Research on the risks of financial derivatives and risk control from the perspective of the financial crisis

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Received 28 October 2014, www.cmnt.lv

Abstract

After the economic crisis in Wall Street in 2008, the risks of financial derivatives and risk control have received great attention from countries in the world. The research on the risks of financial derivatives and risk control can effectively prevent the financial crisis. Through the extraction of the characteristics of risks of financial derivatives, the paper expounds the application of sensitivity analysis and in the risk measurement financial derivatives. The result shows that despite certain achievements of China's financial derivatives in the development process, there is still much room for improvement. Based on the result and with reference to the practice of the UK, US and Japan in the risk prevention and control of financial derivatives, the paper proposes some suggestions.

Keywords: financial derivatives, risk prevention and control, VAR model, financial crisis

1 Introduction

The economic crisis in the world financial center Wall Street in 2008 resulted in the global economic depression. After analysis, researchers believed that the lack of control of the investment in financial derivatives was the main factor. At the same time, as shown in Figure 1, some state-owned enterprises in China like China Railway and China Eastern Airlines also suffered serious losses due to the investment in financial derivatives. In order to effectively limit the investment in financial derivatives, two investment channels were added in the Chinese financial market in 2010 and the new two kinds of investment channels, Several Opinions on Further Doing a Good Job in the Utilization of Foreign Investment was released.

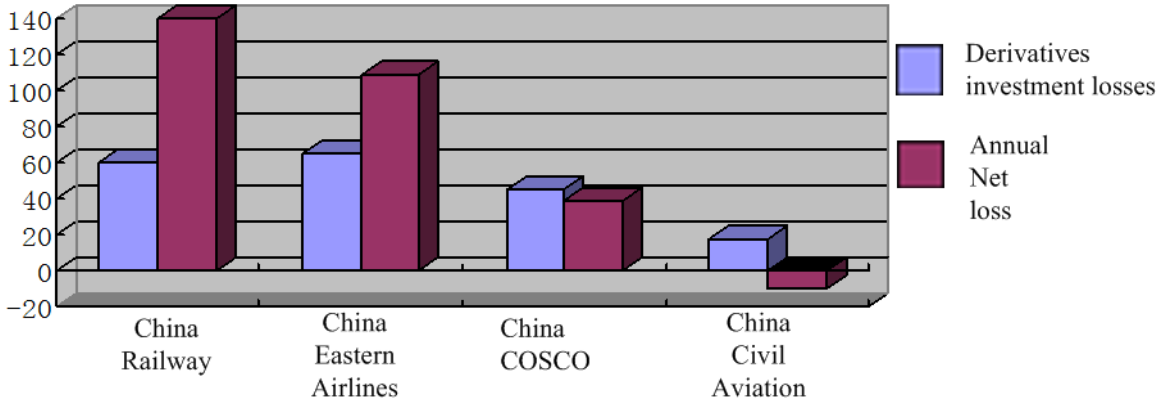

FIGURE 1 The Losses of the investment in financial derivatives in China

The emergence of inflation also let China's economic market face the shock from the development of financial derivatives, which is reflected by the US's economic pressure on China. In addition, financial derivatives are bound to affect China's economy. Many researchers believe that China's market economy will be affected by the development of global financial derivatives and the development orientation of financial derivatives is a common issue concerned by all countries at present. At the same time, whether some derivatives really conforms to our national situation is open to question.

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2 Risk types and characteristics of financial derivatives

ISDA explains the industry of financial derivatives as follow: "financial derivative is a financial instrument used for swapping cash flow, transferring risks, etc. After the trade, the debt is determined by the market stock and index futures. It's also a way of securities trading used to reduce risks". This instrument has many characteristics and owns the basic characteristics of some financial products. As a derivative, its income comes from the gains of other financial products. The slight fluctuations in the financial market can also cause the great changes in its gains, so it's very sensitive to the financial market. Futures and risk contract are the typical types.

