000 times and the mean and standard deviation of the 1000 holding period returns are reported in Panel A of Table 4. Panel B shows the coefficients of variation and Panel C shows the Sharpe ratios.

In Panel A, both total horizon returns and risks increased monotonically. While annualized monthly returns increased with the holding period, standard deviations declined monotonically as the holding period lengthened. Despite employing a method to preserve the independence assumption, the benefits of time diversification are still apparent, as evidenced by the reduction of standard deviation of returns with longer horizons. Concerning the behaviour of the coefficient of variation, irrespective of the investment horizon, investment in TBILLS[7] is by far the most efficient investment strategy over the past 47 years in terms of risk and return. The other three asset classes performed similar to each other without a clear "winner". The implication of this is that investing in TBILLS, for most risk-averse investors, may be a better investment strategy than investing in any other asset class, regardless of the investment horizon. This is a very surprising finding that requires further investigation as it contradicts previous research and all previously reported asset model allocations and recommendations. Perhaps previously inappropriate sampling techniques produced inappropriate asset allocation recommendations followed by financial planners (to the detriment of their clients' wealth). The Sharpe ratios reported in Table 4, Panel C behaved as one would normally expect; namely, increasing as one moved from low to higher risk asset classes and from short to longer holding periods.

While academics and practitioners tend to favour the Sharpe ratio as a measure of relative performance, the Sharpe ratio masks some interesting findings that the coefficient of variation reveals. One may have to calculate both measures to obtain a complete and accurate picture of the relative risk-return behaviour of various asset classes. For example, due to its extremely low standard deviation, TBILLS seem to have been a very efficient asset class based on the coefficient of variation in terms of returns per unit of risk. This information, however, would have been totally missed if one had looked solely at the Sharpe ratio, which calculates risk premium per unit of risk.

Wealth Distributions

If someone chooses to invest in a particular asset class for a specific holding period, what would be the

Table 4

Returns and Risks of Asset Classes at Different Holding Periods

(Based on 1000 Bootstrapped Samples)

Panel A - Returns		1 year	5 years	10 years	15 years	20 years
Total horizon returns						
EW	Mean	0.165	0.807	1.606	2.495	3.300
	standard deviation	0.202	0.444	0.586	0.731	0.877
VW	Mean	0.096	0.473	0.926	1.413	1.911
	standard deviation	0.162	0.355	0.355	0.617	0.712
TBONDS	Mean	0.075	0.384	0.758	1.095	1.516
	standard deviation	0.092	0.211	0.283	0.353	0.404
TBILLS	Mean	0.064	0.323	0.650	0.975	1.300
	standard deviation	0.011	0.023	0.033	0.037	0.047
Annualized returns						
EW	Mean	0.158	0.164	0.162	0.166	0.164
	standard deviation	0.196	0.090	0.058	0.048	0.044
VW	Mean	0.089	0.096	0.094	0.094	0.094
	standard deviation	0.162	0.074	0.048	0.041	0.036
TBONDS	Mean	0.073	0.075	0.074	0.073	0.074
	standard deviation	0.084	0.040	0.028	0.023	0.020
TBILLS	Mean	0.065	0.065	0.065	0.065	0.065
	standard deviation	0.010	0.004	0.003	0.002	0.002

Panel B - Mean coefficient of variation of asset categories

	1 year	5 years	10 years	15 years	20 years
Total horizon returns					
EW	0.82	1.87	2.68	3.41	3.72
VW	0.58	1.34	1.89	2.29	2.65
TBONDS	0.87	1.92	2.78	3.10	4.08
TBILLS	6.15	13.57	19.54	26.35	28.59
Annualized returns					
EW	0.81	1.82	2.79	3.46	3.73
VW	0.55	1.29	1.96	2.29	2.61
TBONDS	0.87	1.87	2.64	3.17	3.70
TBILLS	6.5	16.25	21.67	32.50	32.50

Panel C - Mean Sharpe ratios of asset categories

	1 year	5 years	10 years	15 years	20 years
Total horizon returns					
EW	0.500	1.090	1.631	2.079	2.281
VW	0.198	0.422	0.574	0.709	0.858
TBONDS	0.119	0.289	0.382	0.393	0.534
TBILLS	0	0	0	0	0
Annualized returns					
EW	0.475	1.100	1.672	2.104	2.250
VW	0.148	0.419	0.604	0.707	0.806
TBONDS	0.095	0.250	0.321	0.348	0.450
TBILLS	0	0	0	0	0

Note:

EW Continuously compounded returns of the CFMRC equal weighted index.
VW Continuously compounded returns of the CFMRC value weighted index
TBONDS Continuously compounded returns of the Long Term Government Bond index.
TBILLS Continuously compounded returns of the T-Bill index.

