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Application and Simulation of Optimal Investment Strategy for Subjective Fault in Criminal Psychology Evaluation

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Abstract: Criminal psychology evaluation is too comprehensive to be easily made, but here the optimal investment strategy is proposed to solve this kind of problem in criminal psychology from the view of subjective fault. First, the investment strategy of subjective fault is modeled by the risk measurement of boundary value, and the complex strategy selection process subjective fault is analyzed. The psychology activity is modeled as a multistage process of strategy selection, and the revenue function of criminal psychology in multi strategy choice is also discussed. Second, considering the subjective fault of criminal psychology, an optimal strategy solution with the opportunity cost and robust portfolio model is described. Third, the optimal strategy is verified by an example, and the results showed that the criminal psychology evaluation problem can be established by using robust optimization model. Last, some practical suggestions, interesting conclusions, and future work are indicated at the end of the paper.

Keywords: Optimal Investment Strategy, Subjective Fault, Criminal Psychology Evaluation, Risk Premium

1. Introduction

Some effects about preference evaluation based on cognitive psychology attracted the attention of some researchers. Matsumot (2016) developed preference evaluation based on cognitive psychology of the quantity of knots present in wood wall panels, and studied the effects of the ratio of knot area of Todomatsu wall panels and of room type on people's preferences for residential living rooms [1-2]. Recently, numerous applications of physiology in medical science have made great progress [3-4]. Nakayama (2015) concerned the effectiveness of aromatherapy on physiology and psychology in patients undergoing I-131 ablation with differentiated thyroid cancer.-using physiological and sensory evaluation [3]. In some cases psychology is used in the evaluation of a specialist HIV psychology service [5]. Besides, it is as a kind of teaching content to train students [6]. According to human psychology, people can feel different environment [7]. Sometimes, novel joint psychology and physician assessment for patients may be faced with psychosexual difficulties [8]. In the previous researchers, Julien gave stepping up psychological care after stroke with an evaluation of psychology and service-user led level 1 training for the stroke professionals [9]. Lavoie implied bridging neuroscience and clinical psychology with cognitive behavioral and psychophysiological models in the evaluation and treatment of syndrome [10]. Camparo indicated a geometrical approach to the ordinal data of liken scaling and attitude measurements by a density matrix in psychology [11]. These studies more or less showed that people's mood, health, learning life and psychology are closely linked.

How to quantify the psychology won great attention recently [12-18]. Jarrar (2015) introduced the impact of Ramadan fasting on psychology, anthropometric measurements and performance for Al Jazira Soccer Players-UAE [12]. Thomas (2013) illustrated research methods in health psychology from viewpoints of measurement, design and data analysis [13]. Bagian (2015) modeled the future of graduate medical education by a systems-based approach to ensure patient safety [14]. Liu (2016) offered a joint estimation of treatment and placebo effects in clinical trials with longitudinal blinding assessments [15]. Kwon (2016) provided an emotional inference by means of Choquet integral and Lambda-fuzzy measurement in consideration of ambiguity of human mentality [16]. Hsiao (2015) took acute simultaneous multiple lacunar infarcts as the initial presentation of cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy [17]. Asura (2014) reviewed the promotion & implementation stroke, and the effectiveness of public stroke educational interventions [18]. Busemann (2013) proposed a curriculum "patient safety" for undergraduate medical students at the department of surgery [19]. Zhang (2013) studied a causal model for joint evaluation of placebo and treatment-specific effects in clinical trials [20]. The above practice has also proved that the researchers used psychology to analyze and solve the social problems, which has brought a lot of benefits for the convenience of the social life.

But there is few work on quantified evaluation of criminal psychology. Vollbach (2012) proposed a compact criminal psychology [21]. Criminal psychology, also referred to as criminological psychology, is the study of the wills, thoughts, intentions, and reactions of criminals and all that partakes in the criminal behavior [21]. Clark (2013) implied an education center with a case study involving, nursing, psychology, and criminal justice [22]. The use of psychology to study the behavior of crime has become more and more widespread. Petersen(2012) introduced the evolutionary psychology and lay intuitions about modern criminal justice [23]. There is no doubt that the basic principle of psychology provides a new route for the development of modern criminology.

Motivated from the development above, in this paper, the basic principles and methods of psychology are used to study the motive of the criminal to reveal the subjective malignant size of the criminal, where the optimal investment strategy is proposed to solve this kind of problem in criminal psychology from the view of subjective fault. First, the investment strategy of subjective fault is modeled by the risk measurement of boundary value, and the complex strategy selection process subjective fault is analyzed. The psychology activity is modeled as a multistage process of strategy selection, and the revenue function of criminal psychology in multi strategy choice is also discussed. Second, considering the subjective fault of criminal psychology, an optimal strategy solution with the opportunity cost and robust portfolio model is described. Third, the optimal strategy is verified by an example, and the results showed that the robust optimization problem can be established by using semi definite programming. Last, some practical suggestions, interesting conclusions and future work are indicated at the end of the paper.

2. Investment Strategy for Subjective Fault

2.1. Subjective Fault in Criminal Psychology

Criminal psychology is often used to understand the mind of the criminal and deal with aspects of criminal behavior as witnesses in court cases to help the judicial decision making. Subjective fault is that a defendant should contemplate the harm he may cause, on the contrary such actions should be avoided in criminal psychology. Different researches provided different notions of subjective fault, and it is more important in practice to avoid it instead of proving fault. It is important to start our task with the variant random variable case which is classical one, the subjective fault in criminal psychology is shown in figure 1.

