Research on Application of Power System Reliability Model Based on Principal-agent Mechanism

Shaomei Yang
Economics and Management Department, North China Electric Power University, Baoding City, China
Email: yangshaomei77@126.com

Qian Zhu
Department of Economic and Trade, Hebei Finance University, Baoding City, China
Email address:year1212@126.com

Zhibin Liu
Economics and Management Department, North China Electric Power University, Baoding City, China
Email: liuzhibin771112@126.com

***Abstract*—Power system reliability has been a widespread concern. With the continuous development of the electricity market, there has been a serious conflict, which between social obligations and necessary requirement. The so-called social obligation is that the power industry must ensure the power system operation reliability; the so-called necessary requirement is that the power industry must solve the power market operation economics. The power system operation reliability is serious challenge, so we must establish a new mechanism adapting to the electricity market, and ensure the power system operation reliability. In this paper, we have researched the model and method based on the principal-agent mechanism from three aspects, which are the reliability principal-agent model starting point, principal-agent model analysis and design, and information transparency level impact analysis. On this basis, we proposed the reliability management model based on the principal-agent mechanism, and carried out example analysis. The example analysis shows that through establishing the principal-agent relationship between power enterprises and the user, the entire power system reliability resources would be more efficient configuration to further enhance the entire society electricity reliability benefits. Further evidence that the principal-agent mechanism is scientific and applicability in the power system reliability study.**

***Index Terms*—power systems, reliability models, principal-agent model, users, electric power enterprises**

I. INTHRODUCTION

The traditional analysis idea of power system reliability is that from the power system integrity and physical point of view, use power system physical characteristics and reliability mathematical theory, evaluate the reliability index of the power system as a whole or partial using artificial intelligence and neural networks, and other tools. The economic indicators haven been balanced in the whole system, but only as an important factor or means in the system reliability analysis, the economy in the traditional reliability analysis tools, as well as the ignored users have become the major role in electricity market, Thus, the traditional reliability management system must be reformed.

In the traditional power system analysis, researchers have been put forward the concepts of power system reliability evaluation including electricity generation, electricity transmission and electricity consumption, established the methods of the joint power system reliability evaluation including large-scale electricity generation, electricity transmission and electricity consumption. But in the electricity market, the complexity of the problem is far more than that. In a mature power market conditions, the user will be free to choose electricity providers, to determine the generation and consumption patterns by the bilateral trade, so there may be very different between the system trends and expected trends, and thus the new operational issues will appear, for example, transmission congestion and so on. In this way, the reliability of power plants, power companies and electricity customers will be interaction and coordination, the integrated treatment of these issues will be new problems of power system study under market environment.

The users have more and more demanding of electricity service reliability. In the market environment, the power companies use still the traditional vertical management system approach in the maintenance of electric reliability; ignore the different needs of the reliability among the different users, hurt the users power interests, which is contrary to the purposes of market reform. In this paper, we put forward the principal-agent model of improving the resources reliability allocation in

doi:10.4304/jsw.7.2.339-345

the deregulated market environment; hope to provide a new approach and ideas to resolve electric reliability issues in the market-oriented reforms.

A The essential characteristic analysis of electric reliability service

Electric Reliability Services, in essence, is a form of public goods with significant non-exclusive and non-competitive.

Non-exclusive, that is, the service has a certain area effect, if a user applies to improve electricity reliability; you can not rule out the other users of the electrical links in the region get the corresponding reliability benefits, while they don't directly pay for it, which will result in a "free rider" phenomenon, then weaken the initiative of the multi-user putting forward reliability demands.

Non-competitive, that is, the service is part of electric power universal service areas; any user enjoys a certain degree of reliability service, which does not affect the possibilities of other users enjoying the service. However, the reliability services are not privatized because of the non-competitive, not achieve the complete supply by the free market, which are the reasons of the traditional electric power system introducing control.

B The information non-symmetric problem of the reliability services

Asymmetric information is the information which some people own, but other people don't own. The electricity companies (generation companies, transmission and distribution companies) and various types of users are two participants of Electric Reliability service. On the one hand, the power enterprises information superiority is reflected in understanding very well the system running condition, having the ability to control system and the decision-making power of reliability resource allocation in the reliability of service; while the information weakness is reflected in poorly understood about the users' reliability demand. On the other hand, the users understand very well their own power efficiency and reliability demand, but they are in information weakness of the system running state and the reliability resources allocation.

