Analysis of Regional Differences in Livelihood Assets of Farmland Rental Households Using Monte Carlo Simulation

Heyuan You
College of Business Administration, Zhejiang University of Finance and Economics, Hangzhou, China
Email: youheyuan@gmail.com

***Abstract*—Given the uncertain future living of peasant households when they rent out farmland, the situation of livelihood assets is important for keeping sustainable livelihood. In this paper, the livelihood assets indicators were selected based on DFID's sustainable livelihoods framework, and Monte Carlo method was adopted to establish the assessment model. The empirical study of peasant households surveyed in three provinces of China was done. Results showed that the peasant households who rent out farmland were different in possession of the livelihood assets. The peasant households in Zhejiang had a greater probability to possess more livelihood assets than those in Guizhou and Shandong. The peasant households in Shandong had the smaller probability to possess more livelihood assets than those in Guizhou. I argue that the diversiform livelihood strategies should be created considering the features of livelihood assets.**

***Index Terms*—livelihood assets, farmland rental household, Monte Carlo simulation, China**

I. INTRODUCTION

The peasant households can't sale farmland in China since the public ownership of farmland [1]. The peasant households own the farmland use right named land contract management right under the household responsibility system [2], and they are entitled to rent out farmland use right which belongs to the peasant households. The primary purpose of the peasant household who rent out farmland is to migrate to non-agricultural sectors, and improve the standard of living since the farmland fragmentation in China that affects households' income [3, 4, 5]. Traditionally, when peasant households transfer farmland, the future living of peasant households is uncertain, and some peasant households are vulnerable to risk [6]. The decisions of different peasant households about their farmland base on the livelihood assets which embody the resources available to the peasant households. And the livelihood assets play an important role in determining the living gained by the peasant household [7, 8, 9]. In order to recognize the relationship between the livelihood assets and future living of peasant households, and use a sustainable livelihoods approach to seek livelihood strategies for the farmland rental households, the features of livelihood assets should be analyzed. In China the local situations in different regions which affect the peasant households' living and decisions are diversiform. Therefore, the regional differences in livelihood assets which are related with the local situations are existed [10, 11]. Yet the regional differences in livelihood assets of farmland rental households in China are not well understood. In this paper, I attempt to evaluate the regional differences in livelihood assets of peasant household whose data is drawn from a survey of peasant households in three provinces of China.

The Monte Carlo simulation is a method that relies on repeatedly drawing random variables to obtain numerical results [12, 13], and it is widely used to optimize and get a random sample from a probability distribution [14, 15]. The transformation in livelihood assets of a peasant household which is induced by renting farmland is uncertain, however, there are many peasant households whose stocks of livelihood assets can be obtained. Thus in this paper, the distributions of various livelihood capitals are estimated by Monte Carlo method from survey data of peasant households. It is suitable us for using the Monte Carlo simulation to explicitly simulate uncertainties of livelihood assets in one region.

The rest of this paper proceeds as follows: Section 2 describes a survey of peasant households in three provinces in China; Section 3 establishes the model for assessing the situation of livelihood assets based on DFID's sustainable livelihoods framework and Monte Carlo method; Section 4 shows probability distributions of livelihood capitals and the results of simulation; Section 5 summarizes the discussion and conclusion.

II. DATA

The data used for this study came from a survey of 606 peasant households in different regions included Guizhou province, Zhejiang province and Shandong province in China between July–October, 2011. West China's Guizhou which is a relatively economically undeveloped province is a mountainous province, but East China's

Manuscript received June 19, 2013; revised June 30, 2013.
Project number: 13YJC630208, 13NDJC040YB.
Corresponding author: Heyuan You.