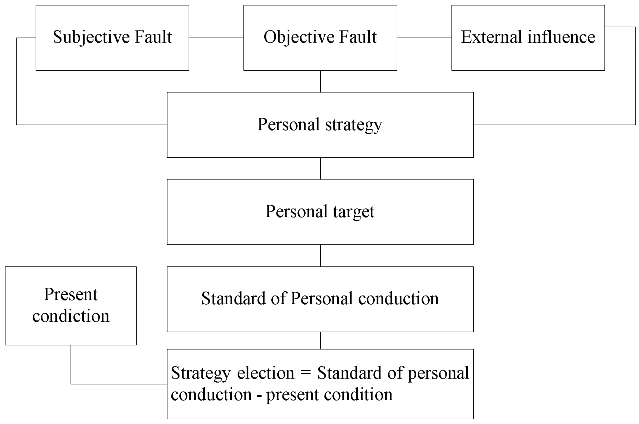

Figure 1. *Subjective fault in criminal psychology.*

First of all, let us brief some nations. Positive semi definite matrix $\Lambda \in S^n_{++}$ and vector $u \in \Re^n$, $F = \{\Pi | G_\Pi[\Phi] = u, \mathrm{Dom}_\Pi[\Phi] = \Lambda \succ 0\}$ is referenced by our team to represent a suit of probability distributions with mean u and covariance Λ. And $W \sim (u, \Lambda)$ is used by us to delegate that the random vector W is part of the set whose elements have mean u and covariance matrix Λ. The notations $\Pi \in F$ and $W \sim (u, \Lambda)$ will be used, because it is a one-on-one relationship between random variables and the distributions of probability.

It is argued that

$$\underset{W\sim(u,\sigma^2)}{\mathrm{smb}} \mathrm{Prob}\{W \le d\} = \underset{W\sim(u,\sigma^2)}{\mathrm{smb}} \mathrm{LCK}_0(d) = \begin{cases} \dfrac{1}{1+(d-u)^2/\sigma^2}, & if\ d < u \\ 1, & if\ d \ge u \end{cases} \tag{1}$$

In the above formula, the W below the benchmark d has an expected shortfall $LCK_1(d)$, which upper bound can be export by Jensen's inequality.

$$\underset{W\sim(u,\sigma^2)}{\mathrm{smb}} G[(d\text{-}W)_+] = \frac{d\text{-}u + \sqrt{\sigma^2 + (d\text{-}u)^2}}{2} \tag{2}$$

To set up a tight bound $LCK_2(d)$, the consult is to give the benchmark by d rather than the meaning.

$$\underset{W\sim(u,\sigma^2)}{\text{smb}} G[(\text{d-W})_+^2]=[(\text{d-u})_+]^2+\sigma^2 \tag{3}$$

For all the $W\sim(u,\sigma^2)$, it is easy to know through Jensen's inequality

$$G[(\text{d-W})_+^2]=G[(\text{d-W})^2]\text{-}G[(\text{d-W})_-^2] \le G[(d-W)^2]-([G(d-W)]_-)^2$$

$$=\sigma^2+(\text{d-}u)^2\text{-}[(d-u)_-]^2=\sigma^2+[(\text{d}-u)_+]^2. \tag{4}$$

In order to show the compactness of the range, a sequence of distributions is considered,

$$W_n=\begin{cases} u+\dfrac{\sigma}{\sqrt{\text{n-1}}}, & \text{with probability } \dfrac{n-1}{n} \\ u\text{-}\sqrt{\text{n-1}} & \text{with probability } \dfrac{1}{n} \end{cases} \tag{5}$$

It is simple to know that $W_n\sim(u,\sigma^2)$ and

$$G[(\text{d-W}_n)_+^2]\to\sigma^2+[(\text{d-}u)_+]^2 \tag{6}$$

As $n\to\infty$, this illustrate that the upper bound is certainly tight.

By watching $G[(\text{d-W}_n)_+^2]\to\infty$ where the sequence W_n is taken as a attest, it is clear that $smb_{W\sim(u,\sigma^2)}G[(d-W)_+^k]=+\infty$ for any $k>2$. Hence, it is necessary to take more attention on lower partial problem such as LCK_0, LCK_1 and LCK_2.

2.2. Conditional Value-at-Risk for Subjective Fault

However, in subjective fault, there are a lot of risks for criminal actions, where VaR and CVaR have drawn much eyesight in the last few years. For the loss of linear functions, the VaR question can be solved precisely with the help of the performance of $LCK_1(d)$.

Let $c(w,\Phi)$ represent the loss function which relevant to decision vector $w\in X\subseteq\Re^n$ and random vector in the analysis of CVaR. Supposing that the cumulative chance spread function for Φ is $\Pi(\cdot)$. Also, $G[|c(w,\Phi)|]<+\infty$ is supposed for any $w\in X$.

Making an assumption w∈ X, the possibility of $c(w,\Phi)$ is not an outnumbering limit, and ∂ is from

$$\Psi(w,\partial)\overset{\Delta}{=}\int_{c(w,\theta)\le\partial} d\Pi(\Phi). \tag{7}$$

For a granted faith level ℓ (generally bigger than 0.9) and a confirmed $w\in X$, the value-at-risk is delimited as

$$\text{VaR}_\ell(\text{w})\overset{\Delta}{=}\min\{\partial\in\Re\,|\,\Psi(w,\partial)\ge\ell\}. \tag{8}$$

The homologous conditional value-at-risk which signified by $CVaR_\ell(\text{w})$, is used to describe the loss of expected value. In other words,

$$CVaR_\ell(\text{w})\overset{\Delta}{=}\frac{1}{1-\ell}\int_{c(w,\theta)\ge VaR_{\ell(w)}} c(w,\Phi)d\Pi(\Phi). \tag{9}$$

