

Forecasting and Assessing the Impact of Financial Derivatives on Financial Risk

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Abstract

Financial derivatives, as products of advanced financial engineering, have witnessed exponential growth in parallel with China's economic expansion and the rising affluence of its populace. This burgeoning market, while offering sophisticated tools for risk management and investment diversification, has also encountered nascent challenges that warrant rigorous scrutiny and innovative approaches to regulation and oversight. The burgeoning complexity and volume of derivatives transactions necessitate enhanced analytical models to predict and mitigate systemic risks effectively. In this context, the present study seeks to dissect the nuanced impacts of financial derivatives on the risk landscape of China's financial markets. It underscores the dual imperative of leveraging financial innovation for market advancement while fortifying the financial architecture against potential shocks. Utilizing the VaR-GARCH model to dissect the performance of the CSI 300 stock index amid the volatility of recent years (2021-2022), this paper endeavors to elucidate the efficacy of financial derivatives in risk modulation. It also prognosticates future risk trajectories, aiming to contribute to the discourse on fostering a resilient and progressive financial ecosystem in China. Through this analysis, this article aims to construct a mosaic of insights that bolster the strategic deployment of financial derivatives, ensuring they serve as bulwarks of stability rather than conduits of instability, thereby safeguarding and propelling the sustainable growth of China's financial markets.

Keywords

Financial Derivative Instruments, Risk Management, Market Risk Prediction, China

1. Introduction

The excerpt from the 20th CPC National Congress report underscores the

pressing need to address significant challenges in averting financial risks. It emphasizes the importance of fortifying the financial stability guarantee system and ensuring comprehensive regulatory oversight of all financial activities within the legal framework to prevent systemic risks. Financial derivatives, as innovative financial tools of the modern era, have the potential to effectively transfer risks through contractual arrangements. However, the adoption of these instruments in China has not achieved the same level of ubiquity as in other developed nations, and this has introduced considerable latent perils. This is exemplified by the setbacks faced by several state-owned enterprises and listed companies when attempting to utilize European financial derivatives for risk transference.

This research is particularly consequential as it seeks to establish the viability of using CSI 300 index futures within the Chinese financial landscape as a predictive and preventative measure against financial risks. The application of the VaR-GARCH model in this context is crucial to assess the effectiveness of these derivatives. Furthermore, this study delves into the potential pitfalls associated with the integration of such financial derivatives into the mainstream financial apparatus in China. It aims to scrutinize their capability to become a standard financial instrument, drawing from both theoretical insights and empirical evidence. The study's findings are expected to contribute to the broader discourse on financial risk management, providing valuable insights for policymakers, financial institutions, and market participants striving to navigate the complexities of financial derivatives usage and regulatory compliance in China's unique market environment. With so many new market risk prediction technologies and tools being developed today, we need to learn more about new technologies and discover new ways to improve the accuracy and feasibility of risk prediction.

2. Literature Review

According to the research of scholars and the long-term practice overseas (the United States and Europe, etc. have started to use in the beginning of the twenty-first century) it can be found that financial derivatives are extremely effective in the prevention of financial risks that will occur in the future and in the allocation of losses. Financial derivatives are contractual instruments derived from the financial system to help companies redistribute, similar to futures contracts and other examples. Wang Buhang once said from the theoretical analysis, financial derivatives can neither further reduce the risk, nor create the risk, only to present a further distribution, that is to say, for the risk of the transfer of hedging is not willing to bear the risk, so this part of the risk falls on speculators (Wang, 2020). Therefore, the generation of financial derivatives will not bring new impact or fluctuation to the risk of the economy, but will not bring new impact or fluctuation, and will not bring new impact or fluctuation to the risk of the economy. Therefore, the substitution of financial derivatives itself does not bring new effects or fluctuations to the risks within the economy, and it is a very relia-

ble way.

Wang Boyi once said that the so-called financial risk, in fact, refers to the financial institutions, the financial industry, even including the bank of the capital risk of the collective term (Wang, 2023). Zhang Xingqi pointed out that from this point of view to understand, financial risk is mainly due to the economic development process of the uncertainty of the factors caused by the financial risk, and this uncertainty often has a greater harm, and therefore must attract sufficient attention in the financial market industry, the financial complexity of the problem of the diversity brought about by the cause of financial risk cannot be judged to be the same, or the cause of financial risk is different, or the cause of financial risk is not the same (Zhang, 2017). Or the causes of financial risk are different and diverse, which also directly leads to the randomness of financial risk management methods. In addition, due to the hidden nature of financial risk, for example, in the operation and management of funds in the early stage, people may sometimes not realize the existence of the problem, and its impact is likely to lead directly to the later stage of the funds are difficult to manage, and thus bring financial risk, leading to the outbreak of a series of economic crises. The impact of such risks can be felt across a wide range of industries, with unimaginable and unpredictable consequences. Therefore, it is necessary to predict and control financial risks at an early stage.

