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Financial Risk Quantification of Indian Agro-Commodities using Value At Risk

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Abstract*: Indian commodity traders are exposed to various risks like price risk, market risk, financial risk, credit risk, etc. To understand the risk resulting in the financial impact, this paper attempts to assess the historical trends of commodity prices and probability of loss occurrence in the commodity invested. The present study analyses five Indian agro commodities namely, Almond, Cardamom, Cotton, Guar Seed and Wheat using the data collected from secondary sources like Multi Commodity Exchange (MCX), Securities Exchange Board of India (SEBI) etc. This paper uses the Historical Simulation method for the calculation of Value at Risk (VaR) by considering spot prices of the commodities on MCX for a five year period (2013-2018). It is established that Value at Risk (VaR) is a relevant measure to arrive at risk which is useful for the commodity traders to estimate the financial risk and thus control the risk exposure.

***Keywords* : value at risk; risk quantification; multi commodity exchange; commodities; spot price.**

I. INTRODUCTION

In India there are various avenues for investments and among these Commodities derivatives are also considered by the investors. Liberalization of the commodity markets have led to a huge growth since 2000. In order to match with the growth of International commodity markets, six national exchanges have been set up in India. In September, 2015, SEBI became the regulator for commodities after the merger with Forward Markets Commission. Currently, more than 100 commodities are traded in India and around 50 of them are actively traded in all the six exchanges put together with MCX and National Commodities & Derivatives Exchange Limited (NCDEX) occupying majority of the trade volume. MCX is the largest Commodity exchange in India.

Risk is the variability in the returns expected from an investment. Taking higher risk would mean opportunity of getting more return and at the same time higher risk of losing money also. There may be a very large variation in risk among different derivatives.

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Commodity prices may vary significantly and by using commodity derivatives the consequences of these price changes can be controlled. Commodity derivatives enable increasing, reducing or completely avoiding commodity price risk.

SEBI's board has permitted the foreign entities to invest in Indian commodity markets classifying them as "Eligible Foreign Entities" except for those commodities claimed as sensitive commodities.

Also, SEBI redefined the risk management norms for commodity derivatives segment which brought a bullish trend in commodity markets in the month of March, 2018. Accordingly, the present study will be relevant in view of foreign trader's interest in assessing the risk in the commodity derivatives.

Commodities traded in Indian exchanges can be classified into Agro, Energy, and Metals etc. The five commodities chosen for study are from MCX which garners 91.2% of the market share.

The present study considers the spot price of five agro commodities namely Almond, Cardamom, Cotton, Guar Seed, and Wheat for the period of five years 1st, October 2013 to 1st October 2018. The choice of the commodities is based on the trading activity for the past years.

Risk in an investment can have various sources. Identification and measurement of the risk can help the investor in deciding the security and quantum of money to be invested. The prominent methods used for measuring risk are Variance, Standard deviation of past returns for a certain previous period, Scenario analysis, Sensitive analysis and Value at Risk models.

Risk in commodities, stock and currency can be measured by using Standard VaR models. Leading banks also measure credit risk using VaR models. VaR model can also be applied to measure operational and legal risks. This model estimates the maximum volume of loss in the investment made in the security or portfolio in the past period with a certain rate of certainty. The estimated probability of loss calculated using Value at Risk model can be considered for taking investment decision and also to take preventive measures to reduce loss.

There are three methods available for calculating VaR which include: Historical Simulation method, Variance-covariance method and Monte Carlo Simulation Method. Past studies prove that Historical simulation method is the most popular method of VaR Calculation. Hence, the present study aims to measure the probability of loss in the investment in commodities using Historical simulation method.

Value at Risk models are adopted to predict risk exposure of an investor or financial institution in the next period. Historical simulation is based on the assumption that history repeats itself. The past returns of a security or portfolio are considered to anticipate the future returns. For example if stock returns are calculated for the past one year and the worst returns made by the stock are considered to anticipate the future returns. Every observation in the past is given the same weightage in order to arrive at better predictions for future. The present study has been carried out to analyze the risk in the five commodities by applying the risk measures like standard deviation, Variance and Value at Risk. The risk profile of the commodities is then understood to suggest the investor the best commodity for investment. Majority of the past studies concentrated on the price discovery mechanism, need for new instruments for handling risk, policy level constraints, strengthening of regulation etc and the risk quantification using Historical simulation for Indian commodities is not considered as such. Hence, the current study aims to establish the risk return relations and the probability of loss that can be expected from the Agro commodities investment. These results obtained would help the investor to select the agro commodity to be invested.