Data are for January 1957-December 2003. This Table reports holding period returns of the asset classes studied in this paper over 1, 5, 10, 15 and 20 year holding periods with returns calculated by resampling with the bootstrapping technique. The coefficient of variation measure for each investment horizon is computed as the mean of the continuously compounded returns of the 1000 bootstrapped samples for each holding period divided by the standard deviation of the 1000 holding period returns. The Sharpe ratio is calculated in a similar fashion as the coefficient of variation except that the numerator now includes an asset's mean excess holding period return over TBILLS.

Table 5

The Statistics of the Distribution of Ending Period Wealth with Different Holding Periods

(Based on 1000 Bootstrapped Samples)

	1 year	5 years	10 years	15 years	20 years
EW					
Mean	1.168	1.828	2.643	3.466	4.239
Standard deviation	0.192	0.442	0.612	0.781	0.870
Median	1.171	1.836	2.625	3.474	4.217
Minimum	0.467	0.394	0.906	0.899	1.318
Maximum	1.891	3.166	4.908	5.361	6.659
Probability of shortfall in wealth	20%	3%	0%	0%	0%
VW					
Mean	1.092	1.484	1.953	2.419	2.866
Standard deviation	0.155	0.360	0.503	0.625	0.705
Median	1.096	1.494	1.937	2.423	2.865
Minimum	0.453	0.266	0.415	0.438	0.618
Maximum	1.667	2.538	3.519	3.847	4.951
Probability of shortfall in wealth	26%	9%	3%	1.50%	0%
TBONDS					
Mean	1.082	1.370	1.753	2.123	2.517
Standard deviation	0.085	0.192	0.270	0.334	0.372
Median	1.081	1.371	1.753	2.124	2.514
Minimum	0.771	0.807	0.590	1.083	1.490
Maximum	1.334	1.979	2.537	3.146	3.567
Probability of shortfall in wealth	18%	4%	0%	0%	0%
TBILLS					
Mean	1.065	1.326	1.649	1.976	2.301
Standard deviation	0.011	0.024	0.033	0.041	0.046
Median	1.065	1.324	1.647	1.975	2.301
Minimum	1.036	1.255	1.541	1.820	2.131
Maximum	1.110	1.406	1.757	2.103	2.437
Probability of shortfall in wealth	0%	0%	0%	0%	0%

Note:

EW Continuously compounded returns of the CFMRC equal weighted index.
VW Continuously compounded returns of the CFMRC value weighted index.
TBONDS Continuously compounded returns of the Long Term Government Bond index.
TBILLS Continuously compounded returns of the T-Bill index.

