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Alternative investments are mean-variance efficient and inflation hedger: fact or fiction?

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ABSTRACT

Weight of alternative investments has been increased in the asset mix portfolio of investors due to the increased global financial uncertainty for the last 25 years. Since 90s to post period of global finance crisis, a significant changing trending has been observed in asset mix portfolio. Farmland and timberland seem to be better choices for an investor to add in her/his portfolio of assets mix as alternative investment due to their diversification characteristics. NCRIEF Farmland and timberland smoothed indices from the 1st quarter of 1992 to the 3rd quarter of 2012 and have been used in this study to explore the mean variance diversification features of both alternative asset classes. De-smoothed series has been generated from smoothed series to overcome the autocorrelation problem. Empirical results demonstrate the significant mean variance diversification characteristics of farmland and timberland. Both farmland and timberland have potential to increase the return of a diversified traditional asset portfolio at a given level of risk and vice versa during the period of low market term oil and high uncertainty. During inflationary period, both farmland and timberland possess low inflation hedging characteristics of the study period.

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1. Introduction

Global financial crisis began in mid-2007 evaporating a significant amount of wealth of international investors and resulted in a decline of real estate prices, and meltdown of a few stock markets[1]. Governments have been injecting billions as rescue plans to stimulate economies that strained their debt holdings even up to 120%. For instance, in the USA, this ratio reaches up to an alarming 80% (Painter, 2011). Increasing liquidity, interest rates and falling equity returns in developed countries all over the world has been documented as the main reasons of alternative investment provision to the traditional portfolio (Karavas, 2000). Globalization is another important element that has made it possible to instantly disseminate the most recent information about securities' performance and thus has diverted investors' attraction from traditional assets to alternative investments to improve their portfolio diversification and risk features. Financial investments stems from the idea of sacrificing current consumption for the future consumption and is a trade-off between risk and return. Markowitz (1952) captures the idea of "high risk high gain and low risk low return" into their modern portfolio theory (MPT) and explain that an efficient portfolio must have highest returns at a given level of risk or minimum risk at any given level of returns. Following MPT as the central theme, this study investigates if alternative investments add to the performance

[1] For example: Dow john industrial average, S&P 500.

efficiency of the portfolio choice of the investors. More specifically, this study considers the diversification features of timberland and farmland to investigate if reducing exposures to traditional assets and increasing investments to alternate investments helps develop a better mix assets portfolio.

1.1 Research Question

Global financial uncertainty shifts investor from traditional investments to alternative investments and increase the alternative assets weight into a traditional assets' portfolio. Investors want to enhance their portfolio efficiency by adding the alternative investments like commodities, real estate, Farmland and timberland into a diversified portfolio of assets mix. So, the objective of our study is to explore that from the alternative investments farmland and timberland can get a significant weight in mean variance optimized portfolio mix of an investor. To answer the question that during inflation and market uncertainty period farmland and timberland will enhance the financial efficiency of a traditional asset's portfolio. We construct the following hypothesis based on our study:

Farmland and timberland are mean variance efficient in the portfolio of traditional assets.
Is farmland and timberland being the better inflation hedger?

2. Literature Review

2.1 Modern portfolio theory

The pioneer work of MPT has been done by the Markowitz (1952), which later lays down the basis of Modern Finance. Markowitz (1991) idea of portfolio theory comes from the idea of present value Williams' (1938) which states that present value of stock's future stream of dividends should be equal to its present value. His portfolio theory states that all optimal investors actually behave in a particular manner to attain the economic equilibrium of capital markets.

Markowitz (1959) introduces two main objectives common to all investors i.e., they prefer (1) high returns over lower returns and (2) certainty over uncertainty. They want to maximize their utility through their utility indifference curve over the efficient frontier resulting from risk and return trade-off. An optimal portfolio occurs at the tangential point of indifference curves and efficient frontier, which represents the highest return at any given level of risk and vice versa. Their risk aversion behavior is visualized by the steeper slope of indifference curve.

Fabozzi, Gupta, and Markowitz (2002) revisit the MPT and document that finance community has been reluctant to give much importance to MPT in the beginning and has been criticizing the idea even after 50 years of its birth; however, this theory is widely considered as basic theory in finance commonly known as mean-variance analysis, mean-variance optimization or portfolio selection theory and many of modern financial models are originated from it. It is said to be a normative theory which tells the investors the actual way of behaving and sets a standard behavior required to optimal portfolio construction. MPT follow the well-known saying that "never put all your eggs in the same basket" on developing the idea of risk diversification of portfolio. Using the historical returns of different assets and the idea of portfolio risk diversification, investors develop a risk-return efficient frontier to obtain an optimal portfolio. Though historical returns, in some cases, are not good inputs for expected returns but they are a good estimator of future returns (Fabozzi et al., 2002). They empirically conclude that inclusion of more than two asset classes in the portfolio increases the expected return at any given level of risk. Sharpe (1963) develops single risk factor model from the MPT which is later extended to three factors by Fama and French (1992) and four factors by Carhart (1997).

2.2 Real estate investments

Risk-return enhancing characteristics of real estate has empirically been supported by the Sharpe (1964) capital asset pricing model (CAPM) analysis (Libbin, Kohler, & Hawkes, 2004). Noland, Paulson, Norvell, and Schnitkey (2011) investigate the annual farmland returns using university of Illinois (UI) pool of endowment farms portfolio over the period 1962-2008. Their results show favorable attributes of holding UI farm in the portfolio of large and small securities of long-term corporate bonds, long and medium-term government bonds, the US treasury bills and consumer price index. UI farmland returns show a negative correlation with other assets reflecting diversification characteristic of farmland. By providing the higher premium over the compensated return to systematic risk, Illinois farmland lowers the risk of the well diversified portfolio compared to the previous studies for instance (Irwin, Forster, & Sherrick, 1988).

Stevenson (2003) explores supplementary diversification benefits to equity portfolio of an international investor in the US market by adding real estate securities in his portfolio choice. NAREIT indices have been used as proxy of the US real estate market with a break down in equity, mortgage and hybrid classes. Their diversification results show that to the US base investor diversification opportunities are significantly present, but when returns are converted into the US dollar, foreign exchange rate reduces the available diversification benefits in Singapore, Hong Kong and Canada. They also add international securities into the local REIT portfolio to explore the diversification benefits, but the results are neither significant for local returns nor for dollar converted returns at conventional levels.

2.3 Timberland

Timberland has been categorized into three classes on the basis of volume of trees; the first category is saw-timber which consists of large trees and is used in heavy products of lumber[2]. Second class is pulpwood which is used to produce paper using small size of trees, and finally third type is chip-n-saw which is used to produce the by-products of chip and small lumber products using large size trees. Healey et al. (2005) document that the value of saw-timber is higher than the chip-n-saw and the value of pulpwood is significantly lower than both.

According to Healey et al. (2005) ownership of timber has increased since last 20 years due to the emergence of timberland investment management organizations (TIMO's). In the US, the main consumer of timber is the construction industry. If consumption of timber increases faster than its production, it may give upward trend to timber prices over the next 40 years (IWC, 2009). Financial crisis of 2007-2009 adversely affected the timber prices because a large volume of timber was being used for house constructions but due to the crisis construction demand for timber declined sharply and this affected the timber prices adversely in turn.