doi:10.4304/jcp.9.2.353-359

Zhejiang which also consists mostly of hills is an economically developed province. East China's Shandong whose terrain is mostly flat is pooper in west region which adjoins Henan province, and is richer in east region which locates along a coast. These three provinces were selected as an empirical study area since they exhibit various features of farmland and peasant households in China. The peasant household survey was run in five counties which were composed of Kaiyang and Baiyun in Guizhou, Cangnan and Xiaoshan in Zhejiang, Mudan in Shandong. The number of countries selected in Shandong was different from others since low economic development level of Heze city which administers Mudan. The location of survey areas was showed in Figure 1. The survey targeted peasant households who rent out their farmland, and the choice of villages in which many peasant households rent out farmland in countries was aided by local bureau of land and resources. Questionnaires are also sharply limited by the fact that respondents must be able to read the questions and respond to them. The peasant households who respond to questions in questionnaires reasonably compose the sample. The sample is consisted of 111 peasant households drawn from 12 villages situated in Kaiyang, 90 peasant households drawn from 10 villages situated in Baiyun, 108 peasant households drawn from 12 villages situated in Cangnan, 94 peasant households drawn from 10 villages situated in Xiaoshan, 203 peasant households drawn from 22 villages situated in Mudan.

Figure 1. Location of survey areas

III. METHODS

The procedure of Monte Carlo simulation for simulating uncertainties of livelihood assets of peasant households in this study was exhibited in Figure 2. And the procedure of Monte Carlo simulation was elaborated as follows.

A. Livelihood Assets Indicators

The livelihood assets indicators were selected to gain an accurate and realistic understanding of peasant households' endowments. The indicator system was constructed in this paper based on DFID's sustainable livelihoods framework [16]. The livelihood assets can be grouped into five types of capitals: human capital, natural capital, physical capital, financial capital and social capital [17]. However the indicators that reveal the situation of livelihood assets are not invariable and it should be adjusted according to the reality and characteristics of livelihood conditions [18]. Lastly, the set of livelihood assets indicators applied to empirical study was presented in Table Ⅰ. And the descriptive statistics of three provinces' indicator values were showed in Table Ⅱ, Table Ⅲ, and Table Ⅳ.

B. Normalization Method

Indicator values of livelihood assets indicator system for Monte Carlo simulation need to be normalized

properly in order to compare indicator values that are measured using different units. There are several methods for normalization [19], and min-max normalization is adopted in this paper. When the min-max normalization is applied, the original indicator values are rescaled to lie within [0.0, 1.0]. The equation for min-max normalization is defined as follows:

$$X_n' = (X_n - \min_{n.value}) / (\max_{n.value} - \min_{n.value}) \quad (1)$$

Where, $\max_{n.value}$ is maximal value of the n-th indicator, $\min_{n.value}$ is minimal value the n-th indicator, X_n is the original input of the n-th indicator, X_n' is the transformed value of the n-th indicator.

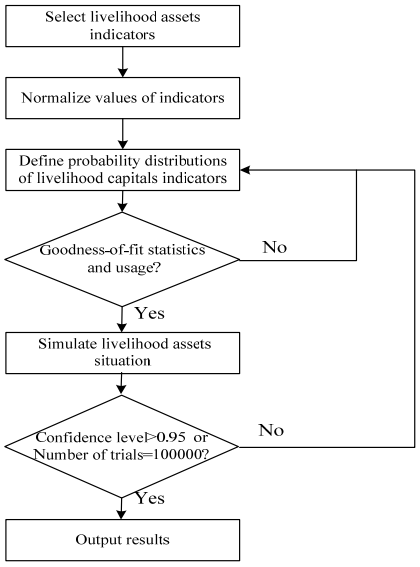

Figure 2. Procedure of Monte Carlo simulation

TABLE I.
THE SET OF LIVELIHOOD ASSETS INDICATORS

Capitals	Indicators	Unit or Definition
Human capital	Peasant household's labor force X_1	Persons
	Education years of peasant household head X_2	Years
	The change of health status of peasant household head X_3	much worse=1, worse=2, unchanged=3, better=4, much better=5
Natural capital	Farmland area per capita X_4	Mu/Person
	Area of farmland which is cultured by oneself X_5	Mu
	Farmland area per plot X_6	Mu/Plot
Physical capital	Transportation ability of peasant household X_7	works in the same town=1, works in the same country=2, works in the same city=3, works in the same province=4, works in the different province=5
	Wealth degree of village [a] X_8	very poor=1, poor=2, normal=3, rich=4, very rich=5
Financial capital	Income of peasant household X_9	Yuan. Income of peasant household consists of non-agricultural income and agricultural income
	Non-agricultural income of peasant household X_{10}	Yuan
Social capital	Weak ties X_{11}	have no contact=1, connect sometimes=2, play together=3, offer some help=4, help to solve important problems=5,
	Strong ties X_{12}	very alienative =1, alienative=2, normal=3, intimate=4, very intimate=5
	Training times X_{13}	Times

a. The standard of the wealth degree of village is subjective judgment of peasant household.