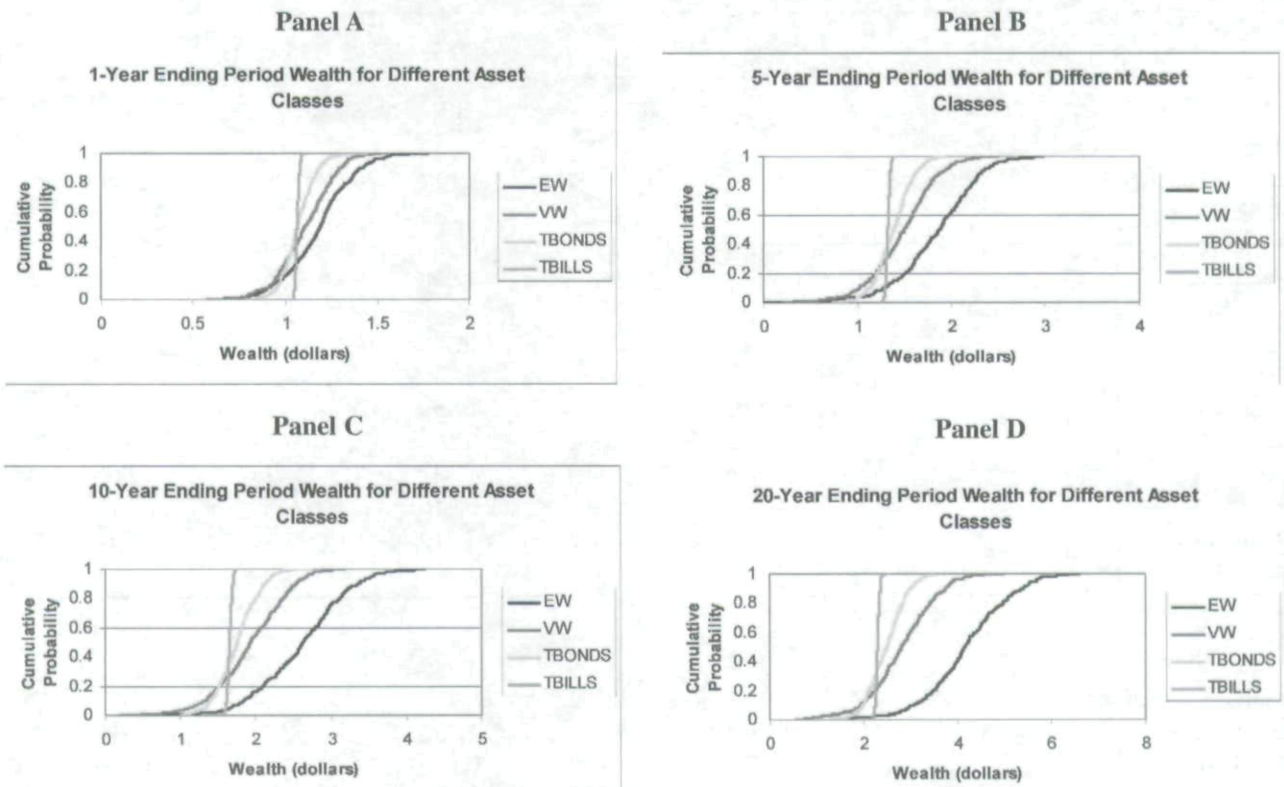
Data are for January 1957-December 20003. This Table reports the summary statistics of the distribution of the end-of-period wealth for the 1000 bootstrapped samples used in this paper. Probability of shortfall in wealth refers to the probability of negative total returns after 1, 5, 10, 15 and 20 years, respectively.

expectation of wealth at the end of the holding period? To answer this question, we assumed an investment of $1 in each of the four asset classes considered in our study and compared the characteristics of the distribution of end-of-period wealth to changes in the distribution of ending period wealth as the holding periods were progressively extended for each asset class. As earlier, we examined holding periods of 1, 5, 10, 15 and 20-years.

For each sample, to compute the end-of-period

Figure 1

Cumulative Probability Distributions of End-of-Period Wealth for the Equally Weighted (EW) and Value Weighted (VW) Stock Indices, Treasury Bonds (TBONDS), and Treasury Bills (TBILLS) at Different Horizons



Notes:

The cumulative probability represents the probability of ending up with less than a specified amount of end-of-period wealth, or shortfall risk. For example, the TBILLS curve is entirely to the right of an ending wealth value of $1, reflecting the absolute safety of recovering the capital by investing in that asset class. The other classes all have higher degrees of shortfall risk.

wealth of investing $1 in a given asset class, we summed the continuously compounded returns obtained with the resampling method for the number of periods required to make up the holding period in question, and added the original $1. For example, the value of a 5 year end-of-period wealth is given by 1 plus the sum of 60 continuously compounded returns. The summary statistics of the distribution of the end-of-period wealth for the 1000 bootstrapped samples are reported in Table 5.

