



Credit risk contagion coupling with sentiment contagion

Shanshan Jiang, Hong Fan*

Glorious Sun School of Business and Management, Donghua University, Shanghai, 200051, China

HIGHLIGHTS

- Relationship between credit risk contagion and sentiment contagion is studied.
- The proposed model can reflect the degree of individual infection.
- The risk attitude, risk resisting ability, and supervision behavior are considered.
- Analysis of different network structures is provided.

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ABSTRACT

The contagion law of credit risk is very important for financial market supervision. In the financial market, the interaction between credit risk holders' sentiment and credit risk is the important factor of credit risk contagion. The existing credit risk contagion models based on complex network theory assume that the credit risk contagion is exogenous, and only analyze the proportion of the individuals infected by the credit risk from a macro perspective. However, existing models cannot explain the coupling relationship between credit risk contagion and emotional contagion, and how individuals are infected from a microscopic perspective is not clear. In this work, the theory of propagation dynamics in complex networks is introduced into the study of coupling relationship between credit risk contagion and sentiment contagion, which can reflect the endogenous problem of credit default in the process of credit risk contagion. The model can analyze the evolution process of individual risk contagion and sentiment contagion in the network, and can effectively reflect the risk contagion degree of individual. The proposed model further analyzes the influence of network structure, individual risk attitude, individual risk resisting ability, and financial market supervision on credit risk contagion and sentiment contagion. The correctness of the model is verified by theoretical deduction and numerical simulation.

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1. Introduction

The contagion of credit risk has always been one of the main problems that plague the whole financial market [1,2]. In reality, the process of credit risk contagion has a strong complexity, and the process of credit risk contagion is always in a nonlinear fluctuation state, which seriously affects the decision-making and the financial market management. With the development of global financial integration, and the speed of innovation and development of financial products and financial instruments is speeding up, the possibility of credit risk contagion in financial markets within and between countries is further strengthen [3]. For example, the U.S. subprime mortgage crisis in 2007 spread rapidly throughout the world, resulting in dramatic fluctuations in the global financial market [4]. The Greek sovereign crisis in 2009 led to the spread of credit risk in

* Corresponding author.

E-mail address: hongfan@dhu.edu.cn (H. Fan).

the Euro area, and eventually formed the European debt crisis in 2011. The European debt crisis has caused the international financial market to shake violently, caused many financial institutions to go bankrupt or the serious loss. At present, the world economy is becoming more and more complex, there are more and more factors leading to credit risk [5,6]. Understanding the dynamic process of credit risk contagion is the key to the supervision of credit risk.

The economic subjects involved in the transaction process of credit risk products are not only wide range, but also complicated in the relationship between economic subjects. Therefore, the process of credit risk contagion is not only dependent on credit default contagion, but with the psychological and behavioral factors of credit risk holders, the network structure of credit risk holders, the behavior of market regulators, and other endogenous and exogenous factors. Credit risk is disturbed or impacted by the interaction of these factors, and it is with complex nonlinear diffusion and contagion in financial market. For a long time, the credit risk theory has attributed the credit risk contagion to the external stochastic disturbance, ignoring the psychology contagion of the holder of the credit risk. In the real financial market, risk holders are susceptible to the influence of their own and other people's subjective sentiment [7,8], which leads to a large number of credit risk holders having similar characteristics and presenting consistency [9]. This leads to the shortage or excess of market liquidity [10–13], while the lack of liquidity is the main reason of credit risk. The spread of credit risk will further enhance the degree of irrational subjective sentiment of credit risk holders, and eventually lead to the volatility of credit risk product prices [14–17]. Therefore, the process of credit risk contagion is not only dependent on credit default contagion, but with the psychological and behavioral factors of credit risk holders [18]. For a long time, the researches on credit risk sentiment mainly concentrate on the empirical aspect. Lee revealed the sentiment contagion path during the financial crisis in the United States, and demonstrated the interdependence between credit risk contagion and emotional contagion [8]. Virlics explains the links between economics, psychology and neuroscience by studying the impact of sentiment on the economic decision-making process [7]. Fei investigated the role of social media in the spread of risk sentiment in credit risk contagion [19]. Li proposed an emotional asset pricing model that provided a partial explanation of excessive financial anomalies [10]. Bekiros took the market in the US as an example to explore the emotional contagion of herd behavior and the uncertainty of its volatility [20]. Aristei investigated the determinants of sovereign bond yield spread in the Euro area and extended the models commonly used in empirical analyses by focusing on the impact of market expectations and behavioral factors [21]. Thus, it can be seen from the above researches, in the study of credit risk contagion, the influence of the psychological and behavioral factors of the economic subject cannot be ignored.

At present, the research on the contagion model of credit risk in financial market mainly includes the following three categories: the simplified model, the structured model, and the complex network evolution model. The stochastic theory based simplified model and structured model are used to describe the impact and contagion effects on the creditor under different circumstances of credit default strength and default loss rate of the debtor [22–24]. The simplified models and the structured models mainly assume that credit default is exogenous, the influence of endogenous factors is not considered in the modeling of credit risk contagion. Complex network method has been paid more and more attention in the research of financial risk contagion in recent years, because the network can intuitively depict the complex relationship between the financial subjects [25,26]. With the rapid development of complex network theory, complex network theory and its methods have been applied to the study of financial risk contagion. In the study of the financial risk contagion, some scholars have carried out the research from the perspective of epidemic contagion [27]. May et al. pointed out that there is a common ground between the financial system and the ecosystem, and the contagion of financial risk is very similar to that of the epidemic [28]. Garas introduced epidemic contagion mechanism into the actual financial network model, and used SIR epidemic model to simulate the contagion of the crisis in the global economic network [29]. Haldane combined the theories of ecology, epidemiology, and complex networks to study the relationship between complexity, diversity, and financial fragility of the financial system network from multiple perspectives [30]. Chen constructed the credit risk contagion network model with the correlation factors of the credit behavior, revealed relationship between credit subjects in social networks [31]. Allen and Gale believed that the transmission of financial risks mainly depends on the internal relations of the financial system, such as the structure of lending relationship. This work indicated that sparse networks are more likely to infect risks [32]. While the opposite view is that the tight network reduces the risk of a single bank, but increases the correlation between banks, thereby increases the risk of contagion [33–35]. Acemoglu assumed that the network structure was not a monotonic linear relationship with the contagion effect. When the negative impact is less than a certain threshold, the tight network is more stable [36]. Upper summarized the simulation method of the contagion of credit risk in interbank market, and pointed out that infectious default cannot be completely eliminated [37]. These studies shown that, the correlation mechanism among economic entities, the network structure, and characteristics of economic entities constituted the significant impact on the credit risk contagion. However, these models are difficult to reflect the dynamic interaction of sentiment contagion in the contagion of credit risk.

Using the complex network theory to analyze the nonlinear dynamic process of credit risk contagion can largely reflect the endogenous problem of credit default in the process of credit risk contagion [38,39]. There are still some problems in the study of credit risk contagion based on complex networks: (i) Existing models analyzed basically the characteristics of network risk contagion from a macro perspective, analyzed mainly the proportion of individuals infected. However there is no analysis of how individuals are infected in the network; (ii) In the existing model, individuals are infected at two levels, that is, they are either completely infected or not infected, while in real financial networks, individuals are infected to varying degrees; (iii) The risk sentiment in existing risk contagion model is mostly using fixed value, it is difficult to analyze the evolution of sentiment contagion, and it cannot explain the nonlinear dynamic coupling relationship between

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