In order to minimize the possible loss of the enterprise in the financial risk, financial derivatives can be reasonably applied to help the enterprise to transfer or relocate its risk. However, financial derivatives are also a double-edged sword, which has both advantages and disadvantages for the development of enterprises. In terms of its advantages, in the market, the effective use of derivative financial instruments can avoid risks and allow people to hedge. Its continuous innovation also greatly promotes the development of basic financial instruments, and at the same time broadens the business of financial institutions, improves the efficiency and promotes the secularization of the financial market. However, in terms of their drawbacks, financial derivatives are subject to various risks such as credit risk, legal risk and market risk. For example, in July 1997, Thailand abandoned the fixed exchange rate of the Thai baht against the US dollar, which triggered off a major financial shock in Southeast Asia. However, financial derivatives can propel the financial market to another level if the risks associated with them are properly prevented and legal awareness is maintained.

Therefore, in order to better know the risk impact of financial derivatives on the financial market, the VaR-GARCH model can be invoked to analyze it. VaR (value at risk: Value at Risk) refers to the maximum amount of loss of the value of a certain financial asset or portfolio of securities in a specific period in the future at a certain level of confidence (either in absolute value or in relative value) (The formula for VaR is: $P(\Delta p \Delta t \leq \text{VaR}) = \alpha$). The VaR-GARCH model is built by modeling the historical up and down data of individual stock index futures contracts or stock price indexes, analyzing and fitting GARCH curves to obtain the variance equations and their predicted standard deviations, and accurately

calculating the VaR of stock index futures contracts and their forecasting standard deviations on a trading day by using value-at-risk (VaR) method at a certain level of confidence (Ji, 2018). Under a certain confidence level, we use the value-at-risk method to accurately calculate the VaR value of a stock index futures contract on a trading day and test its reasonableness through the confidence interval (Vitov et al., 2012). The CSI 300 stock is a typical financial derivative, which is one of the familiar financial derivatives. Through the CSI 300 stock index futures launched by China Financial Futures Exchange, the VaR-GARCH model is invoked to carry out the agglomeration test, smoothness test, and normality test of the return distribution (Chen, 2008). The GARCH (1,1) model is further fitted to the data and found to be more feasible and overlapping.

In conclusion, financial derivatives, when employed with due diligence and legal awareness, can elevate financial markets by mitigating potential losses. However, understanding the complexities and inherent risks is crucial to leveraging their benefits effectively. Future research should continue to refine these models, ensuring that financial derivatives remain a potent tool for risk management in an ever-evolving economic landscape.

Since our country has less knowledge about financial derivatives, it does not have as mature a framework as developed countries such as Europe and the United States, which have been utilizing them for decades. I believe that China needs to build its own financial system on the basis of its own merger and production of its own financial derivatives, rather than relying on some overseas enterprises to transfer risks. Only with the control of financial derivatives in their own hands can they avoid potential risks. And in terms of future trends, the flow of digital currency form has gradually occupied a dominant position, financial derivatives in our country to appear and occupy a place is inevitable, so we need to learn more knowledge, less detour. Similar to financial derivatives, there are various new digital financial derivatives and cryptocurrency derivatives and other new derivatives appearing, perhaps all of which will bring different benefits in various aspects.

Secondly, the main reason why financial derivatives are prone to risk is the lack of market regulation, most financial derivatives are not integrated planning, China should establish a market regulator to carry out extensive management of the overall derivatives as well as the popularization of knowledge, so that more listed companies to see this product as well as how to dominate the use of. Finally, there are a few ways to learn from: First, the Chinese government should strengthen the knowledge supplementation and full coverage of each enterprise (including state-owned enterprises, central enterprises, individual enterprises and Chinese-foreign joint ventures), so that each enterprise's knowledge of financial derivatives can be strengthened in this weak area. Also, companies should strengthen their hard power and soft power at the same time. The industry needs to have more professional people to carry out this kind of operation, and companies need to look for people who have the relevant ability and operation experience to manage them, or through continuous self-learning to grow up