Table 5 demonstrates that stocks have a greater wealth potential than other asset classes. The expected value of $1 in 10 years is 2.64 in EW versus $1.95 in VW, $1.75 in TBONDS and $1.64 in TBILLS. The table also shows patterns in risk characteristics. The probability of ending with a shortfall in wealth decreases as the holding period lengthens. For example, for the EW asset class, the probability of a negative total return is 20% after 1 year, but 3% after 5 years and 0% after 10 years. The only asset class that guarantees an investor no shortfall, regardless of the holding period, are TBILLS. Our results contrast with those of Hickman et al. (2001) in that our wealth distributions seem to be more symmetric than the distributions of wealth relative to US data. The irregularities found in US data by Hickman et al. led them to conclude that the higher risk of end-of-period wealth for small stocks was mostly on the upside and thus irrelevant. This does not appear to be the case in our study, as the risk of end-of-period wealth distributions for stocks is more evenly distributed in the down and upside.[8]

To provide better insight into asset class performance, Panels A to D of Figure 1 plot the cumulative

Table 6

Statistics of the Distribution of the Differential in Ending Period Wealth between Asset Classes with Different Holding Periods (Based on 1000 Bootstrapped Samples)

	EW/ VW	VW/ BONDS	TBONDS/ TBILLS	VW/ TBILLS
1 year				
Mean	0.911	0.306	0.054	0.360
Standard deviation	1.176	1.914	1.005	1.931
Median	0.869	0.319	0.014	0.452
Minimum	-2.320	-8.879	-3.130	-7.689
01-Percentile	-1.580	-4.283	-2.204	-4.071
05-Percentile	-0.851	-2.763	-1.394	-2.830
10-Percentile	-0.543	-2.121	-1.141	-2.149
90-Percentile	2.443	2.748	1.342	2.797
95-Percentile	3.077	3.289	1.714	3.433
99-Percentile	4.053	4.183	2.640	4.275
Maximum	4.608	6.271	3.340	5.905
5 years				
Mean	4.241	1.189	0.673	1.863
Standard deviation	2.658	4.213	2.334	4.230
Median	4.211	1.248	0.756	2.162
Minimum	-2.884	-12.894	-4.850	-12.122
01-Percentile	-1.799	-9.400	-4.433	-8.506
05-Percentile	0.056	-5.762	-3.147	-5.079
10-Percentile	0.868	-3.762	-2.390	-3.333
90-Percentile	7.570	6.530	3.650	7.077
95-Percentile	8.632	7.890	4.525	8.429
99-Percentile	10.327	10.348	5.857	11.014
Maximum	13.458	13.041	8.086	15.514
10 years				
Mean	8.188	2.444	0.920	3.365
Standard deviation	3.897	5.892	3.446	5.800
Median	8.303	2.403	0.835	3.681
Minimum	-3.017	-17.706	-8.062	-14.751
01-Percentile	-0.020	-11.664	-6.582	-9.611
05-Percentile	1.690	-7.186	-4.868	-6.338
10-Percentile	2.848	-5.173	-3.499	-4.161
90-Percentile	13.051	9.629	5.177	10.662
95-Percentile	14.557	12.380	6.730	12.500
99-Percentile	17.559	15.241	9.193	16.064
Maximum	21.170	20.227	11.437	19.191
15 years				
Mean	12.393	3.146	1.718	4.865
Standard deviation	4.812	7.203	3.888	7.053
Median	12.171	3.618	1.537	4.994
Minimum	-1.151	-22.519	-9.039	-21.229
01-Percentile	1.404	-13.985	-7.307	-12.033
05-Percentile	4.932	-9.176	-4.471	-5.915
10-Percentile	6.404	-6.552	-3.166	-4.350
90-Percentile	18.681	12.547	6.860	13.614
95-Percentile	20.336	14.501	7.841	15.912
99-Percentile	23.344	19.085	11.681	19.643
Maximum	26.658	24.361	13.527	27.306
20 years				
Mean	16.901	4.611	2.551	6.938
Standard deviation	5.454	8.595	2.327	8.730
Median	16.414	4.940	4.625	7.362
Minimum	3.087	-19.451	-10.571	-21.666
01-Percentile	5.700	-15.942	-8.802	-13.956
05-Percentile	8.662	-9.880	-5.145	-7.641
10-Percentile	10.044	-7.383	-3.435	-4.611
90-Percentile	24.261	15.729	8.329	17.837
95-Percentile	26.572	17.730	9.520	20.987
99-Percentile	29.233	20.639	12.832	25.462
Maximum	36.715	26.126	14.624	30.361

