



Financial Derivatives: Application and Risk Management

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ABSTRACT

While financial derivatives are a necessary hedge in today's financial markets, they also carry substantial risks. There has been a steady stream of cases of significant losses incurred by companies investing in derivative financial instruments around the world. The highly leveraged nature of derivatives has created a crisis in the financial system. This paper uses a combination of theoretical analysis and case analysis, starting with introducing the origins of derivatives, the principles of trading and the explicit and potential risks that may be encountered. Then, two specific corporate case studies are presented to demonstrate the improper usage of financial derivatives and the crisis that might result from an ineffective risk management strategy. Finally, recommendations for risk management and derivatives regulation systems are presented. It is hoped that the research in this paper will lead to a better understanding of the importance of strengthening regulation and risk-aversion awareness in the financial derivatives market. In addition, provide existing companies with a new approach to derivatives risk management to help the financial derivatives market achieve steady growth.

Keywords: *Financial derivatives, Application, Risk management, Hedging, High leverage.*

1. INTRODUCTION

Since the 1970s, with the development of economic globalization, floating exchange rates have replaced fixed exchange rates and most countries have gradually deregulated their interest rates. The marketization of financial factors has further optimized the allocation of resources, enhanced market efficiency, and promote economic development, but inevitably also brought about an increase in the volatility of interest rates and exchange rates. The need for risk management has arisen among market participants and the derivatives market with its risk management role has grown significantly. Despite the international financial crisis in 2008, the derivatives market has still maintained a steady development with the adoption of the "Dodd-Frank Act" and the relevant regulatory regimes in various countries [1].

When the first financial derivative, the "futures contract," was introduced by the Chicago Board of Trade in 1865, investors have used the futures market as their main financial instrument to hedge against forwarding risk. In today's well-established financial market system, the variety and volume of financial derivatives far exceed that of financial products such as stocks and bonds. As

the essence of financial derivatives is to diversify risk, only through continuous in-depth research and innovative expansion of financial derivatives can we gradually meet the investment needs of a wide range of investors [2].

This article reviews the origins and development of financial derivatives; Section 2 describes the types of derivatives transactions and risks that financial derivatives may present to firms; Section 3 investigates the inappropriate use of financial derivatives and the crisis that can be caused to corporations by a faulty approach to risk management, using case studies of Metallgesellschaft and Lehman Brothers; Section 4 discusses the future direction of derivative innovation and offers risk management recommendations; Section 5 summarizes the whole article and indicates investors should use financial derivatives more prudently and effectively.

2. CONTENTS OF FINANCIAL DERIVATIVES

2.1. Form of trading

Financial derivatives are financial instruments that are derived from underlying assets and can be classified as either exchange-traded or over-the-counter (OTC) trades. Exchange trading refers to centralized trading on an organized exchange. This type of trading is characteristic of the exchange in that it collects margin from participants and is responsible for clearing and guaranteeing performance. The contractual structure of OTC trading is less flexible and more regulated than that of OCT trading, and new contract types designed by market participants on exchanges are usually evaluated by regulators, which is not only time-consuming but also costly [3].

OCT transactions, on the other hand, are primarily conducted on a private bargaining basis, with the size of the contract or agreement entered into, the terms and conditions, and the settlement price tailored to meet the specific needs of the client. As there is no centralized clearinghouse and does not have a centralized mechanism to limit individual and pooled exposures, leveraged assets, credit rollovers. Risk management can be seen as fully decentralized. Thus, the credit or default risk associated with OTC contracts would be greater and the risk management challenges would be greater [4].

A typical feature of financial derivatives is that they can be traded on margin, which allows investors to trade fully by paying a certain percentage of margin, without actually transferring the principal. As a result, financial derivative transactions are leveraged, and the smaller the margin, the greater the leverage effect and the riskier the transaction [5].

2.2. Risk associated with trading derivative

2.2.1. Market risk

Headings may be numbered or unnumbered (“1 Introduction” and “1.2 Numbered level 2 head”), with no ending punctuation. As demonstrated in this document, the initial paragraph after a heading is not indented.

Investors are always exposed to market risk due to fluctuations in asset prices, which is not an additional risk to financial derivative products. If the direction of the price movement of the underlying instrument is incorrectly forecast, significant financial losses can be incurred.