Therefore, at the present, in the field of electric power reliability management, because of information problems, some questions are still outstanding. The users have different needs to the reliability levels, but can not be met through effective channels; the power enterprises reliability resources allocation under the control of the relevant government departments "command-style" indicators, which often does not match the user's actual demand, lack of an effective incentive, so then result in mind-sets and irrational allocation.

II. THE PRINCIPAL-AGENT MODEL OF RELIABILITY

A The starting point of reliability principal-agent model

The information asymmetry leads to the principal-agent problem. Traditional power system reliability management is in fact a special kind of principal-agent relationship, which the entrusting party is the government, and agency party is the power company. The reliability resources is seen as a fair product, the government delegates user interests and compels the power enterprise to execute a class reliability level, all the load point users provide subsidy for power companies through paying for reliability electric power price. As information asymmetry and institutional issues, the users' reliability demands are not reliable reflection, then the electric power enterprise reliability resource allocation has blindness and low efficiency.

Principal-agent model highlights the status of the user, the ideas are as follows: The Government retreats to act as "hidden" commission side, while the user act as the "dominant" commission side instead of the government, who negotiate with power companies for their reliability efficiency. "Hidden" commission side entrust power companies to maintain the existing reliability standards remaining unchanged, "dominant" commission side make their own reliability requirements to the power companies based on "hidden" commission control indicator. While the uses design the incentive contract, not only to maintain the current reliability level and must also encourage power companies to maximize the reliability level space as far as possible. Electric power enterprise can decide whether to accept the contract based on actual conditions, and decide the actions to maximize their own interests according as the acceptable basis. The essence of the model is: For the reliability resources, based on without changing the existing "public" matching, think over the user's different needs as far as possible, achieve a certain degree of "individuation" to guide the reliability resources' diversity management, and tap fully the allocation efficiency to enhance the electricity effectiveness of various types of users.

B Analysis and Design of Principal-agent Model

The previous analysis obtained: In the traditional system, the load point's reliability resources allocation has low efficiency more often than not and exists the space of increasing allocation, which owing to the lack of user involvement. In the electricity market, the principal-agent relationship creation is the complement and improvement for the traditional agency relationship, which enhances the reliability resources allocation further and complies with the direction of electricity reform based on highlighting the user participation. In present reliability level, the users sign a contract with the power companies to meet their own furthest reliability needs through designing the incentive contracts.

Suppose the control reliability level of a load points is λ_0, the principal-agent relationship is built on the existing λ_0, and its commissioning party is the user, the proxy party is still power enterprise. Suppose λ_a is the reliability indicator which the proxy party can improve, its significance rests with the further increasing reliability index value far beyond current level λ_a (unit: h). Then the output function (the reliability electricity-effective increments) as follows:

$$\pi = (\lambda_a + \theta) \cdot V \tag{1}$$

Where: V is the user's average power efficiency in the unit of time; θ is a normal random variable, which the mean value is zero and variance equal is δ^2, representing the exogenous uncertain factors, such as weather and other natural accidents factors, the factors that may cause the effort level deviation of the agents side improving the reliability, when expressed as positive or negative bias. This function is met: $E\left[(\lambda_a+\theta)\cdot V\right]=\lambda_a V$, $Var(\pi)=\delta^2\cdot V^2$, that the power plants effort level determine the output mean value, but does not affect the output variance.

Assume that the commissioning party is risk neutral; the agent party is risk averse. Consider the user's contract is a linear incentive contract:

$$s(\pi)=\alpha+\beta\cdot\pi \tag{2}$$

Where: α is the fixed income which the commission party paid to agent party, $\alpha \geq 0$; β is the share or risk-taking factor which the agent party share power consumption efficiency augmenter, $0 \leq \beta \leq 1$. Since the commissioning party is risk neutral, for a given $s(\pi)$, the commission party expected utility is equal to expected income:

$$E\{v[\pi-s(\pi)]\}=E(\lambda_\alpha V+\theta V-\alpha-\beta\lambda_\alpha V-\beta\theta V) \\ =-\alpha+\lambda_\alpha V-\beta\lambda_\alpha V$$

(3)

