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Research Article

The distortion measurement strategy in manufacturing trading industry using Turkey Lambda survival function (Reliability rate)

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In order to analyze and compare market in the last decades- after the 1987 market crash and 2008 financial crisis in manufacturing trading industry-the empirical research is brought forward to daily industrial indices of market sales volatility using distortion measures fluctuation analysis. This work measures the market risk by calculating the distortion strategy using the survival function of Turkey Lambda distribution and true reliability dimension which can directly dictate roughness of the logarithmic returns. Our distortion analysis uses mined data from unilever trading industry Nigeria as a case study to optimize and re-optimize risk. According to the result; the largest fluctuation transaction execution and appraisal are frequent in distortion measure volatility and non-distortion (true reliability rate) market volatility is larger than distortion market volatility.

Keywords: Distortion measures, data mining form I, turkey lambda, risk measures, coherent measures.

INTRODUCTION

In data mining, the world of finance works better through logistics which is the most powerful force of risk management because, it is the intersection of physical world of finance that allows one to keep up to data information of where everything is going at a particular moment.
How organization and industries manage their capital agenda today will define their competitive position tomorrow.
Risk measures are used to quantify market losses and financial assessments. Several risk measures have been proposed in actuarial science literature like: the value at risk (VaR), which is a risk measure that has received great acceptance in practice; unfortunately it fails to satisfy the sub-additivity property and ignores the potential loss beyond the confidence level. Researchers have come to realize its limitation, limiting its use for reporting purpose when require it or when a simple to interpret number is required by clients. The conditional value at risk (CVaR) developed by Rockafellar et al., (2006), is another risk measure which is said to be a coherent risk measure. The distortion risk measure (DRM)-another risk measure- is the most general risk measure. These risk measures are perspective risk measures because they allow an asset manager to reflect a client's attitude towards risk by choosing the appropriate distortion function. Before we continue with the DRM, it is necessary to introduce data mining models and prediction task in finance relative to DRM typically. Data mining are posed in two forms, namely;

Form I: This is a straight prediction of market characteristics models for testing hypothesis.

Form II: The prediction on the significance of trading cost and assessment of investing risk.

In these form, there is need for forecast and simulation of data set (Becerra, 2002). It uses a decision tree technique and neural networks to a data set (Quinlan, 1993).
Data mining is a cause for concern where only selected information which is not representative of the overall sample group is used to prove a certain hypothesis.
In this paper, the basic problem is that industries such as Nigerian Producers/Manufactures no longer use target espionage but are collecting data at random hence do not monitor in a targeted fashion.
The overall goal in this paper for the data mining form I process via DRM is to decide upon production strategies that can be used to compare and contrast among foreign producers, interpret it into real time analysis that can be used to increase sales, promote new products, delete products that is not value added to the system to avoid influx of customer or clients to foreign producers or customer (clients) exodus. Thereby making the producers consider their issues and challenges, understand their options to make more informed capital decisions, reshaping the operational base, diving cash, working capital and managing portfolio base, assessing future requirements and finding source to strengthen investment appraisal and transaction execution.

THE MODEL

Using DRM in Data Mining Prediction of Market characteristics is applicable to form I, fixing a convention of profit and loss appropriate to the application to the market finance the credit risk and to the market industries. In fact, distortion risk measures have been reportedly used in modeling market risk. For example,Tsukahara (2009) introduced parametric families of distortion risk measures, investigated their properties, and discussed their use in risk management. Weiwei, et al (2009) generalized concepts from cooperative game theory for the allocation of risk capital to portfolios of pooled liabilities, when distortion risk measures are used. Maochao and Taizhong, (2012) studied capital allocation strategies via stochastic comparisons where Independent risks and comonotonic risks are studied in the general loss function scenario and optimal capital allocations and policy limits allocations are discussed.
A risk measure $\rho(x)$ is a coherent distortion risk measure (CDRM) if it is a comonotone law-invariant coherent risk measure and distortion risk measure with a concave distortion function (Ming and Ken, 2012). Representation theorem for CDRM states;
A risk measure $\rho(x)$ is a CDRM if and only if there exists a function $w:[0,1] \to [0,1]$, satisfying $\int_{0=\alpha}^{1} w(\alpha)d\alpha = 1$, such that