II. LITERATURE REVIEW

Peter Kwasi Sarpong et al., (2018), calculated VaR using two methods Historical Simulation and Monte Carlo Simulation for daily prices of stocks, and stated that Historical simulation method is less sensitive to the one exception case or observation and does not absorb the estimation error like parametric methods. He concluded that VaR can be applied for firms by setting risk targets and identifying the relative risk position.

Marie Steen et al., (2015), stated that Historical simulation provides better coverage than the other simple methods like Monte Carlo, Variance- Covariance methods and also than the sophisticated GARCH approach (with normal distribution) for VaR at 99% confidence levels. Quantile Regression approach outperforms the Risk Metrics and historical simulations.

Bogdan, Sinisa et al., (2015), have compared the three prominent methods of VaR namely, historical, Parametric and Monte Carlo methods and applied the methods to estimate the risk of liquid stocks and portfolio on Croatian market. He concluded that VaR models can be applied only in the normal conditions and it has been modified many times to attain precision and best applicability in the stable market conditions.

Prabina Rajib (2015) found that the major stakeholders of Agro markets and products namely farmers show very less participation in Indian commodity derivatives trading even after low price realization. This is resulting in the concentration of the trading within few participants as compared to other markets and products. This has a definite impact on the pricing of commodities. ITC-ABD's commodity hedging strategy provided details of price mitigation facilities to Indian farmers.

Nirmala K. Reddy et al., (2014), analyzed the performance of futures trading and its importance for managing price risk**.** He stated that Metals and energy contracts have shown higher level of efficiency than the agricultural commodities like barley, chana and soyabean.

Svend Reuse (2010) claimed that Historical simulation method considers risk as the variability of the expected return whereas Variance-Covariance method considers risk as the variability in the actual value of the return. Both these approaches have shown different results.

Zhiguang Cao et al., (2008), demonstrated that VaR is a proven semi parametric approach superior to the Standard deviation.

S. M. Lokare, (2007), has performed a detail study on the Commodity derivatives and price risk management and observed that commodity markets are yet to achieve liquidity. Also, stated that there exists co-integration between spot and future price. The spot price showed a higher volatility than the future price.

Bold Sandagdorj (2005), suggested that there is a great need to assess the risk and evaluate the risk management strategies. The price risk management can be done by hedging through futures, options and swap contracts.

Doc. Ing. Tatiana Varcholova et al., (2003) stated that **d**ue to the greater need for Risk management VaR has taken new dimensions. Investors and companies are thinking more than managing the traditional risk and advanced methods are applied to mitigate the risk in investment.

Katerina Simons (2000) stated that VaR is an accepted method in the banking industry and can be used by the other industries also when the limitations are understood**.** He concludes that VaR may not be effective in extreme conditions.

Lindsmeier J. Thomas and Neil D. Pearson (1996) have explained the concept of VaR and compare the three methods of VaR and suggested Historical Simulation is the best method. Also he suggested the alternative measures like sensitivity analysis and Cash flow at risk for market risk.

Defining Value at Risk

Value at Risk according to Phillip Jorion(2007) is "the worst loss over a target horizon such that there is a low, per specified probability that the actual loss will be larger"

VaR is defined as

$$P(L>VaR) <= 1-C \qquad (1)$$

Where,

C→Confidence level

L→Loss

For example if an amount of Rupees 10,000 is invested in a stock and the VaR is calculated as Rupees 1800 at the confidence level 95% (C). Hence, the expression (1) can be explained as the probability of loss to be more than Rupees. 1800 is less than 5% (1-C). Expected Return on commodities can be calculated by many ways. One of them is the Log return method which assumes that the returns are continuously compounded. Log return of an asset is calculated by taking natural logarithm of ending value divided by the beginning value. According to Panna Miskolczi (2017) "logarithmic return has an advantage against the simple return, namely that the multi-period logarithmic return can be calculated as a sum of the one-period logarithmic returns, while the multi-period simple return is the product of the one-period simple returns,

which can lead to computational problems for values close to zero".

