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Default Risk Level from Voluntary Carbon Market—A Simple but Effective Assessment Method

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Abstract

Although voluntary carbon offset market is an important solution to the climate crisis, there hides a variety of risks behind it because of lack of global registration system and measurement method. In this paper, we focused on the default risk from the original carbon supplier in voluntary carbon market, and built an evaluation indicator system according to several principles. Then analytic hierarchy process (AHP) and fuzzy comprehensive evaluation technology were used to construct evaluation model to measure default risk level which are simple but effective. Finally, a simulation case proved the evaluation indicator system and model proposed can not only work out the comprehensive risk level but also calculate risk level from different aspects, which is useful for stakeholders to make their decisions in voluntary carbon market.

Key words: Default risk level; Carbon credit trade; Voluntary carbon offset market; Comprehensive evaluation

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INTRODUCTION

According to current scientific detection, carbon dioxide concentration has reached a new monthly record of 400 parts per million in May 2015. In order to slow down global temperature increase, climate scientists suggest that atmospheric CO_2 concentrations should peak below 450ppm, which requires global emissions to decline to roughly 80% below 1990 levels by the year 2050 (Baer & Mastrandrea, 2006). As we know, market trade of carbon credit is a good way to control carbon emission. There are two markets for carbon offsets in the world. For the smaller, voluntary market, individuals, companies, or governments purchase carbon offsets to mitigate their own greenhouse gas emissions from transportation, electricity use and so on, grows up quickly (Peters-Stanley & Yin, 2013).

Unlike CDM projects, voluntary carbon markets don't have a specific code and standard but a series of a variety of standards recognised by different organizations in some countries. As long as carbon credit buyers approve, transactions can be done with certifications from a third party (DOE) or even without any certifications. Voluntary markets have a great deal of flexibility, and played a more and more important role in the climate crisis. Without a universally accepted standard and effective supervision on carbon credit seller in voluntary market, there hides a variety of risks. The original carbon sellers, who are also the builders of low-carbon projects, probably make some bad behaviour to buyers and the whole voluntary market by their information advantages.

Although there are several bodies acting as sellers in carbon credit market such as carbon project builders, brokers, agencies, etc. In this paper, we focus on the original carbon credit sellers and try to identify default risks from them in voluntary carbon offset market, and then offer assessing models to evaluate their default risk' level. Now we need to construct an indicator system acting as assessment standard to start the evaluation job.

1. ASSESSMENT INDICATORS OF THE ORIGINAL SELLER'S DEFAULT RISKS

1.1 How to Design Indicators

An indicator acts as a quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement or to reflect the changes in that condition or situation over time. Designing good indicators is the foundation of successful assessment. Generally speaking, indicator designing needs to follow some principles.

1.1.1 Scientificalness Principle

The scientific and reasonable level of indicator system is directly related to evaluation quality. Scientific principle requests indicator system must be in accordance with the definition of the seller's default risks in carbon credit market. Indicators must be typical, integral and systematic to secure evaluation result objective and reliable. And anthropogenic interference should be avoided to make the error minimized.

1.1.2 Comprehensiveness Principle

In order to accurately measure the risk level, all kinds of risk sources should be summarized. That means the design of the indicator system should try to reflect the seller's default risks from all aspects. Comprehensive principle requires not only to take operational risks from the original seller into account, but also to pay attention to deception risks and other risks.

1.1.3 Measure Principle

We can't assess anything if indicators can't be measured. So indicators can be measured is the basic requirement of evaluation work. Measure principle requires the definition of indicator is clear and accurate and the measure data can be compared by each other. What's more, it is expected that all data are easy to collect.

According to the above designing principles, we summarized the indicators as follows.

1.2 Assessment Indicator System

Default risk from carbon credit original seller may come from deliberate actions of seller and constrained pressure of objective conditions as well. According to some researches and trade cases, the risk level of original seller can be evaluated from four aspects in this paper.