2.2.2. Credit risk

In derivatives trading, the risk of default or inability to perform by the counterparty to a contract is known as credit risk and arises primarily from the OTC market.

OTC products are personalized products negotiated privately between traders and do not have the margin requirements of over-the-counter trading, which may result in losses due to non-performance by the counterparty. Therefore, even if there is no market risk in an open position in a derivative transaction, there is still credit risk, and the longer the maturity date, the greater the credit risk. As companies tend to hedge their risk through reverse trading rather than disaggregate it in risk management. This can lead to a situation where, to manage an initial risk, a series of products involving multiple traders may be traded in the market, thus significantly increasing the overall credit risk of the market [6].

2.2.3. Liquidity risk

There are two sorts of liquidity risks. Market liquidity risk refers to the risk of being unable to trade or terminate a position due to a shortage of counterparties in the market. Financing liquidity risk refers to the risk of a trader losing money or even going bankrupt due to insufficient liquidity to meet trading capital requirements. In derivatives trading, this is mainly due to the risk that an investor's position will be closed out due to insufficient liquidity to cover margin calls. The extent of liquidity risk depends on the standardization process, the size of the market, and changes in the market environment.

Liquidity risk is low in the case of exchange-traded standardized contracts, owing to the high degree of normalization, the market's size, and traders' capacity to cover their positions at any moment in response to changes in the market environment. However, in the case of OTC derivatives, each contract is effectively personalized, and there is no liquid market to which it can be transferred, making reselling difficult, and hence the liquidity risk is substantial [7].

2.2.4. Management risk

This is the risk associated with managers' errors of judgment, information asymmetry, or limited competence during management operations. This includes deficient automated trading, insufficient internal controls, insufficient contingency preparations, and human errors and management failures. If management problems occur, they can cause irreparable losses to the business and its managers and may inadvertently lead to market and credit risk [5].

2.2.5. Leveraged trading systems have the characteristic of magnifying risk

The majority of financial derivatives are traded on margin, making it possible for investors to trade financial derivatives that are several or even tens of times larger than their capital with only a small margin deposit. This leveraged trading while significantly reducing risk management and arbitrage costs for hedgers and

arbitrageurs. This has also led to increased speculation, which has substantially increased the number, size, and incentive to speculate.

In essence, leveraged trading is a higher risk for a higher return, and a higher risk can mean both a much higher return than capital and a much higher loss than capital. If a trader makes an error in judgment or a mistake in operations, this can lead to large losses and put the trader in a position of bankruptcy, which can lead to further risk of the financial crisis in the market [8].

3. SIGNIFICANT TRADING LOSS CASES FOR ENTERPRISES

With increasing global competition, the development of the financial derivatives market has provided companies with many beneficial instruments for risk management and the demand for derivative products is also becoming more and more customized. The highly leveraged and complex nature of financial derivatives and the opacity of information in operation dictate that while they are effective in helping companies to hedge their risks, they can also expose companies to significant risks.

By analyzing specific case studies of companies that have used financial derivatives incorrectly and thus led to significant losses or bankruptcy, this paper attempts to help other companies optimize their use of financial derivatives and mitigate the pitfalls associated with derivatives.

3.1. Case of Metallgesellschaft Hedging Debacle

3.1.1. Overview of Metallgesellschaft case

Metallgesellschaft AG (MG), is one of Germany's 14th largest conglomerates with 258 subsidiaries. In the early 1990s, the company's American affiliate MGRM launched a new energy business, selling merchants fixed-price contracts for oil with monthly deliveries for two, five, or ten years. MGRM had sold approximately 160 million barrels of oil products under fixed-price contracts by December 1993, rather than procuring physical oil and keeping it for future sale, it opted for a synthetic storage approach that involved a combination of short-term futures and swaps. MGRM purchases short-term futures or swaps for the entire 160 million barrels of oil products committed for delivery under its fixed-price contracts in order to implement stack-and-roll hedges [9].

This rollover technique, however, is cost-free only if the spot price of oil is equal to the forward futures price. If the recent contract price is greater than the forward contract price, a backwardation market exists, and the rollover strategy results in an additional rollover profit. As the expiring contract can be sold for a higher price and the extended futures contract can be purchased for a

lower price. In contrast, if the recent contract price is lower than the forward contract price, indicating a contango market, rollover results in a rollover loss. Oil prices began to fall in 1993, and the futures market transitioned from backwardation to contango. Since losses on futures positions needed to be settled immediately, management faced an increased need for large amounts of cash to meet their daily mark-to-market margin requirements in futures contracts. MGRM and its parent company, MG, did not have enough cash to meet all of its obligations, thus MG was on the verge of bankruptcy by the end of 1993 as a result of this serious cash shortage. MGRM lost \$1.3 billion in futures and swaps, the total loss equating to a loss of more than half of MG's capita [10].

