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Risky Asset Holdings and the Investment Horizon: Empirical Findings

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Abstract

The paper econometricallyestimate investors' optimal portfolios are independent of their investmenthorizon. When ex ante diversification is investigated there appears to be no evidence of increased demand for equity over a longer investment horizons in India. That is, in India we obtain a flat equity profile over the investment horizons.Therefore, the mean-aversion in fixed-income explains the time diversification effect. The results also indicatethat cross- correlation amongst asset returns do not seem to playany role in time diversification either.

Keywords: Stochastic dominance, Vector Autoregressive (VAR) representation, Sharpe ratio, Akaike InformationCriterion (AIC)
JEL Code: E00, G00

Introduction

Over the last few years the growing acceptance of life cycle investment products,such as target retirement mutual funds, has renewed interest in time diversification. Theobjectivein this paper is not to prove or disprove time diversification, but toevaluate whether the concept must be valid for a 'horizon-based' asset-allocationframework to be viable and appropriate [1] .Experts likeKritzman(1994) define timediversification asthe notion that above-average returns of assetstend to offset below-average returns over a longer time horizon. However, he points out that while the annualized dispersion of returns moderatestoward the expected mean,the dispersion of terminal wealth increases as investment horizon increases.He suggests that although the probability of losing money in stocks is lower over longer investmenthorizons than shorter ones, the size of the potential loss increases.Thisview supports the commonly held notions that younger investorsshould favor a portfolio heavily weighted in stocks to capitalize on the equity risk premium relative tobonds and Treasury bills and that, over long enough horizons, this equity risk premium was reliable.Samuelson (1991)rejected the premise that the risk of stocks decreased over longer time horizons. According to Samuelson, theinvestment horizon can have noeffect on portfolio composition. Relying on utility theory, he said that investors want to maximizethe utility of wealth, rather than expected return or terminal wealth. That is, investors should be interestedin what happens to their wealth over time, not just at a point in time (such as at retirement).

The practice ofrationalizing high equity allocations for investors with longer investment horizons seems to have beencommon enough in the financial community to be considered "oversold" in Samuelson's opinion. Many joined the

[1]The aim is not to provide, as in stochastic dominance theory of investment, alternative measures of investment
superiority or to evaluate whether an asset *A* is stochastically superior to asset *B*. Asset A stochastically dominate asset *B* in the sense of what is known as first degree stochastic dominance (FDSD) when the probability that the return on *A* exceeds any value *y* is greater than the probability that the return on B exceeds y, for all possible values of xAsset*A* stochastically dominates asset *B* in the sense of second degree stochastic dominance (SDSD) when the following condition holds:

debate in different ways on either side,adding additional layers to this increasingly complextopic. Bodie (1995) used option pricing theory toillustrate how the cost of insuring against a stockreturn below the risk-free rate increased, rather thandecreased, with longer contracts. Since higher optionpremiums suggested higher perceived risk for longercontracts, he concluded that time diversification was not evident. Reichenstein and Dorsett (1995) modeled two sets of return projections, one based on the "random walk" assumption that is common among detractorsof time diversification and another based on mean reversion, common among its supporters. Bothmodels supported the notions that it is reasonable for investors with longer investment horizons tohave larger allocations to risky assets (such as stocks) and that a portfolio's relative risk depends upon thelength of the holding period.

Fisher and Statman(1999) evaluated not only the time diversification issuebut the assumptionsoften used to rebut the concept, for example, the assumption that stock market returns follow a random walk pattern, or that investors' future wealth depends only on their investment portfolios. Though a debatable topicitself the mean reversion hypothesis would suggest that a longer investment horizon would better enable investorsto weather adverse market outcomes if experienced at the outset of the investment strategy.Samuelson's utility argument is based on the standard finance assumption that investors are always risk averse and that therefore risk tolerance does not vary with wealth. However, he also notes that this may not always be the case and concedes that people may be less risk-tolerant in absolute terms when they face poverty than when they are affluent.

Kahneman and Tversky (1979) also suggest that investors do not display constant risk aversion, but rather, behave as if they are risk averse in particular settings but not in others. Irrationality, according to Kritzman (1994), may also be one reason t an investor might adopt a time-based investment strategybut behaviorists might note that investors are neither irrational nor rational, but 'normal' (Statman,2005).In other words, investors commonly suffer from the behavioral bias of 'recency' embracing recent performance intheir return expectations... This is what we would like to investigate and do it empirically. But, unlike previous studies, we will do it following a different path becauseallocation based on asset-class return expectations that seemed so reasonable at the onset of aninvestment may seem less palatable when the market turns down.