$$P_g(X) = \int_{0=\alpha}^{1} w(\alpha)\varphi_\alpha(X)d\alpha, \qquad (1)$$

where$\varphi_\alpha(X)$ is the $\alpha - CVaR$ of X.
The representation theorem for CDRM in discrete case states; given a concave distortion function g, $\rho(X) = \sum_{i=1}^{m} q_i I_{(i)}$, moreover,

$$\rho(X) = \sum_{i=1}^{m} w_i CVaR_{\frac{i-1}{m}}(X), \qquad (2)$$

where

$$w_i = \begin{cases} \frac{q_1}{p(1)}, & if\ i = 1 \\ \left(q_i - \frac{p(i)}{p(i-1)} q_{i-1} \frac{\sum_{j=1}^{m} p(j)}{p(i)},\ if\ i = 2, \dots, m\right). \end{cases} \qquad (3)$$

Let X be a random variable(rv), representing looses (or gain) of a company with a continuous function $(df)f$. The (DRM) of rvx, due X, (Wang, (1995) is defined as

$$P_g(X) = \int_0^\infty g\big(1 - f(x)\big)dx, \qquad (4)$$

where$g$ is a non-decreasing function called distortion function satisfying $g(0) = 0$, and $g(1) = 1$ hence giving rise to the following functions. In actuarial literature;

$$g_p(s) = S^p \text{for } 0 < p \leq 1$$
$$g_k(s) = \phi(\phi^{-1}(s) + k) \text{for } 0 \leq k < \infty$$
$$g_c(s) = \min(s(1-c), 1) \text{for } 0 \leq c < 1$$
$$g_\alpha(s) = S^\alpha(1 - \alpha \ln s) \text{for } 0 < \alpha \leq 1$$

Where $\phi^{-1}(u) := lnf\ (x: \phi(x) \geq \mu)$ is a quantile function of the standard normal distribution ϕ. Constants P, K, C and α are called distortion constant parameters. Where g_p, g_k, g_c and g_α give rise to proportional hazard transform (PHT) (Wang, 1995), the normal transform (Wang, 2000), or the look back distortion (Hurlimann, 1999). When $p = 1$and $k = c = 0$, there is no distortion and the corresponding DRM is equal to expectation of X.

Distortion risk measure **(DRM)** is a coherent risk measure according to (Arzner, et al 1999) defined on a space of rv's satisfying the following axioms;

(i) Monotonicity: for any non-distortion, if X and y are two random variables or risk and $x \leq y$ then $p(x) \leq p(y)$

(ii) TranslativeInvarance: if CERthen $p(x+c) = p(x) + c$.

(iii) Positive homogeneity: if aER then $p(ax) = ap(x) \forall \ a \geq 0$

(iv) Subadivity: $p(x+y) \leq p(x) + p(y)$ if X and y are two random variable or portfolio.

Properties of DRM

i. Bounded above by maximal loss $g\big(s(x)\big) \leq 1$ for $x \leq \max(x)$ and $g\big(s(x)\big) = 0$for $\max(x)\, p_g(x) = \int_0^\infty g\ s(x)dx \leq \int_0^{max} |dx = \max(x)$.

ii. Bounded below by expected loss $g(x) \geq s(x)$ for $x > 0 E(x) = \int_0^\infty\ s(x)dx \leq \int_0^\infty g\big(s(x)\big)dx = p_g(x)$

iii. Scarlar multiplication and additive; Given $bE(0,1), a \geq 0$ and $b \geq 0$

$$Sa(x) + b(u) = \begin{cases} 0\ for\ \ 0 \leq u < b \\ S\left(\frac{u-b}{a}\right)\ \ for\ \ u \geq b' \end{cases}$$

where $\frac{u-b}{a} = t$, then

$$p_g(x) = \int_a^b |du + \int_0^\infty g\left(S\left(\frac{u-b}{a}\right)du\right.$$

$$= b + a\int_0^\infty g(S(t)dt = ap_g(x) + b$$

$$= \int_0^\infty (S(t)dt.$$

iv. Subadditivity (Wang, 1995). If g is increasing for any two random variable x and y and given$a, b\ \in (0,1)$ for $0 < a < b$

$$p_g(x+y) = p_g(x) + p_g(y)$$

Any arbitrary $x \in (0,1)$

$$g(b+x) - g(a+x) \leq g(b) - g(a)$$

$= g(b+a) \leq g(b) + g(a)$ (Denneberge, 1994)