2.1 RISK TYPE OF FINACIAL DERIVATIVES

The Group of Thirty (G30) is an authority of studying the risk type of financial derivatives which is mainly composed of professional talents in economy, law, banking, financial academics and other fields with the wide and deep research, because the product function determines its risk characteristics. It's found in the process of research that practice and principle are the important reference for risks. In the trading process, the trading market risk is the main source of risk. Then, the performance degree of other risks is different in different periods. There are other standards for classification. For example, the risk analysis by the IOSCO is more specific than the analysis report of G30. It adds the risk analysis of market liquidity, financial operation and transaction settlement. Here, the analysis report of G30 will be discussed.

2.1.1 Market risk

Affected by the price, the trading market risk has great uncertainty. Price change is the source of risk, such as stock, securities, conversion rate, transacting rate and interest rate. According to the trading characteristics, G30 divides the trading market risk into four types such as interest rate risk. Both bank rate and monetary exchange rate can lead to price changes and then result in losses. Equity risk like the change of securities and stock index may cause losses.

2.1.2 Credit risk

Credit risk cite in the paper mainly refers to the risk caused because the other party does not fulfill the stipulated obligations under the contract spirit. In other words, the fiduciary cannot pay principal and interest in the promising time in accordance with the contract conditions, which will lead to the obvious difference between the actual and expected earnings of the accredited party. It's also the main component of the financial risk under the current market economic environment.

2.1.3 Operation risk

Relative to credit risk, operation risk also has great influence on financial derivatives in the market. Operation risk mainly refers to the possibility of being unable to achieve the expected operation goal due to the environmental factors objectively and the insufficient cognition of the influence of environment subjectively. On one hand, operation risk comes from the systematic vulnerabilities caused by poor operation structure, low operation efficiency and unreasonable internal work arrangement; on the other hand, it comes from the external force majeure, such as the unavoidable losses caused by some things which can't be predicted in advance or by natural disasters.

2.1.4 Legal risk

The daily business activities or all kinds of transaction of commercial banks should abide by the relevant business norms and legal principles. In this process, the commercial banks may fail to fulfill the contract because they cannot meet or violate the legal requirements, leading to issues, lawsuits or other disputes and thus causing the risk of economic loss, which is known as the legal risk.

2.2 RISK CHARATERISITICS OF FINACIAL DERIVATIVES

2.2.1 Suddenness

As a product of the development of financial market in a certain period, financial derivative usually refers to the innovation of the financial instruments appeared on the basis of the original assets. It's characterized by completing the trade in full with the corresponding deposit without the problem of principal transfer. Thus, the trading of financial derivatives has the leverage effect. The less the deposit is, the greater the leverage effect is and the greater the risk is. Because of the low threshold, it is difficult to realize the effective control. Therefore, the risks of financial derivatives have certain suddenness.

2.2.2 Strong infection

Due to the characteristic of linkage of financial derivatives, the value of financial instruments is closely linked to basic products or basic variables. Several financial crises in the history were caused due to the spread of the risks of financial derivatives in the market, such as Mexico's financial crisis.

2.2.3 Huge harmfulness

Under the market economy environment, the harmfulness caused by the risks of financial derivatives is huge. It not only brings serious damage to monomer, but also causes the chain harm. For example, due to the bad financial environment, LTcM in the US suffered the crisis of bankruptcy. However, because the financial derivatives of its assets occupy a large share, its influence in the market is huge. Once LTcM sells its assets, the companies buying the financial derivatives of LTcM will also suffer great losses. If LTcM declares bankruptcy, those accreditors will also face dangerous situation. This thing reflects the serious harmfulness of financial derivatives.

