International Journal of Business and Management Invention
ISSN (Online): 2319 – 8028, ISSN (Print): 2319 – 801X
www.ijbmi.org Volume 2 Issue 11 ǁ November. 2013ǁ PP.33-41

Trading in weather risk transfer products – Reengineering rainfall indexation

Shivkumar D P[1], Kotrshwar G[2]
[1] Research Scholar, Department of Commerce, University of Mysore, Mysore, India,
[2] Professor of Commerce, University of Mysore, Mysore, India

---

ABSTRACT: *The proposed study is an attempt to support the policy initiatives taken by the government and exchanges to engage capital markets for absorbing weather related risks, particularly the rainfall. The need of the hour is to conceptualize securitization of rainfall risk as a forerunner for creation of monsoon rainfall risk markets in India. The research reported in this paper focuses on reengineering the process of rainfall indexation based on a ticker value defined as Monsoon Outcome Index (MOX). A thorough examination of the statistical properties of the MOX values for select meteorological subdivisions of India has indicated scope for launching weather RTP (risk transfer product) based on MOX. The results also reinforce the potential of MOX as a new asset class for inclusion in portfolio for risk hedging.*

KEYWORDS: *Index based insurance, Monsoon Outcome Index, Rainfall index, Risk hedging*

I. INTRODUCTION

Financial markets can play a vital role in indemnifying the losses by means of risk sharing. Insurance market, being a conduit of financial markets, is solely lacking in India and is unable to address natural disasters like monsoon failure. There are several reasons why rural financial markets have not developed for risk-sharing from natural disasters that damage agriculture. First, some form of *expoit* failure (drought) relief is common in the form of *free* aid and debt forgiveness. As long as free aid or debt forgiveness is used, vulnerability to disasters becomes self-perpetuating. Second, the governments, both at the state and central level, operate highly subsidized public crop insurance programmes. Skees, *et al (2001),* Jennifer (2001), *Spaulding, et al (2003) and Sinha (2004)* found crop insurance programmes, in general, costlier than expected due to operational problems involved.

Fortunately, developments in global financial markets provide unique opportunities for managing catastrophic risks. The two promising innovations that could provide for effective management of monsoon risk are: (1) Index-based insurance contracts and (2) Weather derivatives. Index-based insurance is an alternative form of insurance that makes payments based not on measures of farm yields, but rather on some objective weather event such as rainfall.

II. THE SCOPE FOR RAINFALL-INDEX-BASED RISK TRANSFER PRODUCTS (RTP)

Index insurance provides an effective policy alternative as it seeks to protect the crop-yield losses due to vagaries of rainfall, drought etc. It is being experimented in many developing countries including India. Varsha Bima scheme of Agricultural Insurance Company of India (AICI) and Barish Bima of IFFCO Tokio General Insurance Company (ITGI) are the ongoing projects experimenting with index insurance in India.

Index-based insurance is emerging as a promising alternative to traditional crop insurance (Shivkumar, *et al* (2013) in view of its improvement over the traditional crop insurance. The private sector is keen to take up this venture, as private insurance can be observed world wide, even though it is not highly developed (Jennifer, 2001). Government needs to put the necessary infrastructure in place and give credibility to the programme. In the end, government intervention should disappear and the market would decide how this programme develop, reach to groups involved in and affected by agriculture (Spaulding et al, 2003). To realize its full potential, it requires reinsurance facility for private insurers at grass root level. This in turn involves bringing about a convergence of insurance and financial markets via special purpose vehicles (SPVs) such as weather derivatives. The weather derivatives market would help private insurers to hedge their weather risk exposure by trading in weather derivative contracts.

Weather derivatives represent an advanced form of index-based insurance and are available in standard forms like options, futures and swaps. When weather event is a source of economic risk for agriculture, a weather derivative can become a hedging tool for wide range of stakeholders. The increasing popularity of temperature based weather derivatives in U.S. and elsewhere has brightened the prospects of innovating with rainfall based weather derivatives, particularly in some agro-based developing economies. Countries like South Africa (Geyser and Venter, 2001), India (Sinha, 2004), Morocco (Skees, *et al,* 2001) and others have already started experimenting with rainfall derivatives, though the contracts strictly do not resemble the true nature of derivatives structure. Kotreshwar (2006) suggest that the precipitation derivatives suits Indian economy.