The computing of CVaR can be finished by minimizing the following assistant function, for the variable $\partial\in\Re$:

$$B_\ell(w,\partial)\overset{\Delta}{=}\partial+\frac{1}{1-\ell}\int_{\Phi\in\Re^n}[c(w,\Phi)-\partial]_+d\Pi(\Phi), \tag{10}$$

and then,

$$CVaR_\ell(\text{w})=\min_{\partial\in\Re}B_\ell(w,\partial). \tag{11}$$

It is supposed that the spread $\Pi(\cdot)$:

$$\Pi\in\text{F}=\{\Pi\,|\,G_\Pi[\Phi]=u, Dom_\Pi(\Phi)=\Lambda\succ0\}. \tag{12}$$

For stationary $w\in X$, the robust major correspondence of the tactics selection questions making use of CVaR or VaR as the risk solution, are developed by

$$\text{P}CVaR_\ell(w)\overset{\Delta}{=}\underset{\Pi\in F}{smb}\,CVaR_\ell(w), \tag{13}$$

and

$$\text{P}VaR_\ell(w)\overset{\Delta}{=}\underset{\Pi\in F}{smb}\,VaR_\ell(w). \tag{14}$$

As well, it has been found that the robust portfolio problem with CVaR or VaR as venture solution could be finished precisely with the ordinary restrict $w^Re=1$.

Assuming that the loss function is $c(w,\Phi)=-w^R\Phi$ and the random vector Φ has average value u and the matrix $\Lambda\succ0$.Let$\ell\in(0.5,1]$. Then

$$\begin{aligned} &\text{b}(MC_\ell)=\min_w\underset{\Pi\in F}{smb}\,CVaR_\ell(w) \\ &\text{s.t.}\quad w^Re=1. \end{aligned} \tag{15}$$

and

$$\begin{aligned} &\text{b}(\text{N}V_\ell)=\min_w\underset{\Pi\in F}{smb}\,VaR_\ell(w) \\ &\text{s.t.}\quad w^Re=1. \end{aligned} \tag{16}$$

After that the measure of CVaR in worst-case is:

$$\text{b}(MC_\ell)=\begin{cases} \dfrac{\sqrt{j_0j_2-j_1^2\sqrt{\dfrac{\ell j_0}{1-\ell}-1}}}{j_0}-\dfrac{j_1}{j_0}, & if\ \dfrac{\ell}{1-\ell}\cdot j_0\ge1 \\ -\infty, & if\ \dfrac{\ell}{1-\ell}\cdot j_0<1 \end{cases} \tag{17}$$

when $\ell/(1-\ell)\cdot j_0\ge1$, with best way to solve the problem.

$$\mathrm{w}^*_{\mathrm{MC}_\ell}=(\Lambda^{-1}u \quad \Lambda^{-1}\mathrm{e})\begin{pmatrix} j_0 & -j_1 \\ -j_1 & j_2 \end{pmatrix}\cdot\begin{pmatrix} \dfrac{\sqrt{j_0 j_2-j_1^2}}{j_0\sqrt{\ell j_0/(1-\ell)-1}}+\dfrac{j_1}{j_0} \\ 1 \end{pmatrix}\cdot \quad (18)$$

$$\mathrm{NV}_\ell=\begin{cases} \dfrac{\sqrt{j_0 j_2-j_1^2}\sqrt{j_0/(4\ell(1-\ell))-j_0-1}}{j_0}-\dfrac{j_1}{j_0}, & if\ \dfrac{j_0}{4\ell(1-\ell)}\geq 1+j_0, \\ -\infty, & if\ \dfrac{j_0}{4\ell(1-\ell)}\leq 1+j_0 \end{cases} \quad (19)$$

Then the answer of worst-case VaR is:

When $\mathrm{j}_0/(4\ell(1-\ell))\geq 1+j_0$, the major resolution way is

$$\mathrm{w}^*_{\mathrm{NV}_\ell}=(\Lambda^{-1}u \quad \Lambda^{-1}\mathrm{e})\begin{pmatrix} j_0 & -j_1 \\ -j_1 & j_2 \end{pmatrix}\cdot\begin{pmatrix} \dfrac{\sqrt{j_0 j_2-j_1^2}}{j_0\sqrt{j_0/(4\ell(1-\ell))-j_0-1}}+\dfrac{j_1}{j_0} \\ 1 \end{pmatrix}\cdot \quad (20)$$

when $\ell/(1-\ell)\cdot \mathrm{j}_0 < 1$ and $j_0/(4\ell(1-\ell))\leq 1+j_0$, the anticipated collapse gauged by CVaR and VaR are unlimited. And in all other solutions, the major investment portfolios are mean-variance optimization.

3. Multistage Strategy Selection in Criminal Psychology

From the figure 1, it is simple to know the criminal psychology is a multi-stage process. Let us think over an I-stage tactics choose model, and suppose j_i to be the ith phase recourse portfolio choose, $i=1,...,I$. Moneyman's purpose is to minimum the end terminal $L\mathrm{CK}_2 risk, i, e.,$ $\mathrm{G}[(d-j_I^R\Phi_I)_+^2]$. Hence Φ_I is used to be the probability of return vector for the ith phase. Their first two moments estimate: (u_i,Λ_i) are known as the random vectors Φ_i Because Φ_i is uncertain, before the real identity of $\Phi_{\mathrm{i+1}}$ is showed, it is necessary to make the $(i+1)$ th phase recourse choose j_{i+1}, in which $\mathrm{i}=1,2,...,\mathrm{I}$. The real identity of the give back Φ_1 is uncertain. When j_1 is chosen, further more when the portfolio is selected, it is obvious that $\mathrm{j}_i(i\geq 2),\Phi_1,...,\Phi_{k-1}$ but Φ_i is still uncertain, so j_i is an exchangeable variable to turn on the unsure data $\Phi_1,..,\Phi_{\mathrm{i}-1}$.