in the midst of failures, to improve the proficiency in the use of financial derivatives (Yi, 2018). In the process of development of the international market, financial derivatives transactions are also actively carried out, and their transactions are characterized by supra-government and supra-national boundaries, so it has become a major consensus among the financial authorities of various countries and the international financial community to further strengthen the control and comprehensive grasp of financial transactions, and to promote international and supervisory cooperation. After the case of the Bank of Bahrain, the international community has begun to control the risks of financial derivatives, and the Basel Accord has been supplemented and amended with regard to the risk prevention and control of off-balance-sheet business, so as to further reduce the potential risks of financial derivatives, and further enhance the risk prevention and control ability of banks.

3. Methods Introduction

Financial time series are an important area of application and research in probability theory and statistics. In particular, one of the challenges facing this field is the presence of heteroskedasticity effects, i.e., the volatility of the process under consideration is usually not constant. In particular, simple GARCH (1,1) models have been widely used in financial time series modeling and are implemented in most statistical and econometric software packages. Many economists favor GARCH (1,1) models because of their relative simplicity of implementation: since they are given by stochastic difference equations in discrete time, the likelihood function is easier to handle than in continuous time models, and since financial data are usually collected at discrete intervals. And GARCH (1,1) has his own advantages on predicting datas. It is able to handle volatility in finance. GARCH models are able to model volatility in financial time series, which is not possible with other time series models.

And it is able to perform well in forecasting. GARCH models are able to accurately predict volatility in financial time series, which is very important for risk management and investment decisions in financial markets. It is also High flexibility. The GARCH model can be adjusted and optimized according to the different characteristics of the data to get more accurate prediction results.

The model that will be applied in this experiment is the GARCH (1,1) model. GARCH (1,1) stands for Generalized Auto-regressive Conditional Heteroskedasticity, which is a commonly used tool for modeling volatility in financial time series data. This model consists of two main components: an auto-regressive component (AR) and a conditional heteroskedasticity component (ARCH). The parameters of a GARCH (1,1) model are usually determined by maximum likelihood estimation (MLE). The goal of maximum likelihood estimation is to find the values of the model parameters that maximize the probability that the model will produce the observed data. This can be accomplished using a statistical software package. Once the model parameters have been estimated, the fit of the

model needs to be evaluated.

4. Data Collection

This data utilizes the price changes of CSI 300 stock index futures returns for almost five years from 2018-12-28 to 2023-09-01 (China's Financial Future Exchange database) imported into the program and finally the GARCH (1,1) model was chosen to have a greater advantage over the original VaR model. The value of return is derived by $\sigma^2 t = \omega + \alpha \sigma^2 t - 1 + \beta \sigma^2 t - 1$, and then the time series in numpy is utilized to call the model in python library for estimation (Tsay, 2005). And in this context the values of mean and variance are derived based on AIC criterion (The Akaike information criterion AIC is a mathematical method for evaluating how well a model fits the data it was generated from. In statistics, AIC is used to compare different possible models and determine which one is the best fit for the data.) and SIC information criterion (is a measure of the goodness of fit of a statistical model. It is often used as a criterion for model selection among a finite set of models), which are calculated through Eviews software and finally the results are as follows:

As we seen in **Figure 1**, on this basis the VaR value in 95% confidence level is calculated by the formula of the GARCH (1,1) model, which yields a plot line comparison of the predicted value with the absolute value of the return, similar to QQ plot in statistics. The overlap between the line and the plot is compared. When there is a tendency for the line in the graph to overlap with the bar graph data, and when they intersect in more than one place, it means that the model's are somehow useful. For financial time series, volatility tends to have the following characteristics: 1) There is volatility aggregation. That is, volatility is high over time and low over time. 2) Volatility varies in continuous time with few jumps. 3) Volatility does not diverge to infinity, volatility tends to be smooth. 4) Volatility reacts differently to large price increases and large price decreases, a phenomenon known as leverage. (Pan) one can observe the graph below.