The vast majority of the previous studies are *ex post* in nature use past returnsso, what we will do here is to testtime diversification in the context of ex*ante* investmentbehavior. In large part, it is this disconnect between theexpected lower risk of an investment in stocks over the long run and the expected higher risk of such aninvestment in the short run that creates doubt and can foster poor decision-making under stress.

Let us therefore, submit two alternative definitions of time diversification.Underthe firstdefinition at each point in timeinvestors form risk-adjusted conditional expectations of future returns. The asset with the highest ex ante Sharpe ration is then selected. This decision process is recursively applied through the data for investors with various investment horizons and the total number of equity positions taken is calculated. A significant increase in the number of equity positions as the investment horizon is increased is taken as evidence in favor of *ex ante* time diversification.

Under the second definition, we form optimal portfolios within a mean-variance framework using the estimated conditional expectations of future returns. If the equity weight significantly increases as the investment horizon is increased then this is also taken as evidence of *ex ante* time diversification.Actually what we do here is offer a rationale for the observed effects that is consistent with the empirical facts concerning the time series behavior of asset returns.Before examining the strategies being adopted by investors, we will first describe the method which is the method of VAR representation through which return expectations are generated.

VAR representation

Given the limited availability of data over the sample period, real asset returns are assumed to be determined by their own pas values and past values of competing assets. Therefore, real returns are modeled following Vector Auto Regressive (VAR) representation:

$$\begin{bmatrix} r_t^{e} \\ r_t^{g} \\ r_t^{b} \end{bmatrix} = \begin{bmatrix} A(L) & B(L) & C(L) \\ D(L) & E(L) & F(L) \\ G(L) & H(L) & I(L) \end{bmatrix} = \begin{bmatrix} r_{t-1}^{e} \\ r_{t-1}^{g} \\ r_{t-1}^{b} \end{bmatrix} + \begin{bmatrix} v_{t,1} \\ v_{t,2} \\ v_{t,3} \end{bmatrix} \quad (1)$$

where r_t^e, r_t^g r_t^b denote the one – period real returns to equity, bonds, and bills, respectively and $A(L)$, $B(L)$, etc are lag polynomials each of order p. This VAR can be more compactly written as a

$$r_t = \gamma\, r_{t-1} + v_t \quad (2)$$

where r_t is a $3p$ x 1 vector of returns, γ is a $3p$ x $3p$ matrix of coefficients, v_t ~ IN [0, Ω] with expectation E [v_t] = 0 and variance matrix $V[v_t] = \Omega$. Assuming the forecasting model coincides with the DGP, Clements and Hendry (1998) show that the forecasts of the *N*- horizon ahead returns are given by

$$\bar{r}_N \equiv E_t\, r_{t+1},_N = \sum_{j=1}^{N} E_t r_{t+j} = \sum_{j=1}^{N} \gamma^j r_t \quad (3)$$

With the associated forecast error variance-covariance matrix is:

$$\Sigma_N = V_t \quad [\quad r_{t-1,N} - E_t r_{t+1,N} \quad] \quad = \sum_{j=1}^{N} \Phi_j \Omega \Phi_j^{/} \text{ where } \Phi_j = \sum_{i=0}^{N-j} \gamma^i \quad (4)$$

The expression given in (3) and (4) are used to construct expected returns for an investment strategy and the forecast error variance-covariance matrix[2].

Investment Strategies

Let us assume that investors will adopt in the spirit of Tokat and Stochton (2006) one of two possible strategies. The first strategy is based on market betting while the second strategy involves optimalportfolio construction in a mean variance framework.

Strategy 1. The first strategy used by investors is based on taking a position in one of the three assets, namely, equity, bonds, or bills. The decision is based on the conditional expectation of the asset's return over the appropriate investment horizon and the reliabilityof the expectation. These two characteristicsare combined in the following *ex an e* Sharpe ratio.[3]

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[2]This VAR representation is time-consistent in that only information that is publicly available at time t is used
to make investment decisions at time t +1. However, it can be argued that investors were not quite knowledgeable in applying statistical methodologies in their decision making. The purpose of our work is to find investor's decisions in real time; it does not try to replicate the investment decisions in real time. We attempt to capture, in the spirit of Strong and Taylor (2001), the important features of two different investment strategies used by rational investors.

$$\int [\ F_A(X) - F_B(X)\ ] \leq 0\ \forall z$$

DenotedASDSD B.See Hipp (2002).