Caulfield (1998) documents main drivers of timberland returns along with their contribution to the total returns. First driver of timberland returns has been biological growth which is a positive and main contributing component to the total returns of timber, about 61% and risk reduction. Secondly, timber prices which contribute about 31%, the one third, to the total returns; this is unpredictable which may be positive over long period of time and shows negative trend over short period of time. Thirdly land appreciation for timberland contributes only 6% to the total returns.

3. Research Methodology

Given that farmland and timberland have the diversification characteristics if individually added to a traditional asset's portfolio, this section extracts and extends the models from literature to explore portfolio efficiency in the presence of both type of assets in the traditional asset mix. For the sake of completeness and clarity, this section has further been segregated into different divisions explaining hypotheses of the study, the supporting model and nitty-gritty of envisaged sample data set.

3.1 Methodology

Existing main stream literature Caulfield (1998); (Healey et al., 2005; Hennings et al., 2005; IWC, 2009; Painter, 2010) focuses on diversification features of farmland and timberland if included in the portfolio of traditional assets one by one. However, this study not only tests the prevailed theory but also extends existing literature by developing the following hypotheses:

- Farmland and timberland enhance the mean variance optimization features of traditional assets' portfolio.

[2] Slices of forest timber for the purpose of sale and manufacturing.

- Conventional asset portfolio enjoys mean variance optimization if included.
- Farmland and timberland are better inflation hedging over our period of study.

We follow the literature (Caulfield, 1998; Healey et al., 2005; Hennings et al., 2005; IWC, 2009; Painter, 2010; Scholtens & Spierdijk, 2010) to test the above mentioned hypotheses using Markowitz (1952) modern portfolio theory (MPT). In order to understand and interpret this theory, it is crucial to understand the assumptions lying behind MPT.

These assumptions are related to the investor behavior and are given as:

1. Investors want to maximize their utility for a single period within the framework of diminishing marginal utility.
2. Investor's utility is a function of expected returns of assets and variability of returns for the given period of time.
3. Investors are risk averters.
4. Risk is measured by the standard deviation of returns of the assets.
5. Investors want to maximize the returns at a given level of risk and minimize the risk at given level of return.
6. Information and transaction cost is zero (frictionless market).

Standing on these assumptions, MPT is also based on several observations. These include: 1) there is a choice among different investable assets for investors. 2) All investors have money to invest. 3) Investors have their own preferences for investment.

Using MPT Bianchi (2007) states that the expected return $E(R_p)$ of an optimized portfolio of *N* assets is the result of the expected returns r_i on asset *i* holding portfolio optimized weights w_i. Mathematically,

$$E(R_p) = \sum_{i=1}^{N} E(R_i) = \sum_{i=1}^{N} r_i w_i$$

Or

$$E(R_p) = w^T r$$

. i.e. portfolio return is equal to the portfolio weights times expected returns.

Where w^Tdenotes the vector of portfolio weights and r represent the expected returns of assets. The portfolio risk is represented by variance-covariance matrix which is defined as:

$$Var(R_p) = \sum_{j=1}^{N}\sum_{i=1}^{N} w_i\, w_j \sigma_{ij}$$

Where,

σ_{ij} is covariance between asset i and j.

$$\sigma_{ij} = \rho_{ij}\sigma_i\sigma_j$$

$\rho_{ij}$is equal to the correlation between the rate of returns of assets *i* and *j*, and $\sigma_i \; and \; \sigma_j$ represents the standard deviation of rate of returns of asset *i* and *j* respectively.

In matrix notation variance of portfolio represents as follow.

$$Var(R_p) = w^T C w$$

Where w is the vector of asset weights w^T is the transpose vector of asset weights, and C represents the variance covariance matrix of the assets. Where variance covariance matrix is defined as:

$$C = \begin{bmatrix} \sigma_1^2 & \sigma_{1,2} & \cdots & \sigma_{1,n} \\ \sigma_{2,1} & \sigma_2^2 & & \vdots \\ \vdots & & \ddots & \sigma_{n-1,n} \\ \sigma_{n,1} & \cdots & \sigma_{n,n-1} & \sigma_n^2 \end{bmatrix}$$

According to MPT theory and mean-variance investor looks for portfolio having minimum variance at a given level of return or maximum return at a given level of portfolio risk. Thus, the objective of the MPT theory is to find a set of efficient optimized portfolios.

Portfolio assets vector of weights w can be calculated by minimizing the variance of portfolio $Var(R_p)$ at a given level of portfolio return$E(R_p)$. Bianchi (2007) purposes a mathematical mean variance framework to solve the following problem of minimum variance of portfolio $Var(R_p)$ at given level of portfolio return $E(R_p)$.

$$\min Var(R_p).$$

Which is subject to

1. $E(R_p) \geq target\ return$

It means the return of optimized portfolio must be greater than or equal to the any target return.

2. $\sum_{i=1}^{N} w_i = 1$

Its means that sum of optimized portfolio weights must be 100%.

One specific optimized portfolio with an efficient combination of standard deviation and return will be constructed from each target return. Here efficient means that with a lower volatility, there is no other combination of assets in the model will deliver that target return.

To optimize the portfolios, we will do the variance minimization process in excel with the help of Solver Add-In. for the construction of efficient frontier we will do the minimization process in excel again and again with small increase in target returns. Constructing efficient frontier in this way is a lengthy process, which can also be programmed in visual basic (VBA) with MS excel. To construct the efficient frontier, we need a variance covariance matrix and a vector of expected returns as an input of VBA program.

3.2 Data

The envisaged data set span 1st quarter of 1992 to 3rd quarter of 2012 and has been used by some other studies (Hennings et al., 2005; IWC, 2009; Kaplan, 1985). The two main asset classes are farmland and timberland and are represented by NCREIF timberland and farmland indices. The remaining asset classes (see Table 1) comprise of MSCI world total returns index, Russell 2000, 3 months US T-bills, US consumer price index and S&P 500 as a proxy of global stock, small caps, risk free rate, inflation and large caps respectively. Data of real estate, farmland, timberland and Townsend fund indices has obtained from NCREIF official website[3]. Short, medium and long-term bonds, T-bills and the US CPI index data have been acquired from worlds' database and MSCI world total return, Russell 2000 and S&P 500 taken from DataStream.

Table 1: asset classes with their benchmarks (1992 Q1-2012 Q3)

Asset Classes	Benchmark
Farmland	NCREIF Farmland Returns Index
Timberland	NCREIF Timberland Returns Index
Real estate	NCREIF Property Index
Townsend	NCREIF Townsend Fund Index
Large Cap	S&P 500
Small Cap	Russell 2000
Global Stock	MSCI world total return index
Inflation	US Consumer price index
Risk Free rate	3 months US T-bills
Short term bonds	1 year US Govt. bonds
Medium term bonds	2 year US Govt. bonds
Long term bonds	10 years US Govt. bonds

Note: Table 1 indicates all asset classes with there benchmark

[3] http://www.ncreif.org

3.3 Data Classes

3.3.1 Farmland

The NCREIF farmland is a quarterly returns index based on individual agricultural properties purchased in private market with the intention of investment. Tax exempted institutional investors are the acquirers of farmland index in the fiduciaries environment. Hennings et al. (2005) has used the NCREIF farmland index in his study.