3 Methods of risk measurement of financial derivatives

At present, the expansion of financial accessories raises higher requirements on the existing risk prevention system. The specific measures for risk prevention include sensitivity test and VAR. The former is to test the sensitivity of the relevant elements on the basis of multiple financial accessories. It mainly reflects the trading measures through the sensitivity of risks under some simple trading environments. The latter is to show all risks in the numerical value. The value also means the concealed loss of the trade.

3.1 SENSITIVITY ANALYSISI

The maximum advantage of the sensitivity test is that it allows the user to intuitively observe the sensitivity of the accessories and their values in the transaction. Due to its simple operation, it's favored by the users. After getting the change of elements in the market and the correlation of the produced values, the change of values can be obtained through certain calculation. John C Hull proposed the method of the sensitivity test. The values brought by the derivatives are set to be *F*. It's the function of *S*, α and *t* and is expanded with Taylor:

$$\Delta f = \frac{af}{aS}\Delta S + \frac{af}{a\alpha}\Delta\alpha + \frac{af}{at}\Delta t + \frac{1}{2}\frac{af}{aS^2}\Delta S^2 + \ldots,$$

where *f* is the value of the derivatives; *S* is the standard assets; *a* is the changing probability of the assets price; *t* is the time; Δt is the change of time; Δf is the change of *f*; ΔS is the change of *S*; and, $\Delta\alpha$ is the change of *a*.

In fact, Deltas is the first order function and Gamma is the second order function. In the above equation, Delta means the price change of the derivatives in a small scope in a short period of time on the premise of no any explanation. Gamma means the change in a large scope without sensitivity to the assets on the premise of nearly no explanation. These two derivatives symbolize the linear and nonlinear risk test of the derivatives on the change of assets.

Evga represents the effectiveness degree of the instrument value in reflecting the price change in the market environment. Theta and Rho represent the reflection ability of the derivatives in the risk level.

3.2 VAR ANALYSIS

VAR analysis is also known as Value at Risk. It provides an overall guiding value for the existing risks in the market. Value risk is based on the fixed time and the determined proportion, because the market value risk means the possible harm to the enterprises due to the market interest rate change in certain time and at certain probability.

Risk model establishment and risk calculation measure can be included into two aspects: the first is to get the partial calculation result and the second is to get the global calculation result. Those two different aspects in essence are reflected by the different treating methods of the profits brought by different assets.

3.2.1 Delta-the normal method

The following formula shows the profit earned by an investment portfolio in a certain period of time:

$$R_{P^{t+1}} = \sum_{i=1}^{n} W_{i,t} P_{i,t+1},$$

$$VaR = E(\omega) - \omega^* = W_0[1+E(R)] - W_0(1+R^*) = W_0[E(R)-R^*] = -W_0[E(R)-R^*] = W_0 R^*,$$

(setting $E(R)=0$),

where $W_{i,t}$ refers to the ratio of change of different assets based on the change of time. The change of time can show the development form of an investment portfolio. In the actual application, Delta –normal method first acquiesces the extensive existence of the normal distribution in the profit rate. Represented by $R_{i,t+1}$, the profit rate shows the obvious characteristics of the normal distribution variable in the calculation process. Thus, it can be assumed like that. The variance calculation formula of the investment portfolio is:

$$V(R_{p,t+1}) = {}_{\alpha\sigma\rho}\, W = \alpha\sqrt{x\sum x}.$$

3.2.2 Historical data simulation method

As a common method in the current comprehensive valuation, historical data simulation method can provide the valuation result more conveniently and quickly. In the specific application process, the current weight and the

portfolio composed of historical asset profit rates are its core content.

$$R_{p,t+1} = \sum_{i=1}^{n} W_{i,t} R_{i,t+1} .$$

The complete price data is the basis of the successful application of the method. The price in the t[th] period of time can be calculated with the current price and the historical price changes.

$$R^*_{j-\tau} = P_{j-\mu} + \Delta P_{j,\tau} .$$

With the complete virtual price, the key data in the above formula can be solved. In the process, the non-linear relationship can be verified. Then, the virtual profit ratio corresponding to *r* can be obtained:

$$P_{p.t} = \frac{P_{p,t+1} - P_{p,0}}{P_{p,0}} .$$

On this basis, VAR value can be obtained.