$$R = \ln\left(\frac{p1}{p0}\right) \qquad (2)$$

Where,
R → Expected Return of the commodity
p1→price on day 2
p0→price on day 1

The Value at Risk calculated for the expected returns of the five commodities using the formula as stated below:

$$VaR = V0 * \alpha * \sigma \qquad (3)$$

Where,
$V0$→Initial Investment in the asset

α→The number of standard deviations below the mean

corresponding to the (1-C) quantile of the standard normal distribution
σ→Standard deviation of the assets daily returns

There are three prominent methods of Value at Risk namely, Historical Simulation, Monte-Carlo Simulation Method, Variance-Covariance Method.
Historical Simulation Method is the non-parametric method for calculating VaR. Historical Simulation method uses the past daily returns of the asset. It calculates the probability of loss from the historical observations. This method has certain advantages like simplicity and applicability to any financial asset. The present study considered these advantages and applied the method for the five selected commodities to calculate the Value at Risk .The results obtained help to understand the past performance which can be used to project the future performance of the commodities. These projections help the investor in taking a decision regarding to the investment in the commodities

III. DATA ANALYSIS

The Data analysis is organized in to two sections as mentioned below:

Section A focuses on the descriptive statistics performed on the five commodities. This is performed to understand the risk with traditional measures of Standard deviation and variance. These measures are calculated for the five commodities and the variability of the return is compared.

Section B focuses on the Value at Risk calculation using Historical Simulation method for the five commodities. This section concentrates on the comparison of the probability of loss occurrence by investing in the five commodities and compared.

Section –A

Table 1: Descriptive Statistics of the Return (1st October, 2013 - 1st October, 2018)

Commodity	Almond	Cotton	Guar Seed	Cardamom	Wheat
Mean	0.0000229008	0.000026533	0.0000994011	-0.000228234	-0.0000981367
Standard Deviation	0.008145229	0.004449036	0.015423004	0.009564485	0.01911555
Sample Variance	0.0000663448	.0000197939	0.000237869	.0000914794	0.000365404
Kurtosis	28.57219737	12.3768413	27.73025142	50.12174771	1033.47
Skewness	0.75783734	0.222400463	0.747126886	-0.937129576	0.023443796
Range	0.197420418	0.076450891	0.397421321	0.282735879	1.283387798
Sum	-0.055488686	0.065085355	0.244327973	-.56145681	0.241220062

Standard Error	0.000165473	.0000898291	0.000311084	0.000192839	0.000385563
Minimum	-0.098710209	-0.034618842	0.165619707	-0.144015199	-0.641693899
Maximum	0.098710209	0.041832049	0.231801614	0.13872068	0.641693899
Count	2423	2453	2458	2460	2458

Summary of the Descriptive Statistics:

Mean return of Almond, Cotton, Guar Seed are positive but mean return for cardamom and wheat are negative which would mean that there is a possibility of getting loss if invested in cardamom and wheat.

Minimum return is positive only for guar seed which indicate that investors can reap benefit by investing in it where as for the other four commodities there is probability of loss though low for some of them.

Maximum return is seen highest in case of wheat followed by guar seed and also range for the wheat is highest which mean that there is greater dispersion in returns from the mean. There is no consistency in the returns from wheat investment with low predictability. This indicates higher risk to the investor for wheat.

Standard deviation is highest in case of Wheat also confirming that there is great volatility in the returns from the investment in this commodity. The least deviation is in cotton hence, it could be a better investment as variability would be less.

The standard error is on the lower side for all the five which means the sample represents the overall population. This signifies that the results obtained for the five commodities can be applied for other commodities in Multi Commodity Exchange.

Sample variance of all the five commodities is lower which imply that the data is spread around mean.

Only Cardamom is negatively skewed whereas the other four commodities are positively skewed. Investors putting money in Cardamom have a greater chance of extremely negative outcomes. Investors who put money in Almond, Cotton, Guar Seed and Wheat have a greater chance of extremely positive outcomes.