Note:
EW Continuously compounded returns of the CFMRC equal weighted index.
VW Continuously compounded returns of the CFMRC value weighted index.
TBONDS Continuously compounded returns of the Long Term Government Bond index.
TBILLS Continuously compounded returns of the T-Bill index
Data are for January 1957-December 2003. This Table reports the characteristics of the distribution of the difference in total horizon returns obtained from the bootstrapped sample for indicated pairs at 1, 5, 10, 15 and 20 year horizons. Positive values in this Table represent situations where the first asset class outperforms the second, and vice versa.

probability distributions of end-of-period wealth for the four asset classes we examined at holding periods 1, 5, 10 and 20 years respectively.[9] The cumulative probability represents the probability of ending up with a less than specified amount of end-of-period wealth, or shortfall risk. In Figure 1, Panel A, the TBILLS curve is entirely to the right of an ending wealth value of \$1, reflecting the absolute safety of recovering the capital by investing in that asset class. The other classes all have higher degrees of shortfall risk. A noteworthy fact is the lower cumulative probability of recovering the initial capital in the EW index in comparison to the VW index asset class despite the higher standard deviation of returns of the EW index observed in Table 4. A comparison of Panels A to D of Figure 1 shows the remarkably favourable performance of the EW asset class as the investing horizon lengthens. At a 20 year horizon the curve is almost entirely to the right of the curves of all other asset classes. This reflects this asset's dominance over all other asset classes in the first order sense. Regardless of the investor's risk preferences, a first order stochastic dominance would imply a preference for that asset class.

Asset Class Return Differentials

Investors who wish to invest in one asset class over another would probably choose the asset class that outperforms. To provide the information sought by such investors, we investigated the relative performance of asset classes by examining the differential in returns between pairs of asset classes over different holding periods. We again applied the bootstrap technique to draw monthly returns from the data set and computed holding period returns and end-of-period wealth values. The differential in end-of-period wealth is defined as the difference in total horizon returns of a holding period between the two asset classes considered. To preserve the contemporaneous correlation structure across asset classes, we drew return observations from each asset class at the same time we resampled. From these data, we then computed return differentials and the differentials in total horizon returns for the different holding periods. Table 6 reports the characteristics of the distribution of difference in total horizon returns obtained with the bootstrapped samples. The pairs examined are EW/VW, VW/TBONDS, TBONDS/TBILLS and VW/TBILLS.

Positive values in this Table represent situations where the first asset class outperforms the second, and vice versa. The mean values are all positive, and indicate that on average, the first class is the superior performer in all cases. In other words, moving to higher risk asset classes as the time horizon increases benefits the investors. Moreover, investing in higher risk classes increases benefits monotonically as the time horizon increases. The percentiles of the distribution give an indication of the probabilities of the differentials being above or below certain values. For example, with one year holding periods, there is more than a 10% probability of the second asset class outperforming the first in all the pairs considered. Yet, there is a considerable change in the probability values for such out-performance as the holding period lengthens from 1 to 20 years.

To examine the changes of the probabilities of the return differentials and the possibilities of out-performance, we computed the cumulative probabilities of the return differentials of the asset pairs. Panels A to D of Figure 2 plot the cumulative probability distributions of the paired differences among the four asset classes we examined at holding periods of 1, 5, 10, 15 and 20 years. Figure 2, Panel A clearly demonstrates the increasingly superior performance of the EW class relative to the VW class at longer horizons. Panels B and C of Figure 2 compare the VW performance with TBILLS and TBONDS respectively. The greater upside potential of VW relative to these two asset classes as the horizon lengthens is quite evident. For example, Figure 2, Panel C shows that the cumulative probability of an ending wealth differential of zero or less drops from approximately 0.5 to 0.25 as the investment horizon lengthens from 1 to 20 years. This means that the probability of the TBONDS outperforming VW declines quite dramatically with increases in the investment horizon. This indicates that stocks may become more attractive to risk-averse investors when longer investment horizons are considered. The same conclusion can be reached when considering investing in TBONDS versus TBILLS as is shown in Figure 2, Panel D.