3.1.2. Suggestions for risk management measures

The reasons for Metallgesellschaft's substantial losses are directly related to external market factors. For example, the failure of the OPEC to reach an agreement has caused oil prices to fall for a short period, and these factors are difficult for companies to anticipate in advance. However, this case also reveals several internal risk management failures that can be contributed to some extent to the underlying causes of MG's losses.

MG's hedging strategies should be improved in four areas. Firstly, proper oil physical storage is required. If physical storage of oil is implemented, oil can be obtained at reduced prices under the terms of forwarding contracts. However, this strategy hedges the risk while losing most of the profit. Through a detailed break-even analysis, the company should be able to get a better price for the supply agreement while cutting down on risk [9].

Secondly, position adjustment. MG maintained a long position in the futures market of 55 million barrels of oil to hedge its risk, while swap holdings were approximately 100-110 million barrels. Due to a large number of holdings, MGRM is subject to a high risk of adding in subsequent market operations, which contributed significantly to MG's eventual losses when the market direction shifted. Furthermore, MGRM has not implemented any strategies to lessen its risk when oil prices fall. MGRM should adjust the size of its positions according to the different times and prices [11].

Third, depending on the time of year, MGRM may change the assets utilized to hedge its exposure. For example, historical data shows that from April to November, gasoline is indicated as a Backwardation market, thus MGRM may consider altering its position to generate rollover profits when the oil futures market is adverse [10].

Finally, the transparency and liquidity of the company's trading information should be increased. MGRM's forward contracts were booking profits during the oil price collapse, and MGRM may have

contemplated securitizing assets. Meanwhile, the company should increase the liquidity of the forward contracts to obtain cash to meet margin calls. In addition, consideration can also be given to disclosing some of the contracts and strategies and seeking credit enhancements such as bank guarantees to address credit risk issues. A bank guarantee is a deposit in the form of a written commitment from a bank, which is a monetary guarantee provided by a third party. The bank guarantee can optimize the allocation of limited funds compared with cash margin payment and avoid the complicated procedure of collecting and returning the margin, which improves efficiency [12].

3.2. Case of Lehman Brothers Bankruptcy

3.2.1. Overview of the Lehman Brothers case

On September 15, 2008, Lehman Brothers Holdings Inc., the fourth-largest investment bank in the United States, filed for bankruptcy protection, commencing the largest bankruptcy procedure in US history. Prior to this, Lehman Brothers, as an investment bank, was not supervised in the same way as a deposit-taking commercial bank. Hence, Lehman Brothers had a long history of successfully pursuing a highly leveraged and risky business model. Investment banks were also not subject to regulatory capital requirements, which allowed Lehman Brothers to borrow on very short notice and hold riskier long-term assets with lower levels of capital or reserves to respond to changing market conditions. At the time Lehman Brothers needed to raise billions of dollars a day to keep up with its operations. Since 2006, Lehman began investing extensively in real estate-related assets, particularly housing and subprime mortgages. In the wake of the US subprime crisis, Lehman's assets shrank significantly due to its huge holdings of mortgage securities, and the company's share price plummeted by almost 95% in the year following the subprime crisis. Therefore, the demise of Lehman Brothers was the result of its highly aggressive leverage policy in the context of a market financial crisis [13].

3.2.2. Analysis of reasons for Bankruptcy

The main reasons for Lehman's collapse are divided into the impact of the external economic environment caused by the subprime mortgage crisis and the failure of the company's internal management decisions.

3.2.2.1. Impact of the subprime mortgage crisis

Between 2000 and 2006, the US house price index rose by 130%, reaching the highest rate of increase in an upward cycle. Interest rates fell precipitously during this time, house prices rose, and borrowers and lenders became more risk-averse because of higher yields. Besides, financial derivatives like subprime loans, CDOs,

and CDSs rose quickly in the United States. However, beginning in 2006, house prices began to decrease, falling an average of 3.5% in a single year. Lehman held a large number of subprime loans and financial derivatives backed by subprime loans, which meant that when marketing interest rates rose and home prices fell, the high risk inherent in them detonated instantly, resulting in massive losses.