Returns of the five commodities are having positive and high kurtosis value which indicates that the tails are heavy and indicate a higher level of risk. There is a probability of earning very high or very low returns. The distribution of the returns is leptokurtic which implies that investment in agro commodities is riskier and wheat being most risky among all.

Section –B

Table 2: Value at Risk Calculation

Commodity	**Almond**	**Cotton**	**Guar Seed**	**Cardamom**	**Wheat**
Alpha(α)	-1.644853627	-1.644853627	-1.64485363	-1.644853627	-1.644853627
Investment(Rs.) V0	100000	100000	100000	100000	100000
Std. Dev.(σ)	0.008145229	0.004449036	0.015423004	0.009564485	0.01911555
VaR (V0* $\alpha * \sigma$**)** **(Rupees)**	-1339.77	-731.80	-2588.48	-1573.22	-3144.23
Confidence level(C)	95%	95%	95%	95%	95%
Probability of worst loss	0.04%	0.04%	0.04%	0.04%	0.04%

Worst loss (return)	-0.09871	-0.03462	-0.16562	-0.14402	-0.64169

Value at Risk is calculated at 95% confidence level and an assumed investment of Rs.100, 000. It is found to be least for Cotton and highest for wheat. If an investor invests Rupees 100,000 equally in each of the commodities, the probability of facing highest loss is in Wheat then guar seed, cardamom, almond and cotton respectively. It is not safe for the investor to put money in wheat as returns can be extreme, volatility is high and Value at Risk is also highest among all. This can also be confirmed from the distribution in the histogram. An investor can select Cotton for investment based on the VaR calculation as the probability of loss is lowest in this commodity. This concludes that the worst case loss of Cotton is Rs.731.80 for an investment of Rs. 100,000 at the 95% confidence level. This means that there can be situation of loss more than this but chances of its occurrence is very low. There is 5% chance that the loss can be more that Rs. 731.80

IV. CONCLUSION

Risk Assessment tool which help in risk management is a skill and those who know it can win the game and those who do not know are bound to lose. The results arrived using Value at Risk prove that investment in wheat can have a higher probability of loss. The quantum of financial risk for the investor is higher in case of guar seed also. Cotton could be the best commodity for the investor followed by almond and cardamom respectively.

The present study focuses on only Agro Commodities which are traded in Multi Commodity Exchange (MCX). It can be extended to other type of commodities like metal and energy commodities as well as commodities traded in other exchanges like National Commodities & Derivatives Exchange Limited (NCDEX).