3.3.2 Timberland

The NCREIF timberland is a quarterly returns index based on individual agricultural properties purchased in private market with the intention of investment. Tax exempted institutional investors are the acquirers of timberland index in the fiduciaries environment. Its returns starts from 1987 with quarterly updates and published in 1994 for the first time. IWC (2009) has used the NCREIF timberland index in its report.

3.3.3 Real estate

The NCREIF property is a quarterly returns index based on individual agricultural properties purchased in private market with the intention of investment. Tax exempted institutional investors are the acquirers of property index in the fiduciaries environment. NCRIEF property index has been used in several studies for instance Friedman (1971).

3.3.4 Townsend Fund

The NCREIF Townsend fund is a quarterly private equity real estate index describing the performance information. The data in Townsend fund index are comprising of continued (discontinued) funds and active investments.

3.3.5 Large Caps

We use S&P 500 index series as a proxy for the large caps; the S&P 500 index comprises of 500 leading US companies from different industries listed on largest stock markets i.e. NASDAQ, NYE and Euro. S&P 500 is a market capitalized weighted index and studies for instance IWC (2009) and Friedman (1971) have used the S&P 500 index in their investigations.

3.3.6 Small Cap

Russell 2000 index has been used as the proxy for small caps which is a composition of 2000 stocks from the Russell 3000 index of US small stocks. Approximately 8% of market capitalization of Russell 3000 index has been represented by the Russell 2000 index.

3.3.7 Global Stock

Following the literature (IWC (2009), we use MSCI world total returns index as a proxy for the global stocks. MSCI world total returns index comprises of 6000 world stocks of 24 economies excluding emerging and frontier markets.

3.3.8 Data descriptive

Table-1 presents the basic statistics for different return series. It is stated that there is a difference in terms of mean, media and standard deviation among the stated classes as shown in Table 2 of the study. However, in terms of Skewness and Kurtosis, Timberland and Farmland are showing some highest scores comparatively to the rest of the titles under Table 2.

Table 2: descriptive statistics of return series (1992 Q1 – 2012 Q3)

	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
Timberland	0.025	0.016	0.223	-0.065	0.039	2.474	12.423
Farmland	0.028	0.019	0.228	0.000	0.032	3.904	21.623
Real estate	0.020	0.026	0.054	-0.083	0.024	-2.106	8.646

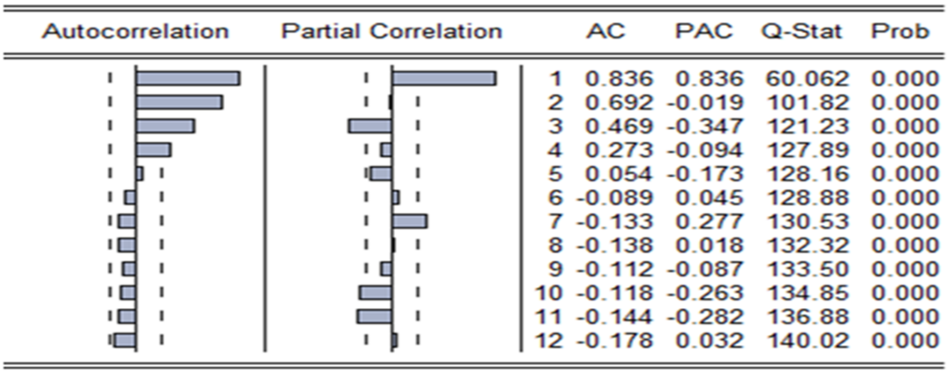
Townsend Fund	0.018	0.024	0.060	-0.134	0.033	-2.593	11.072
Small Caps	0.023	0.035	0.230	-0.265	0.104	-0.466	3.210
Large Caps	0.018	0.024	0.209	-0.226	0.082	-0.486	3.385
Global Stocks	0.016	0.000	0.324	-0.295	0.129	-0.144	3.274
Short term	0.010	0.010	0.026	-0.003	0.007	0.229	2.108
Medium Term	0.011	0.009	0.039	-0.015	0.012	0.425	2.499
Long Term	0.017	0.014	0.114	-0.052	0.039	0.451	2.704
Inflation	0.025	0.027	0.053	-0.016	0.011	-1.093	6.392
T-Bills	0.007	0.008	0.015	0.000	0.005	-0.238	1.591

Note: Table 2 explains basic descriptive statistics of returns over the 1st quarter of 1992 to 3rd quarter of 2012. Source: NCREIF, DataStream & Wrds.

3.3.9 NCREIF real estate index

In step one we select the appropriate structure of lags of real estate to include in the de-smoothing process. For selection of lags we compute the correlogram of twelve lags from the data is shown in Figure 1.

Figure 1: Correlogram of Quarterly NCREIF Real Estate Index from the first quarter of 1992 to the third quarter of 2012.



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.836	0.836	60.062	0.000
		2	0.692	-0.019	101.82	0.000
		3	0.469	-0.347	121.23	0.000
		4	0.273	-0.094	127.89	0.000
		5	0.054	-0.173	128.16	0.000
		6	-0.089	0.045	128.88	0.000
		7	-0.133	0.277	130.53	0.000
		8	-0.138	0.018	132.32	0.000
		9	-0.112	-0.087	133.50	0.000
		10	-0.118	-0.263	134.85	0.000
		11	-0.144	-0.282	136.88	0.000
		12	-0.178	0.032	140.02	0.000

Note: Figure 3 exhibits the correlogram of real estate index from the 1st quarter of 1992 to 3rd quarter of 2012 to estimate the proper lag structure. Source: NCREIF.

Correlogram shows that first four lags of real estate are significantly differently from zero.

Table 3: Descriptive statistics of full information index of NCREIF real estate index from the 1st quarter of 1992 to the 3rd quarter of 2012.

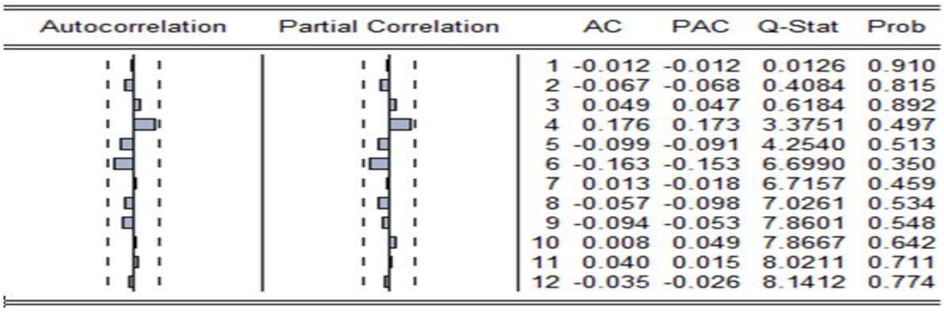
Measures	Values
Mean	0.015320
Median	0.017867
Maximum	0.108335
Minimum	-0.257674
Std. Dev.	0.040890
Skewness	-3.441870
Kurtosis	25.55792
Jarque-Bera	1923.682
Probability	0.000000
Sum	1.271580
Sum Sq. Dev.	0.137103

Note: Table 5 presents descriptive statistics of estimated de-smoothed real estate index through Fisher et al. (1994) desmoothing methodology over 1992 Q1 to 2012 Q3. Source: NCREIF

It can be seen in Table 3 of descriptive statistics of generated series of full information index that the return span of de-smoothed index is from -2.58% to 10.83% with the mean of 1.53% as compared to smoothed index return span from -8.3% to 5.4% and a mean of 2.1%. the standard deviation of full information index is increased from 2.4% to the 4.10% which is the main purpose of Fisher et al. (1994) de-smoothing procedure.