TABLE II.
DESCRIPTIVE STATISTICS OF INDICATOR VALUES IN GUIZHOU

	Min.	Max.	Mean	Std.Deviation
X_1	0.00	6.00	2.65	1.03
X_2	0.00	12.00	4.10	2.57
X_3	1.00	5.00	3.00	0.89
X_4	0.26	3.25	1.12	0.43
X_5	0.00	5.80	1.54	1.41
X_6	0.29	7.00	1.44	1.08
X_7	0.00	5.00	2.34	1.57
X_8	1.00	5.00	2.90	0.76
X_9	0.35	10.60	3.66	1.75
X_{10}	0.03	8.60	3.07	1.82
X_{11}	1.00	5.00	2.95	0.98
X_{12}	1.00	5.00	3.44	0.96
X_{13}	1.00	5.00	2.34	1.37

TABLE III.
DESCRIPTIVE STATISTICS OF INDICATOR VALUES IN ZHEJIANG

	Min.	Max.	Mean	Std.Deviation
X_1	0.00	6.00	3.14	1.12
X_2	0.00	12.00	4.94	3.14
X_3	1.00	5.00	3.14	0.73
X_4	0.08	2.50	0.46	0.29
X_5	0.00	4.10	1.11	0.64
X_6	0.30	7.00	1.21	0.79
X_7	0.00	5.00	1.92	1.06
X_8	1.00	5.00	3.29	0.62
X_9	1.80	15.60	6.69	2.23
X_{10}	1.30	15.00	6.53	2.30
X_{11}	1.00	5.00	2.65	1.09
X_{12}	1.00	5.00	3.18	0.82
X_{13}	1.00	5.00	1.62	1.07

TABLE IV.
DESCRIPTIVE STATISTICS OF INDICATOR VALUES IN SHANDONG

	Min.	Max.	Mean	Std.Deviation
X_1	0.00	6.00	2.62	0.99
X_2	0.00	13.00	4.99	2.82
X_3	1.00	5.00	3.20	0.76
X_4	0.07	7.00	1.27	0.60
X_5	0.00	6.00	1.36	1.32
X_6	0.40	6.00	1.96	0.91
X_7	0.00	5.00	2.37	1.44
X_8	2.00	5.00	2.99	0.63
X_9	0.90	5.70	2.71	0.91
X_{10}	0.54	5.00	2.24	0.98
X_{11}	1.00	5.00	2.48	0.99
X_{12}	1.00	5.00	3.01	0.77
X_{13}	1.00	5.00	1.49	0.91

C. Approach for Livelihood Assets Assessment

The situations of five types of capitals which were composed of human capital, natural capital, physical capital, financial capital and social capital were estimated by Equation (2).

$$Y_i = \sum X'_{in} \tag{2}$$

Where, X_{in}' is the transformed value of the n-th indicator of i-th livelihood capital of one peasant household, Y_i is the i-th livelihood capital situation of one peasant household.

The probability distributions of livelihood capitals were fitted according to the data from the values estimated by Equation (2). In order to analyze the regional differences in livelihood assets of peasant households, the probability distributions of livelihood capitals in Guizhou, Zhejiang and Shandong were fitted, respectively. According the results of goodness-of-fit test and usage, the suitable probability distributions were selected which were high qualities of the fit. During a Monte Carlo simulation, the uncertain indicator values were repeatedly picked from the selected probability distributions of livelihood capitals. The livelihood capitals were defined as the assumption variables in Crystal Ball [20].

On the basis of distribution analysis of all livelihood capitals, the livelihood assets situation of peasant household which was defined as the forecast variable in Crystal Ball was estimated by Equation (3).

$$Y = \sum \frac{a_i}{b_i} Y_i \times 100 \tag{3}$$

Where, a_i is the coefficient of the i-th livelihood capital, b_i is the number of indicators composed of the i-th livelihood capital,Y is the livelihood assets situation, . Y was defined as the forecast variable in Crystal Ball. In this paper, five types of livelihood capitals were of the same importance to sustainable livelihoods. Therefore the coefficients of the livelihood capitals (a_i) were selected as 0.2.