According to the power grid actual situation, along with the advancement of reliability level, the power companies transit the risk attitude to reliability from risk-neutral to risk aversion, were as follows: The reliability level maintain higher, the impact proportion of the uncertainties is greater, the degree of difficulty is greater, the more power companies are not willing to strive to improve. It is assumed that the agent's party utility function has the same absolute risk aversion characteristics, that is, $u=-e^{-\rho\omega}$, where ρ is the absolute risk aversion measure, ω is the real money income. Assumed that the agent side efforts cost can be equivalent to the money cost, the cost function is simplified as

$$c(\lambda_a)=b_0\lambda_a^2/2 \tag{4}$$

Where: cost factor $b_0=b_0(\lambda_0)$ has some connection with the existing control reliability level, meet:

$$\partial b_0/\partial\lambda_0>0,\quad \partial^2 b_0/\partial\lambda_0^2>0$$

That the existing reliability level is higher, the cost of improving the same magnitude reliability indicators is larger. So, the real income of electric power enterprises is:

$$\omega=s(\pi)-c(\lambda_a)=\alpha+\beta\cdot V(\lambda_a+\theta)-b_0\lambda_a^2/2 \tag{5}$$

Then the certainty equivalent income is equal to the difference between the random income mean value and the risk cost caused by θ.

$$\omega=s(\pi)-c(\lambda_a)=\alpha+\beta\cdot V(\lambda_a+\theta)-b_0\lambda_a^2/2 \tag{6}$$

Where: $E(\omega)$ is the expected revenue of the agency side; $\rho\beta^2\delta^2V^2/2$ is the agency's risk cost; the agency side maximized expected utility function $E(\omega)=-E(e^{-\rho\omega})$ is equivalent to maximizing equation (6).

As the traditional system, the electric power enterprises is non-profit in nature in the reliability maintenance, that is, the income of maintaining control reliability level is zero, which the retained income level of the electric power enterprises maintaining reliability can be considered zero, then the agent-side participation constraint (IR) expressed as:

$$\alpha+\beta V\lambda_a-b_0\lambda_a^2/2-\rho\beta^2\delta^2V^2/2\geq 0 \tag{7}$$

Incentive constraint (IC) expressed as the agent party choose the optimal effort level in order to maximize the certainty equivalent revenue: $\lambda_a=\beta V/b_0$, Thus, the problem of the commissioning party is to choose (α,β,V) and then solve the following optimization problem based on the principal-agent relationship

$$\begin{cases} ....\max\{-\alpha+\lambda_\alpha-\beta\lambda_\alpha V\} \\ s.t...(IR):\alpha+\beta\lambda_\alpha V-b_0\lambda_\alpha^2/2-\rho\beta^2\delta^2V^2/2\geq 0 \\ ....(IC):\lambda_\alpha=\beta V/b_0 \end{cases} \tag{8}$$

Where: α, β is the commissioning party's decision-making variable; V is the decision-making parameters of the commissioning party's own power characteristics; λ_a is the agency's decision-making variables after the commissioning party's decision variable decided.

C The Influence Analysis of the information transparency degree

1) The information symmetry state analysis between the users and power enterprises

At this point, incentive constraint (IC) does not work, any level λ_a can be achieved through the mandatory contract of meeting the participation constraint (IR). Since in the optimal circumstances, the equation of the participation constraint set up (the user does not need to pay for more power enterprises), substitute the participation constraint into the user's objective function by the fixed item α, then the above optimization problem re-expressed as, $\max\{\lambda_a V-\rho\beta^2\delta^2V^2/2-b_0\lambda_a^2/2\}$, according to the most optimized first-order conditions solved, can be obtained $\begin{cases}\lambda_a^*=V/b_0 \\ \beta^*=0\end{cases}$, and substituted into the participation constraint was: $\alpha^*=V^2/2b_0$, this is the Pareto optimal contract. As the two parties are symmetrical in reliability maintaining information, the user can observe clearly the practical efforts condition of power enterprises; and also because the user is risk neutral, the power companies are risk averse, Pareto optimal risk-sharing require the power companies not bear any risk($\beta^* = 0$),the fixed income which the user paid to the power company is just equal to the sum of the power companies' retain income level (that is zero) and the effort cost; and that the optimal reliability level magnitude λ_a^* which the load point can improve meet: The marginal revenue V of the effort level is equal to the marginal cost of effort level $\lambda_a^* b_0$.

In this case, the power companies will make the optimal decision-making according to the load point's actual reliability efficiency and reliability maintenance costs, the improved level of reliability index depending on power efficiency V in the unit time which the user declare and cost factor b_0 .The users pay for the reliability maintenance costs to electric power enterprises, and fully responsible for the risk-adjusted returns.