3.2.3 Parameter method

It's also known as the variance-covariance method in some literate with the core of estimating the variance-covariance matrix of the return on assets. It sets the current assumption and the normal distribution assumption to make calculation, namely, $X - \mu / \sigma \sim N(0,1)$ and setting $\mu = 0$, then $X \sim N(0, \sigma^2)$. In the process of solving the σ variance, the equal weight formula can be adopted according to the actual situation. It tests the unconditional volatility in the financial derivative market, that is:

$$\sigma = \sqrt{\frac{1}{n-1} \sum_{t=1}^{n} (R_t - \mu)^2} .$$

The application of the index weight formula can provide us with the conditional volatility, that is:

$$\sigma = \sqrt{(1-\lambda) \sum_{t=1}^{n} \lambda^{n-t} (R_t - \mu)^2} .$$

The equation above can effectively express the volatility of the financial time series in the current market.

4 Empirical Analysis of Risk Measurement with the VAR Model

4.1 NORMAL VAR SINGLE RISK FACTOR δ

The simple statistical processing was done on the trading data in 1308 days with the relevant statistical tools to get the geometric profit rate level in a single period of time. On this basis, the specialized software was adopted to analyze the data statistically and get the daily standard deviation of 0.00142 of the national debt. The data of securities investment funds, stocks and bank deposits were 0.0032, 0.00753, and 0.00097, respectively. In the actual calculation process, we could think that the calculation formula of the maximum level of the negative change of the national debt in a single period of time could be simplified as $0.00142 \times 1.65 \times 1 = 0.00234$ under 95% confidence level. In the same calculation method, the data of securities funds, stocks and band deposits could be calculated to be 0.00528, 0.00753 and 0.0016, respectively.

Thus, the single factor
VAR of the national debt was $27.1 \times 0.00234 = 0.0634$;
VAR of securities was $VaR = 19.4 \times 0.058 = 0.1024$;
VAR of stocks was $VdR = 10.2 \times 0.00753 = 0.1268$
and
VAR of band deposits was $VaR = 43.3 \times 0.0016 = 0.06925$.

After calculation of the total VAR with the factor promoting method, the sum of the absolute values was 0.3618. In the actual application process, the method did not give full consideration to the correlation among four kinds of assets above but made the simple superposition. Thus, from the perspective of historical data, we could get the VAR invested by the insurance company was 0.3618 hundred billion yuan at the confidence level of 95%. In fact, the data proved that in the current market economy environment, more than 95% of people held that the total losses of the insurance company were less than 0.3618 hundred billion yuan in the unit period of time.

4.2 NORMAL VAR OF MULTI-RISK FACTOR δ

Next, on the premise of considering the correlation of assets, the normal VAR of double risk factors was calculated.

$$VaR_{ALL} = \sqrt{VaR_1^2 + VaR_1^2 + 2\rho_{12} VaR_1 VaR_2} .$$

In the equation above, ρ_{12} represented the correlation coefficient of two risk factors participating in the calculation.

The calculation of VAR depending on three risk factors could be expressed as:

$$VaR_{ALL} = \sqrt{VaR_1^2 + VaR_1^2 + VaR_3^2 + 2\rho_{12} VaR_1 VaR_2 + 2\rho_{13} VaR_1 VaR_3} .$$

The calculation formation of VAR of n risk factors could be expressed as:

$$VaR_{ALL} = \sqrt{\left(\sum_i \sum_j \rho_{ij} VaR_i VaR_j \right)^{12}} .$$

The application of matrix sign was the necessary choice in the case of many risk factors. Its basic formula could be simply expressed as:

$$VaR_{ALL} = \sqrt{VCV^T},$$

where V represented the row vector of VAR of n single factors; C was the $n \times n$ correlation matrix between factors; T was the matrix transposition calculation sign.