Hence $g(\ 0) = 0\ \ and\ g(1) \Rightarrow g(x) \geq x$

v. Monotonicity: If X and y are γV where $x \leq y$ then $p_g(x) \leq p_g(y)$ for any distortion "g"

vi. Positive homogeneity: for any $rV\quad X$ and non-negative constant a

$$p_g(ax) = ap_g(x)$$

vii. Translative invariance: If $C \in R$ then $p_g(x) + c = p_g(x) + c, c$ is just additional effort.

Distortion for Normal Distribution

For $X \sim N(\mu, \delta^2)$ we have

$$s_x(t) = p(x)t$$

$$1 - p\left(\frac{x-\mu}{\delta} < \frac{t-u}{\delta}\right)$$

$$= 1 - \phi_\alpha \frac{t-u}{\delta} \quad \alpha = 0, 1$$

$$H(X,\alpha) = \int_{-\infty}^0 \big(g_\alpha(s_x(t) - 1)\big)dt + \int_0^\infty g_\alpha\big(s_x(t)\big)dt$$

Given $X = Z$

$$\int_{-\infty}^0 (s_z(t) - 1)\, dt + \int_0^\infty s_z(t)dt$$

$$E(Z) = u + \alpha\, p$$

Distortion for lognormal Distribution

$$\text{If } (\ln x) \sim N(\mu, \delta^2)\ for\ x = z, t = u$$
$$H(x, \alpha) = \int_0^\infty g_\alpha(s_x(t))dt = \int_0^\infty s_z(u)dt$$
$$= E(z) = e^{u+\alpha\delta} + \frac{\delta^2}{2}$$

Where $s_y = p(y > t)$

$$= 1 - p\left(\frac{\ln y - \mu}{\delta} < \frac{\ln t - u}{\delta}\right)$$
$$= 1 - \phi_{0,1}\left(\frac{\ln t - u}{\delta}\right) = 1 - 1 - \phi_\alpha\left(\frac{\ln t - u}{\delta}\right)$$

Wang's distortion decumulative distortion function.

$$\left(s_y(t)\right) = \phi_\wedge[\phi_\wedge^{-1}(s_y(t) + \alpha)]$$
$$= \phi_\wedge\left[\phi_\wedge^{-1}\left(1 - \phi_\wedge\left(\frac{\ln t - u}{\delta}\right)\right) + \alpha\right]$$
$$= \phi_\wedge\left[\phi_\wedge^{-1}\left(\phi_\wedge\left(\frac{\ln t - u}{\delta}\right)\right) + \alpha\right].$$

By symmetry of the normal density

$$\phi_\wedge\left(\frac{\ln t - u - \alpha\delta}{\delta}\right) = 1 - \phi_\wedge\left(\frac{\ln t - (u + \alpha\delta)}{\delta}\right) = s_z(u),$$

where $\ln z \sim N(u + \alpha\delta, \delta)$.

Illustrative Exampleon DM

DM is a distorted probability of a non-negative random variable X or it is adjusting the true probability to give more weight to higher risk event (Wang, 1995).
The DM associated with the distortion function "g" for the $rv\ X$ with the reliability rate $S(X)$ on a probability space (Ω, f, p) is given as

$$p_g(x) = \int_0^\infty g\big(s(x)\big)dx \qquad (5)$$

"g" is a non-decreasing function $g(0) = 0\ \ and\ \ g(1) = 1$

A DRM is coherent if it is continuous meaning that it must be differentiable and integrable (condition).
Wang (1996) describe a shifted premium principle also in terms of a distortion function, such that:

$$g\big(s(x)\big) = \phi(\phi^{-1}(s(x) + k) \qquad (6)$$

Then the true reliability rate non distorted probability is $\phi\left(\frac{\log x - u}{\delta}\right)$