2) The information asymmetric state analysis between the users and power enterprises

When the state is information asymmetry between the users and power enterprises in reliability maintaining, if the users contract with the electricity companies by using the previous mode, the power companies will be taken to maximize their own certainty equivalent income $\lambda_a^* = V / b_0 = 0$, the income and output are irrelevant in electric power enterprises, which leading to the power enterprises' inaction, thereby the user's power reliability effectiveness depends entirely on "luck". Therefore, when the user can not know the electric power enterprises reliability maintenance conduct or the supervise costs excessive, the new contract parameters must be designed to achieve commissioning party maximum benefits.

Now re-consider the principal-agent model as shown in the equation (7), at this time incentive constraint (IC) play a role, substitute the participation constraint (IR) and incentive constraint (IC) into the objective function, then the optimization problem can be re-expressed as

$$\max \left\{ \beta V^2 / b_0 - \beta^2 V^2 / 2b_0 - \rho \beta^2 \delta^2 / 2 \right\} \tag{9}$$

Obtained:

$$\beta = 1 / (1 + \rho \delta^2 b_0) \tag{10}$$

Type (10) implies that the power companies must take some risks, which income and output is related. At the same time, we can see, β is the decreasing function of ρ , δ^2 and b_0, that is, power enterprises are the more risk-averse, the output variance is greater, the more unwilling to increase the reliability level, the risk which should shoulder is smaller. The type (10) substituted into the incentive constraint (IC) were:

$$\lambda_a = V / (b_0 + \rho \delta^2 b_0^2) \tag{11}$$

Type (11) is the partial derivative, obtained:

$$\frac{\partial \lambda_a}{\partial \lambda_0} = \frac{-V(1 + 2\rho \delta^2 b_0)}{(b_0 + \rho \delta^2 b_0^2)^2} \cdot \frac{\partial b_0}{\partial \lambda_0} < 0 \tag{12}$$

We can get three conclusions from Type (11) and type (12): first of all, the reliability control level λ_0 of the user load point is higher, the cost b_0 which the reliability indicators raise again is greater, and the power companies' effort level is smaller; secondly, when the users' electricity reliability efficiency V improve, the effort space of the power plants will increase, then the users' electricity reliability can be enhanced again; thirdly, if the natural environment of the load point is more severe (δ^2 is larger), the more power enterprises do not work hard to improve the reliability level.

Needs to be noted is that when the power companies have ample financial resources, we can assume that the power company is risk neutral (ρ = 0), which is no longer sensitive to external uncertainties, then the point β = 1, $\lambda_a = V / b_0$, the power company is the only residual claimants persons, raising or lowering the electric reliability benefits all belong to the power enterprises on the foundation of λ_0 ,then the effort level is equal to the Pareto optimal level $\lambda_a^* = V / b_0$.

To sum up, the key question which the users and the power enterprises establish a principal-agent relationship is how to design an effective incentive contracts, in particular, how to set risk-taking coefficient. The coefficient depends on the exchange condition of both sides' reliability information and the uncertainty β impacting the reliability. At the same time, the average power efficiency of the user per unit time and the existing reliability level will also affect the agency's reliability resource allocation behavior.

III. Example Analysis of Principal-Agent Contract

For two different types of load points A and B, explore the reliability incentive contract design problems in different circumstances. Among them, the load point A is a single heavy user; the load point B is the number of business users, the business users commissioned the electricity supplier (virtual commissioning party) of the point to sign a contract with the electricity companies, and assuming that all users are risk-neutral person. Assume that the load point basic information is known: including the control reliability level λ_0 (annual number of hours for electricity), the average electricity consumption effectiveness per hour V which the users return and cost function $c(\lambda_a) = b_0 \lambda_a^2 / 2$ (the power companies disclose the information to the user, subject to supervision). At the same time assuming the exogenous variable θ obey a normal distribution $N(0, \delta^2)$, the utility function of the power company is $u = -e^{-\rho \omega}$, the coefficient set as shown in Table I.

TABLE I. BASIC INFORMATION OF THE VARIOUS LOAD POINTS

The load point	Load point feature	Reliability Control level λ_0 (h/ year)
A	Single User	8758
B	Multi-user	8750

CONTINUED TABLE

The load point	Power Efficiency V (Million /h)	Uncertainty distribution θ
A	10	$N(0,0.5)$
B	5	$N(0,4)$

When information is symmetric, because users can see clearly the power enterprises effort level, while the reliability maintenance cost is known, the user can ask the power companies to maintain the optimal reliability level and pay directly the maintenance costs based on their own power effectiveness condition. The optimal incentive contract of load points A and B, as shown in Table II, the computing ideas refer to type (2), type (8) and type (9).