IV. RESULTS

A. Probability Distributions of Livelihood Capitals

The values of livelihood capitals in Guizhou, Zhejiang and Shandong were tested to gain the suitable probability distributions of livelihood capitals using Crystal Ball. The probability distributions of livelihood capitals were selected on the basis of goodness-of-fit statistics and usage [21, 22, 23]. The parameters of variables of the livelihood capitals were showed in Table 2. And Figure. 2 showed the distribution fit of human capital, natural capital, physical capital, financial capital and social capital in three provinces, respectively.

TABLE V.
THE PARAMETERS OF VARIABLES OF LIVELIHOOD CAPITALS

Capitals		Probability Distributions	Parameters
Human capital:	Guizhou	Triangular Distribution	Min.=0.11, Likeliest=1.16, Max.=2.25
	Zhejiang	Normal Distribution	Mean=1.33, Std.Dev=0.31
	Shandong	Lognormal Distribution	Location=-2089.12, Mean=1.26, Std.Dev=0.30
Natural capital:	Guizhou	Normal Distribution	Mean=1.06, Std.Dev=0.30
	Zhejiang	Logistic Distribution	Mean=0.97, Scale=0.07
	Shandong	Logistic Distribution	Mean=1.19, Scale=0.19
Physical capital:	Guizhou	Lognormal Distribution	Location=-1.46, Mean=0.85, Std.Dev=0.36
	Zhejiang	Lognormal Distribution	Location=-1.58, Mean=0.84, Std.Dev=0.25
	Shandong	Lognormal Distribution	Location=-0.77, Mean=0.87, Std.Dev=0.33
Financial capital:	Guizhou	Normal Distribution	Mean=0.41, Std.Dev=0.23
	Zhejiang	Normal Distribution	Mean=0.84, Std.Dev=0.30
	Shandong	Lognormal Distribution	Location=-0.71, Mean=0.30, Std.Dev=0.12
Social capital:	Guizhou	Lognormal Distribution	Location=-1.69, Mean=1.15, Std.Dev=0.42
	Zhejiang	Lognormal Distribution	Location=-4.91, Mean=0.89, Std.Dev=0.37
	Shandong	Lognormal Distribution	Location=-0.60, Mean=0.80, Std.Dev=0.35