The Indian situation with the monsoon is the perfect opportunity to design derivative products. The monsoon has an enormous impact on many enterprises, including agriculture, commodity trading, agro-processing, energy and insurance. An equally important reason for the development of derivatives market is to absorb systemic monsoon risk, in the expected deregulation of financial and insurance markets. The stakeholders in these markets have the need to manage monsoon related risks through monsoon derivatives. From a boarder perspective, risk markets have the potential to yield additional benefits too. They can promote integration of markets by expanding the horizon of asset classes for investment. From the perspective of Markowitz mean-variance efficiency, as long as the market is not complete, a new asset class will always improve the risk-return trade off (Cao, *et al* 2003).

Monsoon derivative contracts can be based on conventional derivative structures including over the counter (OTC) as well as exchange-traded products. Basic OTC structures may be call/put options and swaps. The purchaser of the option is paid the difference between the strike (i.e. agreed rainfall) and the actual rainfall. The strike quantity of a monsoon option would be based on historical rainfall-data for a particular area, as collected by the area meteorological station. Some form of rainfall index usually measures the historical data. The strike point of the option would then be based on the index. For example, if the average rainfall for June to September in a particular area were 400 mm, a four-month call option for that period would have a strike of approximately 400mm. Actual rainfall over the same period would be the 'actual quantity' and that determines the payout of the option. A predefined Rupee value per millimeter in excess of the strike or less than the strike would determine the payout of the option. The payments are made/ received depending upon whether the actual rainfall decrease below (increase above) a specified level. However, the monsoon derivatives market will only prove useful if it becomes liquid. This requires stock exchanges to list contracts on monsoon risk. For example, the Chicago Mercantile Exchange introduced temperature based weather derivatives contracts in 1999 and rainfall based weather derivatives contracts in 2011. The Forward Market Commission's initiative to redefine commodity derivatives for enabling trades in 'exotic commodities' like weather holds a big promise for the development of monsoon derivatives market in India.

Any change in the pattern of rainfall affects the volume of agricultural production. If variability in rainfall can be structured into a contract, it should be possible for the farmer to protect himself against a downside risk in production volumes (and his income) by selling and/or buying rainfall options. Similarly, if a company's raw material is agricultural produce, whose price is a function of market arrivals, company can hedge its position by a put or call on rainfall index. The institutions in deregulated financial and insurance markets need to manage monsoon related risks through rainfall derivatives.

III. DEVELOPING RAINFALL INDEX

While existence of a forward rainfall index is essential to support the development of hedging contract, it is obviously a limitation as such trading contracts do not exist in India except earlier pilot version of National Commodity Exchange (NCDEX) and Multi Commodity Exchange(MCX) rainfall index which mainly served as a reference value for insurance claims settlements

For any exchange to successfully trade rainfall options, the construction of an appropriate rainfall index which can be observed on a daily/monthly basis and which provide volatility benchmarks is critical. Rainfall index which has unique character of randomness meets the requirement. A hedger planning a hedge for the ensuing monsoon (south-west) would normally assume that the monsoon rainfall pattern would follow the average pattern as dictated by history. Critical to this is the additional assumption that the rainfall is mean reverting. Mean reversion is supposed to be a natural phenomenon; the tendencies for quantum rainfall to fall within a normal range following an excess, to rise to normal following deficit is clearly a norm rather than an exception

In this section a general approach for constructing a rainfall index using historical data is presented. In the next section the index model will be applied to MOX contracts for selected meteorological subdivisions.

Rainfall index indicates what percentage of cumulative normal expected rainfall is realized? A higher index would mean that, compared to the cumulative long period average rainfall up to the date of index, there has been more rainfall.