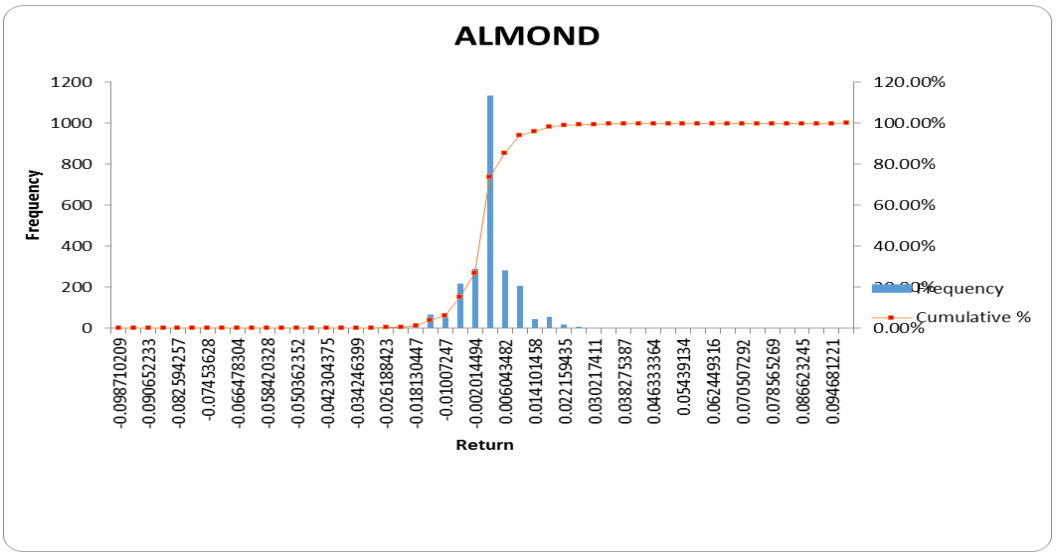

Figure 1: Value at Risk of Almond

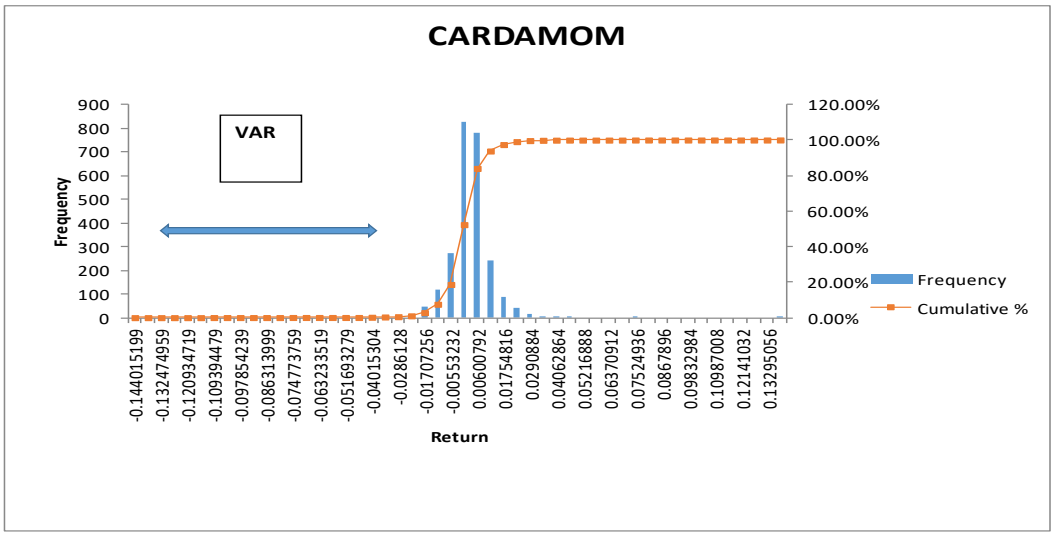

Figure 2: Value at Risk of Cardamom