$$S_{(X)} = 1 - \phi\left(\frac{\log X - u}{\delta}\right)$$
$$\therefore g\left(s(x)\right) = \phi(\phi^{-1}(s(x) + k)$$
$$g\left(s(x)\right) = \phi(\phi^{-1}(s(x) + k)$$
$$g\left(s(x)\right) = \phi(1 - \phi\left(\frac{\log X - u}{\delta}\right) + k$$
$$= \phi(\phi^{-1}\left(\phi\left(\frac{\log X + u}{\delta}\right) + k\right.$$
$$= \phi\left(\frac{-\log(X) + u}{\delta} + k\right)$$
$$= 1 - \phi\left(\frac{\log(X) - u - k\delta}{\delta}\right),$$

which is the distortion for lognormal $(u + k\delta, \delta)$ as required.
So the distorted probability of being this far tail is more than the true probability giving more weight to the tail in the value calculation. This premium principle works well with lognormal losses as the distorted reliability rate is the survival function for lognormal distribution with shifted parameter δ.

FOR POWER LOGNORMAL DISTORTION

$$S(x) = \phi\left(\frac{-\log X}{\delta}\right)^p X, p, \delta > 0$$
$$g\ s(x) = \phi(\phi^{-1}(s(x) + k)$$
$$= \phi\left(\phi^{-1}\left(\phi\left(\frac{-\log X}{\delta}\right)^p + k\right)\right.$$
$$= \phi\left(\frac{-\log X}{\delta}\right)^p + k$$

$$1-\phi\left(\frac{\log(X)}{\delta}\right)^{p}+k$$
$$1-\phi\left(\frac{\log(X)}{\delta}\right)^{p}+k\delta$$

With shifted parameter δ
Suppose we have a lognormal with $u = 0 \ and \ \delta = 1$ right tail loss probability with $p(<> 12)$ and $\delta = 2.16$ with Wang distortion we have

$$g\ s(x) = \phi(\phi^{-1}(s(x)+k) \qquad (7)$$

The true distorted probability

$$= 1-\phi\left(\frac{\log 12 - u}{\delta}\right)$$
$$S(x) = 1-\phi\frac{\log 12 - 0}{1}$$
$$1-\phi(\log 12)$$
$$1-\phi(2.4849 = 0.0065)$$

If in $1-\phi\left(\frac{\log(X)-u-k\delta}{\delta}\right)$ and $k = 1$ which is the probability assigned by taking the inverse of $\phi(\phi^{-1})$: $\phi(\phi^{-1}(S(x)+k)$

$$= \phi^{-1}(0.0065) = -2.4849$$

Re-applying the normal distortion function by $k = 1$. We have

$$\phi(0.006541) = 1.4849$$
$$\phi^{-1}(1.4849) = -1.4849$$

Re-applying the normal distortion function to give the distorted probability

$$g\ s(x) = \phi(-1.4849)$$
$$= 0.06879.$$

Non Distortion (True Reliability Rate)

True reliability rate is not adjusting the true probability function which is the true survival function being the reliability rate (Delbean et al, 2000).To build a successful distortion regulatory policy, one must recognize all possible conflicts of interest that might arise subsequently and provides incentive to align them with the objectives of the regulatory system.
In this work, we identify two potential sources of strategic measures which are distortion and non-distortion (true reliability rate) and then analyze their effect. That is adjusting the true owners decision to prevent shortfall.

TURKEY LAMBDA DISTRIBUTION

Turkey Lambda distribution is a continuous probability distribution defined in terms of its quantity function formalized by John Turkey (VasicekOldrich, 1976). It is typically used to identify an appropriate distribution and not used in statistical models directly (Shaw and McCabe, 2009).
The Turkey Lambda distribution has a shape parameter λ. As with other probability distribution, the Turkey Lambda distribution can be transformed with a location parameter, μ and a scale parameter, σ.
Hence the distribution function for Turkey Lambda distribution is;