National Commodities Exchange (NCDEX) pioneered the introduction of rainfall index in India. Rainfall Index for Mumbai was launched on June 01, 2005. Index for Belgaum, Erode, Guntur, Karimnagar, Ganganagar, Kottayam, Murshidabad, Rajkot and Ujjain launched on June 01, 2006. The index has been based on long period average expected rainfall. It indicates what percentage of cumulative normal expected rainfall is realized. A higher index would mean that, compared to the cumulative long period average rainfall up to the date of index, there has been more rainfall. The methodology adopted by NCDEX for calculated rainfall index is summed up by an example:

Based on historical data, normal expected rain by June 02, 2005: 28.6 mm
Actual rain by June 02, 2005:0.65 mm
Rainfall index (scaled by 1000) on June 03, 2005:(0.65/28.6) x 1000 = 22.7
It has rained 2.27 pc of normal rain by June 02, 2005.

The farmer would be typically the seller of the index at the start of the monsoon, and will buy it back at the end of the monsoon. A monsoon failure will imply a lower index and lower monetary value. The index thus bought back by the farmer will compensate the loss suffered on the output front.

The MCX and Weather Risk Management Services Pvt. Ltd jointly developed rainfall indexes - RAINDEXMUM, RAINDEXIDR and RAINDEXJAI - records rainfall at Mumbai (Colaba), Indore and Jaipur respectively, and is designed such that it considers the normal historical rainfall in Mumbai, Indore and Jaipur.

The index is computed based on historical annual cumulative rainfall and adjusted with net surplus or deficit of actual cumulative rainfall as of that date. The adjustment factor takes into account the impact of historical and actual rainfall during the period. The normal index values for Mumbai, Indore and Jaipur are 1950, 950 and 350 respectively. A cap is adopted on the maximum daily rainfall to reduce the impact on index at times of unprecedented rainfall on any single day.

NCDEX and MCX rainfall indices are only for purpose of display and dissemination of information, emphasizing the importance of weather trading platform for the country. Yet regulators of Indian Commodity Exchanges have not come forwarded with mechanism that would help farmers hedge against weather. Parliament yet to clear amendments to Forward Contract Regulations Act, as of now Indian regulation does not define weather as a commodity, thus impeding trading.

The rainfall indexation discussed in this paper is different in the perspective of development of risk transfer products meant for capital market. It is proposed to recognize the index using a ticker symbol, MOX (Monsoon Outcome Index), which would form the basis of rainfall derivatives:

$$MOX = \Sigma R_{it} / \Sigma R_{ct} \times 1000 \qquad \ldots\ldots(1)$$

Where R_{it} represents cumulative rainfall for end of i^{th} month of the t^{th} season; R_{ct} stands for historical average cumulative monthly rainfall for the t^{th} season; and 1000 is the multiplier value.

The computation of MOX values for each of the major selected meteorological subdivision in place of few selected city/locations is preferable mainly for two reasons:

The index becomes broad-based which in turn should facilitate the launch of a trading mechanism at the national level to meet the diverse needs, i.e., speculation, risk hedging and arbitraging. A broad-based index minimizes the impact of basis risk which looms large in any weather-based risk transfer product.

According to equation (1), the MOX values have been computed for the selected 6 out of 36 meteorological subdivisions of India, summarized in Table 1(a,b). The selected meteorological subdivisions are Assam Meghalaya (ASMEG), Punjab (PUNJB), East Madhya Pradesh (EMPRA), Gujarat (GUJRT), Madhya Maharashtra (MADMH) and Tamilnadu and Pondicherry (TLNAD). They have been selected from North East, North West, West Central and Peninsular region. The graph of the MOX values for one of the sub division, Assam Meghalaya for all the monsoon months is provided in Fig 1(a,b).