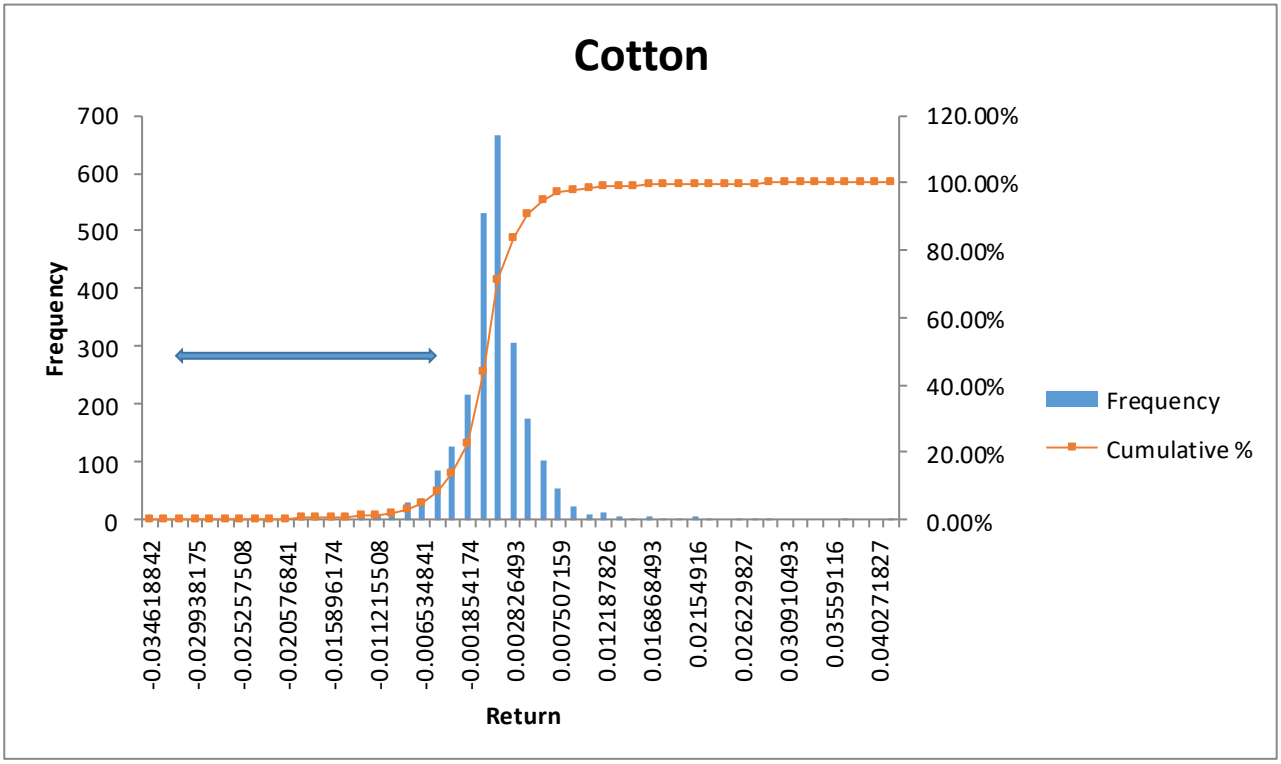

Figure 3: Value at Risk of Cotton

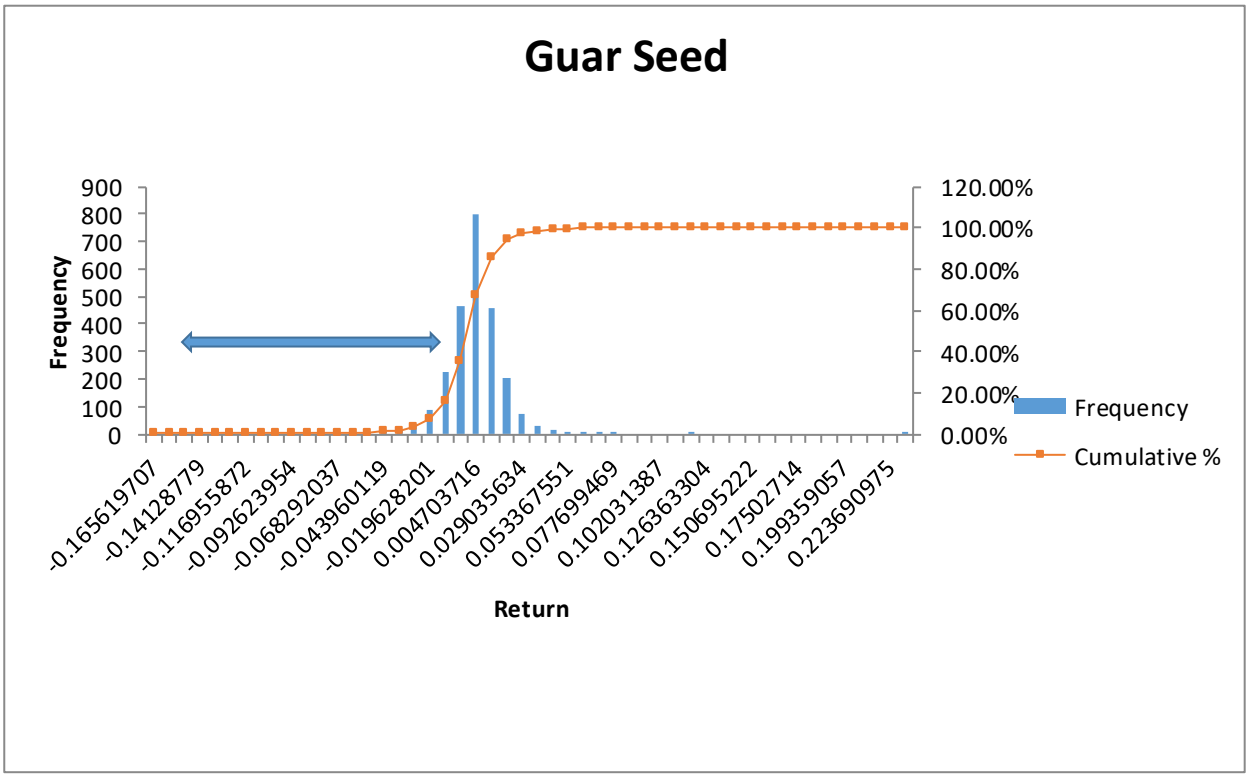

Figure 4: Value at Risk of Guar Seed