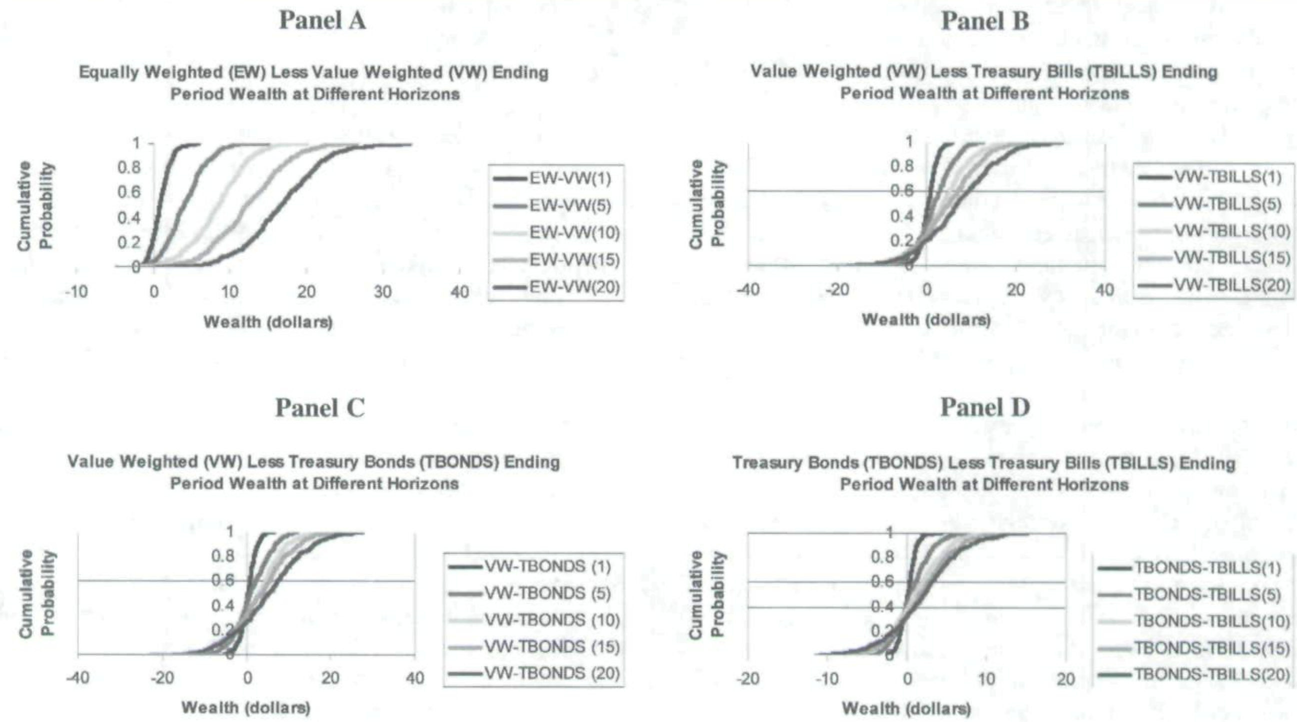
Summary and Conclusions

Summary Highlights

The objective of this paper was to investigate whether the current practice among financial planners of recommending a heavy investment in stocks at an early age and progressively moving into cash or bonds as retirement approaches would be appropriate given that according to most investment models moving away from equities altogether would be suboptimal. To this end four questions were examined: First, how do holding period returns and investment risk change at longer investment horizons? Second, what implications does this have towards the efficiency of portfolios invested in different asset classes, and does this have implications for an opti-

Figure 2

Cumulative Probability Distributions of Paired Differences of Ending Period Wealth Among the Value-Weighted Stock Index (VW), Equally-Weighted Stock Index (EW), TBONDS, and TBILLS at Different Horizons



Notes:
This Figure plots the cumulative probability distributions of the differences between the EW and VW asset classes examined in this paper at holding periods of 1, 5, 10, 15 and 20 years, respectively. This Figure clearly demonstrates the increasingly superior performance of the EW classs relative to the VW class at longer horizons.

mal investment horizon when investing in a particular asset class? Third, what is the distribution of ending wealth as the investment horizon and the probability of ending up with a shortfall in wealth change as the investment horizon lengthens in each asset class, and what is the probability of one asset class outperforming another? Fourth, what does this imply for the preferences of investors to invest in one asset class versus another?