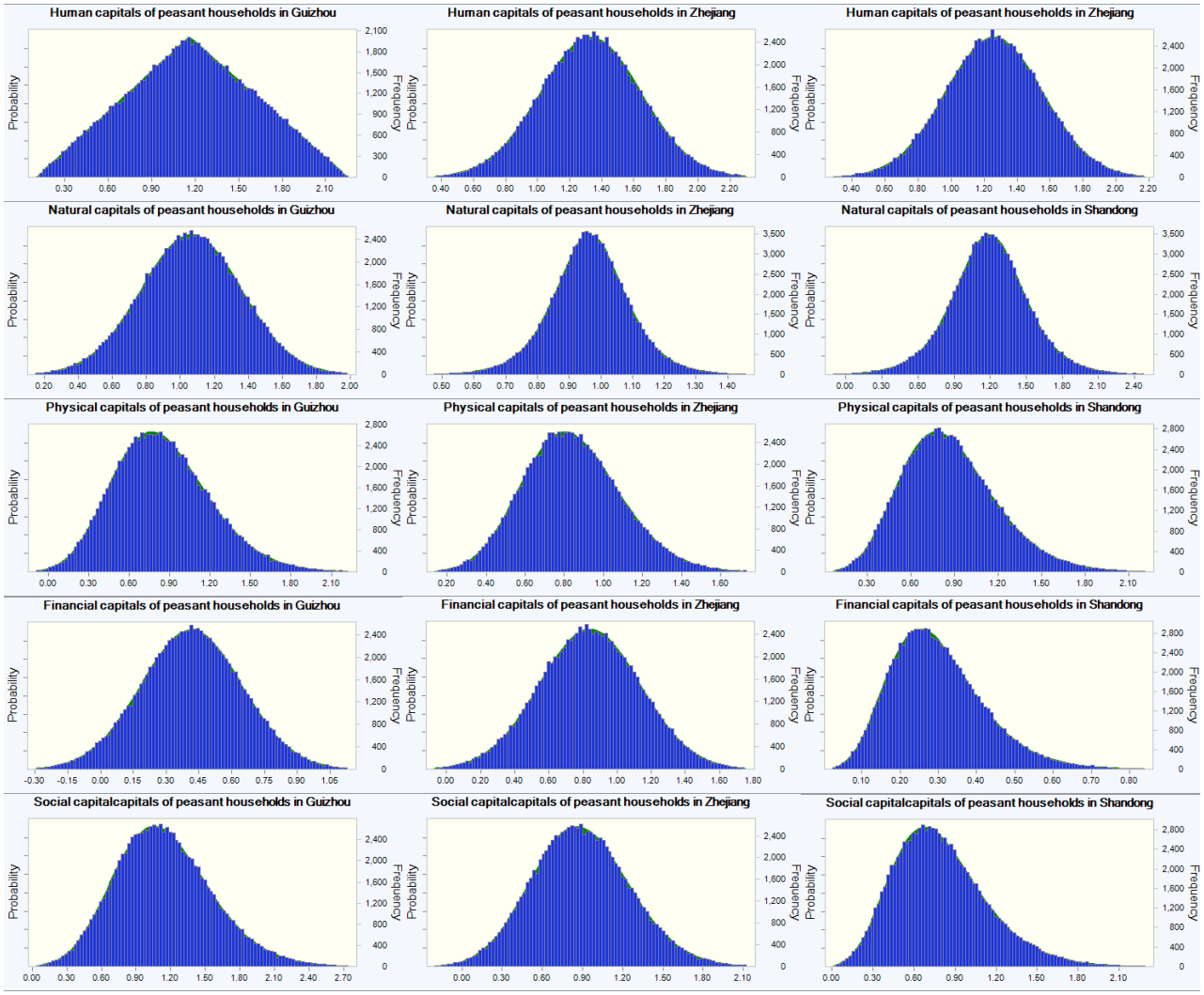

Figure 3. DISTRIBUTION FIT OF HUMAN CAPITAL, NATURAL CAPITAL, PHYSICAL CAPITAL, FINANCIAL CAPITAL AND SOCIAL CAPITAL

B. The Assessment of Livelihood Assets

The stopping criteria for the Monte Carlo simulation was either that the maximum number of trials had been executed or the precision of simulation succeed in confidence level. Before simulative calculation, the maximum number of trials was defined as 100000, and the confidence level was defined as 0.95 in this paper. The Monte Carlo simulation was run in Crystal Ball after setting parameters. The results of simulation were showed in the Table 3, and the difference in percentile of livelihood assets was presented in Figure. 3.

TABLE VI.
RESULTS OF MONTE CARLO SIMULATION

Percentile	Guizhou	Zhejiang	Shandong
0%	10.02	15.78	12.79
10%	27.30	31.59	26.90
20%	29.91	33.78	29.00
30%	31.83	35.38	30.55
40%	33.49	36.74	31.87
50%	35.06	38.01	33.15
60%	36.63	39.31	34.45
70%	38.34	40.70	35.90
80%	40.37	42.36	37.63
90%	43.28	44.67	40.10
100%	70.02	60.90	62.90