TABLE II. INCENTIVE CONTRACT IN INFORMATION SYMMETRY CONDITION

The load point	The optimal effort level λ_a (h)	Risk factor β
A	1	0
B	2	0

CONTINUED TABLE

The load point	Fixed Income α (Million)	Incentive contract $S(\lambda_a,\theta)$ (Million)
A	5	5
B	5	5

When the information asymmetry, the user can not observe the actual effort level of power enterprises, which requires power companies and users share the output results, share a certain degree of risk, under power enterprises' different risk attitude circumstances, the users set the value of parameters α, β, V according to type (1), type (2) and type (10), and then design the optimal incentive contract. Among them, the power company's fixed income is determined mainly by negotiations between the user and the power companies based on type (7) and the participation constraint (IR), at the same time, according to many contractual relationships' establishment and information gradual announcement, the fixed income will tend to reflect truly the actual cost of power enterprises. In the incentive contract between the user and the power companies, λ_a and θ are unknown, and that the power companies' payment is decided by the two unknown quantity. The incentive contract and the parameters, which the user-signed, as shown in Table III.

TABLE III. INCENTIVE CONTRACT IN INFORMATION ASYMMETRY CONDITION

The load point	The risk attitude of electricity sector ρ / Million	Risk factor β
A	Neutral $\rho=0$	1
	Aversion $\rho=0.2$	0.5
B	Neutral $\rho=0$	1
	Aversion $\rho=0.2$	0.33

CONTINUED TABLE

The load point	Fixed Income α (Million)	Incentive contract $S(\lambda_a,\theta)$ (Million)
A	0	$10(\lambda_a+\theta)$
	1.25	$1.25+5(\lambda_a+\theta)$
B	0	$5(\lambda_a+\theta)$
	1	$1+1.65(\lambda_a+\theta)$

When the contract is near the end of the period, on the existing regulatory reliability level, the reliability index increment is the sum of effort level and bias which caused by uncertainty. To illustrate the effects which the different reliability indicators incremental to different incentive contract, and the bilateral actual earnings, without loss of generality, we have been classified in discussion for the load point A (Electric Power Enterprise risk attitude $\rho = 0.2$), as shown in Table IV, the calculate thinking refer to type (3), type (4) and type (5).

TABLE IV. THE BILATERAL RELIABILITY EARNINGS OF THE LOAD POINT A UNDER DIFFERENT CIRCUMSTANCES

Information Case	Changes in the reliability level $(\lambda_a+\theta)$/hour	The cost payment of electricity sector / Million
Symmetry	(1+0.2)=1.2	5
	(1-0.2)=0.8	5
Asymmetry	(0.5+0.2)=0.7	1.25
	(0.5-0.2)=0.3	1.25
	(0.4+0.2)=0.6	0.8
	(0.6+0.2)=0.8	1.8

CONTINUED TABLE

Information Case	The actual earnings of electricity sector / Million	The actual earnings of users / Million
Symmetry	0	7
	0	3
Asymmetry	3.5	2.25
	1.5	0.25
	3.45	1.75
	3.45	2.75

Table IV shows: in the case of the reliability information symmetric, the user fully responsible for the risks, the actual electricity revenues depend on" luck"(θ) good or bad; and power companies avoid the risk entirely, the actual return is 0. In the case of reliability information asymmetric, the reliability index increments of the load point A reducing, thus the user's actual reliability returns have been reduced. Because electric power enterprises shared a certain amount of output results, "luck" is good or bad, which also affects the real return of the for power enterprises, while we can see from Table IV, when θ is constant (θ = 0.2), the optimal effort level of the electric power enterprises reliability income λ_a = 0.5h, the reason is that power companies aim at the actual situation of the load point, such as risk factor β ,cost factor b_0 and the average power efficiency V.

An example analysis shows that through establishing the principal-agent relationship between power enterprises and the user, the entire power system reliability resources would be more efficient configuration to further enhance the entire society electricity reliability benefits.