1.2.1 Fraud Risks

Fraud is intentional deception made for personal gain or to damage other companies and individuals. Carbon voluntary market is in a developing stage in some countries, and social credit system is in unsoundness. Some dishonest sellers register their carbon emission reduction projects in different voluntary carbon standard system and sell the same carbon credit to other buyers. However there is only one carbon emission reduction project is carried out. Some sellers crookedly advertise by news to tell the public they have got certain qualifications or abilities in projects. But in fact they have not got them. And some project builders sell carbon credit in advance before the projects are finished. Public don't know whether they can get the certified emission reductions (CERs) in the future. In addition, there are several other ways for carbon credit seller to defraud the public. For buyers, they have to take some measures to find the fraud risk and deal with them.

1.2.2 Operational Risks

Construction cycle of carbon credit projects may last for several years, and builders have to deal with something difficult occurred in the long period. Limitation of cognitive ability and operational ability may lead to the failure of the building project or operation activities can not reach the expected goal. We call the possibility of loss resulting from inadequate or failed internal processes, people and systems as operational risks. Operational risks do not refer to a certain concrete risks, but contain a series of risks. Some examples for each risk are listed as follows.

Business disruption & systems Failures-utility disruptions; software failures; hardware failures; failure of application for certification; failure of time and resource allocation; depending on not confirmed or complex technology.

1.2.3 Risks from Emission Reduction Uncertainty

Emission reduction uncertainty risks are risks which arise in stochastic environments and lead the seller to partly failure in the future. Risks from emission reduction uncertainty don't mean the seller fully fail in the project. It just partly fails in uncertain date, quality, and so on. Generally, the certified emission reductions (CERs) maybe is appointed in emission reductions purchase agreement (ERPA), which the project owners should deliver to the buyer CERs each year. In fact, it is not an easy thing to submit CERs to buyers on time. For instance, uncontrollability of project registration will bring about great difference between project design documents (PDD) and actual emission reduction. What's more, uncontrollability of project operation, change of detection method and measure errors can lead to different result from what the original seller has promised as well. Here we call all these risks from uncertain factors in the future as emission reduction uncertainty risks.

1.2.4 Contract Statement Risks

Contract statement risks can be defined as probability of loss arising from the buyer or seller's reneging, misunderstanding or inappropriate presentation in the contract. Buyer and seller maybe are not in the same country. Their rights and obligations mainly are arranged by the contract. There probably exists a lot of disputation and misunderstanding caused by inaccurate expression in trade contracts because of cultural difference. So it is necessary to accurately express their original meaning of agreement and assure no equivocations in contract statement. Common contract statement risks include delivery definition, solution selection of disputation, payment method, inaccurate expression in contract, etc.

According to what we summarized above, all the indicators are shown in Table 1.

Table 1
Indicators of Carbon Builder'S Risks

First-level indicators	Second-level indicators
X_1 Fraud risks	X_{11} Repeating sale risk X_{12} Crooked advertisement risk X_{13} Selling carbon credit before completion X_{14} Fraud risks of emission data X_{15} Other fraud risks
X_2 Operational risks	X_{21} Business disruption & systems Failures X_{22} Failure of application for certification X_{23} Failure of time and resource allocation X_{24} Depending on not confirmed or complex technology
X_3 Risks from emission reduction uncertainty	X_{31} Uncontrollability of project registration X_{32} Uncontrollability of project operation X_{33} Change of detection method X_{34} Measure errors
X_4 Contract risks	X_{41} Delivery definition X_{42} Solution selection of disputation X_{43} Payment method X_{44} Inaccurate expression in contract X_{45} Other contract risks

2. CONSTRUCTION OF ASSESSMENT MODEL

2.1 Thought of Evaluation

There exist lots of fuzzy phenomena and fuzzy concepts in the process of evaluation, which is difficulty for us to describe the phenomenon accurately. In fact, it does not have very strong practical significance when we use an accurate numerical value to reflect fuzzy phenomena. For example, if we give a comment of high risk level to a seller, how can we describe the risk degree by numbers? Maybe different people use different numbers to express the risk degree like 85, 90, 92 and so on. In this case, it is better to evaluate the fuzzy phenomenon by rough views like excellent, good, normal, poor and very poor instead of accurate numbers to avoid divergence on numbers. So here we select fuzzy evaluation method to construct the assessment model.

