Simulation of sovereign CDS market based on interaction between market participant

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HIGHLIGHTS

- This research introduces creation of CDS market and utilize occurrence characteristics (to shift risk).
- The various statistics including distributional property could promote understanding about the market.
- The parameters can cover not only basic statistics but also multifractal properties of most countries.
- It can be checked to be used in estimation of future and additional empirical studies.
- This research will serve as a momentum double-checking indirectly.

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ABSTRACT

A research for distributional property of financial asset is the subject of intense interest not only for financial theory but also for practitioner. Such respect is no exception to CDS market. The CDS market, which began to receive attention since the global financial debacle, is not well researched despite of the importance of research necessity. This research introduces creation of CDS market and use Ising system utilizing occurrence characteristics (to shift risk) as an important factor. Therefore the results of this paper would be of great assistance to both financial theory and practice. From this study, not only distributional property of the CDS market but also various statistics like multifractal characteristics could promote understanding about the market. A salient point in this study is that countries are mainly clustering into 2 groups and it might be because of market situation and geographical characteristics of each country. This paper suggested 2 simulation parameters representing this market based on understanding such CDS market situation. The estimated parameters are suitable for high and low risk event of CDS market respectively and these two parameters are complementary and can cover not only basic statistics but also multifractal properties of most countries. Therefore these estimated parameters can be used in researches preparing for a certain event (high or low risk). Finally this research will serve as a momentum double-checking indirectly the performance of Ising system based on these results.

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1. Introduction

These days, the form and characteristics of return distribution is considered significantly to manage the investment risks of financial assets. Especially, long memory property of financial assets or price fluctuations behaviors are representative. With recent computational analysis techniques getting more and more advanced, the elaboration of financial assets distribution is needed for the lesson of the recent global financial debacle. This research is focused on the distribution of Credit Default Swap (CDS). CDS, one of credit derivatives, come into the spotlight after the global financial debacle, and the importance of CDS is increasing. Although the distribution of CDS market show difference with stick and bond markets being already researched a lot, related research is rarely progressed. It cause insufficiency of research about not only financial theory concerned about CDS market but also simulation frequently used in empirical research. Therefore this research suggest simulation parameters representing CDS market covering behavior analysis of CDS market and the results of this paper would be of great assistance to both financial theory and practice.

Although financial market responds to external shock and is a highly complex system having many non-linear properties, it has been researched supposing the logarithmic returns follow normal distribution. It goes back to Central Limit Theorem which is widely used. CLT assume that return is a time series of many independent events. It derived the assumption of normal distribution and independent uncorrelated random walk was modeled by this assumption. After this, Gaussian assumption have been used in many financial research and identically Gaussian distributed or Brownian random variables [1] appeared. It was used as one of important assumptions in Black–Scholes option pricing model [2] and was applied to many financial derivatives. Although the assumption of normal distribution simplify calculation course, empirical studies have not normal distribution but heavy-tailed distribution and underestimation by Gaussian process have been suggested consistently [3–9]. Therefore, finding out characteristics of financial probability distribution would be a compulsory thing in financial management. This feature appears not only in financial field but also in other markets and many statistical measures have been developed to catch it. For example, Ref. [9,10] are researches about how much the market fluctuates. Especially, power-law behavior is one of the stylized facts appeared not only in underlying asset but also in correlation, autocorrelation or cross-correlation of fluctuation etc. Likewise, CDS market is not free from these distributional assumption and properties.

Actually, embodying the distribution of returns is not an easy work and not inconsiderable data and computation are needed to research rare events making properties breaking normal distribution like fat-tail [11]. Furthermore, parametric distributional approach using not only normal distribution but also other alternative distributions has certain parameters to fit financial data. Various researches simplifying the condition of these parameters have been conducted. For principal models treating the credit risk, two models are widely used. First is the structural models which concentrate on the structural variables of the firms [12–14]. On the other hand, the reduced form models tried more flexible approach. The reduced form models handle the default interest rate and compare with the risk-free interest rate [15,16]. However these models do not reflect the heavy-tail phenomenon of CDS index or intense interactions between CDS traders in real CDS market efficiently. If protection buyers are willing to buy CDS, then the CDS goes up and if protection sellers are willing to sell CDS, then the CDS goes down. Therefore, the CDS is decided by the trial of strength between protection buyers and protection sellers. That is, protection buyers transfer their credit risk to protection sellers. Since CDS trades are made very carefully, its liquidity is not enough unlike stock market. It is because certain people are hard to rig price in contrast with stock market. Thus, interaction between market participants in CDS market becomes a relatively important factor. This paper tries to do an empirical model approach by using Ising dynamic system on Sierpinski carpet lattice. Since this model is based on interaction between market participants, it is suitable for researching CDS market.

There has been many scientist tried to find appropriate models and methods taking after real world and describing economical phenomena [17–31]. Ising dynamic system is one of typical methodologies. Ising dynamic system that is a physical model of ferromagnetism, also has been an useful tool modeling financial systems [18,21,23,25–27,29]. By using the two-dimensional Ising model, the phase transition between positions of market traders can be achieved [18]. In advance, main factors of asset returns model can be duplicated by computer simulation [21,26,27]. Ising model is composed of variables that show atomic spin orientation can take $+1$ value or -1 value and there can be phase transitions. It can be adapted to simulate the decision-making mechanism. The behavior of agents tend to come to a "herded" state which is one of economical phenomena [25]. In the original Ising dynamic system, since every agent has the same number of connection to their neighbors, they are all equally treated. However, in real CDS market, the number of connections of each trader is different. These days, it is agreed that the time series of social chaotic processes are related to natural shape and present fractal behavior on some scales [32–35]. Furthermore, it is already known that the Sierpinski carpet lattice which use fractal concept is self-similar [36–38]. Therefore, we select Ising system to mimic the interaction between CDS traders just like in real CDS market and describe the fluctuation behavior of CDS market for different parameter values.

This research focuses on statistical properties of CDS market and present guideline on simulation of this market. First of all, not only distributional properties of CDS market but also various statistics like multifractal characteristics would promote understanding about the market. A salient point in this study is that countries are mainly clustering into 2 groups and it might be because of market situation and geographical characteristics of each country. This research suggest parameters corresponding to 2 cases representing CDS market using Ising system reflecting occurrence characteristics (to shift risk) of