[3]The Sharpe ratio, S is used to characterize how well the return of an asset compensates the investor for the risk taken, the higher the Sharpe ratio number, the better. The Sharpe ratio, in fact, increases with the investment horizon $\hat{T}$, S= $\sqrt{\frac{T}{\hat{T}}}$ T is the time interval. The Sharpe ratio has as its principal advantage that it is directly computable from any observed series of returns without need for additional information

$$\bar{r}_{t+1,N} = \frac{E_t r_{t+1,N} - r_f}{\sigma_{t+1,N}} \qquad (5)$$

where $\bar{r}_{t+1,N}$ is the risk-adjusted expected return to an asset from t+1 to $t+N$, $E_t\ r_{t+1,N}$ is the conditional expectation of the return to an asset from$t$+1 to $t + N$, $\sigma_{t+1,N}$ is the standard deviation of the forecast error from t+1 to $t + N, r_f$ is the risk free rate. We assume that the asset with the highest $\bar{r}_{t+1,N}$ is held by the investorat t. As real returns are used the risk-free rate is set equal to the return on a Perfect inflation hedge asset. In the absence of any inflation premia or risk premia this rate is set equal to zero.

Strategy 2.An alternative investment strategy is also considered whereby investors take positions (short or long) in each of the available assets (equity, bonds, and/or bills) such that the variance of particular return is minimized for a given level of desired expected return. These investors maximize their expected utilityby holding such portfolios. The investor's problem then is:

$$\text{Min } \frac{1}{2} w'_N \Sigma_N w_N$$

Subject to

$$I'\ w_N = I \quad \text{I} \qquad (6)$$

$$\bar{r}'\ w_N = \mu$$

surrounding the source of profitability. Other ratios such as the 'bias ratio' have recently been introduced into the literature to handle cases where the observed volatility may be an especially poor proxy for the risk inherent in a time-series of observed returns. But While most of the ratios, for example, the 'Treynor ratio' works only with systematicrisk of a portfolio, the Sharpe ratio observes both systematic and idiosyncratic risks. See Bouchaud and Potters (2003).

where w_N is a vector of N-period horizonportfolio weights and μ is the desired expected portfolio return. The optimal weights are given by

$$w_N^{\ *} = \lambda \Sigma_N^{-1} 1 + \gamma\ \Sigma_N^{-1} \bar{r}'_N \quad (7)$$

Where $\lambda = (C - \mu B)/\Delta$, $\gamma = (\mu A - B)/\Delta$, A= $\mathbf{1}\ \Sigma_N^{-1}\ \mathbf{1}$, $B = I'\ \Sigma_N^{-1}\ \bar{r}_N$, $C = \bar{r}_N\ \Sigma_N^{-1}\ \bar{r}_N$, And $\Delta \equiv AC - B^2$. To ensure that the desired portfolio return is greater than the expected return on the global minimum variance portfolio, μ is set equal to the return on the global minimum variance portfolio(=B / A) plus some annualized percentage 'excess return' denoted δ .

This necessarily results in a positive relationship between δ and the standard deviation of portfolio returns and thus enables inferences to be drawn about the relation between the asset weight and the degree of risk aversion.Investors here are assumed to base their investment decisions on real return. The real return is defined as the nominal return observed at time t minus the inflation rate observed at time t– 2 because the real return cannot be observed at time $t$because the appearance of inflation data are approximately delayed by two months.

Dataandthe Methodology

The data comprise monthly return series for equity, bonds, and Treasury bills in India. Data come from *Securities and Exchange Bond of India (Annual Reports)* and *Handbook of Statistics – the Indian Security Market* (1995- 2007), and *The Reserve Bank of India Bulletin*, providing returns data for equity, short and long term government bonds, corporate bonds for the years under investigation. All returns are continuously compounded holding period returns. The holding period varies between one month and ten years: for the 1995-2007 data, the holding periods are given in months. Here we use N = {1, 12, 60}; the longer data runs add N =120. For all months and periods the returns are non-overlapping.