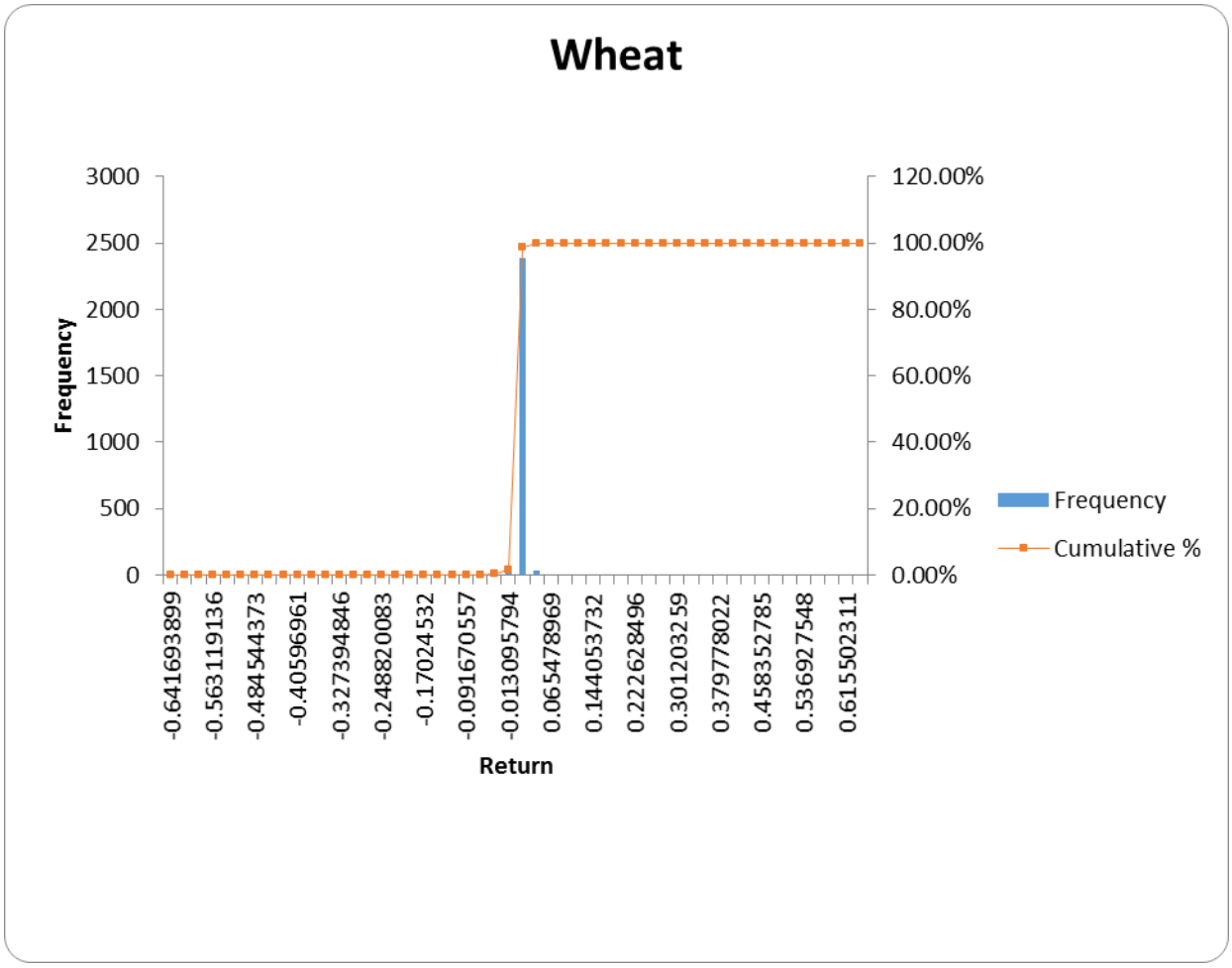

Figure 5: Value at Risk of Wheat

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