

## Hedging Opportunities between Weather and Other Financial Instruments using Pair-wise Trading Technique for Non-exchange Markets.

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### Abstract

This article provides an analysis on the hedging opportunities between weather and other financial instruments with pair wise trading technique. Methods of analysis include growth rate calculations, its mean (return) and standard deviation (Risk). Other calculation includes finding hedging opportunities between all stocks individually and portfolio wise as well. All calculations can be found on attached excel. Result of data analyzed shows that any portfolio containing Weather is outperforming than the other financial instruments. In particular comparison of Weather to CPI shows the maximum hedging opportunities in Weather and in pair wise trading Weather – Maize and Bse- Weather are the best pair which showed 51 hedging opportunities revealing to 85.00%. The article finds the prospects of the Weather as effective tool to hedge the risk if traded actively in the stock market. Recommendation as discussed includes that agricultural insurance companies can use it as an effective measure to hedge the risk of investors.

### Introduction and Overview

In India, There is a high dependency of agriculture on the monsoon and for commodities, it plays a significant role. Though trends in temperature fundamentally have no connection with trends in the stock markets but unexpected change in temperature can often cause significant financial losses to economy and to prevent these losses Weather data can be used as an effective tool. Weather related financial contracts are spatio-temporal in nature i.e. the impact of monsoon (south-west in particular) decides how it will spread its precipitation impact in the months to follow. On the similar front, the temperature of Punjab and adjoining places decide that whether the crop yields and together its “aggregate trading prices in the National markets” (based on supply side issues) perform in close concordance with the rest of the commodities data. Non-exchange markets are governed by insurers, bankers, brokers and hedge funds.

This article deals with the Use of Weather data as any other financial instrument to hedge the losses. It shows presence of Weather makes an effective portfolio in comparison with other indexes and stocks.

To prove the same, Weather data of Amritsar, Punjab (as an aggregate pricing function) is compared with all the non-Weather portfolios and analyzed the monthly performance in last 5 years.

### Research Problem

The research problem is analyzing the hedging opportunities between Weather and other financial instruments with pair wise trading technique.

### It's Relevance

In India, It has been witnessed that due to non-favorable Weather conditions or uncertain change in temperature has always lead to farmer's suicide and losses in agricultural economy and there is no way to support farmers or economy in such conditions. But the outcomes of this report will give you some insight that on use of Weather data in portfolios can hedge the losses in uncertainty.

### Research Objectives

- To gather historical data of local Weather, indexes and commodity.
- To make different pairs of Weather and non- Weather portfolios.
- To frame a call-option based hedging opportunity model utilizing the above data
- To find out hedging opportunities in all portfolios.
- To compare hedging opportunities available in Weather portfolio to non-Weather portfolio.
- Interpret the result for same, whether the study is giving relevant outcome or not.

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## Literature review

As per the article, Wiesner and Bank (2010) took SME sector and confirmed that weather had greater role to play as operational risk since it is not controllable. It can be great tool for SME since they have very less financial reinsurances against weather related losses.

According to this research (Ifft, 2001) Indian insurances companies must be allowed to create more innovative weather related contracts like rainfall contracts to benefit the farmers. Jewson and Penzer (2006) pricing of Weather derivatives mainly depends upon the prediction of weather for future which is a complex exercise. As revealed in this article the authors (Liu, Cabrera, Urvasev and Fraisse, n.d.), in most of the countries during extreme winters the demand of energy increases posing pressure to increase prices. With the advent of Weather derivatives some amount of financial losses can be reduced.

With the fluctuations in temperature with relatively high humidity and heat during summer and extremely chillness in the cold Weather, demand of energy increase many-fold.

In the study the data was gathered on the energy consumption and the daily temperature termed as HDD and CDD.

$$\text{Mean} = \bar{X} = \frac{\sum X}{N}$$

$\bar{X}$  (Sometimes call the X-bar) is the symbol for the mean.

$\Sigma$  (The Greek letter *sigma*) is the symbol for summation.

X is the symbol for the Scores.