In answering these questions, we computed returns and risks at increasing horizons for a number of Canadian asset classes between 1957 and 2003, based on the bootstrapping technique. Although traditionally followed, high correlations across asset classes would make it inappropriate to compare the mean and standard deviation of the asset classes.

Based on this method, we examined the risk and return properties and wealth distributions for four asset classes, namely, large cap stocks, small cap stocks, long-term government of Canada bonds and T-Bills. Results showed that investment outcomes at short horizons can be quite different from outcomes at longer horizons. Investment outcomes can also vary with the asset class. While the current market practice of life cycle investing is not fully supported as stocks continue in many cases to exhibit quite favourable risk-return payoffs compared to other asset classes, even at shorter time intervals, evidence was provided in favour of time diversification. In this respect, evidence supporting Merton's models is provided in that while a lighter stock position may be appropriate as one approaches retirement, there is no need to exit stocks completely.

It was observed that with longer investing horizons, portfolio efficiency increases in all asset classes. Surprisingly, T-Bills seemed to be the most efficient asset class across all time horizons examined based on the coefficient of variation. This information, however, would be totally masked if one looked only at the Sharpe ratios. From this we conclude that one needs to calculate both the coefficient of variation and the Sharpe ratio to obtain a full and complete picture of the relative return-risk performance of various asset classes.

Investing in stocks, especially those classified as small cap, has a greater end-of-period wealth potential than other asset classes. Interesting patterns in risk characteristics are also found. The probability of ending with a shortfall in wealth also decreases with the holding period. While T-Bills and government of Canada long-term bonds may be safer asset classes in the short run, as the investing horizon lengthens, the stock classes examined dominate in return. However, despite the length of the investment horizon, the risk of stock classes still remains a consideration that may make some investors unwilling to commit to stocks even for longer time periods. Further research may be needed to examine this last point.

We also looked at period by period return differentials among the asset classes examined. We found that higher risk classes have higher end-of-period wealth as the time horizon increases and will thus outperform lower risk asset classes. Moreover, investing in higher risk classes will increase benefits monotonically as the time horizon increases. There is, however, a considerable change in the probability values for such out-performance as the holding period lengthens from 1 to 20 years.

Applied Implications

What are the conclusions financial planners can reach from this study and how can they use our findings to advise clients, especially those with 5 years or less before retirement? The main lesson learned is that while it is unlikely for an investor to end up with a shortfall in end-of-period wealth by investing in equities (regardless of the time horizon), the issue of asset allocation becomes more important as an investor approaches retirement. Figure 2, Panel C, for example, shows that there is about a 50% probability of bonds outperforming equities for time horizons of 5 years or less. Given the significant probability that other asset classes may outperform equities at short investment horizons, a financial planner should thus advise clients nearing retirement to carefully consider an asset allocation strategy that includes equities and bonds, as well as T-Bills. Our findings are consistent with Milevsky, et al. (1997) and Ho, et al. (1994a; 1994b) who concluded that the traditional advice financial planners give on life cycle investing is not always correct. Our conclusions are also consistent with Barberis (2000, p. 225) who noted that "even after incorporating parameter uncertainty, there is enough predictability in returns to make investors allocate substantially more on stocks, the longer their horizon". Similarly, Cochrane (1999), showed that stock prices exhibit negative serial correlation or mean reversion, which contributes to time diversification and is consistent with our conclusions.

Limitations

In considering past findings when making recommendations on future performance, we must understand the historic economic environment within which these past findings were realized. Booth (1995, 2001) argued that while equity markets have not changed much over time, the government bond market has changed significantly. He noted that there is definitely a break in the historical government bond yields of 1957. Government bond yields were "basically flat from 1936 to about 1956". "From 1956-1981, yields then on average increased (. . .) bond yields on average declined from 1981-2000" (Booth, 2001, p. 6). Our sample period started in 1957 and spanned to 2003: a period which should better reflect the future than the pre-1957 period of relative yield stability and bond market illiquidity. Yet even within the 1957-2003 period of our sample, the government bond markets experienced dramatic changes with implications for bond yields (and returns). These changes were driven by: (a) the change in the contact of US monetary policy in the late 70's and subsequent changes in Canada that broke the back of inflation by targeting money supply rather than interest rates, and (b) the increased liquidity of the Canadian government bond market which was prompted by the increased government deficits in the mid to late 70's and the resulting increase in government bond issuance.