It is also seen that de-smoothing series shows negative skewness of -3.44 and positive kurtosis of 25.55 like the smoothed index. Significant rejection of null hypothesis of Jerque-Bera test at 5 % confidence level shows that data is not normally distributed. We can see the correlogram of full information index in Figure 2 below.

Figure 2: Correlogram of full information index from the 1st quarter of 1992 to the 3rd quarter of 2012:



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.012	-0.012	0.0126	0.910
		2	-0.067	-0.068	0.4084	0.815
		3	0.049	0.047	0.6184	0.892
		4	0.176	0.173	3.3751	0.497
		5	-0.099	-0.091	4.2540	0.513
		6	-0.163	-0.153	6.6990	0.350
		7	0.013	-0.018	6.7157	0.459
		8	-0.057	-0.098	7.0261	0.534
		9	-0.094	-0.053	7.8601	0.548
		10	0.008	0.049	7.8667	0.642
		11	0.040	0.015	8.0211	0.711
		12	-0.035	-0.026	8.1412	0.774

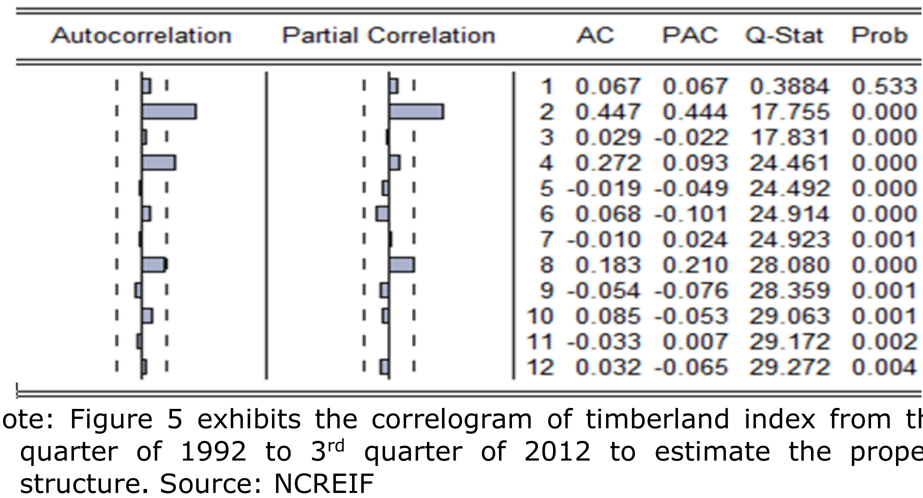
Note: Figure 4 depicts correlogram of estimated de-smoothed real estate index through Fisher et al. (1994) desmoothing methodology over 1992 Q1 to 2012 Q3. Source: NCREIF.

It can be seen in the above figure that there is no more autocorrelation in the de-smoothed series of NCREIF real estate.

3.3.10 NCREIF Timberland Index

To generate the full information index of NCREIF timberland series we will select the appropriate lag structure to include in Fisher et al. (1994) de-smoothing methodology.

Figure 3: Correlogram of Quarterly NCREIF Timberland Index from the first quarter of 1992 to the third quarter of 2012.



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.067	0.067	0.3884	0.533
		2	0.447	0.444	17.755	0.000
		3	0.029	-0.022	17.831	0.000
		4	0.272	0.093	24.461	0.000
		5	-0.019	-0.049	24.492	0.000
		6	0.068	-0.101	24.914	0.000
		7	-0.010	0.024	24.923	0.001
		8	0.183	0.210	28.080	0.000
		9	-0.054	-0.076	28.359	0.001
		10	0.085	-0.053	29.063	0.001
		11	-0.033	0.007	29.172	0.002
		12	0.032	-0.065	29.272	0.004

Note: Figure 5 exhibits the correlogram of timberland index from the 1st quarter of 1992 to 3rd quarter of 2012 to estimate the proper lag structure. Source: NCREIF

It is evident in Figure 3 that lags two and four of timberland is significantly different from zero. We include the two and four lags into autoregressive model.

$$\vartheta(P) = \vartheta_2 P + \vartheta_4 P \quad \text{(a)}$$

Now we run the ordinary least square analysis of timberland series with its lags and get the following equation.

$$r_t^* = 0.0104 + 0.296 * r_{t-2} + 0.154 * r_{t-4} \quad \text{(b)}$$

Table 4: Descriptive statistics of full information index of NCREIF Timberland index from the 1st quarter of 1992 to the 3rd quarter of 2012.

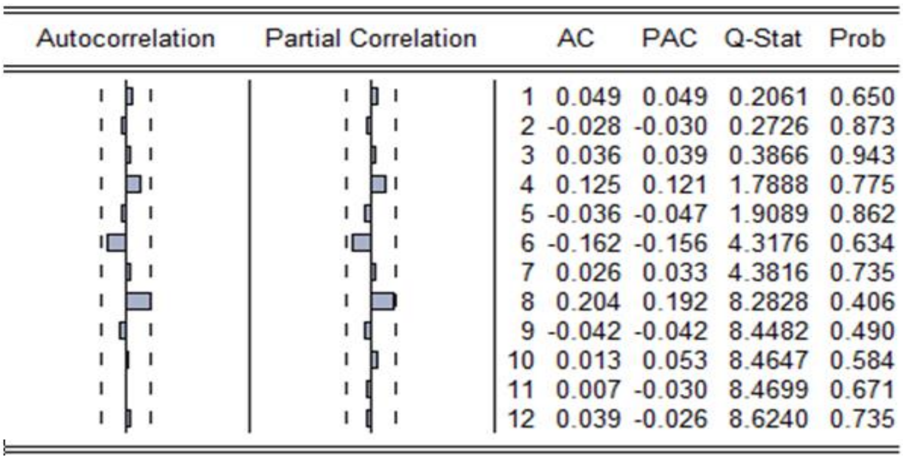
Measures	Values
Mean	0.016162
Median	0.010950
Maximum	0.221128
Minimum	-0.079132
Std. Dev.	0.041685
Skewness	1.678771
Kurtosis	9.489846
Jarque-Bera	184.6445
Probability	0.000000
Sum	1.341455
Sum Sq. Dev.	0.142484

Note: Table 6 presents descriptive statistics of estimated de-smoothed timberland index through Fisher et al. (1994) desmoothing methodology over 1992 Q1 to 2012 Q3. Source: NCREIF

Table 4 shows descriptive statistics of NCREIF timberland full information index that the span of returns is -0.079 to .221 with the mean value 0.016, as compared to the smoothed index returns span from -0.065 to 0.223 with the average of 0.025. Standard deviation of timberland smoothed index is 0.039 and the standard deviation of timberland generated index is 0.042 which is obviously higher than the smoothed index.