$$f(x) = (e^{x}+1)^{-1} \qquad (8)$$

Properties of Turkey Lambda Distribution

Notation	Turkey (λ)
Parameters	$\lambda \epsilon R$ – shape parameter
Support	$x\epsilon\left[\frac{-1}{\lambda},\frac{1}{\lambda}\right]$ $for\ \lambda > 0$; $x\epsilon R\ for\ \lambda \le 0,$
Pdf	$(Q\ (p;\lambda)), Q^{'}(p;\lambda)^{-1}, 0 \le p \le 1$
CDF	$(e^{-x}+\ 1)^{-1},\ \lambda = 0$
Mean	$0, \lambda > \ -1$
Variance	$\frac{2}{\lambda^2}\left(\frac{1}{1+2\lambda}-\frac{\Gamma(\lambda+1)^2}{\Gamma(2\lambda+2)}\right),\ \lambda > {}^{-1}/_{2}$; $\frac{\pi^2}{3}, \lambda = 0$
Skewness	$0, \lambda > {}^{-1}/_{3}$
Ex-kurtosis	$\frac{(2\lambda+1)^2}{2(4\lambda+1)}\frac{g_2^2(3g_2^2-4\ g\ g_3+\ g_4)}{g_4(g_1^2-g_2)^2}$

Where $g_k = \Gamma(k\lambda + 1) and\ \lambda > {}^{-1}/_{4}$

Turkey Lambda is a family of distribution that can approximate a number of common distribution. For example, for $\lambda = -1 \Rightarrow$ approximately Cauchy; $\lambda = 0 \Rightarrow$ exactly logistic; $\lambda = 0.14 \Rightarrow$ approximately Normal; $\lambda = 0.5 \Rightarrow$ u shaped and $\lambda = 1 \Rightarrow$ exactly uniform (from -1 to +1)
So as the optimal value of λ goes or becomes greater than 0.14 shorter tails are implies vice versa.
The survival function (true reliability rate)$s(x) = e^x + 1$ which is the reliability rate.

Distorted Turkey Lambda Copulas

The first strategy is on the owners of the industry's decision on production which optimizes exponential recursive utility X (non-distortion⟹reliability rate).$S(x) = e^x + 1\,;x$ = probability time of restricting the product.The second strategy is on the distorting the owners decision on production by the trader which determines what specific strategy they might adopt on a particular day, today which re-optimizes the exponential recursive utility X. That is updating the optimal strategy at each time step which is also re-optimizing the decision criterion taking into accounts the new state of portfolio and information that become available under the present scenario which are independent of the ones used for the optimization.
Assume that the traders' decision at each point in time is given by the distorted survival function.

$$g\big(s(x)\big) = e^{-x\delta}$$

$$\therefore p_g\big(s(x)\big) = \int_0^\infty g\big(s(x)\big)dx \qquad (9)$$

δ = measure of risk aversion (re-optimizing at each point in time).
Let $u = x^\delta$ and $\frac{du}{dx} = \delta x^{\delta-1}$ such that $dx = \frac{du}{\delta x^{\delta-1}}$.
Then

$$p_g\big(s(x)\big) = \int_0^\infty e^{-u}\,dx$$

$$= \int_0^\infty e^{-u}\frac{du}{\delta x^{\delta-1}}$$

$$= -\frac{1}{\delta x^{\delta-1}}\Big|_0^\infty e^{-u}$$

$$= \delta^{-1}x^{1-\delta}.$$

Therefore the Distortion reliability risk measure is the expected value under the distorted survival function given by $\delta^{-1}x^{1-\delta} = p_g s(x)$ which is the traders' re-optimizing function.
The non-distortion/true reliability rate: The expected value under the reliability rate $s(x) = e^x + 1$ which is the owners optimizing function.

FIRST STRATEGY (True reliability rate/Non distortion) on the owners point (optimizing)

$$s(x) = e^x + 1$$
$$1972 = e^{1.0} + 1 = 3.7$$
$$1987 = e^0 + 1 = 2.0$$
$$1993 = e^{0.7} + 1 = 3.0$$
$$1998 = e^{0.5} + 1 = 2.6$$
$$2003 = e^{1.0} + 1 = 3.7$$
$$2008 = e^0 + 1 = 2.0$$

SECOND STRATEGY (Distortion) on the traders' point of view (Re-optimizing)
We have:

$$p_g s(x) = \delta^{-1}x^{1-\delta}, \qquad (10)$$

where $\delta = 2$, measure of risk aversion (Re-optimizing function)