In mid-summer 2007, the subprime mortgage crisis started in the United States. This started a global financial storm that led to the collapse of Lehman Brothers. As the crisis continued to wreak havoc on the market, widespread panic ensued, and investors incurred credit risk against investment banks. The faith of Lehman's numerous clients waned, and clients withdrew considerable sums from the company, resulting in a "bank run". In addition, a significant downgrading by the rating agencies greatly increased Lehman's financing costs and ultimately made it impossible to continue [14].

3.2.2.2. Excessive concentration of business

The over-concentration of Lehman Brothers' business in the fixed income sector prevented Lehman from getting out of the fixed income sector rapidly enough to transform it into cash in the short term when it encountered a liquidity risk. Even though Lehman made progress in other sectors like mergers and acquisitions and stock trading in the years before the collapse, it was still a long way behind its competitors when it came to business diversification [15].

3.2.2.3. Over-leveraged and highly dependent on short-term financing

With limited capital of their own, Lehman Brothers had to rely on the bond and interbank lending markets to raise funds to expand their business. Lehman's leverage ratio was 23.9 times in 2004 but climbed to 30.7 times in November 2007. While this model boosted profitability, it also multiplied risk.

Additionally, due to the relatively high proportion of short-term debt, Lehman Brothers' business model necessitated a high level of short-term liquidity, and its holdings of real estate mortgages and other assets were considerably impaired and difficult to realize following the crisis, leaving the company with serious short-term liquidity concerns [13].

3.2.2.4. Management's lack of risk awareness and poor decision-making

As a high-risk industry, Lehman's profitability relies heavily on the firm's ability to identify and assess risk, and its ability to manage the balance of risk to match its potential returns. Lehman used to establish a series of systems to manage the firm's risks, such as establishing

limits at the beginning of each year on the risks it could take for the year and using stress tests to determine the potential losses that could result from adverse effects of the economic environment on its assets and portfolio.

However, these risk management measures are not implemented. When management discovered that the company's risk exposure had exceeded the established threshold, they did not attempt to mitigate the risk. Instead, they were addressed those investment operations that posed an excessive risk by increasing the company's risk limits.

Additionally, as a result of the last great performance, management took an excessively optimistic view of the situation. A serious misjudgment of the future situation was made, allowing Lehman to continue to expand its business in 2007 when the first signs of a crisis in the property market were emerging [13, 15].

4.IMPROVEMENTS AND INNOVATIONS

To avoid a more severe global financial crisis and the serious economic losses caused by the proliferation of non-compliant financial derivatives. On the other hand, improving the supervisory regime for financial derivatives. Regulators should strengthen the public disclosure regime for financial derivative transactions and improve the financial reporting standards for accounting to increase the transparency of financial derivative transactions as well as limit the use of leveraged trading by companies. Besides, with the flexibility of the OTC market and the convenience of avoiding regulation, a corresponding OCT clearing system should be built to bring OTC market information under regulatory control, which would greatly reduce counterparty risk in the OTC market [4].

On the one hand, the role of credit derivatives should be exploited. Enable investors to manage capital and credit by using credit derivatives, for example by using CDS indexes to hedge the credit risk of their portfolios. In terms of capital management, commercial banks and investment banks should only be allowed to make limited use of credit derivatives such as CDS for risk mitigation and capital mitigation under the standardized approach and internal ratings approach in strict accordance with the relevant provisions of the "Basel Accord". Additionally, the credit market is a market with a high degree of information asymmetry. So, financial technology platforms should be established to collect information and data on issuers or borrowers via big data and cloud computing. As a result, information asymmetries will be reduced, and credit risk will be managed more effectively [14].

5. CONCLUSION

This article provides an overview of the derivatives market and uses theoretical analysis and case studies to introduce how derivatives are traded, the associated risks, misconceptions about the application of derivatives by companies and improvements to market risk aversion. By describing the theoretical basis, the reader is provided with an understanding of the process and profitability mechanisms of derivatives trading and the risks to which they may be exposed. In addition, investors' awareness of the risk management of derivatives is enhanced through case studies of specific companies' failed use of derivatives.