Table: 1(a) MOX Values for select 6 subdivisions for 30 years (1982-2011)

	MOX values for Jun month						MOX values for July month					
Year	ASSMEG	PUNJB	EMPRA	GUJRT	MADMH	TLNAD	ASSMEG	PUNJB	EMPRA	GUJRT	MADMH	TLNAD
1982	931	419	654	251	688	1455	871	468	744	779	603	1147
1983	698	507	736	1082	1000	1063	978	623	890	1302	881	1042
1984	785	1056	666	667	705	397	949	1090	642	1140	986	963
1985	1039	1023	958	58	673	701	1018	1109	1146	619	676	1069
1986	604	2228	1405	1518	1631	952	704	989	1023	752	912	809
1987	1044	513	395	594	878	725	1157	260	652	463	720	436
1988	844	813	1579	530	710	419	1023	1525	1166	1569	1077	1156
1989	933	708	1389	867	1142	530	1197	900	857	1045	1163	2162
1990	867	337	1987	707	1246	728	822	1066	1404	661	1020	587
1991	918	1665	816	670	2158	2763	793	751	874	1291	1604	1581
1992	729	724	359	1318	1097	899	771	683	729	928	870	926
1993	1474	1130	826	806	1072	543	1443	2261	770	1511	1068	859
1994	930	1126	1981	2155	1973	617	812	1427	1780	1635	1449	785
1995	1037	1151	591	36	555	926	979	962	914	992	785	1398
1996	530	3061	652	892	1247	3831	717	1054	840	1155	1133	1995
1997	1080	1112	738	4040	1260	1036	927	784	1078	1733	1066	684
1998	1061	1164	853	821	1021	532	1096	1244	860	978	991	982
1999	749	1052	892	1142	1284	724	934	1110	1058	848	1086	677
2000	941	2431	1508	434	1308	1669	797	1538	1268	817	1024	1196
2001	725	1416	2161	1727	954	367	749	1163	1718	1167	715	453
2002	962	646	728	1481	1598	1128	990	533	406	572	896	739
2003	961	1293	891	1439	1110	816	856	972	997	1529	938	989
2004	739	700	1645	1132	1199	678	996	364	1013	1041	945	937
2005	969	1023	1021	1932	1582	940	867	804	1658	1452	1655	1101
2006	1078	833	466	859	1140	1428	848	855	1133	1356	1463	776
2007	1141	1332	638	570	1581	3628	1054	539	774	1118	1396	2006
2008	1073	3899	1925	606	705	478	941	1395	1232	818	660	735
2009	639	175	257	119	402	869	669	650	790	843	956	519
2010	998	608	441	473	1128	1281	813	960	918	847	1194	1443
2011	786	1536	2407	114	736	624	758	765	1467	627	955	870

Table: 1(b) MOX Values for select 6 subdivisions for 30 years (1982-2011)

	MOX values for Aug month						MOX values for Sept month					
Year	ASSMEG	PUNJB	EMPRA	GUJRT	MADMH	TLNAD	ASSMEG	PUNJB	EMPRA	GUJRT	MADMH	TLNAD
1982	914	748	1122	794	633	851	943	597	1067	665	697	899
1983	990	803	887	1335	1034	1324	1078	736	1093	1268	1217	1541
1984	941	994	1013	1314	819	659	1014	975	963	1193	838	653
1985	964	1034	1051	640	627	995	985	893	990	549	606	766
1986	754	896	852	672	901	688	810	794	787	561	819	799
1987	1112	321	726	541	892	796	1191	275	872	455	766	759
1988	1288	1264	1000	1300	1069	1624	1271	1729	942	1343	1314	1446
1989	1099	866	856	1096	1051	1437	1147	769	821	990	1111	1394
1990	795	1020	1133	1151	1221	750	863	1138	1264	1192	1092	878
1991	854	810	1028	1063	1319	1303	924	740	905	961	1112	1114
1992	820	808	940	986	968	927	819	776	998	1129	943	845
1993	1446	1393	780	1036	993	1105	1362	1361	1020	1009	958	1042
1994	845	1440	1590	1486	1249	846	841	1319	1460	1672	1109	650
1995	1001	1224	913	800	889	1262	1036	1386	875	759	833	935
1996	778	973	862	1057	1009	2011	778	951	855	1044	1008	1801
1997	886	1007	1055	1667	1115	655	934	886	1112	1549	975	1112
1998	1170	1033	861	878	1068	1241	1061	1186	935	1193	1148	1317
1999	1015	985	978	599	844	830	994	943	1212	549	880	767
2000	939	1093	939	690	981	1663	1033	975	873	603	923	1337
2001	734	941	1229	1053	721	571	744	853	1063	914	881	968
2002	951	574	822	706	994	655	904	739	858	723	889	655
2003	874	900	965	1383	874	954	853	922	1203	1338	814	867
2004	916	616	944	1215	1140	651	902	512	849	1110	1152	874
2005	986	772	1266	1245	1584	1107	897	844	1227	1511	1620	1063
2006	769	792	1020	1433	1703	681	752	863	914	1376	1572	736
2007	991	668	676	1204	1309	2076	1033	611	695	1302	1251	1826
2008	1034	1597	1041	991	773	777	986	1549	953	1091	1019	831
2009	802	605	670	706	884	754	755	634	715	670	941	979
2010	820	892	865	998	1179	1480	851	914	907	1093	1153	1251
2011	780	853	1234	950	1012	1074	763	937	1240	984	1000	867