The VAR methodology represented above, a time-consistent methodology is a convenient way of incorporating this basic feature.The VAR is estimated recursively usingIndia's monthly data.An initial learning period of fifteen years is used for the first estimate of the expected returns. The estimation process is then repeated using one more month of return data. The order of the VAR is determined by the Akaike Information Criterion (AIC) as this produces VAR specifications that yieldforecasts, as shown in Luktpohl (1951) that are superior to forecasts produced by VAR specifications with alternative information criterion. After the VAR is estimated the *N*-horizonexpected returns and *N*- horizon forecasts variances are calculated for {*N* = 1, 12, 60,120}and $\delta =$ {0%, 1%}. The information is then used by investors adopting the above strategies. If strategies 1is used then the investor purchases one of the three assets while investors who use strategy 2 will place a proportion of their wealth in each of the three assets. The process is repeated until the entire sample period is used. When strategy 1 is assumed this means that a series of one's (equity position taken) and zeros (no equity position) is obtained for each investment horizon while a series of equity weights is obtained for each investment horizon when strategy 2 is adopted. In both cases, these series denoted x_t (short horizon) and x_t' (long horizon) are averaged togive either a proportion of time that equity positions are taken (strategy1) or a mean equity weight (strategy2).

For a null hypothesis of *ex ante* time diversification is tested by comparing the equity proportions (mean weight) at the one month investment horizon, dented x_t' with the equity proportions (0r mean weight) at the longer investment horizons (one year, five years, and ten years), denoted $\bar{x}_t$ .If normality assumption is used then a sample t- test of the difference oftwo means could be used. However, in the current application this assumption cannot be made[4]. Moreover, the investment horizons and the proportions (or mean weights) obtained when using the short investment horizons make use of the overlapping data. To incorporate this time-dependency in the data, we make use of the studentized bootstrap method with block *resampling*. using the proportions (or mean weights)calculated using short and long investment horizons the following test statistic is calculated[5].

$$Z_0 = \frac{\bar{x}_t - \bar{x}_t'}{\sqrt{\hat{\sigma}_x^{\,2} / T + \hat{\sigma}_{x'}^{\,2} / T}}$$

where $\hat{\sigma}_x^{\,2}$ and $\hat{\sigma}_{x'}^{\,2}$ denote the sample variances of x_t and x_t' calculated over the long and short investment horizons. respectively. The distribution of this test statistic is calculated using block bootstrap *re sampling.* In particular *R* values of

$$Z^* = \frac{\bar{x}_t^{\,*} - \bar{x}_t^{\,\prime *} - (\bar{x}_t - \bar{x}_t')}{\sqrt{\hat{\sigma}_{x*}^{\,2} / T + \hat{\sigma}_{x'}^{\,2} / T}}$$

Aregenerated wherestatistics denoted by * indicate that they are based on the shuffled blocks of x_t land x_t' . Finally Z_0 statistic is compared with the *R* separate Z^* statistics and (two sided)*p*values are calculated. In the particular application *we* set *R* = 100 i.e., the p-value iscalculated using a 100 repetition bootstrap technique[6,7]

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[4]To compare the goodness of fit we use the Kolmogorovdistance $D = sup_x \ [F(x) - \bar{F}(x)]$ and itsstandardized counterpart, $\sqrt{T}\ D$ where *T* is the sample size and *F* and $\bar{F}$ are the empirical and fitted cumulative density functions, respectively. Of the different distributions we considered, for example, Laplace, generalized exponential of the second kind, Student's *t* did not produce the lowest Kolmogov*D* value, see Marsaglia et al (2003)

[5]The usual to sample *t* – statistic

$$Z = \frac{\bar{x}_t - \bar{x}_t' - (\mu_x - \mu_{x'})}{\sqrt{\sigma_x^{\,2} / T + \sigma_{x'}^{\,2} / T}}$$

[6]This technique is appropriate when using autocorrelated time series and/or series that have

Estimation

The total number of equity positions and mean equity weights are presented in Table 1.These are calculated using the entire sample period and over various sub-periods. The results of the horizon invariance test are presented in the final three columns of Table 1.There is no evidence of *ex ante* (strategy 1) time diversification to the Indian equity markets. For instance, 135 equity positions are taken by investors with a one-month investment horizon between 1955 and 1998. This compares to 129 equity propositions taken by investors with a ten-year investment horizon over the same period. Moreover, the *p*-values associated with this difference equal 1. In addition equity is not the most popular asset across all investment horizons.