In mathematics, the multistage strategy selection in criminal psychology is showed as:

$$\mathrm{B}_1(1)=\min_{j_1}\ \underset{\theta_1\sim(u_1,\Lambda_1)}{smb}\ G[B_2(j_1^R\Phi_1)] \qquad s.t. \qquad j_1^R e=1. \quad (21)$$

$$B_I(\varsigma_{I-1})=\min_{j_I}\ \underset{\theta_I\sim(u_I,\Lambda_I)}{smb}\ G[(d-j_1^R\Phi_I)_+^2] \quad (22)$$

$$\text{s.t. } \mathrm{j}_1^R e=\varsigma_{I-1}$$

$\mathrm{B}_{i+1}(\varsigma_i)$ is supposed by us as the major goal value at phase i+1, given the value $\varsigma_\mathrm{i}=j_i^R\Phi_i$ as the outcome of investment at phase $\mathrm{i}, i=1,...,\mathrm{I}-1$.

For the first two instants of Φ_i there are (u_i,Λ_i) $\mathrm{i}=1,...,I$, besides, for $\mathrm{i}=1,...,I-1$, it is supposed

$$\mathrm{w}_0^i:=e^R\tilde{\Lambda}_i^{-1}e,\ \ \mathrm{w}_1^i:=e^R\tilde{\Lambda}_i^{-1}u_\mathrm{i},\ \ w_2^i:=u^R\tilde{\Lambda}_i^{-1}u_\mathrm{i},$$

$$x_0^i:=\frac{w_0^i}{w_0^i w_2^i-w_1^{i^2}},\ x_1^i:=\frac{w_1^i}{w_0^i w_2^i-w_1^{i^2}},\ \mathrm{x}_2^i:=\frac{w_2^i}{w_0^i w_2^i-w_1^{i^2}}$$

$$a_i=\frac{x_1^{i+1}}{\sqrt{x_0^{i+1}(x_0^{i+1}+1)}},\ d_i=\frac{x_0^{i+1}b_{i+1}}{x_1^{i+1}},\ \tilde{\Lambda}_\mathrm{i}=\Lambda_i+\frac{\Lambda_i+u_i^R u_i}{w_0^{i+1}\cdot a_i^2}, \quad (23)$$

Supposing that $\mathrm{d}_i=d, a_i=1$, for $\mathrm{i}=1,...,\mathrm{I}$, there is

$$\mathrm{B}_i(j_{i-1}^R\Phi_{i-1})=(a_{I-1}...a_{i-1})^2\cdot[(b_{i-1}-j_{i-1}^R\Phi_{i-1})_+^2]+(a_{I-1}...a_i)^2\cdot\frac{(j_{i-1}^R\Phi_{i-1})^2}{w_0^i}; \quad (24)$$

$$\mathrm{j}_\mathrm{i}^*=(\tilde{\Lambda}_\mathrm{i}^{-1}u_i \quad \tilde{\Lambda}_\mathrm{i}^{-1}\mathrm{e})\begin{pmatrix} x_0^{\,i} & -x_1^\mathrm{i} \\ -x_1^\mathrm{i} & x_2^\mathrm{i} \end{pmatrix}\cdot\begin{pmatrix} \dfrac{(x_0^i b_i-x_1^i(j_i^R\Phi_{i-1}))_+}{x_0^i(x_0^i+1)}+\dfrac{x_1^i(j_{i-1}^R\Phi_{i-1})}{x_0^i} \\ 1 \end{pmatrix}\cdot \quad (25)$$

Looking back upon that

$$\underset{T\sim(u,\sigma)}{s\mathrm{mb}}\ G[(d-T_+^2)]=(d-u)_+^2+\sigma^2,\forall d\in\Re \quad (26)$$

So

$$\min_{\mathrm{w}}\ \sup_{\Phi\sim(u,\Lambda)} G[(d-\Phi^R)_+^2]=\min_{\mathrm{w}}(d-w^R u)_+^2+w^R\Lambda w \qquad \text{s.t.}\mathrm{w}^R e=\varsigma; \quad (27)$$

$$=\min(\mathrm{d}-\varsigma\cdot z^R\mu)_+^2+\varsigma^2\cdot z^R\Lambda z \qquad \text{s.t.} \qquad \mathrm{z}^R e=1$$

If the major value and measures are clearly known, the above questions can be solved correctly.

$$b^* = \frac{[(x_0 d - x_1 \cdot \varsigma)_+]^2}{x_0(x_0+1)} + \frac{\varsigma^2}{w_0}, \quad (28)$$

$$w^* = (\Lambda^{-1}u \quad \Lambda^{-1}e)\begin{pmatrix} x_0 & -x_1 \\ -x_1 & x_2 \end{pmatrix}\begin{pmatrix} \frac{(x_0 d - x_1 \cdot \varsigma)_+}{x_0(x_0+1)} + \frac{x_1 \cdot \varsigma}{x_0} \\ 1 \end{pmatrix} \quad (29)$$

particularly

$$w_0 := e^R \Lambda^{-1} e,\ w_1 := e^R \Lambda^{-1} u,\ w_2 := e^R \Lambda^{-1} u,$$

$$x_0 := \frac{w_0}{w_0 w_2 - w_1^2},\ x_1 := \frac{w_1}{w_0 w_2 - w_1^2},\ x_2 := \frac{w_2}{w_0 w_2 - w_1^2}. \quad (30)$$