Skewness and kurtosis of generated series is positive as the smoothed index skewness and kurtosis. Jerque-Bera test's null hypothesis is rejected significantly at 5% confidence level, which shows that generated series are not normally distributed. We can see the correlogram of full information index in
Figure 4 below.

Figure 4: Correlogram of Timberland full information index from the 1st quarter of 1992 to the 3rd quarter of 2012.



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.049	0.049	0.2061	0.650
		2	-0.028	-0.030	0.2726	0.873
		3	0.036	0.039	0.3866	0.943
		4	0.125	0.121	1.7888	0.775
		5	-0.036	-0.047	1.9089	0.862
		6	-0.162	-0.156	4.3176	0.634
		7	0.026	0.033	4.3816	0.735
		8	0.204	0.192	8.2828	0.406
		9	-0.042	-0.042	8.4482	0.490
		10	0.013	0.053	8.4647	0.584
		11	0.007	-0.030	8.4699	0.671
		12	0.039	-0.026	8.6240	0.735

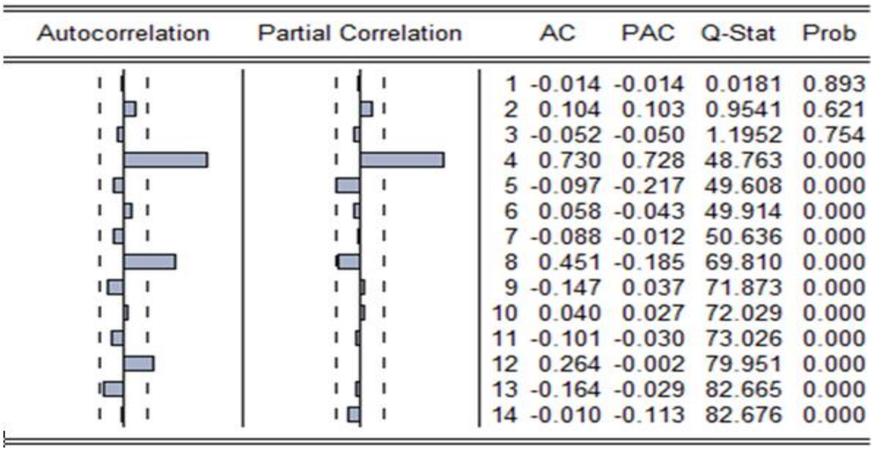
Note: Figure 6 depicts correlogram of estimated de-smoothed timberland index through Fisher et al. (1994) desmoothing methodology over 1992 Q1 to 2012 Q3. Source: NCREIF.

Figure 4 shows that there is still very low autocorrelation but insignificant as compared to the smoothed timberland index.

3.3.11 NCREIF Farmland Index

Now we are going to generate the NCREIF farmland de-smoothed series through the Fisher et al. (1994) proposed methodology. To select the appropriate lag structure we generate the correlogram as given below.

Figure 5: Correlogram of Quarterly NCREIF Farmland Index from the first quarter of 1992 to the third quarter of 2012.



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.014	-0.014	0.0181	0.893
		2	0.104	0.103	0.9541	0.621
		3	-0.052	-0.050	1.1952	0.754
		4	0.730	0.728	48.763	0.000
		5	-0.097	-0.217	49.608	0.000
		6	0.058	-0.043	49.914	0.000
		7	-0.088	-0.012	50.636	0.000
		8	0.451	-0.185	69.810	0.000
		9	-0.147	0.037	71.873	0.000
		10	0.040	0.027	72.029	0.000
		11	-0.101	-0.030	73.026	0.000
		12	0.264	-0.002	79.951	0.000
		13	-0.164	-0.029	82.665	0.000
		14	-0.010	-0.113	82.676	0.000

Note: Figure 7 exhibits the correlogram of faemland index from the 1st quarter of 1992 to 3rd quarter of 2012 to estimate the proper lag structure. Source: NCREIF

Correlogram of NCREIF farmland smoothed an index show that lags four; eight and twelve are significantly different from zero as seen in Figure 5.

Table 5: Descriptive statistics of full information index of NCREIF Farmland index from the 1st quarter of 1992 to the 3rd quarter of 2012.

Measures	Values
Mean	0.015210
Median	0.008635
Maximum	0.220010
Minimum	-0.111581
Std. Dev.	0.040458
Skewness	2.310075
Kurtosis	14.85883
Jarque-Bera	560.1722
Probability	0.000000
Sum	1.262460
Sum Sq. Dev.	0.134223

Note: Table 7 presents descriptive statistics of estimated de-smoothed farmland index through Fisher et al. (1994) desmoothing methodology over 1992 Q1 to 2012 Q3. Source: NCREIF

Above Table 5 of descriptive statistics of NCREIF farmland full information index show returns span between -0.115 to 0.220 and mean 0.015 as compared to the smoothed index returns span -0001 to 0.228 with the mean 0.028. farmland full information index standard deviation is increased from the 0.032 standard deviation of smoothed index, to 0.40 which is the main goal of Fisher et al. (1994) de-smoothing methodology.

NCREIF farmland full information series are not normally distributed as it is evident from the significant rejection of Jerque-Bera normality test at 5% confidence level. For more clearance we can see the correlogram of full information index in Figure 6.

Figure 6: Correlogram of Farmland full information index from the 1st quarter of 1992 to the 3rd quarter of 2012.

Note: Figure 8 depicts correlogram of estimated de-smoothed farmland

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.203	0.203	3.5515	0.059
		2	0.124	0.086	4.8878	0.087
		3	0.017	-0.024	4.9143	0.178
		4	0.150	0.147	6.9122	0.141
		5	-0.063	-0.125	7.2673	0.202
		6	-0.069	-0.067	7.7042	0.261
		7	-0.006	0.049	7.7074	0.359
		8	-0.097	-0.129	8.5869	0.378
		9	-0.051	0.016	8.8340	0.453
		10	0.102	0.165	9.8390	0.455
		11	0.041	-0.042	10.005	0.530
		12	0.052	0.066	10.276	0.592
		13	-0.077	-0.110	10.881	0.621
		14	-0.071	-0.134	11.389	0.655

index through Fisher et al. (1994) desmoothing methodology over 1992 Q1 to 2012 Q3. Source: NCREIF.

It can be seen in the correlogram of farmland full information index that there in miner type of autocorrelation but insignificant as compare to the smoothed farmland index.

4. Results

In this section we are going to apply our research model on the dataset and interpret the inferred empirical results. Firstly we take an overview of farmland, timberland, real estate and other asset class's performance characteristics over the study period. A snapshot of returns and standard deviation of all asset classes will be taken to see the relationship of return and associated risk of asset classes.

Secondly, we will see the farmland and timberland correlation with other asset classes separately and correlation among the other entire asset classes also. For this purpose we will calculate the Pearson correlation coefficients. Thirdly we will go to overlook the financial performance of all asset classes. In order to do this we will calculate the Sharpe ratio to check the financial performance of each asset class.

