Risk Contagion and Investor Behaviour: a New Perspective Based on Agent Modelling

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Abstract. In financial markets, investors have various trading behaviours based on their risk preferences and investment strategies. The trading behaviours make it easy to transfer financial assets among different market participants. With the transactions in financial assets, the fluctuation of asset prices causes risk contagion in financial market. By analyzing existing literature, the research status of risk contagion based on investor behaviours are discussed and summarized. As heterogeneous characteristics of investor behaviours and complexities of financial market, agent modelling as a new computer modelling technique, is used for studying risk contagion in financial market. By simulating investor behaviours, agent modelling approach contributes to achieve the combination of macroscopic research and microscopic analysis, and form a new research trend about risk contagion.

1. Introduction
Risk contagion is often inevitable in financial markets. Up to now, the theories of risk contagion have been developed with the frequent appearances of financial crisis. The earliest theory of risk contagion is the first generation model of monetary crisis, which put forwarded by Krugman (1979). With Mexico Peso Crisis in 1973 and Argentine Crisis in 1978 as research backgrounds, Krugman thought the main reason of risk contagion was the policy coordination between economic expansion and stable exchange rate. Since Krugman’s model was nonlinear, explicit solution of the model could not be calculated. Flood and Garber (1984) modified Krugman’s model and presented Krugman-Flood-Garber model, which could calculate the collapse time of the fixed exchange rate and defined the notion of shadow exchange rate. The first generation model of risk contagion argued that domestic monetary policy caused risk contagion. But the European currency crisis happened in 1992, could not be explained from this point of view. Thus, the second generation theory of risk contagion was put forwarded by Obstfeld (1996). The second generation theory considered the influences of revenue function of government and investor expectation. In particular, the reason of risk contagion was no longer the deteriorated economic fundamentals, but devaluation expectations. The outbreak of European currency crisis was due to investors’ currency speculation under the strong expectation for DEM appreciation. The significant difference comparing with the first generation theory, is that this theory emphasized on the self-fulfillment of risk contagion under the investor expectation. But the first generation theory and the second generation theory could not give some reasonable explanations for Asian financial crisis in 1997. The third generation theory of risk contagion argued that the primary causes of Asian financial crisis were summed up the credit expansion of financial intermediary, the relaxed financial supervision, the increase of short-term debt and the inflated asset bubble. As the third generation theory focused on financial intermediary and asset price volatility, it gradually formed
some theoretical viewpoint, such as moral hazard theory, financial panic theory, liquidity crisis theory and balance sheet theory.

The above researches use the method of macroscopic analysis, which centres on currency policies, economic situations, financial institutions, asset price, and so on. These researches see risk contagion as a macroeconomic phenomenon, and never reveal microcosmic mechanisms of contagious process and characteristics of risk contagion. Accordingly, the researches on risk contagion gradually turn towards market participants. The investors as important market players can change their investment strategies under the influences of market factors and non-market factors, and investor behaviours cause the fluctuation of assets prices and the transmission of financial risk.

2. Research Situations of Risk Contagion and Investor Behaviour

The researches on risk contagion related to various types of financial markets in recent years. After analyzing stock market and bond market, Baur and Lucey (2009) divided risk contagion into two parts: positive contagion and negative contagion. And by data analysis from financial markets of American and European countries, the conclusions could be arrived by Baur and Lucey (2009) that the phenomenon of risk contagion happened between stock market and bond market during Asian financial crisis in 1997 and Russian debt crisis in 1998. This phenomenon of risk contagion became more obvious after the United States “911” incident. Zhou et al. (2012) analyzed the price movement of Shanghai copper and found accumulative effect of risk contagion in financial markets. Zhao et al. (2013) used nonlinear Granger causality test method for discussing co-movement of global stock markets during the American subprime crisis and the European debt crisis. The results showed that Chinese stock market took a part of external financial risk during the American sub-prime crisis, but the influence of risk contagion weakened during the European debt crisis. A compound copula function adopted by Tang and Xu (2013) to analyse dynamic correlation characteristics of stock market returns in different countries. The correlation in the tails indicated the Chinese stock market was easy to be affected by stock markets in America, Britain, Japan and Hong Kong. Zhen and Zhen (2014) chose the date from stock market, bond market and foreign exchange market in China to discuss the dynamic relationship in different types of markets. The study discovered that volatility spillover effects of risk contagion increased not only the risks in a single market but also the risks of investment portfolio in different markets.