For the final stage,

$$B_I(j_{I-1}^T \Phi_{I-1}) = \min_{j_1} \underset{\theta_I \sim (u_I, \Lambda_I)}{smb} G[(d - j_1^R \Phi_I)_+^2] \quad \text{s.t.} \quad j_1^R e = j_{I-1}^R \Phi_{I-1}$$

$$= \min_{j_I} [(d - j_1^R u_I)_+^2] + j_I^R \Lambda_I j_I \quad \text{s.t.} \quad j_1^R e = j_{I-1}^R \Phi_{I-1}$$

$$= \frac{[(x_0^I d_I - x_1^I \cdot (j_{I-1}^R \Phi_{I-1}))_+]^2}{x_0^I (x_0^I + 1)} + \frac{(j_I^R \Phi_{I-1})^2}{w_0^I}$$

$$= a_{I-1}^2 \cdot [(d_{I-1} - j_{I-1}^R \Phi_{I-1})_+]^2 + \frac{(j_{I-1}^R \Phi_{I-1})^2}{w_0^I} \quad (31)$$

Suppose that the formula for the best major wealthy and measure suit for

$$B_i(j_{i-1}^R \Phi_{i-1}) = \min_{j_i} \underset{\Phi_i \sim (u_i, \Lambda_i)}{smb} G[B_{i+1}(j_i^R \Phi_i)]$$

$$= \min_{j_i} (a_{I-1} ... a_i) \cdot \{[(d_i - j_i^R u_i)_+^2] + j_i^R \tilde{\Lambda}_i j_i\}$$

$$\text{s.t.} \quad j_i^R e = j_{i-1}^R \Phi_{i-1} \quad (32)$$

And

$$j_i^* = (\tilde{\Lambda}_i^{-1} u_i \quad \tilde{\Lambda}_i^{-1} e)\begin{pmatrix} x_0^i & -x_1^i \\ -x_1^i & x_2^i \end{pmatrix}.$$

$$\begin{pmatrix} \frac{(x_0^i d_i - x_1^i \cdot (j_{i-1}^R \Phi_{i-1}))_+}{x_0^i (x_0^i + 1)} + \frac{x_1^i \cdot (j_{i-1}^R \Phi_{i-1})}{x_0^i} \\ 1 \end{pmatrix}. \quad (33)$$

It is uncertain for the criminal that how to expand the result to other risk solutions, because there is a similar structure between the robust $LCK_2(d)$ and its non robust one.

4. Optimal Strategy for Criminal Control

4.1. Chance Constraints for Subjective Fault

According to the criminal portfolios above, chance constraints can be used for subjective fault. If the criminal find his or her subjective fault, and actively terminate the criminal process, the lost chance will help he or she diminish the criminal loss. Hence, the lost chance is described as Φ, and Prob $\{\Phi^R Q \Phi + q^R \Phi > d\} \le \ell$, where Q is a sure *n*-dimensional symmetric matrix, as well as q is a *n*-dimensional vector. Understanding the first two instants of Φ together, the best investment policy model turns into

$$\max_{w \in W} \min_{\Phi} G[U(w^R \Phi)]$$

$$s.t. \quad \Phi \sim (u, \Lambda) \quad and \quad \text{Prob}\{\Phi^R Q \Phi + q^R \Phi > d\} \le \ell \quad (34)$$

There are $\bar{\Phi} \in \Re$, so that $\bar{\Phi}^R Q \bar{\Phi} + q^R \bar{\Phi} < d$, $\Lambda \succ 0$ and $\ell \in (0,1)$.

Assume that $U(y) := \min\{i + jy, 0\}$ with $i, j \in \Re$. The above questions can be expressed as

$$\max_{w \in W} \max_{L, l_0, l_1, l_3} \{l_0 + l_1^R u + L \cdot (\Lambda + uu^R) - \ell l_3\}$$

$$s.t. \quad l_0 + l_1^R \Phi + \Phi^R L \Phi \le l_3 + i + j(w^R \Phi), \quad \forall \Phi \in \Re^n$$

$$l_0 + l_1^R \Phi + \Phi^R L \Phi \le l \, \forall \Phi \in \Re^n$$

$$l_0 + l_1^R \Phi + \Phi^R L \Phi \le i + j(w^R \Phi),$$

$$\begin{aligned} & \forall \Phi^R Q \Phi + q^R \Phi \le d \\ & l_0 + l_1^R \Phi + \Phi^R L \Phi \le 0, \quad \forall \Phi^T Q \Phi + q^R \Phi \le d \\ & l_3 \ge 0. \end{aligned} \quad (35)$$

It is likely to expand the means to include more opportunities restricted in the robust best formulation.

The subjective fault of the chance constraint can be described as

$$\max_{w \in W} \min_{\Phi \sim (u, \Lambda)} G[U(w^R \Phi)]$$

$$\begin{aligned} \text{s.t.} \quad & \text{Prob}\{\Phi^R Q \Phi + q^R \Phi > d_1\} \le \ell_1 \\ & \text{Prob} \quad \{r^R \Phi > d_2\} \le \ell_2. \end{aligned} \quad (36)$$

Where $Q \succeq 0$ and there have $\bar{\Phi} \in \Re^n$ so $\bar{\Phi}^R Q \bar{\Phi} + q^R \bar{\Phi} < d_1$ and $r^R \bar{\Phi} < d_2$.

Additionally $\Lambda \succ 0$ and $\ell_1, \ell_2 \in (0,1)$.