N is the symbol for the number of scores.

$$\sigma = \sqrt{\frac{\sum (x - \bar{x})^2}{n}}$$

$\sigma$  = standard deviation

$\Sigma$  = sum of

x = each value in the data set

$\bar{x}$  = mean of all values in the data set

n = number of value in the data set

Therefore for each Stock it is coming out to be as follows:

Stock Name	Mean	Standard Deviation
Weather	0.0394	0.3383
CPI	0.0017	0.0261
Maize	0.0188	0.0731
Bse	-0.0023	0.0838

● Make portfolios with combination of two stocks each which would emerge as follows:

- Weather – CPI
- Weather – Maize
- Maize – CPI
- BSE – CPI
- BSE – Weather
- Maize- BSE

For checking the same, Hedging will be done for each portfolio which will be as follows:

If(x variable is more than average of 60 months, true, false).

Table 1  
Call option strategy Single asset

SUM			=IF(B4>\$B\$64,TRUE,FALSE)		
	A	B	C		
1	Monthly	Growth Rate - Weather	CALL If true		
2	Date				
3	Oct-07	-	-		
4	Nov-07	-0.2083	=IF(B4>\$B\$64,TRUE, FALSE)		
5	Dec-07	-0.3684			

Similarly it is calculated for Y variable.  
If(Y variable is more than average of 60 months,true,false)

Table 2  
Call option strategy two asset

SUM					=IF(D4>\$D\$64,TRUE, FALSE)				
	A	B	C	D	E				
1	Monthly	Growth Rate - Weather	CALL If true	CPI	CALL If true				
2	Date								
3	Oct-07	-	-	-	-				
4	Nov-07	-0.2083	FALSE	0.0000	=IF(D4>\$D\$64, TRUE, FALSE)				
5	Dec-07	-0.3684	FALSE	0.0000					

- Comparison of Weather value is done with “non-Weather” stocks or indexes that how many times does portfolio containing Weather value outperformed.
- Now all these portfolios are made into 6 pairs and co-relation trading is done for same. Out of these 6 pairs we come out with 15 combinations for finding hedging opportunities between Weather portfolio and non-Weather portfolio.
- Pair wise trading means the strategy of matching a long position with a short position in two stocks of the same sector. This creates a hedge against the sector and the overall market that the two stocks are in. The hedge created is essentially a bet that you are placing on the two stocks; the stock you are long in versus the stock you are short in

Table 3: 15 pair-wise Weather related portfolio combinations

Pair 1 (Weather - CPI)	Pair 2 (Weather -Maize)
Pair 1 (Weather - CPI)	Pair 3 (Maize - CPI )
Pair 1 (Weather - CPI)	Pair 4 (Bse - CPI )
Pair 1 (Weather - CPI)	Pair 5 ( Bse - Weather )
Pair 1 (Weather - CPI)	Pair 6 (Maize - Bse )
Pair 2 (Weather -Maize)	Pair 3 (Maize - CPI )
Pair 2 (Weather -Maize)	Pair 4 (Bse - CPI )
Pair 2 (Weather -Maize)	Pair 5 ( Bse - Weather )
Pair 2 (Weather -Maize)	Pair 6 (Maize - Bse )
Pair 3 (Maize - CPI )	Pair 4 (Bse - CPI )

Pair 3 (Maize - CPI )	Pair 5 ( Bse - Weather )
Pair 3 (Maize - CPI )	Pair 6 (Maize - Bse )
Pair 4 (Bse - CPI )	Pair 5 ( Bse - Weather )
Pair 4 (Bse - CPI )	Pair 6 (Maize - Bse )
Pair 5 ( Bse - Weather )	Pair 6 (Maize - Bse )

Similarly Now ,comparison of Weather pair is done with “non-Weather” pairs that how many times does portfolio containing Weather value outperformed.

**Analysis**

Shown below is the graphical representation of growth rates of all portfolios.