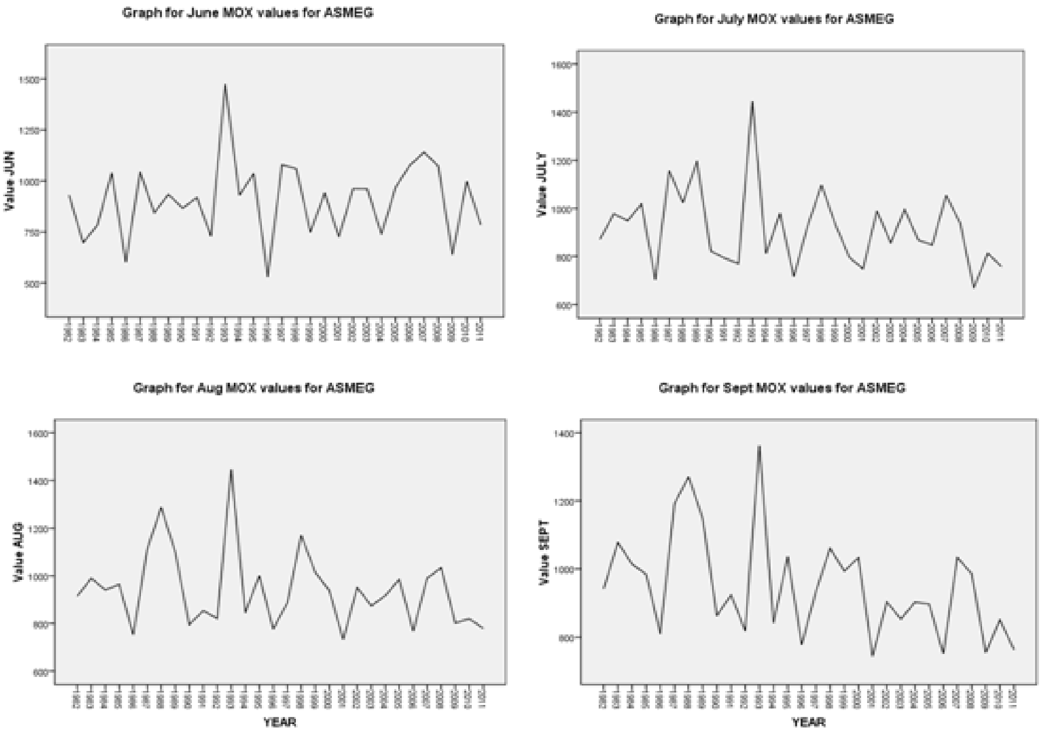

Figure 1 (a),(b),(c),(d): MOX values for ASMEG for June, July, Aug, Sept months

The rainfall data is sourced from the Indian Institute of Tropical Meteorology (IITM) website, for South-West monsoon season starting from 1st June and ending on 30th September and the MOX values for end of each month are computed for 30 years for the select 6 subdivisions. R_{ct}, value is based on the 30 years moving average cumulative rainfall for the monsoon months. It can be observed that MOX value have taken a wide range both across years and subdivisions. For instance, the MOX value for the end of June month for Madhya Maharashtra (MADMH) sub division it varied between a minimum of 402 in the year 2009 and a maximum of 2158 in the year 1991.