To better understand the micro-mechanism of risk contagion, the study about investor behaviour has become a hot topic and gotten some research conclusions by financial experiments and empirical researches. For example, the correlations of investor’s learning behaviour, marker price and herd behaviour were researched by Dasgupta and Prat (2005). In order to reflect the microscopic mechanism of investor behaviour, Cipriani and Guarino (2008) made many financial experiments and achieved a series of experimental results. Xiao et al. (2012) used quarterly data of mutual funds from 2005 to 2010 and a network quantification model for studying the behaviour of institutional investor and the anomaly of asset price. The empirical results showed that the change of stocks holdings had positive correlation to the network structures of stocks in a bear market, but this correlation is not significant in a bull market. From the viewpoint of behavioural finance, Ma (2012) analyzed investor behaviour in Chinese stock market. In the process of investment, the investor was very easy to generate behavioural bias owing to psychological factors. This behavioural bias could cause risk contagion and anonymous phenomenon in stock market. Hoffmann et al. (2013) examined individual investor perception change and risk-taking behaviour during the financial crisis from 2008 to 2009. Investor perception appeared significant fluctuations in this period. According to the characteristics of institutional investors, Wang (2014) discussed the effect of institutional investors on stock market, which could be divided into positive effect and negative effect. The positive effect centered on enriching types of investment, increasing market sizes, improving the structures of security market, promoting rational investments, and so on. In addition, the negative effect focused on herd behaviour that intensified fluctuations in stock market and affected financial market stability. Abrar et al. (2014) used primary date which was collected through questionnaire to analyse determinants of retail investor behaviour. The findings suggested that the dimension of overconfidence was the most important factor influencing retail investor behaviour.
3. Applications of Agent Modelling Approach to Investor Behaviour

Financial market showed the fluctuation of disequilibrium owing to its great complexity. For a long time, the research of investor behaviour in financial market was often based on efficient market hypothesis and rational expectation. And the investor was regarded as the homogeneous individual having rationality. Due to the differences of knowledge structure, analytical ability and risk preference, investors often showed obvious characteristics of heterogeneity in real stock market. Moreover, the complex feature of financial market became harder to explain under the influence of investor behaviour. In order to solve this problem, some scholars began using agent modelling approach to research stock market risk based on traditional methods. Lux and Marchesi (1999) built a multi-agent stochastic model in stock market based on the volatility of investor sentiment. The investment strategy was divided into two parts: fundamental analysis and technical analysis. The multi-agent stochastic model suggested the idea that scaling in price changes would simply reflect similar scaling in the input signals that influence them. Cont and Bouchaud (2000) discussed the characteristics of fat-tail in stock market by using agent modelling approach, and considered the effect of sheep flock was the main reason of heavy tailed distribution. The conclusion was that investment returns obeyed power-law distribution if the interactive probability between agents was close to a critical value. Based on the research of Cont and Bouchaud, Iori (2002) argued an agent would receive information set in every period after analysing individual decision making. According to the change of information set, an agent could adjust investment decision spontaneously. The feedback mechanism between stock price and threshold value was built in this model. Shimokawa et al. (2006) proposed an agent-based model for word-of-mouth interactions in an artificial stock market and reported how information propagation affected stock prices. Huang (2011) applied a heterogeneous agent model to study Taiwanese stock market. The result suggested that expected price deviated from the short-term moving average and mean, reverted to long-term moving average for fundamentalist investors. Tirea et al. (2012) created a hybrid recommendation system based on a multi-agent architecture that would inform the trader about the future stock trend in order to improve the profitability of a short or medium time period investment. Bertella et al. (2014) constructed an artificial market consisting of fundamentalists and chartists to model the decision-making process of various agents. Excess volatility and kurtosis appeared in the simulation model, when the heterogeneity of the strategies used by the agents was increased. Using an actual and reliable data-set in the Brazilian stock exchange, supports the market making process in high-frequency trading. Jabbur et al. (2014) designed and evaluated some models of automated agents for stock market intraday trading. The modelled strategies are inspired by the Elliot Wave Principle and based on some technical concepts commonly used by stock market analysts. A variety of results were observed, part of them providing gains for all assets in specific trading days, and other part showing losses for other trading days.