As a result, our sample period contained a period of low and rising yields and a period of high and falling yields. The average behaviour of government bond yields from 1957 to 2003 could very well be used as a proxy of future developments. We would have been concerned if we were standing at the early 1980's and had attempted to extrapolate into the future as yields had been rising in a secular fashion up to that point and vice versa if we had not had the pre-1980 history and were trying to anticipate the future by looking at the 1981-2003 government bond performance in a declining yield environment. We feel more comfortable about the combination of rising and falling yields over our sample period as a better environment from which to draw conclusions about the future. Hence, the conclusions drawn in this paper should be considered, on average, a realistic reflection of the expected performance of equity and bond returns going forward.

Can our results be translated into practical investment decisions given that the asset classes examined from CFMRC are not directly tradable? An investor can still invest in tradable asset classes that are highly correlated with those examined from the CFMRC database. Exchange traded funds (ETFs), such as Barclays' iUnits S&P 60, iUnits S&P Mid Cap, and iUnits Government of Canada 10 Year bonds, are all ETFs that mimic large and intermediate cap stock portfolios and long term government bonds. Additionally, there is the existence of a larger number of mutual funds that also mimic the series examined in this study.

Directions for Future Research

As discussed earlier, our study should be useful to other research on Canadian markets examining asset allocation strategies designed to prevent people from outliving their money. Studies, such as those of Milevsky, et al. (1997), Ho, et al. (1994a, 1994b) needed distributions of actual asset returns at various horizons to run simulations in order to determine probabilities of shortfall. However, due to their different approach, they used return approximations from a variety of different sources which may have affected the consistency of the findings and generalizability of the conclusions. Future research should examine whether their conclusions change under our study's holding period returns.

Moreover, our finding T-Bills to be the most efficient asset class across all time horizons based on the coefficient of variation is surprising and needs to be investigated further as it contradicts previous research and previously reported asset model allocations and recommendations. It may also suggest that previously employed sampling techniques may have produced inappropriate asset allocation recommendations widely followed by financial planners.

Finally, another possible avenue for future research is to examine whether understanding an investor's risk aversion at a given point in time and throughout his life can enable us to better identify appropriate asset allocations as the investor's horizon lengthens.

Notes

1. Discussions along these lines have led to what is known as the time diversification debate (e.g., Athanassakos, 1997; Bodie, 1995; Kritzman, 1994; Samuelson, 1963).
2. The Canadian economy is considerably more heavily taxed, more mature, less growth oriented, more regulated, smaller, less diversified and more risk averse than the US. If one accounts for the major banks and utilities or pipelines, that is, the more mature, more regulated and less growth oriented sectors, one will have accounted for a large part of the Canadian economy. The Canadian economy is also heavily resource based with resource stocks dominating the Toronto Stock Exchange (TSX). About 25-30% of the TSX capitalization has been in metals, minerals, and Gold stocks, making the TSX less diversified and more exposed to the business cycle swings than the US market
3. For example, 36% of Canadian equity funds, as opposed to only 16% of US equity funds, have beaten the index over a 10 year period ending January 31, 2006 (See Carrick, 2006).
4. The EW index is a good proxy of small cap stocks and the VW index is a good proxy of large stocks. For example, for the period 1981-2003, the average January return for the VW index is .014 (t-stat=1.41) and for the EW Index is .043 (t-stat=3.27). It is well known that the "January effect" is a small firm effect (see Keim, 1983).
5. See Sharpe (1966).
6. A description of the bootstrap resampling technique can be found in Efron (1979).
7. While this may be surprising and counter-intuitive, it is consistent with Hatch and White (1988) who discuss extensively the CFMRC data-base and produce summary statistics of the various data series in this data-base over a much shorter period.
8. What may explain, to some extent, the discrepancy, is that our distributions are generated with 1000 iterations, while those of Hickman et al (2001) were generated with 500 iterations.
9. Due to space limitations, the cumulative distributions of end of period wealth for the four asset classes for the 15-year holding period are not shown but are available from the authors upon request.

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