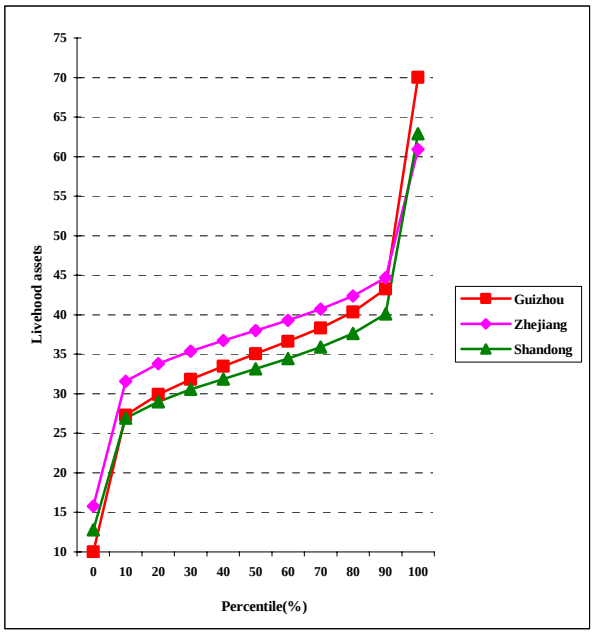

Figure 4. DIFFERENCES IN LIVELIHOOD ASSETS IN THREE PROVINCES

V. DISCUSSION AND CONCLUSIONS

In this Monte Carlo simulation, the Table VI reveals the regional differences in livelihood assets of farmland rental households. It can be seen that the 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80% and 90% percentile values of livelihood assets in Zhejiang are greatest. And the values of livelihood assets, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80% and 90% of peasant households in Guizhou are all higher than those in Shandong. In Zhejiang, 50% of the predicted values of livelihood assets are below 38.01, and 90% of the predicted values of livelihood assets are below 44.67. In Guizhou, 50% of the predicted values of livelihood assets are below 35.06, and 90% of the predicted values of livelihood assets are below 43.28. In Shandong, 50% of the predicted values of livelihood assets are below 33.15, and 90% of the predicted values of livelihood assets are below 40.10. Consequently, the peasant households who rent out farmland are different in possession of the livelihood assets. The peasant households in Zhejiang have a greater probability to possess more livelihood assets than them in Guizhou and Shandong. In addition, the situations of livelihood assets of peasant households in Shandong are worse than them in Guizhou since the smaller probability to possess more livelihood assets.

Some factors affect the peasant households' livelihood assets when they rent out the farmland. The peasant households in Zhejiang have lower stocks of natural capital because the per capita farmland is small, and they rent out a majority of farmland. However, Zhejiang' annual per capita net income of peasant households is highest in China, and developed economy creates more opportunities of non-agricultural employment for peasant households. The stocks of financial capital and social capital of peasant households in Zhejiang are abundant and active hence. There is shortage of some types of livelihood capitals in Zhejiang province, but the peasant households' livelihood assets as a whole have an obvious advantage which helps to obtain sustainable livelihood compared with livelihood assets of peasant households in other provinces.

The peasant households in Shandong have lower stocks of livelihood assets than them in Guizhou. Actually, Guizhou is an undeveloped province, and the farming is limited by natural condition since landform and climate. A possible explanation for the phenomenon is the location difference of surveyed villages. The surveyed villages in Guizhou are located in Guiyang which is the capital of Guizhou province. The location advantage offers more availability for peasant households to obtain livelihood assets, especially physical capital, financial capital and social capital. And the peasant households have more opportunities to seek one efficient way to improve the livelihoods when they rent out farmland. Although the peasant households in Heze have higher stocks of natural capital since the city is situated almost entirely on an alluvial plain, the behavior logic of peasant households and undeveloped economy limit the increase of livelihood assets.

In this paper, Monte Carlo simulation is used to establish one method for assessing livelihood assets of peasant households renting out farmland. The results of Monte Carlo simulation are credible. Therefore the

method can be modified to apply in other study areas according to the local reality and characteristics of livelihood conditions. The purpose of analyzing regional differences in livelihood assets of peasant households in three provinces is not only obtaining the situation of the livelihood assets from complicated indicators but also understanding the features which affect the sustainable livelihood of peasant household. Consequently in order to create diversiform livelihood strategies, the similar research about livelihood assets should be done.

ACKNOWLEDGMENT

The author wishes to thank local bureaus of land and resources of survey areas. This research was supported in part by a grant from Humanity and Social Science Youth Foundation of Ministry of Education of China (No. 13YJC630208), and by Foundation of Zhejiang Planning Project of Philosophy and Social Sciences (No. 13NDJC040YB).

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Heyuan You, he was born in Wenzhou City, Zhejiang Province of China in 1983. He received the PhD degree in land resource management from Institute of Land Science and Property Management, Zhejiang University in 2012.

He is currently working as a lecturer in the College of Business Administration, Zhejiang University of Finance and Economics, Zhejiang, China. His research area centers on land use simulation and land ecology management.