4. Concluding Remarks

The first generation crisis model, the second generation crisis model and the third generation crisis model are the most important achievements in the field of theoretic research of risk contagion. These theories show the important reasons of risk contagion contain market expectation, economic fundamental, credit expansion of financial intermediary, financial supervision, short term debt and asset bubble with the background of financial crisis. On the basis of the third generation crisis model, some typical theories gradually formed such as moral hazard theory, financial panic theory, liquidity crisis theory and balance sheet theory after the Asian financial crisis. Since the problem of risk contagion involved multiple individuals in different markets, many scholars discussed the mechanism of risk contagion based on currency market and capital market. The available studies about risk contagion mainly have two types of research thoughts according to the existence of emergency. In the first case, risk contagion could be calculated by price fluctuations of assets in financial markets if an emergency occurred in domestic financial market or international financial market. In the second case, financial risk was able to be transmitted among different markets even if an emergency never happen. But the second type of risk contagion had a characteristic of concealment. As the nature of capital profitability made the capital flow to assets having high return, the whole process of risk contagion could be realized under the influence of capital movement.
In order to analyse microcosmic mechanisms of risk contagion, the studies about investor behaviour make it easy for scholars to learn about the formation and transmission of risk in financial markets. The current researches on risk contagion from investor behaviour perspective primarily centre on cognitive bias of market fluctuation. Some anonymous phenomena can be well explained by analyzing investors’ perceptions and preferences, which are the foundations built the model of risk contagion in financial market, such as BSV model, DHS model and HS model. Under the influence of bounded rationality and cognitive bias, the final transaction behaviour of investor causes asset price fluctuation in a market and risk contagion between markets. It is not hard to generalize a research idea about available literature from the perspective of investor behaviour. The current research approach adopts empirical analysis to describe stock price fluctuation, and then explains risk contagion characterized by stock price fluctuation based on behaviour financial theory. But this research approach realizes a combination of microscopic analysis and macroscopic analysis, the microscopic mechanism of investor behaviour cannot be accurately described in essence. The theory of investor behaviour has certain ability to explain risk contagion, but it is very difficult to quantify investor behaviour by market data. But if investor behaviour is not yet fully expressed by quantifying data, the results of empirical analysis would be inaccurate. Thus, empirical analysis cannot reflect inherent characteristics of investor behaviour. With the development of complexity science, agent-based computational experiment finance can solve this dilemma well.

As a new field of research, agent modelling approach has bright prospects to study the problem of risk contagion. The available researches adopting agent modelling approach to analyse financial risk mainly focus on how to build the artificial stock market, in which model parameters can be adjusted to match a real market condition. In addition, scholars have performed studies on interactive mechanism between the agent and external environment, financial policy simulation, arbitrage strategy, priced mechanism of warrant, and so on. As the design of interactive rule is different, it is gradually formed some representative simulation models based on agent modelling approach, for example SFI-ASM model, modified Lux model, continuous double auction model, prescriptive model, belief learning model, small-world network model. More and more researchers begin choosing computational experiment methods to discuss risk contagion in financial market.

In the above analysis, it is easy to see that agent modelling approach can describe investor behaviour more accurately than traditional analyzing methods. Agent modelling approach discards unrealistic assumptions of traditional economics, and reflects the real market circumstances to the largest extent. In addition, comparing with traditional econometrics methods, agent modelling approach can reveal the interaction mechanism among different market players by computer programming and computer modelling, rather than empirical data and econometric model. In the process of research, agent modelling approach can better reflect the microscopic mechanism of risk contagion, and contribute to realizing the coordination of micro-analysis and macro-analysis in the research field of risk contagion.

5. Acknowledgments
This work was supported by the Fundamental Research Funds for the Central Universities of China (No. GK201803093).

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