4.2. Optimal Strategy for Criminal Control

According to the chance constraints for subjective fault, it is possible to control criminal by diminishing chance cost and subjective fault. Assuming chance cost s_1 and s_2, that average vector $u \in \Re^2$ and covariance matrix Λ are known. Assume that the evaluate on the chance of subjective fault s_2 upper some consult points d is known by us**.**

So the question is to obtain the closest expected asset of a European call option on subjective fault. In mathematics, the question is

$$\max_{(s_1,s_2)\sim(\mathrm{u},\Lambda)} G[(s_1-t)_+] \quad \text{s.t.} \quad \mathrm{Prob}\{\mathrm{s}_2 > \mathrm{d}\} \le \ell \tag{37}$$

To elude simple cases, employing the Chebyshev-Cantelli bound, let us think about the parameters to meet:

$$\ell \in \begin{cases} [0, \dfrac{\Lambda_{22}}{(r-u_2)^2+\Lambda_{22}}], & and \quad d \ge u_2 \\ [\dfrac{(\mathrm{d}-\mu_2)^2}{(d-u_2)^2+\Lambda_{22}}, 1], & and \quad d \le u_2 \end{cases} \tag{38}$$

Resemble above, the dual is in:

$$\min_{L,l_0,l_1,l_3} \{l_0 + l_1^R u + L\cdot(\Lambda + u\nu^R) + \ell l_3\} \tag{39}$$

$$s.t. \quad l_0 + l_1^R \begin{pmatrix} s_1 \\ s_2 \end{pmatrix} + \begin{pmatrix} s_1 \\ s_2 \end{pmatrix}^R L \begin{pmatrix} s_1 \\ s_2 \end{pmatrix} + l_3 1_{\{s_2>d\}} \ge (s_1-k)_+,$$

$$\forall (s_1,s_2)\in \Re^2 \ , l_3 \ge 0$$

A simple application is to reinforce the Chebyshev-type inequality by the first two instants. Particularly, let us use the same method as in 4.2 to discover the upper and lower bounds of the probability $\mathrm{Prob}\{\mathrm{s}_1 \ge \mathrm{t}\}$ with the messages that $(s_1,s_2)\sim(\mathrm{u},\Lambda)$, and Prob $(s_2 > d) \le \ell$, in which

$$\ell \in \begin{cases} 0, \dfrac{\Lambda_{22}}{(\mathrm{d}-u_2)^2+\Lambda_{22}} & \text{and} \quad d \ge u_2, \\ \dfrac{(d-u_2)^2}{(d-u_2)^2+\Lambda_{22}}, 1 & and \quad d \le u_2, \end{cases} \tag{40}$$

First, think about the upper bound question, which is expressed as

$$\max_{(s_1,s_2)\ \sim(\mathrm{u},\Lambda)} \mathrm{Prob}\{\mathrm{s}_1 \ge \mathrm{t}\} \quad \text{s.t.} \quad \mathrm{Prob}\{\mathrm{s}_2 \ge \mathrm{d}\} \le \ell \tag{41}$$

Through writing out the first restrict, it is known that:

$$\min_{L,l_0,l_1,l_3} \{l_0 + l_1^R u + L\cdot(\Lambda + uu^R) + \ell l_3\} \tag{42}$$

$$s.t. \quad l_0 + l_1^R \begin{pmatrix} s_1 \\ s_2 \end{pmatrix} + \begin{pmatrix} s_1 \\ s_2 \end{pmatrix}^R L \begin{pmatrix} s_1 \\ s_2 \end{pmatrix} + l_3 1_{\{s_2>d\}} \ge 1_{\{s_1 \ge t\}},$$

$$l_3 \ge 0.$$

$$\forall (s_1,s_2)\in \Re^2$$

5. Example and Analysis

5.1. Problem Description

In this section, the results of some numerical experiments with two experiments will be shown to demonstrate the effectiveness of the proposed method. The S-type function will be selected to simulate the criminal psychology process, where the criminal wants to maximize his or her robust portfolio value.

To control the criminal actions, a classical Chebyshev type probabilistic constraint is employed for chance constraints for subjective fault. To simplify analysis, the decision matrix of invest and revenue is shown as follow.

Table 1. *The decision matrix of invest and revenue.*

variable	Value1	Value2	Value3	Value4	Value5
u	0.257389	0.338176	0.400419	0.278299	0.237673
	0.188010	0.131507	0.154736	0.157468	0.142284
	0.131507	0.149705	0.147108	0.139625	0.122447
Λ	0.154736	0.147108	0.136378	0.158835	0.132134
	0.157468	0.139525	0.158835	0.217114	0.159792
	0.142284	0.122447	0.134134	0.159792	0.176237

Portfolios for the S-Shaped Value Function

In this section, the following setting will be used to test the performance of the robust portfolio based on the S-shaped value function. In order to avoid the complicated case, $W=\{w\,|\,e^R w=1\}$ is considered. Assuming Φ is normally distributed with mean and covariance matrix (μ,Λ), and introducing the notations $s=w^R\mu-d, t=\sqrt{w^R\Lambda w}$, it is known that $G[b(\Phi^R w-d)] = G_{T\sim N(0,1)}[b(\mathrm{t}T+s)]$.

When Φ is a normal distribution, the nonrobust optimal portfolio is

$$w_{NR} \in \{w\,|\,w^R u = d + s^*, w^R\Lambda w = (t^*)^2, w^R e = 1\}$$

where the pair (s^*, t^*) is the optimal solution to

$$\max_{s,\mathrm{t}} G_{\chi\sim N(0,1)}[b(tT+s)]$$

$$s.t. \quad \mathrm{t} \ge \sqrt{j_0(s+d)^2 - 2j_1(s+d) + j_2},$$

5.2. Result Analysis

Figure 2 showed the probability of subjective fault in criminal process, where all the revenue functions are S-shaped portfolio for different criminal decision makers. And the avg curve is specified in the percentage of different subjective fault.