Through the above analysis, this paper has the following four conclusions: The purpose of financial derivatives is to mitigate risk. The prudent use of derivatives contributes to the enhancement of enterprise value, the improvement of overall efficiency, the upgrading of industrial structure, and the optimization of resource allocation. Secondly, governments and regulators should strengthen the legal framework for derivatives and implement dynamic regulation. The regulatory system needs to adapt to the changing nature of risk and the development of derivatives. The financial crisis of globalization can be avoided by constantly adapting regulatory instruments and improving the quality of regulators. Thirdly, the application of derivatives needs to be matched with a diversified corporate business model. A single sector structure is not conducive to the use of financial derivatives, and companies that do not have sufficient conditions should use derivatives with caution. Fourthly, the development of derivatives should not be separated from the real economy and leveraged transactions should be used with caution to avoid the creation of a bubble economy.

In the future, the financial derivatives market should improve its stability and reduce its risks through more in-depth research and practice. Also, ensuring that investors can effectively use derivatives to hedge risk and create higher value with reasonable risk management. Markets and companies can develop their derivatives business more steadily and within a robust, transparent, and orderly framework.

REFERENCES

- [1] A. Stankovska, Global derivatives market, *Seeur Review*, vol.12, no.1,2017, pp. 81-93.DOI: 10.1515/seeur-2017-0006
- [2] S. Mixon, Option markets and implied volatility: Past versus present, *Journal of Financial Economics*, vol.94, no.2, 2009, pp.171-191.DOI: <https://doi.org/10.1016/j.jfineco.2008.09.010>.
- [3] V. Somanathan, A. Nageswaran, *The economics of derivatives*, Cambridge University Press, 2015.

- [4] J. Gregor, Central counterparties: mandatory central clearing and initial margin requirements for OTC derivatives, John Wiley & Sons, 2014.
- [5] M. Chisholm, Derivatives demystified: a step-by-step guide to forwards, futures, swaps and options, John Wiley & Sons, 2011.
- [6] R. Das, Credit risk derivatives, World Scientific Reference on Contingent Claims Analysis in Corporate Finance, vol.3, no.2, 2019, pp. 373-400. DOI: https://doi.org/10.1142/9789814759601_0014
- [7] D. Bongaerts, F. De Jong, J. Driessen, Derivative pricing with liquidity risk: Theory and evidence from the credit default swap market, The Journal of Finance, vol.66, no.1, 2011, pp. 203-240. DOI: <https://doi.org/10.1111/j.1540-6261.2010.01630.x>
- [8] N. Mandelker, G. Rhee, The impact of the degrees of operating and financial leverage on systematic risk of common stock, Journal of financial and quantitative analysis, vol.19, no.1, 1984, pp.45-57. DOI: <https://doi.org/10.2307/2331000>
- [9] C. Haddock, Reexamining Metallgesellschaft's Hedging Policy: Does Anything Beat a One-For-One Hedge Ratio, All Graduate Plan B and other Reports, vol.1465, 2020. DOI: <https://doi.org/10.26076/78d7-e3f2>
- [10] D. Saha, The Collapse of Metallgesellschaft (MG): Hedging or Speculation, SSRN 2394915, 2011. DOI: <http://dx.doi.org/10.2139/ssrn.2394915>
- [11] E. Krapels, Re-examining the Metallgesellschaft affair and its implications for oil traders, Oil and Gas Journal, vol. 99, no.13, 2001, pp.70-77.
- [12] M. Wahrenburg, Hedging oil price risk: Lessons from Metallgesellschaft, Univ Fachbereich Wirtschaftswissenschaften, 1996.
- [13] R. Wiggins, T. Piontek, A. Metrick, The Lehman brother's bankruptcy a: overview, Yale program on financial stability case study, vol. 1, no.3, 2014. DOI: <http://dx.doi.org/10.2139/ssrn.2588531>
- [14] A. Jarrow, The role of ABS, CDS and CDOs in the credit crisis and the economy, Rethinking the financial crisis, vol.202, 2011, pp. 210-235
- [15] R. Swedberg, The structure of confidence and the collapse of Lehman Brothers, Research in the Sociology of Organizations, vol. 30, part a, 2010, pp. 71-114. DOI: [https://doi.org/10.1108/S0733-558X\(2010\)000030A007](https://doi.org/10.1108/S0733-558X(2010)000030A007)

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