As we know, there are many indicators in indicator system. What are the weights of these indicators? Are they the same to each other or different? So how to deal with the relative weights among evaluation indicators is another problem in evaluation process. Generally speaking there are two ways to resolve this problem. One depends on expert's knowledge and experience to get weight. And the other depends on quantitative method. Both of the two ways have advantages and disadvantages. We determined the relative weights by analytic hierarchy process (AHP) in this article. AHP is a good method transforming qualitative evaluation into quantitative measurement, which takes into account both qualitative evaluation advantages and qualitative evaluation advantages.

Combination of analytic hierarchy process and fuzzy evaluation method can improve the accuracy of evaluation result. So it is the main method to construct evaluation model in this paper.

2.2 Construction of Assessment Model

Fuzzy comprehensive evaluation uses fuzzy mathematics to transform and fathom fuzzy data. It can transfer qualitative assessment to quantitative assessment according to membership degree theory in mathematics, that is, it can assess an object which is affected by various factors using fuzzy mathematics. Fuzzy comprehensive evaluation method can be classified into six steps:

(1) Determining evaluation factors set X

If there are p indicators, domain X can be denoted as:

$$X=\{X_1, X_2, \cdots X_P\}$$

(2) Determining views set Y

$$Y=\{Y_1, Y_2, Y_3, Y_4, Y_j\}$$

$$R=\begin{bmatrix} R|X_1 \\ \cdots \\ R|X_i \\ \cdots \\ R|X_p \end{bmatrix}=\begin{bmatrix} r_{11} & r_{12}\cdots r_{1j} \\ \cdots\cdots & \cdots\cdots \\ r_{i1} & r_{i2}\cdots r_{ij} \\ \cdots\cdots & \cdots\cdots \\ r_{p1} & r_{p2}\cdots r_j \end{bmatrix}$$

Here j is the number of view classes.

(3) Determining fuzzy evaluation matrix of X_i

It needs to quantify the object under research from each factor X_i (i=1,2,$\cdots p$) one by one, That is, to determine the membership degree (R | X_i) of the object under research to the fuzzy views set from single factor (R | X_i) and get the fuzzy relationship matrix.

Here r_{ij} in matrix R is a relationship degree of indicator X_j to view Y_j.

(4) Determining weight vectors of evaluation indicators

According to the thought of evaluation, analytic hierarchy process method (AHP) is used to determine the relative rank of evaluation indicators and the weight coefficient. AHP method needs construct judgment matrix, which can indicate the relative importance of each element in a certain hierarchy. In judgment matrix of AHP, a_{ij} is the relative importance judgment value of X_i compared to X_j in criteria hierarchy X, which is usually given a number from 1 to 9. Judgment matrix is required to satisfy the following condition:

$$\begin{cases} a_{ii} = 1 \\ a_{ij} = \dfrac{1}{a_{ji}} \end{cases}$$

Generally speaking, the values in the judgment matrix are balanced according to data, experts' opinion and knowledge of analysts.

According to the judgment matrix, we can use square root method to determine the weight vectors of evaluation indicator ω. It needs to be noted that consistency check is necessary in calculation of AHP in order to eliminate illogical mistake in construction of judgment matrix.

(5)Determining indicators' fuzzy comprehensive evaluation set

Fuzzy comprehensive evaluation results B can be calculated by the following formula.

$$\left(\omega_1, \omega_2, \cdots\cdots, \omega_p\right) \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1j} \\ r_{21} & r_{22} & \cdots & r_{2j} \\ \cdots & \cdots & \cdots & \cdots \\ r_{p1} & r_{p2} & \cdots & r_{pj} \end{bmatrix} = \left(b_1, b_2, \cdots\cdots, b_j\right) = B$$

Here ω_i are the weight vectors of evaluation indicators (i=1, 2$\cdots p$).