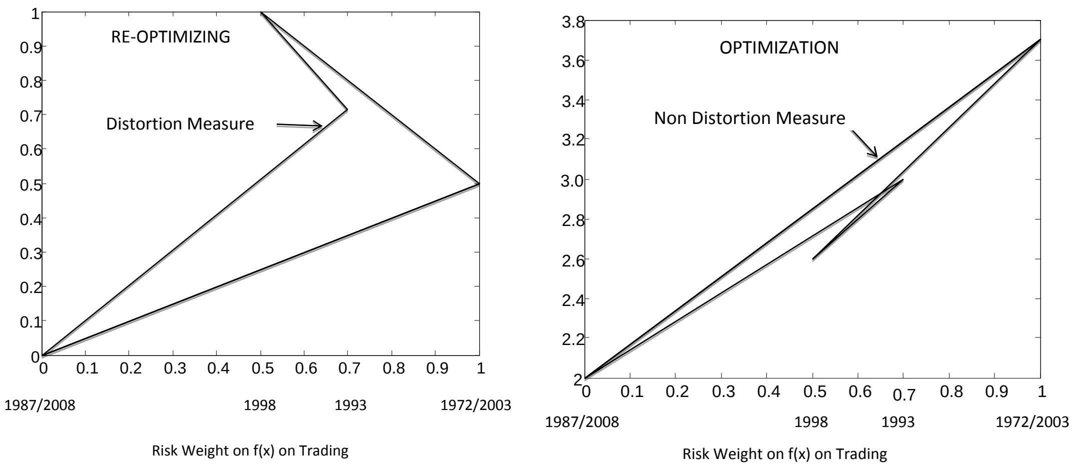
$$1972 = \frac{1}{2}(1.0)^{1-2} = 0.5$$
$$1987 = \frac{1}{2}(0)^{-1} = 0$$
$$1993 = \frac{1}{2}(0.7)^{-1} = 0.714$$
$$1998 = \frac{1}{2}(0.5)^{-1} = 1.0$$
$$2003 = \frac{1}{2}(1.0)^{-1} = 0.5$$
$$2008 = \frac{1}{2}(0)^{-1} = 0.$$

Table 1. Summary of trading report of Unilever Nigeria from 1972-2008 apical year.

Year Trend	Risk weight on $f(x)$ on trading	Impact on sales in millions (N)	Probability $f(x)$ on sales	True reliability rate non distortion $s(x)$	Distortion measure $p_g s(x)$
1972	1.0	1	0.390	3.7	0.5
1987	0	0	0.600	2.0	0
1993	0.7	11	0.010	3.0	0.714
1998	0.5	5	0.025	2.6	1.0
2003	1.0	1	0.375	3.7	0.5
2008	0	0	0.600	2.0	0

The table below shows the summary of trading report over the year from 1972-2008 apical year of Unilever Nigeria.

Figure 1(a,b). The Graph of optimizing and re-optimizing copular.



CONCLUSIONS

The risk in optimization is higher than that of re-optimization. So using the distortion risk measure, it is incentive to say that the traders of the products that determine what specific strategies, they might adopt on a particular day and it is important to see to what extent the owners can control their action.

As advice of control, the owners writes contracts and make decision to the managers then the managers take most of the trading decision.

Moreover, managers cannot usually be fined (paid negative salaries) in the event of losses or shortfall. So decision about liability only adds to list of troubles because if fired, most managers are usually able to find jobs while the owners have to suffer the losses in the trading book and pay the penalty in the case of a breach.

REMARK

This form of re-optimizing distortion dynamic value measure has appealing feature on entangling the risk aversion and temporal elasticity of substitution of preferences by making them transparent to decision makers. In addition, the model allows one to define an optimal positioning between a reduction in the risk of the final return and likelihood of bankruptcy within the given time horizon.

Last we show that distortion increases the relative performance of strategies targeting optimal planning and temporal smoothness of cash returns flows with minimum risk.

However, from the social point of view, under taking higher trading risk precisely implies low returns and undertaking low risk implies high returns and smoothness of cash flow.

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