**Weather – CPI** – where CPI is showing a very consistent movement with the return of 0.17% and deviation of 2.61% and Weather is highly volatile with return of 3.94%, deviation is 33.83%

Table 4

Analysison the hedging opportunities between Weather and non-Weather portfolio

For Call Option								
Variable X	Variable Y	"X" out Performance (In Times)	"Y" out Performance (In Times)	Individual asset call option execution possibilities	Actual Hedging Opportunities	Average of HO available in portfolio of Weather	Average of HO available in portfolio of other stocks	In %
Weather	CPI	21	42	63	33	33		55.00 %
Weather	Maize	21	31	52	28	28		46.67 %
Maize	CPI	31	42	73	31		31	51.67 %
BSE	CPI	33	42	75	31		31	51.67 %
BSE	Weather	33	21	54	30	30		50.00 %
Maize	Bse	31	33	64	24		24	40.00 %
						30.333	28.666	0.4833

For all non-Weather data, mainly CPI, maize, Sensex hedging multiples is compared with same period when the Weather data did not have favorable results. On the contrary, the Weather data hedging multiples are compared during the same period when the “non-Weather” data do not have favorable results. Therefore together it gives the measure of all possible hedging opportunities which co – existed during last 60 months.

**For all Weather portfolios**

- With regard to Weather and CPI, CPI performed 42 times better than the bench mark i.e. average return in 60 months where Weather was significantly at half in growth ie 21 times better than the bench mark, resulting to overall hedging opportunities of 33 times revealing a value of 55.00%

- Similarly in case of Weather and maize, maize out performed 31 times better than its average in 60 months average, where Weather have only 21 times growth than its average, resulting to overall hedging opportunities of 28 times revealing a value of 46.67%

- With sensex and Weather, sensex performed 33 times better than its 60 months average whereas Weather has only 21 times growth than its average, resulting to overall hedging opportunities of 30 times revealing a value of 55.00%

**For non-Weather portfolios**

- With Maize and CPI, CPI out performed 42 times better than the bench mark i.e. average return in 60 months where maize only show growth at the pace of 31 times better than its average of 60 months.

- Similarly with Sensex and CPI, CPI out performed 42 times better than the bench mark i.e. average return in 60 months where sensex only show growth of 31 times better than its average of 60 months.

- Whereas in Maize and Sensex, Sensex out performed 33 times than its average growth in 60 months and maize performed 31 times better than its average.

**Comparison between Weather portfolios and non-Weather portfolios**

- For Portfolios containing Weather clearly shows the average hedging opportunity of 30.33 where in “non-Weather” portfolio it is 28.66, less than the Weather portfolios.

Therefore it signifies that Weather portfolio have more potential than the non- Weather portfolios in consideration of hedging opportunity.

**Analysis on the pair wise trading or co-relation trading is as follows**

As we clearly see above that out of these 6 pairs we come out with 15 combinations for finding hedging opportunities between Weather portfolio and non- weather portfolio.

Out of which 12 are such combinations where in Weather is in any one of the pair and only 3 combinations which came out to be non – Weather pairs.

Table 5  
Analysis on the Pair Wise Trading or Co-Relation Trading

FOR CALL OPTION								
Variable X	Variable Y	"X" out Performance (In Times)	"Y" out Performance (In Times)	Individual asset call option execution possibilities	Actual Hedging Opportunities	Average of HO available in portfolio of weather	Average of HO available in portfolio of other stocks	In %
Pair 1 (Weather - CPI)	Pair 2 (Weather -Maize)	23	25	48	6	6	-	10.00%
Pair 1 (Weather - CPI)	Pair 3 (Maize - CPI)	23	22	45	29	29	-	48.33%
Pair 1 (Weather - CPI)	Pair 4 (Bse - CPI)	23	16	39	29	29	-	48.33%
Pair 1 (Weather - CPI)	Pair 5 ( Bse - Weather )	23	28	51	49	49	-	81.67%
Pair 1 (Weather - CPI)	Pair 6 (Maize - Bse)	23	20	43	25	25	-	41.67%
Pair 2 (Weather -Maize)	Pair 3 (Maize - CPI)	29	22	51	37	37	-	61.67%
Pair 2 (Weather -Maize)	Pair 4 (Bse - CPI)	29	16	45	35	35	-	58.33%
Pair 2 (Weather -Maize)	Pair 5 ( Bse - Weather )	29	28	57	51	51	-	85.00%
Pair 2 (Weather -Maize)	Pair 6 (Maize - Bse)	29	20	49	31	31	-	51.67%
Pair 3 (Maize - CPI)	Pair 4 (Bse - CPI)	35	16	51	25	-	25	41.67%
Pair 3 (Maize - CPI)	Pair 5 ( Bse - Weather )	35	28	63	23	23	-	38.33%
Pair 3 (Maize - CPI)	Pair 6 (Maize - Bse)	35	20	55	21	-	21	35.00%
Pair 4 (Bse - CPI)	Pair 5 ( Bse - Weather )	30	28	58	20	20	-	33.33%
Pair 4 (Bse - CPI)	Pair 6 (Maize - Bse)	30	20	50	40	-	40	66.67%
Pair 5 ( Bse - Weather )	Pair 6 (Maize - Bse)	33	20	53	34	34	-	56.67%
						30.75	28.66666667	