VaR is the maximum possible loss of a portfolio at a future time under a certain confidence interval, and mathematically it measures the quantile of the distribution of portfolio gains and losses, assuming that c is the confidence interval we choose, then VaR corresponds to the quantile of the distribution of gains and losses of $1-c$ the lower tail of the P&L distribution. For example, if the confidence interval is 95%, then VaR is equal to the quartile at 5% of the P&L distribution function. VaR measures the tail loss, i.e., the extreme loss under normal market volatility, which explains the maximum possible loss under normal market volatility, not the loss under extreme market scenarios. As **Figure 2** showed above, what counts as an extreme scenario would be major movements such as wars, political and financial crises. The VaR prediction value obtained with the VaR-GARCH model must be greater than or equal to the absolute value of each trading day's return, and a comparison of the data shows that the resulting prediction value basically has a great deal of overlap with its return, which suggests that its methodology can be applied.

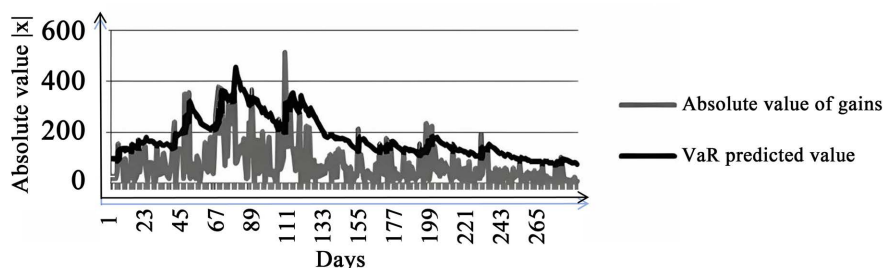


Figure 1. Comparison of forecast to actual futures rate curve.

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Dep. Variable:          price      R-squared:                0.000
Mean Model:            Constant Mean  Adj. R-squared:          0.000
Vol Model:             GARCH        Log-Likelihood:         -8020.12
Distribution:          Normal       AIC:                    16048.2
Method:               Maximum Likelihood  BIC:                    16068.4
Date:                 Wed, Sep 27 2023  No. Observations:      1135
Time:                 02:47:15      Df Residuals:          1134
                                           Df Model:              1
                                           Mean Model
=====
                    coef  std err      t      P>|t|      95.0% Conf. Int.
-----+-----
mu                 3953.1009   13.886    284.682   0.000   [3.926e+03, 3.980e+03]
                    Volatility Model
=====
                    coef  std err      t      P>|t|      95.0% Conf. Int.
-----+-----
omega              1463.5341   447.337     3.272   1.069e-03   [5.868e+02, 2.340e+03]
alpha[1]           0.8449   6.558e-02    12.883   5.630e-38   [ 0.716,  0.973]
beta[1]            0.1551   6.451e-02     2.405   1.617e-02   [2.871e-02,  0.282]
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Figure 2. A partial screenshot of the data computed using the VaR model.

5. Conclusion

From the above data, we can actually see that financial derivatives similar to the CSI 300 stock index futures such a similar risk transfer tool in fact to a certain extent can be able to transfer the company's risk so as to reduce the company's risk. However, due to the precedent of many former listed companies, including state-owned enterprises, cooperating with Europe to carry out financial derivatives and expert risk overseas to end in failure, but there are lots of new starts coming out, For example, The European Futures Exchange (EFE) launched its Asia Training and Education Program in August 2010 to build partnerships and provide expertise and valuable information to market participants. The program covers the regions and markets of Chinese mainland, Hong Kong SAR, Taiwan Region, Singapore, India, Japan, UAE and Malaysia. The objective of the training and education program is to provide professional education and training in derivatives to those in the trading and investment fields, thereby raising the overall level of the market and developing new industry players. The training includes an introduction to the European market and the teaching of futures and options trading theory and experience. Under the program, Eurex has partnered with a number of leading Asian universities and industry organizations, including the China Futures Association, Shanghai Advanced Institute of Finance of

Shanghai Jiao Tong University, Chinese University of Hong Kong, National Taiwan University and Singapore Management University. To date, more than 5000 people have participated in professional training courses and other activities organized by Eurex in Asia. China in the development of financial derivatives there are still many places to pay attention to (Wang, 2011). First of all, the most dangerous place is that it can be shorted, because most of the financial derivatives are futures and many companies and unscrupulous interest organizations will engage in illegal shorting and other forms of illegal profits leading to extremely serious consequences.

In the future domestic development of financial derivatives on risk prediction and prevention, it is hoped that more people will pay attention to this area, as well as through more experience in the use of futures to get better practice, so as to be able to achieve the ideal minimization of market risk. It is also hoped that companies will cooperate with each other and contribute their own basic information, so that they can integrate and make market operations and risk avoidance more possible.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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