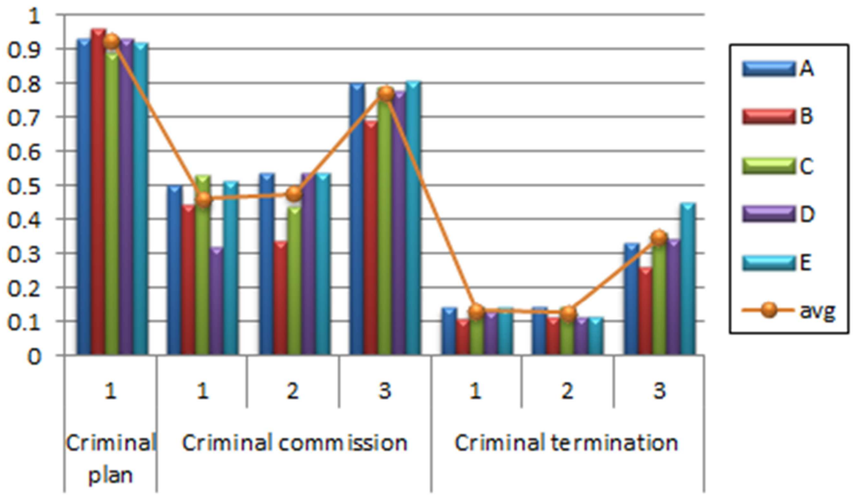

Figure 2. *Subjective fault in criminal process.*

In this chart, the Blue A is the result of proposed model, and the outcomes of the references [1], [6], [7] and [21], is shown by the B, C, D, E in figure 2. In comparison, it is clear that our result is with the better investment strategy because others always have more risks.

Basically, in criminal plan, it is very easy to get very high subjective fault. It also provides a method to solve the maximization problem of criminal revenue to get the optimal s* and t*, and then solve the equations $w^R e = 1$, $w^R \Lambda w = (t^*)^2$, $w^R u = d + s^*$ to get an optimal portfolio w*.

The calculation of non robust and robust optimal portfolio model for each of the parameters $(\partial, \ell, \chi, d)$ are also provided and the simulation run more than 10 times to ensure the stability of the simulation results, each simulation will generate 10^5 of the implementation of the standard logarithmic normal random vector. The criminal revenue in different stages are shown in Figure 3.

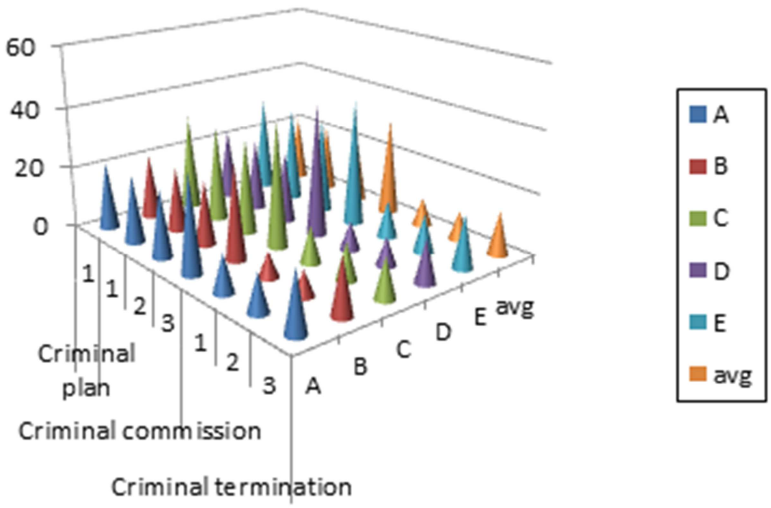

Figure 3. *Criminal revenue in different stages.*

After evaluation of the S-shaped function value and then according to non robust and robust investment portfolio. The revenue of different portfolio performance for non robust is shown by the statistical mean and standard deviation statistics for these S-shaped functions in figure 3. And the simulated value listed the maximization revenue takes place at the stage of criminal commission. The simulation results are in a logarithmic distribution with the actual situation, while the actual distribution of the results should be normal distribution. In this chart, A represents the proposed outcome, B, C, D, E are the results of the references [1], [6], [7] and [21].

Carefully observed from Figure 2, our result is more similar to the avg, hence, in Figure 3, our result of experiment is better than other. It may help us control criminal opportunity in practice.

Furthermore, to control criminal, it is possible to increase chance cost and chance constraints. The probability value of different chance cost is different. The chance constraints and criminal possibility in the stage of criminal plan is shown Figure 4.

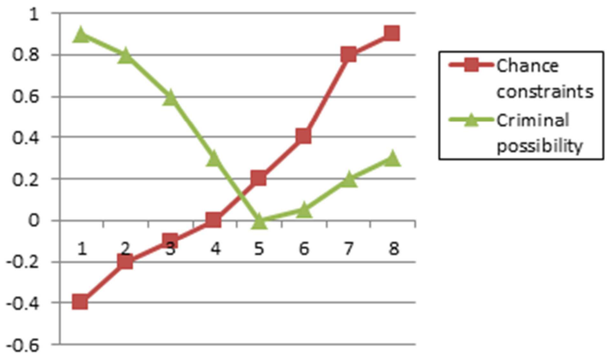

Figure 4. *The chance constraints and criminal possibility.*

From the figure, it is simple to know that at the stage of criminal plan, the chance constraints can help us control criminal from the view point of subjective fault. The curve of the criminal possibility is reverse relation with the chance constraints totally, but very high chance cost may not help us as more as expecting. Similarly, the standard deviation of more than 50% of the robust and non robust model values in different criminal stages can conform to different rules respectively. The result of reference [21] is similar to our outcome, in other words, it shows our result's correctness. The chance constraints and criminal possibility at the stage of criminal commissions are shown in Figure 5.