IV. STATISTICAL PROPERTIES OF MOX VALUES

Table 2 (a,b,c,d,e) presents few statistics like mean, standard deviation and Coefficient of variation for the MOX values for each of the four monsoon months from 1982 to 2011 of IITM rainfall data for the select sample 6 subdivisions.

The Coefficient of variation value for MOX June is highest for all the subdivisions and varied from 21.07% to 82.43%. It decreases in the subsequent months and is lowest for September month. It implies that the MOX values revert back to the long time average rainfall at the end of monsoon period. For the end of September month MOX values, Coefficient of variation varied from 16.29% to 33.42%, indicates the existence of variations in the MOX values for rainfall amongst the sub-divisions.

Table: 2(a) Statistics of MOX Values for June for 30 Years rain fall data (1982-2011)

	ASSMEG	PUNJB	EMPRA	GUJRT	MADMH	TLNAD
Mean	909	1189	1052	968	1126	1092
Std Deviation	192	807	595	798	408	861
Coef. of Variation in %	21.07	67.81	56.54	82.43	36.27	78.91

Table: 2(b)Statistics of MOX Values for July for 30 Years rain fall data (1982-2011)

	ASSMEG	PUNJB	EMPRA	GUJRT	MADMH	TLNAD
Mean	918	961	1027	1053	1029	1034
Std Deviation	166	409	328	345	268	442
Coef. of Variation in %	18.12	42.51	31.93	32.72	26.08	42.71

Table: 2(c)Statistics of MOX Values for Aug for 30 Years rain fall data (1982-2011)

	ASSMEG	PUNJB	EMPRA	GUJRT	MADMH	TLNAD
Mean	942	931	977	1033	1028	1058
Std Deviation	162	269	191	291	244	408
Coef. of Variation in %	17.20	28.88	19.49	28.15	23.69	38.59

Table: 2(d)Statistics of MOX Values for Sept for 30 Years rain fall data (1982-2011)

	ASSMEG	PUNJB	EMPRA	GUJRT	MADMH	TLNAD
Mean	951	927	989	1027	1021	1032
Std Deviation	155	310	176	327	227	323
Coef. of Variation in %	16.29	33.42	17.83	31.88	22.27	31.27

Table: 2(e)Coefficient of Variation in % for all 6 sub for all 4 monsoon months

	ASSMEG	PUNJB	EMPRA	GUJRT	MADMH	TLNAD
JUN	21.07	67.81	56.54	82.43	36.27	78.91
JULY	18.12	42.51	31.93	32.72	26.08	42.71
AUG	17.20	28.88	19.49	28.15	23.69	38.59
SEPT	16.29	33.42	17.83	31.88	22.27	31.27

To determine the degree of inter-divisional independence in MOX values of rainfall data, correlation analysis amongst these 6 sample sub-divisions has been carried out Table 3(a,b,c,d). It can be seen that for very few subdivisions significant correlation exists and for majority of subdivisions the correlation is very weak and insignificant. This is amongst sample subdivisions and for all monsoon months. Geographically nearer sub-divisions have moderate correlation where as distant sub-divisions have a correlation close to zero or in some cases even negative. Even within same sub division, MOX values for different monsoon months have variable correlation and will reduce as the months are apart. Such weak and insignificant correlation ideally creates portfolio situation for risk control on the basis of diversification principle.