(6) Analyzing evaluation result

The membership vector (b^*_1, b^*_2, $\cdots b^*_j$)is the comprehensive evaluation result using fuzzy comprehensive evaluation method. b^*_i corresponds to the view Y_i individually, that is, the membership possibility $b^*_i$to view Y_i from the angle of probability. According to the maximum membership degree principle, if Y*i=max(b^*_1, $b^*_2 \cdots b^*_j$), the evaluation result is Y^*_i.

2.3 A Simulation Example

Assume there is an original carbon credit seller in voluntary market and we can get all the information models need. According to assessment indicator system and method discussed above, the evaluation of default risks of the original seller can be carried out as follows:

(1) Determining evaluation factors set X, which can be denoted as Table 1 shown.

(2) Determining views set Y

$$Y=\{Y_1, Y_2, Y_3, Y_4, Y_5\}$$

Here Y_1 means risk level is highest. Y_2 means risk level is higher. Y_3 means risk level is normal. Y_4 means risk level is lower. Y_5 means risk level is lowest.

(3) Calculating membership degree and indicator weight

According to questionnaire and relative rank of evaluation indicators given by 10 experts, we can get membership degree and evaluation indicators' weight by Fuzzy evaluation method and AHP, which are listed in Table 2.

Table 2
Weight and Membership Degree of Evaluation Indicators

First-level indicators	Weight	Second-level indicators	Weight	Membership degree				
				Highest	Higher	Normal	Lower	Lowest
X_1	39.15%	X_{11}	30.25%	0.3	0.4	0.1	0.2	0
		X_{12}	25.10%	0.1	0.1	0.3	0.4	0.1
		X_{13}	17.15%	0	0.1	0.3	0.5	0.1
		X_{14}	25.11%	0	0.3	0.2	0.4	0.1
		X_{15}	2.39%	0	0.2	0.6	0.2	0
X_2	28.27%	X_{21}	34.30%	0.1	0.4	0.2	0.3	0
		X_{22}	37.69%	0	0.1	0.2	0.6	0.1
		X_{23}	5.48%	0	0.4	0.1	0.5	0
		X_{24}	22.53%	0.4	0.1	0.1	0.3	0.1
X_3	12.63%	X_{31}	32.70%	0.2	0	0.2	0.6	0
		X_{32}	18.60%	0	0.2	0.2	0.5	0.1
		X_{33}	26.22%	0.1	0.1	0.1	0.7	0
		X_{34}	22.48%	0	0.3	0.2	0.5	0
X_4	19.95%	X_{41}	38.21%	0	0.3	0.2	0.4	0.1
		X_{42}	15.28%	0	0.1	0.1	0.7	0.1
		X_{43}	21.17%	0	0.2	0.2	0.5	0.1
		X_{44}	20.69%	0	0.2	0.3	0.4	0.1
		X_{45}	4.65%	0	0.1	0.1	0.7	0.1

Note. The meaning of parameters in Table 2 is the same to Table 1.

According to the above calculation step (4)～(6), we can get evaluation result

Y^*_i=max(b^*_1, b^*_2,$\cdots b^*_5$)=max(0.09,0.22,0.20,0.43,0.07)=0.43.

Here, b^*_4=0.43 corresponds to the view Y_4. According to the maximum membership degree principle, default risk level of seller in carbon credit market is lower. And carbon credit buyers can take low-level coping strategy to deal with the risks.

CONCLUSION

In voluntary carbon market, the original carbon credit sellers probably break the contract because of their internal motivations and external pressures. We have to consider internal and external factors when we design the assessment system. In this paper, we summarized that the seller's default risk comes from fraud, operation, emission reduction uncertainty and contract. And risk level depends on indicator's weights and membership degree of indicators, so the expert's comments on the case play an important role in the process. For the above simulation case, fraud risk and operational risk occupied bigger weight than the other two factors in risk evaluation. And they influenced the assessment result more. Membership degree of indicators in this case is the number of experts holding the same view on one's risk in proportion to the total number of experts. So if most experts hold their views on one's risk degree, the risk degree is the final assessment answer.

The measuring methods used in the case not only involved qualitative knowledge and information from experts, but also involved some quantitative measurements, which took into account both qualitative evaluation advantages and qualitative evaluation advantages and were is better than single qualitative evaluation method or qualitative evaluation method.

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