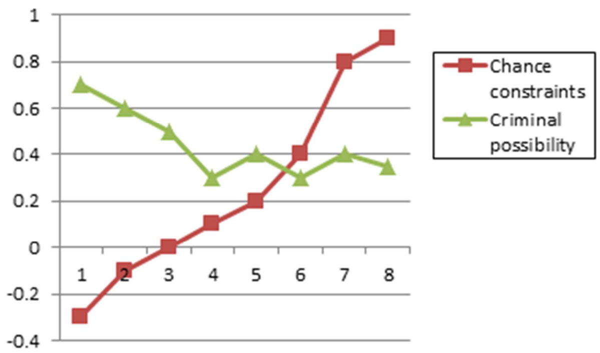

Figure 5. *The chance constraints and criminal possibility.*

From it, it is easy to know that the effect of chance constraints plays less important role at the stage of criminal commission. If the actual distribution obeys the log normal distribution, the results show the non robust model to generate the expected value of criminal. However, if the distribution is actually normal, then the criminal control model performs less optimal effect. Although the robust solutions still have over a 30% chance to beat the non-controlled ones, it is obvious from the whole stage that the criminal possibility value is close to 30% greater than initial value. Through this figure, the outcome of reference [22] is analogous to the result of our experiment, it also proved the accuracy of our result.

The mean and variance of the criminal revenue are

$$u = [74.24683 \ \ 48.19062]$$

$$\Lambda_1 = 47.17665, \ \Lambda_2 = 73.96162.$$

It is chosen

$$d = 0.6 \cdot u(2);$$

$$\ell = \min\{1.2 \cdot \frac{(d - u(2)^2)}{\Lambda_2 + (d - u(2)^2)}, 1\}$$

The most revenue takes place at the stage of criminal plan and criminal commission, especially the latter. The correlation between mean and variance of the subjective fault has a different degree, and the range of choice differs from that of the boundaries. Figure 4 and 5 show the effects of chance constraints in the criminal control are different. In legal practice, it is more important to implement criminal control at the stage of criminal plan with significant improvement and better effect.

Similarly, the chance constraints and criminal possibility at stage of criminal termination are shown in Figure 6.

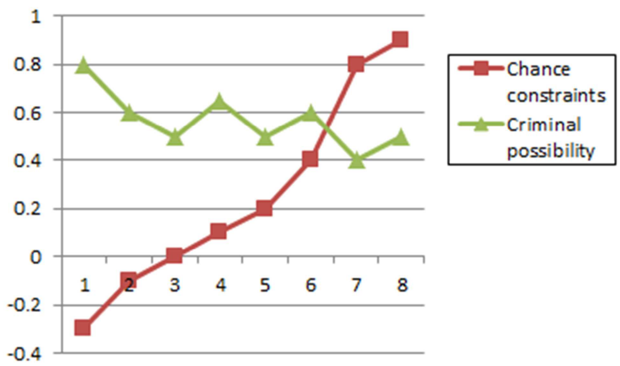

Figure 6. *The chance constraints and criminal possibility.*

Apparently, the chance constraints at the stage of criminal termination play the lest effect among the all three stages. At this stage, it is very difficult to ask the criminal abandon all he has done because too many criminal revenue involved. Using the same parameters as in Figure 2, the extended Chebyshev probability of upper and lower bounds is also compared. From the numerical results of different criminal stages, if the criminal possibility is between high levels either positive or negative, it is very significant to improve the chance constraints, as shown in figure 4-6. The result of reference [21] and reference [22] are similar to our outcome, on the other hand, at stage of criminal termination, the chance constraints can also help us control criminal from the view point of subjective fault.

On the whole, according to the criminal psychology, the upper and lower bounds of Chebyshev will change at different criminal stages, and the horizontal line on the Chebyshev is a benchmark for criminal termination.

6. Conclusions

Some practical suggestions are made here. Criminal psychology as a study of criminal behavior and criminal motives plays an important role in real life. However, in practical applications, it is still necessary to pay attention to the following aspects, so that the direction of this research can be better applied.

(a) Criminal psychology, as an important factor in the control of criminal behavior, not only dominated one criminal act. Therefore, it is needed to accurately analyze the diversity and level of criminal behavior. First, in a criminal psychological domination of the implementation of a crime, the implementation of the crime should be under the control of the motive of corruption. Second, actualizing manifold criminal actions under the domination of a criminal psychology include the implementation of stealing, robbery, fraud and other acts under the control of the motive of corruption. Because criminal psychology plays different roles in different crime, it is important to analyze the different effect of criminal psychology in different criminal stages.

(b) Under normal circumstances, criminal psychology and criminal behavior can be in a consistency, But under the influence of subjective factors, sometimes there will be inconsistencies between the two situations, for example, first, the results of criminal motives and criminal behavior are inconsistent and the indirect intentional crime in Criminal Law is a kind of situation. Second, the offender has no criminal motive, but under the coercion of others, a man may carry out criminal behavior. Based on these considerations, in the practical application of criminal psychology, more exploration should be done.

In this article, investment portfolio is introduced for criminal psychology analysis and criminal control. The subjective fault at different criminal stages is analyzed and modeled as mathematics functions, while the criminal control is also modeled as optimal strategy with chance constraints. A set of numerical experiments and results show that the proposed method is effective. In the near future, the proposed portfolio will be used for criminal psychology analysis and revenue maximization, and the classical Chebyshev -type probability constraints can be used for criminal control. Future work should be focused more on different correlation coefficients, and different probability constraints. Furthermore, putting this quantified tool into practice is also very important.

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