For all Asset returns containing Weather as active stock: If we carefully analyze the above details, with regard to Weather Asset Returns following are the observations.

- With regard to Weather – CPI & Maize - CPI ,Weather - CPI performed 23 times better than the bench mark i.e. average return in 60 months where Maize –
- CPI performed only 22 times better than the bench mark, resulting to overall hedging opportunities of 29 times revealing a value of 48.33%
- Similarly in case of Weather- CPI and BSE- CPI, Weather - CPI performed 23 times better than the bench mark i.e. average return in 60 months where BSE- CPI performed only 16 times better than its average, , resulting to overall hedging opportunities of 29 times revealing a value of 48.33%
- With Weather- CPI and Maize- BSE, Weather- CPI performed 23 times better than its 60 months average whereas Maize- BSE has only 20 times outperformed than its average, resulting to overall hedging opportunities of 25 times revealing a value of 41.70%
- Weather- Maize and Maize- CPI, Weather- Maize performed 29 times better than its 60 months average whereas Maize- CPI has only 22 times outperformed than its average, resulting to overall hedging opportunities of 37 times revealing a value of 61.67%
- Weather- Maize and BSE- CPI, Weather- Maize performed 29 times better than its 60 months average whereas Maize- CPI has only 16 times outperformed than its average, resulting to overall hedging opportunities of 35 times revealing a value of 58.33%
- Weather- Maize and Maize- BSE, Weather- Maize performed 29 times better than its 60 months average whereas Weather- Maize has only 20 times outperformed than its average, resulting to overall hedging opportunities of 31 times revealing a value of 51.67%
- Now with Maize – CPI and BSE – Weather, Maize – CPI has out performed exceptionally 35 times better than its 60 months average whereas BSE – Weather only performed 28 times better than its average bench mark. resulting to overall hedging opportunities of 23 times revealing a value of 38.33%
- Similarly in BSE – CPI and BSE – Weather, BSE – CPI outperformed 30 times better than its overage bench mark of average in 60 months whereas BSE – Weather outperformed slightly lesser than BSE – CPI which is 28 times of its average bench mark.
- Lastly BSE – Weather and Maize – BSE, BSE – Weather out performed 33 times in comparison to Maize -BSE which only performed 20 times better than the average bench mark of 60 months.

#### **For non-weather portfolios**

- Pair containing Maize – CPI always out performed 35 times better than the bench mark i.e. average return in 60 months in comparison to BSE – CPI and Maize – BSE which only outperformed only 16 and 20 times respectively.
- Whereas in BSE- CPI and Maize – BSE , BSE – CPI performed 30 times better than its average bench mark and Maize CPI only out performed 20 times

Therefore, if we look at overall average hedging opportunity in both Weather and “non-Weather” pair wise trading, Weather portfolios have an average of 30.75 where as “non-Weather” portfolio has 28.67, which clearly supports that if we make Weather an actively trading stock , it stands the greater chances of hedging the risk than any other financial instrument.

#### **Conclusion**

The result clearly shows that Weather portfolios performed better than the non- Weather portfolios. Therefore in India, most of the companies can utilize this tool to hedge against losses occurring from uncertain Weather events and can help reduce the impact of adverse Weather on Economies profitability.

It is important to bring this segment to active trading platform. Also, the Weather portfolios have done better in past brings more junctions to agricultural insurance companies, who can track prices and hedge investor's risk.

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