IV. Conclusion

Principal-agent theory is based on asymmetric information game theory. Asymmetric information refers to the information, which certain participants possess, but others do not possess. As the principal-agent relationships prevalent in society, the principal-agent theory can be used to solve various problems. Such as in the state-owned enterprises, state and state-owned enterprise managers, state-owned enterprise managers and employees, state-owned enterprise owners and certified public accountants, shareholders and managers, voters and government officials, doctors and patients, the creditor and the debtor, which are the principal-agent relationship. In this paper, we have researched the model and method based on the principal-agent mechanism from three aspects, which are the reliability principal-agent model starting point, principal-agent model analysis and design, and information transparency level impact analysis. On this basis, we proposed the reliability management model based on the principal-agent mechanism, and carried out example analysis. In this paper we demonstrated again the scientific nature and applicability of principal-agent model, and provided a new approach and ideas for the study of the power systems reliability, which can serve as the means and basis of guaranteeing power system reliability under the power market conditions.

Acknowledgment

This work is supported by the 2010 projects of Social Scientific Research Foundation of Hebei Province Office of Education under Grant No. SZ2010504.

This research was supported by “the Fundamental Research Funds for the Central Universities”.

This research was supported by the Philosophy and Social Science Research Topics of Baoding City. The item No. is 200902035.

References

[1] Chongqing Kang, Weiming Lin. Research on Framework of power system reliability analysis in Electricity market environment [J]. Shanxi Electric Power, 2007, 35(4):1-7.
[2] Changsheng Huang. The principal-agent problems and countermeasures in the public goods supply marketing [D]. Chongqing: School of Economics and Business Administration, Chongqing University, 2005.
[3] Billinton R. Composite system reliability evaluation. IEEE, 1968, PAS88: 276-281
[4] Fotuhi-Firuzabad H, Billinton R, Faried S. Incorporting a DC link in composite system reliability evaluation. IEEE Power Engineering Society Winter Meeting, 2000, 3: 1760-1765.
[5] Kariuki K, Allan R. Evaluation of reliability worth and value of lost load. IEEE proceedings on Generation, Transmission and Distribution, 1996, 143(2): 171-180.
[6] Okada K, Asano H, Yokoyama R. Reliability based impact analysis of independent power producers for power system operations under deregulation. IEEE Canadian Conference on Electrical and Computer Engineering.Edmonton, Canada: 1991，3:1325 一 1330.
[7] Yu Zuwei，Nderitu G,Smardo F. A proposed LOSBE as a generation reliability index for deregulated electricity markets. IEEE Power Engineering Society Winter Meeting. Ohio, America: 2000, 3:1820-1824.
[8] R.Billintion, W.Zhang. Cost Related Reliability Evaluation of Bulk Power Systems[J]. International of Electrical Power and Energy Systems, 2001, 23(2): 99~112.
[9] Yongji Guo. Reliability theory and applications in Power system [M]. Beijing: Qinghua University Press, 1986.
[10] Jing Zhao. Research on Reliability theory in Power system[D]. Beijing: Qinghua University Press, 2004, 12.
[11] Jincheng Shang, Yonghao Huang, Qing Xia. The theory research and application of Power system [M]. China Electric Power Publishing House, 2002.
[12] Lunnong Tan, Baohui Zhang, Haitao Liu. The security reliability problem of Power system in the Market environment [J]. Power system automation, 2002.26 (6): 1-14.
[13] Jing Zhao, Chongqing Kang, Qing Xia. The Research Status and Development Prospects of the reliability problem in the Market environment [J]. Power system automation, 2004，28 (5):6-10.
[14] Guofu Chen. The Principal - agent and Incentive Design: feature cutting-edge of motivation theory [M]. Tianjin: Nankai University Press, 2003.

Shaomei Yang, was born in Handan City, China, and graduated from the agricultural university of Hebei in 2003, gained the master's degree of management. The author’s major field of study is the business management.

Since 2003, she is always working at the North China Electric Power University, Baoding City, China. And she has published more than 20 papers and 2 books. Such as the Electric Power Enterprise Management (Beijing: Chinese Electric Power Publishing Company).

Qian Zhu, was born in Baoding City, China, and graduated from the North China Electric Power University in 2011, gained the master's degree of management. The author's major field of study is the Management Information System and E-commerce.

Since 2004, he is always working at the Hebei Finance University, Baoding City, China. And she has published more than 10 papers and 2 books.

Zhibin Liu, was born in Luannan County, China, and graduated from the agricultural university of Hebei in 2004, gained the master's degree of management. The author's major field of study is the information management.

Since 2004, he is always working at the North China Electric Power University, Baoding City, China. And he has published more than 40 papers and 3 books. Such as the Research on the Advancing Front Topic of Asset Valuation (Beijing: Chinese Finance and Economical Publishing Company).