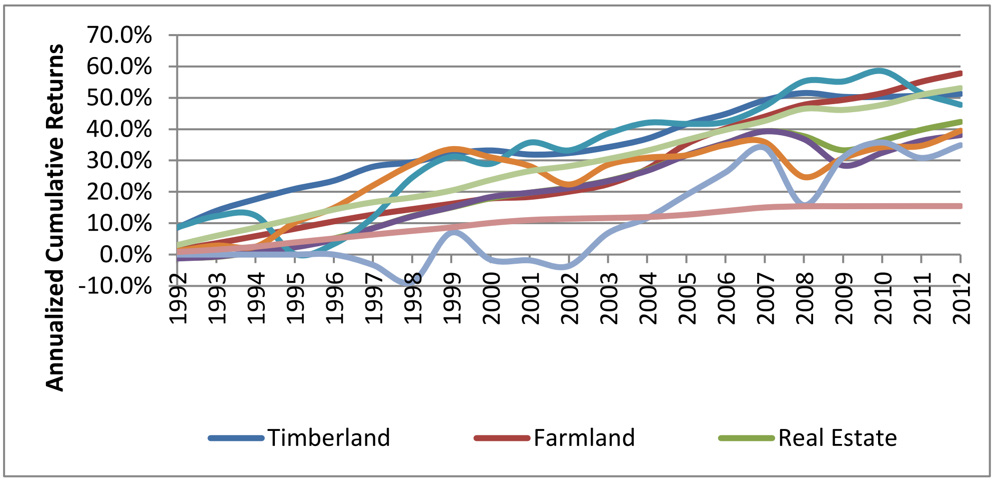
Fourthly, to test that by adding the farmland and timberland into a diversified portfolio of mix asset, there is any improvement in risk-return relationship. In order to check this graphically we will construct the efficient frontier of optimized portfolios. Fifthly, we will run the mean variance spanning-a statistical test to check the shift in efficient frontier by adding farmland and timberland in the mix assets portfolio- to see whether it is significant or not. Finally, we will discuss the inflation hedging characteristics of farmland and timberland.

4.1 Farmland, Timberland and all other classes' performance features

To see the performance characteristics of all asset classes over time period we calculate the annualized cumulative returns from 1992 to 2012. To look the over time performance effect of all asset classes, we present the cumulative returns graphically in Figure 7. The figure shows how the returns of different asset classes devolved over time. Timberland shows appreciation in returns overtime from 1992 to 2008, after that timberland returns decrease slightly. Farmland returns increase overtime slowly from 1992 to 2005 and from 2005 farmland returns take a boost in increase to 2012. Farmland returns are quite stable during crises period from 2007 to 2009. Small cap shows increasing trend from 1995 onwards and demonstrates peak returns in 2010 but large cap shows high results in 1999 and downturn in crises period. Global stocks demonstrate very dramatic trend; they go negative in 1998 and 2000 to 2002, then shows increasing trend till crises period. It can be seen that global stocks are badly affected during both the crises periods 2001 to 2002 and 2007 to 2009. It can be noted that all asset returns show a downturn in crises period except the treasury bills. All assets show a slow recovery after crises period. During crises period farmland is not so much

affected as the timberland and other asset classes. Now we see that how these overtime increasing returns relate to their standard deviation in
Figure 8.

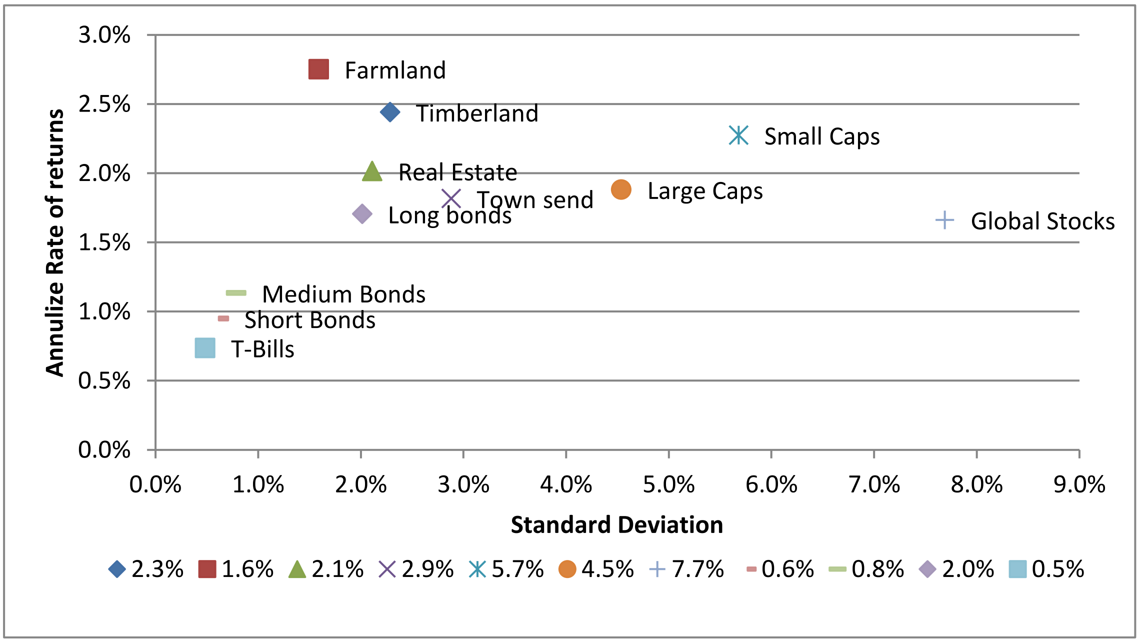
Figure 7: cumulative returns of all asset classes (annual data 1992 – 2012).



Note: Figure 9 depicts the quarterly cumulative annualized returns of all asset classes over 1992 to 2012. Source: NCREIF, DataStream & Wrds.

It can be seen that farmland gives highest returns 2.8 % at low level of risk 1.6% as compared to the all-asset classes. Timberland gives low returns than farmland with high level of risk but high than real estate. Global stock is more risky than all other asset classes and gives low returns from all stocks and real assets. T-bills shows lowest returns at lowest level of risk and short-term bonds are less risky than medium and long-term bonds and also prove lower returns than other bonds. Small caps provide high returns 2.3% than large caps with high level of risk 5.7% but as compared to global stocks returns 1.7% provide higher returns at lower risk. For the purpose of portfolio optimization farmland and timberland have interesting characteristics in terms of return and standard deviation.

Figure 8: Annual rates of returns and standard deviation of all asset classes (1992 Q1 – 2012 Q3).



Note: Figure 10 exhibits the risk return combination of all asset classes over 1st quarter of 1992 to 3rd quarter of 2012. Source: NCREIF, DataStream & Wrds.