When investors are assumed to follow strategy 2, the results for Panel B reveal evidence of time diversification effects only during the first sub-period 1990-1998. In particular,when $\delta = 1\%$, the p-value associated with thehorizon invariance test all indicates significant time diversification effects. However, over the whole period, no time diversification effects are seen though the equity weights does increase from 2% when N= 1 to 32 % when N= 120 when $\delta = 1\%$. The contribution of mean-aversion in fixed-income assets to this finding can be explained by the fact that the forecast of fixed-income returns and the associated variances vary over*Nin* accordance with the assumption of a random process. The results do indicate that the restriction does indeed lead to a flat equity profile under the investment horizon[8].

time-varying conditional Variances. To maintain the time-dependency in the data, blocks of data are selected at random andused to construct *p* Values. Five overlapping blocks are selected with each replication of the data. For details of this technique, see Davison and Hinkkley (1997).

[7]See Gongalves and Meddahi(2009)

[8] In particular, both the forecast return and variances are assumed to increase in direct proportion to *N*. this restriction is achieved by direct manipulation of the weight formula given in (7) above.

Therefore, themean-aversion in fixed income contributes to the time diversification effect. Manipulation of the weight formula in (7) also enables us to consider the role of predicted cross-correlations amongst asset returns. The restriction of zero cross correlations is imposed by setting the off-diagonal elements in $\sum N$ to zero. The results indicate that these cross correlations do not contribute to the time diversification effect.

Conclusion and A Few Remarks

We investigated on the basis of Indian data if itis reasonable and appropriate for investors with longer investment horizonsto allocate a large portion of their portfolios to riskyassets, particularly equities. When *ex ante* diversification is investigated we findnoevidence for increased demand for equity over longer investment horizons in the context of the Indian markets. In Indian market thetime diversification is the result of mean-aversion in fixed income assets and predicted cross-correlation amongst the asset returns.

We expected for most investmentstrategies based on age or timethat the longer the timehorizon, the larger will be the relative weight of equities inthe portfolio. Although in the Indian market some horizon-based funds maintain amore or less static allocation, others, such as targetretirement funds, do not seem to moderate the equity allocation ina predictable manner as time passes and the targethorizon approaches.Indeedthe investmenthorizon is considered by leading investment andfinancial planning professional associations in India as not being akey factor in developing investment policy statementsand asset allocations.

The point is: not every investor is equally prepared—either emotionally or financially—to contend with the uncertainty that comes with seeking returns above the risk-free rate.

Table-1: Ex Ante Time Diversification

		Equity Proportion weights					Horizon invariance		
Period Filter	δ	N=1	N=12	N=60	N=120		1 v 12	1 v 60	1v120
Panel A Indian Data [Market-timing]									
1990-1998	N0	80	70	68	68		0.70	0.80	0.70
1998-2010	N0	55	57	60	61		0.80	0.75	0.90
1990-2010	N0	135	127	128	129		0.97	0.87	1.00
Panel B Indian Data [Mean Variance Portfolio]									
1990-1998	N0	0%	0.01	0.01	0.01	0.010.34	0.44	0.52	
	N0	1%	0.03	0.54	0.98	1.32	0.00	0.00	0.00
1998-2010	N0	0%	0.01	0.03	0.03	0.42	0.55	0.55	0.55
	N0	1%	0.01	0.01	0.02	0.48	0.60	0.61	0.63
1990-2010	N0	0%	0.01	0.03	0.03	0.24	0.21	0.21	0.23
	N0	1%	0.01	0.04	0/03	0.49	0.23	0.23	0.18
CC	1%	0.02	0.04	0.04	0.23		0.76	031	0.33
FI	1%	0.01	0.05	0.12	0.32		0.71	0.68	0.58
FI = CC	1%	0.01	0.04	0.05	0.41		0.06	0.080.06	[9]

[9] Notes: This table prepares the number of times equity is selected when the asset with the highest risk-adjusted expected returns is held by investments strategies, (strategy 1-market timing and by the mean weights associated with equity in mean-variance framework (strategy 2 – mean variance portfolio. In both cases, four different investment horizons (N) are considered and there are three assets (equity, bonds, and bills) available. Expected returns are generated by a Vector Autoregressive (VAR) model with lag length selected by AIC and where a twenty year planning period has been assumed. The p- values associated with the horizon invariance test are given in the last three columns of the table. Panel A reports these for 1955 to 1975 Indian data when strategy 1 is adopted. Panel B for 1955 to 1998 when strategy 2 is adopted. The annualized excess mean return over the global minimum variance portfolio is given by δ . Filter refers to whether fixed-income asset returns, denoted (FT) have been filtered to remove the effects of mean-aversion, whether predicted asset return cross-correlations have been set to zero, denoted (CC) 0r, whether both of these filters have been applied, denoted (FI + CC).

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