Through the statistical analysis of four kinds of assets above, the following matrix could be obtained:

$$\begin{bmatrix} 1 & -0.0267 & 0.00716 & 0.54653 \\ -0.0267 & 1 & 0.08848 & 0.05440 \\ 0.00716 & 0.008848 & 1 & 0.00260 \\ 0.54653 & 0.05440 & 0.00260 & 1 \end{bmatrix}.$$

Then, the corresponding normal VAR of δ was:

$$VaR_{ALL} = \sqrt{(0.0634, 0.1024, 0.1268, 0.0693) \begin{bmatrix} 1 & -0.0267 & 0.00716 & 0.54653 \\ -0.0267 & 1 & 0.08848 & 0.05440 \\ 0.00716 & 0.008848 & 1 & 0.00260 \\ 0.54653 & 0.05440 & 0.00260 & 1 \end{bmatrix} (0.0634, 0.1024, 0.1268, 0.0693)^T} \approx 0.19681.$$

The historical market prices of all subjects at the current stage can be known according to the above empirical analysis results. Through the matrix analysis and calculation, the VAR value under 95% confidence level is 0.19681 hundred million yuan, which actually proves that the probability that the company may lose less than 0.19681 hundred million yuan on the current day in the current market economy environment was 95%.

At the same time, the above calculation results also prove that the total VAR of δ is 0.19681 hundred million yuan, which is greater than any single factor VAR obtained above but not greater than the VAR value promoted by total factors. Objectively, the differential investment objects provided in the asset portfolio process are closely correlated. For this reason, the result obtained with the matrix method can ensure the normal VAR of δ is more consistent with the actual situation. Similarly, on this basis, the insurance company can obtain the total VAR and then determine the ultimate loss amount under the extreme situation of 5%, so as to withdraw the reserves in advance and take measures to control the investment risks.

5 Conclusion and Suggestions

Through the above research, despite certain achievements of China's financial derivatives in the development process, there is still much room for improvement. In order to control the risks of financial derivatives in the market economy more effectively, the following aspects must be done:

The first is to strengthen legislation, so as to create a good institutional environment for the development of financial derivatives. The government's laws, regulations and systems on the financial derivative industry are very important for the development of the financial market. Thus, China needs to improve the relevant regulations and systems, make the comprehensive supervision and management of the specific trading processes in the industry, create the reasonable and orderly trading environment for the futures market, protect the interests of both parties to the maximum and realize the good development of the financial derivatives.

The second is to strengthen the external supervision of the finance supervision institutions and ensure the standard development of the financial derivative market. The financial derivative industry in Europe, the US and Japan develops in a good environment, in which the governments play an important role despite their different supervision ways. The strong supervision of the governments ensures the orderly and reasonable development of the market and the bright prospects of the financial derivatives.

The third is to strengthen the supervision on the financial derivative transaction and ensure the fair trading in the exchange. As the important sector managing the financial market and the main place for the financial derivative trading, on one hand, the exchange supervises and manages the orderly development of the financial derivatives; on the other hand, it creates the open and equal environment for the development of the financial market. Considering that the exchange is a sector of investment operation, it should also be fully supervised.

The fourth is to give full play to the role of the self-regulation organization in supervising the financial derivatives. China should draw lessons from the foreign self-regulation organizations of finance to make ours more complete and play the supervision role.

The last is to build the risk measurement model of the financial derivative trading. In order to more accurately predict the potential risks in the financial transactions, the financial enterprises adopt the risk measurement model. The VAR model which is widely used in the foreign countries is an obvious example. VAR model makes precise prediction of the risks in transaction and prevents risks timely or reduce the losses to the minimum when the risks occur in the process of financial derivative transaction, which is conductive to the successful development of the financial derivative market.

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