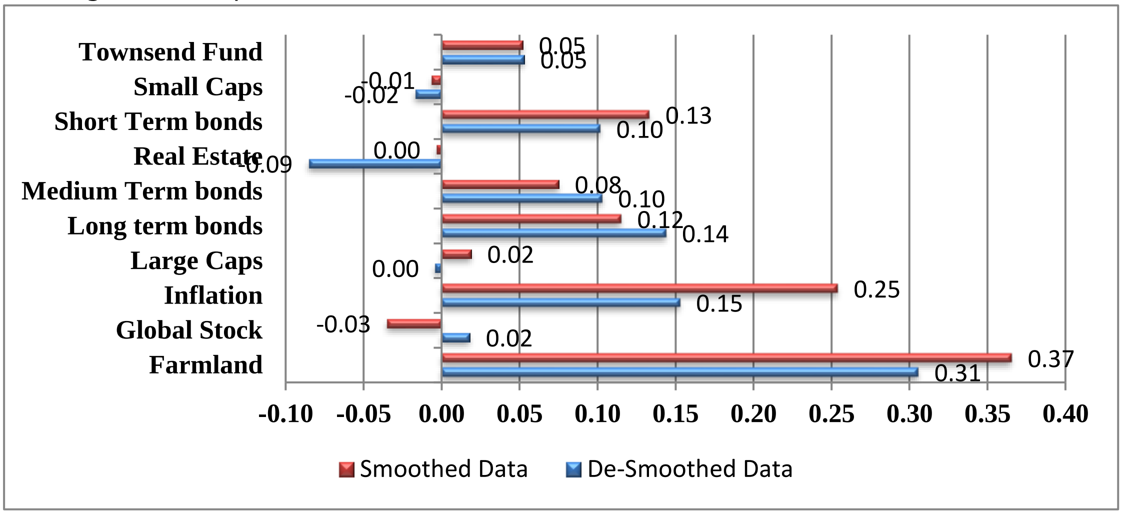
4.2 Farmland and timberland correlation with other asset classes

To analyze the diversification characteristics of farmland and timberland we see that how farmland and timberland are correlated to other asset classes. We graphically analyze the correlation of timberland and farmland with other asset classes. The red bars in

Figure **9** and Figure 10 represent the correlation of timberland and farmland smoothed quarterly series from first quarter of 1992 to third quarter of 2012 with other asset classes. Blue bars represent the correlation of farmland and timberland de-smoothed quarterly series from first quarter of 1992 to third quarter of 2012 with other asset classes.

Figure 9: Correlation of timberland with all other assets.

Note: Figure 11 depicts correlation of timberland smoothed and de-smoothed series with



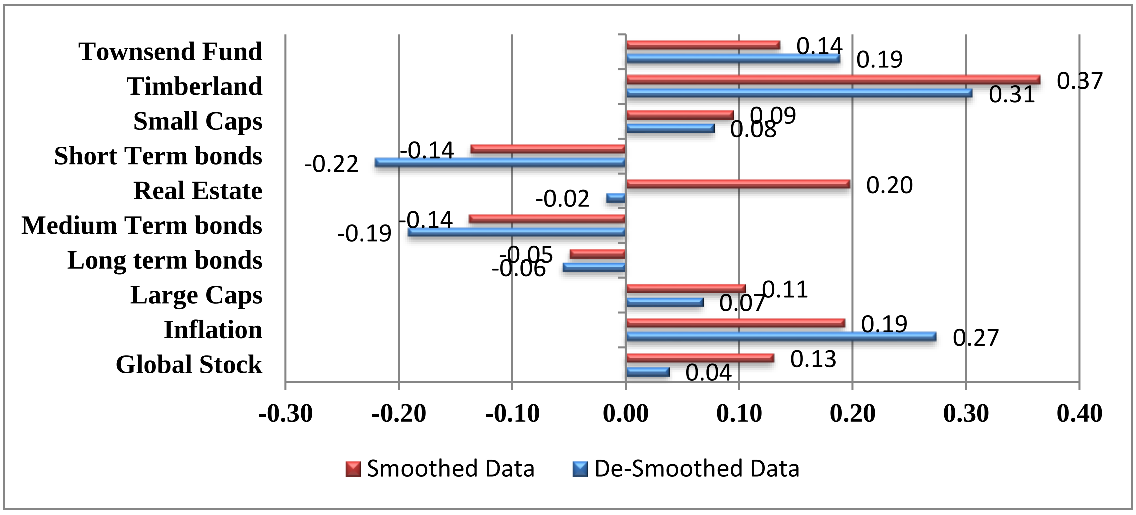
all other asset classes over 1992 Q1 to 2012 Q3. Source: NCREIF, DataStream & Wrds.

Figure **9** shows correlation of timberland with other assets, it can be seen that smoothed returns of timberland are correlate positively with all other assets except small caps, real estate and global stocks. Timberland smoothed series have negative correlation with real estate but very minor in value. Timberland and farmland smoothed series have high positive correlation with each other, with value of 0.37. as IWC (2009), Scholtens and Spierdijk (2010) and Martin (2010) studies state that timberland have positive correlation with inflation, it can be seen in

Figure **9** that timberland smoothed series is highly correlated with inflation.

When we see the de-smoothed timberland correlation with other asset class as the blue bar represents, it can be seen that correlation between farmland and timberland decreased from 0.37 to .31 points. Correlation between global stack and timberland with smoothed series was negative but it becomes positive with de-smoothed timberland series. Correlation between real estate has become more negative, with de-smoothed timberland series. Long- and medium-term bonds correlation increased with de-smoothed timberland series but with short it decreases. Correlation with inflation of de-smoothed timberland series also decreases.

Figure 10: Correlation of farmland with all other assets classes.



Note: Figure 12 depicts correlation of farmland smoothed and de-smoothed series with all other asset classes over 1992 Q1 to 2012 Q3. Source: NCREIF, DataStream & Wrds.

Figure 10 shows the farmland correlation with other asset classes. Farmland smoothed series show positive correlation with most of the assets except short, medium and long-term bonds. Farmland shows positive correlation with inflation as stated by Scholtens and Spierdijk (2010) and Painter (2002) in their studies. Smoothed farmland series show positive correlation with inflation but less positive than timberland. Real estate shows positive correlation with smoothed farmland as compared to the timberland.

De-smoothed farmland series also show positive correlation most of the assets except all bonds and real estate. It can be seen that correlation between de-smoothed farmland and real estate become negative from positive. Correlation of de-smoothed farmland series with all other assets decrease as compared to smoothed farmland series. But it can be seen that correlation between de-smoothed farmland series and inflation is increased from 0.19 to 0.27. It means de-smoothed farmland series have more inflation hedging features than smoothed farmland and timberland series.

4.3 Performance Measurement

To analyse the risk return performance characteristics or risk adjusted performance of all asset classes we use Sharpe's measure. Although usually this measure is employed to provide the different portfolios ranking, it may also be used for the comparison of asset classes. It is a relative measure which tells that how much risk premium would an asset offer against one unit of risk. Sharpe ratio or measure can be calculated by dividing the excess returns of assets by their standard deviation.

$$S = \frac{\overline{r_i} - \overline{r_f}}{\sigma_i}$$

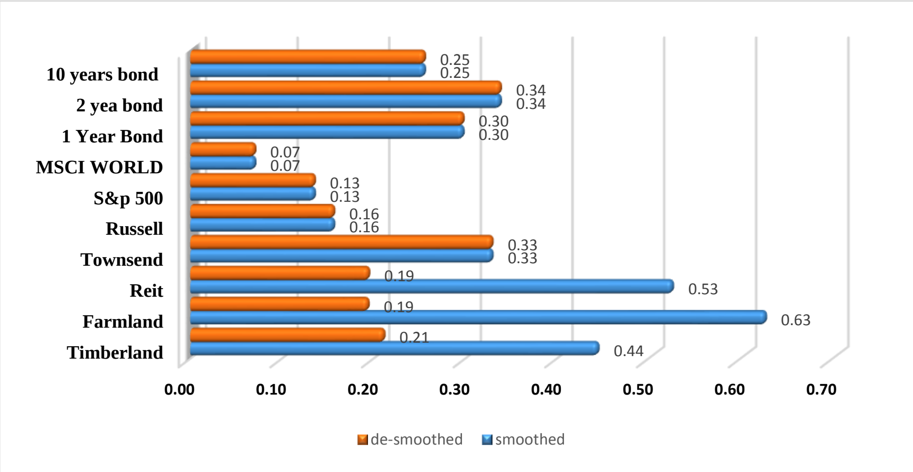
Here

$\overline{r_i}$Represents the mean returns of an asset class $\overline{r_f}$ represents the mean risk free rate and σ_i represents the standard deviation of that asset class returns.