Table 3(a): Correlation for June Month MOX values for 6 select sub-div

	ASSMEG	PUNJB	EMPRA	GUJRT	MADMH	TLNAD
ASSMEG	1.000	-0.055	-0.150	-0.001	0.031	-0.083
PUNJB		1.000	0.328	0.004	0.136	0.310
EMPRA			1.000	0.073	0.093	-0.339
GUJRT				1.000	.466**	-0.098
MADMH					1.000	.417*
TLNAD						1.000

Table 3(b): Correlation for July Month MOX values for 6 select sub-div

	ASSMEG	PUNJB	EMPRA	GUJRT	MADMH	TLNAD
ASSMEG	1.000	0.258	-0.355	0.109	-0.084	0.126
PUNJB		1.000	0.318	0.336	0.070	-0.041
EMPRA			1.000	0.265	0.237	-0.242
GUJRT				1.000	.532**	0.142
MADMH					1.000	.367*
TLNAD						1.000

Table 3(c) : Correlation for Aug Month MOX values for 6 select sub-div						
	ASSMEG	PUNJB	EMPRA	GUJRT	MADMH	TLNAD
ASSMEG	1.000	0.294	-0.307	-0.076	-0.092	0.248
PUNJB		1.000	.396*	0.226	-0.132	0.093
EMPRA			1.000	.393*	0.146	-0.303
GUJRT				1.000	.532**	0.024
MADMH					1.000	0.204
TLNAD						1.000

Table 3(d) : Correlation for Sept Month MOX values for 6 select sub-div						
	ASSMEG	PUNJB	EMPRA	GUJRT	MADMH	TLNAD
ASSMEG	1.000	0.283	-0.158	-0.083	-0.033	0.261
PUNJB		1.000	0.286	0.328	0.142	0.037
EMPRA			1.000	.418*	0.057	-0.352
GUJRT				1.000	.676**	0.216
MADMH					1.000	0.360
TLNAD						1.000

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

V. POTENTIAL OF MOX AS AN ASSET CLASS

Volatility is the basis for index trading. Most index trades rely heavily on volatility information. In this section an attempt is made to explore the potential of MOX as an asset class complementing other tradable indices.

An analysis of statistical properties of MOX implies that MOX can be a potential tool for both hedging and speculation. It may also be an excellent instrument in the quest for portfolio diversification. Risk reduction through diversification is based on the premise that the prices of components of a portfolio are uncorrelated. One interesting feature of MOX is its relative inter-divisional independence, as the correlation between geographically distant subdivisions found to be close to zero. This creates an opportunity for the market makers to hold a portfolio of MOX trades to stem the systemic risk.

MOX would be an excellent speculation instrument as well. Coefficient of variation (Table 2e), particularly for June are so high, it indicates MOX could be attractive for speculators. The Coefficient of variation is high for Gujarat, Tamilnadu and Punjab sub divisions. Though the variation reduces systematically in the subsequent months, but this is still higher than the variation of range bound stock indices, thus providing outstanding trading opportunities.

To ascertain the possibility of MOX as a distinct asset class, correlation matrix involving other related asset classes has been determined. Two popular equity indices-BSE SENSEX and NSE NIFFTY are considered. For Fixed income, Bond Index of NSE Government Security Index (NSE G-Sec), a well defined Bond index to measure the returns in the bond market is considered. This index reflects return on the account of changes in interest rate. This bond index is used as benchmark for portfolio management and for designing index funds, derivative such as options and futures. Among NSE G-Sec, Principle Return Index (PRI), which captures the changes in the clean prices due to interest rate, is considered. Since NSE G-Sec index is available from Jan1, 1997, the correlation analysis is carried for the period 1997 to 2011.