In first step we analyze the NCREIF timberland, farmland and real estate smoothed indices performance characteristics with other asset classes. Secondly we analyze the NCREIF un-smoothed return indices performance characteristics with other asset classes.

Figure 11 shows the Sharpe's ratio graphical representation of NCREIF smoothed indices and all other asset classes in blue color. It can be seen that first three NCREIF Farmland, Real estate and timberland indices show better performance as compared to the other assets and low standard deviation. Its means these asset classes provide the high risk premium against per unit of risk.

Figure 11: Sharpe ratios of all assets and with farmland and timberland smoothed series (1992 Q1 – 2012 Q2).



Note: Figure 13 depicts the Sharpe ratio of all asset classes with smoothed and de-smoothed farmland and timberland series over 1992 Q1 to 2012 Q2. Source: NCREIF, DataStream and Wrds.

It can also be seen that United States bond indices provide the good Sharpe ratio relative to the global, large and small stocks. But the medium term bonds show higher performance than the short term and long term bonds. Townsend fund also perform higher with the Sharpe ratio .33 than all bonds and stocks, but the global stocks shows worst performance as compared to all other asset classes with Sharpe ratio 0.07. It is interesting that farmland and timberland have better financial characteristics and portfolio optimization.

Furthermore, Sharpe ratio of NCREIF de-smoothed timberland, farmland and real estate series in red color, is dramatically decreased as compared to the smoothed indices as can be seen in Figure 11. Sharpe ratio of NCREIF timberland, farmland and real estate indices is decreased because the Fisher et al. (1994) de-smoothing procedure increases the standard deviation of these indices.

After de-smoothing, timberland shows high ratio than the real estate and farmland as compared to the smoothed series but low performance than all bonds and Townsend fund. De-smoothed Farmland and real estate shows same performance but high than the global, large and small stocks. It means unsmoothed returns of timberland, farmland and real estate still have portfolio optimization characteristics.

5. Conclusions

After the recent global crises' investors want more security from the market uncertainty and they are converting from traditional investments to the alternative investments. Alternative investments like real estate, commodities, farmland and timberland. Farmland and timberland have financial performance characteristics as we analyze in our thesis.

The main objective of this thesis was to examine the risk return performance characteristics of a mixed assets portfolio with farmland and timberland. We explore that both farmland and timberland or separately enhance the return of a mix assets portfolio at a given level of risk. The main research of our study was:

Is farmland and/or timberland are the mean variance efficient in the portfolio of traditional assets?

In literature section we had a look at previous studies related to our research question and tried to explain the basic framework of this thesis with the modern portfolio theory. We discussed our thesis main topics like MPT, timberland, real estate and, farmland with their portfolio optimization and risk and inflation hedging features. The literature suggests that farmland and timberland both have risk and inflation hedging characteristics and interesting portfolio optimization features.

The main data set used in this study and the statistical model of the research has discussed in methodology section. Descriptive analysis of data series suggests that farmland and timberland have high returns with low standard deviation as compared to the other asset. In this section we discussed about autocorrelation of NCREIF series and calculate the de-smoothed series of NCREIF indices with Fisher et al. (1994)proposed methodology. De-smoothing process increases the NCRIEF indices standard deviation from the smoothed series.

In results section we have examined the overtime performance characteristics of all assets with respect to their associated risk, which shows that farmland and timberland have high characters to enhance the relationship of risk and return as compared to the other assets. In correlation section we examined the correlation of smoothed and de-smoothed series of timberland and farmland with other assets. Timberland and farmland both have the positive correlation with other assets except the real estate and all bonds. After de-smoothing negative correlation between farmland and real estate become positive. Timberland and farmland show positive correlation with inflation which indicates the inflation hedging features of both the assets. Correlation with inflation of timberland decreases after se-smoothing but increases with farmland after de-smoothing.

We measure the extra returns performance against one unit of risk with the Sharpe ratio. Timberland and farmland show high performance with smoothed series but with de-smoothed series performance decreases of the both the assets. After de-smoothing timberland shows high performance than farmland, as compared to the smoothed series. To analyze the risk hedging characteristics we calculate the portfolio returns in top 10 high and low market volatility quarters. In high and low market volatility most of the quarter's portfolio returns enhanced by adding farmland and timberland. Results of analysis reveals, that farmland and timberland have better risk hedging features in the period of high market volatility. Worst case scenario analysis depicts the portfolio returns with and without farmland and timberland enhancing features in the period of low turmoil which shows that farmland and timberland both can enhance the portfolio returns in low turmoil.

To analyze the inflation hedging features of farmland and timberland, calculate the portfolio returns with and without farmland and timberland of top 10 high and low inflation quarters. Farmland and timberland both have inflation hedging characteristics in high inflation period but less than the low inflation periods. Inflation hedging analyses reveal that farmland and timberland do not show the inflation hedging features as the previous studies suggests.

Efficient frontiers were constructed to assess the impact of farmland and timberland into a traditional assets portfolio. We can see that by adding timberland and farmland the efficient frontiers shifts positively towards high returns with less risk. Efficient frontier with smoothed farmland and timberland shows more positive shift than de-smoothed farmland and timberland series. It means smoothed farmland and timberland poses more risk return enhancing features than de-smoothed series. Mean variance spanning test with smoothed farmland and timberland series reveal that shift in efficient frontier with timberland is significant and insignificant with farmland efficient frontier. With de-smoothed series mean variance spanning test explores that shift in efficient frontier with farmland is significant as compared to the timberland efficient frontier. After de-smoothing mean variance results become opposite to the smoothed series results.

After doing all the analyses of this study we come to the main question of the study. We analyze all interested features of farmland and timberland which are to be proven quite positive. As the title of thesis alternative investment are mean variance efficient and inflation hedger a fact or fiction? After considering the thesis data and models, it is a fact for timberland with smoothed data and a fact for farmland with de-smoothed data.

6. Future research Recommendations

For future research we recommend a comprehensive analysis of data distribution. As in general financial data is not normally distributed. In non-normally distributed data arises the problem of heteroskedasticity. In heteroskedasticity problem the variance of error terms not constant, there will also be the possibility of autoregressive conditional heteroskedasticity; if the error terms variance changes with time rather than systematically with one of the independent variables. To eliminate the heteroskedasticity problem we recommend general test of one of the heteroscedasticity tests.

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