Table 4 : Correlation for different asset indices at the end of Sept for years 1997-2011										For 2007-11
	SENSEX	NIFFTY	PRI	ASSMEG	PUNJB	EMPRA	GUJRT	MADMH	TLNAD	DHANNYA
SENSEX	1.00	.999**	0.01	-0.30	-0.07	-0.32	0.08	0.32	0.26	0.24
NIFFTY		1.00	0.03	-0.30	-0.06	-0.31	0.07	0.31	0.25	0.31
PRI			1.00	-0.49	-0.47	-0.03	0.06	-0.06	-0.35	0.12
ASSMEG				1.00	0.32	-0.16	-0.02	-0.05	0.50	-0.88
PUNJB					1.00	0.31	0.04	-0.11	-0.12	-0.02
EMPRA						1.00	0.21	-0.07	-0.40	0.76
GUJRT							1.00	.595*	0.22	-0.52
MADMH								1.00	0.18	-0.56
TLNAD									1.00	-0.63

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

In table 4, the equity indices, fixed income index and MOX values of select 6 subdivisions are considered for correlation coefficient calculations for index values as at the end of Sept month for the years 1997-2011(15 years). However, the Commodity Index DHAANYA is developed by NCDEX and is trading from 2007, so it's correlation with other indices is for the years 2007 to 2011 (5 years) at the end of Sept month

It can be seen from the table 4, the equity indices have weak correlation with bond index. The equity indices have insignificant correlation with MOX values and ranges from negative to positive. The bond index has insignificant correlation with MOX values and has weak correlation varying from positive to negative. The commodity index has strong significant negative correlation with ASSMEG and negative insignificant correlation with other subdivisions except EMPRA.

MOX as an asset class complements other tradable indices as correlation of MOX values with other assets is insignificant and varying between negative to positive. For this reason the proposed MOX, if launched on an exchange, can be a potential tradable asset class. This means that those who seek to hedge risk will have a new instrument to their hedging arsenal. Options on MOX would be attractive for the hedgers and speculators as well.

VI. CONCLUSIONS

Rainfall index based RTPs are critical for the development of insurance and risk markets to create hedging opportunities to insurers and other players in the market whose financial prospects closely interconnected to monsoon outcome. In this background, conceptualization is attempted by constructing MOX series for select 6 meteorological subdivisions. The coefficient of variation analysis indicates existence of variations in the MOX values for rainfall amongst the sub-divisions and reverting of MOX back to the long time average rainfall at the end of monsoon period. It can be seen that for very few subdivisions significant correlation exists and for majority of subdivisions the correlation is very weak and insignificant. Geographically nearer sub-divisions have moderate correlation where as distant sub-divisions have weak to very weak (negative) correlation MOX as an asset class complements other tradable indices as correlation of MOX values with other assets is insignificant and varying between negative to positive.MOX can be an excellent instrument in the quest for portfolio diversification. For this reason the proposed MOX, if launched on an exchange can be a popular trading tool.

REFERENCES

[1] Skees, J.R., et al (2001). "Developing Rainfall-Based Index Insurance in Morocco" World Bank Working Paper, 2577

[2] Jennifer Ifft (2001). "Government Vs Weather – The True Story of Crop Insurance in India", Research Internship Paper Centre for Civil Society, 2-5

[3] Spaulding,A. et al (2003). "Can Weather Derivatives Contracts help Mitigating Agricultural Risk? Microeconomic Policy Implications for Romania", a paper presented at international conference on policy modeling, Istanbul.

[4] Sinha, S (2004). "Agricultural Insurance in India:Scope for Participation of Private Insurers", Economic and Political Weekly, June 19: 2605-12.

[5] Shivkumar D. P.,Prabhu M.,Kotreshwar G.,(2013),,"Modeling Indian Monsoon(rainfall) volatility as an index based risk transfer product", International Journal of research in commerce, IT & Management, 3; 66-71

[6] Geyser, J.M. & Venter, V.D.(2001). "Hedging Maize Yield with Weather Derivatives", working paper: 2001-13, University of Pretoria

[7] Kotreshwar G (2006), "Managing monsoon risk in India, why not Monsoon Derivatives ?",The ICFAI journal of derivatives markets, Vol III, No 3, July

[8] Cao, M. Li, A. and Wei, J. (2003). "Weather Derivatives: A New Class of Financial Instruments", Working Paper, 2003, York University and University of Toronto, 3-4.