The Financial Portfolio Hedging Strategies Applications and Verifications in International Financial Markets

Field of study: Finance

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1 Introduction

The Doctoral dissertation presents the applications and verifications of financial portfolio hedging strategies in international financial markets. The objective of doctoral dissertation is verification of chosen hedging strategies (minimum variance partial hedging strategy, minimal Value at Risk hedging strategy, Delta-Gamma hedging strategy and Beta hedging strategy) on domestic or international financial portfolio in China, US, European financial markets.

Financial markets are those companies get capital to expand, as in the stock or bond markets, or hedge their risks, like the foreign exchange or commodities markets. Financial markets can be found in nearly every nation in the world. Most financial markets have periods of heavy trading and demand for securities. Financial markets are typically defined by having transparent pricing, basic regulations on trading, costs and fees and market forces determining the prices of securities that trade.

Hedging is the traditional approach to market risk management. It consists of taking positions that lower the risk profile of the portfolio. Buying financial derivatives and instruments as a hedge is one kind of hedging, it is long position, and in other words it is a position held in derivatives such that a rise in the market increases the value of the position. Otherwise, in short hedging position, something is sold to cover a risk. The techniques for hedging have been developed in the futures markets, such as use financial instruments to hedge the price risk of their products. Usually the application of hedging consists of finding the optimal position in financial derivatives that minimizes the variance, hedged position. The objective function is the portfolio variance and hedging instruments are linear. It can be distinguished between the static (passive) hedging and dynamic (active) hedging. Static hedging which consists of putting on, and leaving, a position until the hedging horizon. Dynamic hedging which consists of continuously rebalancing the portfolio to the horizon. In general, hedging will create basis risk. This can be measured by unexpected movements in the value of the hedged portfolio. Hedging options will focus on non-linear hedging, because of outright positions in options or because the financial instrument has itself embedded non-linear payoff pattern.

The methodologies of doctoral dissertation with minimum variance partial hedging strategy, minimal Value at Risk hedging strategy, Delta-Gamma hedging strategy and Beta hedging strategy are applied problems of estimation of financial portfolio partial hedging strategy in China stock exchange, hedging strategy with international financial portfolio in international financial markets, minimal Value at Risk hedging strategy with normal distribution returns of financial portfolio in China stock exchange,
Delta-Gamma hedging strategy in US financial market and Beta hedging strategy in Hong Kong stock exchange. The verification of doctoral dissertation consists in chosen hedging strategies on domestic and international financial portfolio that estimating parameters of in-sample period and evaluate out-of-sample period.
2 Objective and Structure of Doctoral Dissertation

The objective of doctoral dissertation is verification of chosen hedging strategies (minimum variance partial hedging strategy, minimal Value at Risk hedging strategy, Delta-Gamma hedging strategy and Beta hedging strategy) on domestic or international financial portfolio in China, US, European financial markets.

The framework of doctoral dissertation, first to describe financial markets in chapter two, which including the international financial markets (see subchapter 2.1), US financial markets (see subchapter 2.1.1), European financial markets (see subchapter 2.1.2) and China financial market (see subchapter 2.2) description, also to make comparison between China financial market and US financial market (see subchapter 2.3) from side of development process (see subchapter 2.3.1), investment products (see subchapter 2.3.2), issuance market (see subchapter 2.3.3), financial market size (see subchapter 2.3.4), financial market structure (see subchapter 2.3.5) and financial market function oriented (see subchapter 2.3.6).

Financial derivatives and instruments plays an important role in financial markets trading. Hence, chapter three is to describe financial derivatives and instruments which regarding to futures and forwards instruments (see subchapter 3.1), options (see subchapter 3.2) and option pricing (see subchapter 3.3) of the Black-Scholes model (see subchapter 3.3.1) and the binomial model (see subchapter 3.3.2).

The approaches and methodologies for hedging strategies are in chapter four which includes minimum variance partial hedging strategy (see subchapter 4.1) with domestic financial portfolio (see subchapter 4.1.1) and international financial portfolio (see subchapter 4.1.2), minimal Value at Risk hedging strategy (see subchapter 4.2), Delta-Gamma hedging strategy (see subchapter 4.3) and Beta hedging strategy (see subchapter 4.4).

Chapter five is applications and verifications of hedging strategies, which consist of estimation of financial portfolio partial hedging strategy in China stock exchange (see subchapter 5.1), hedging strategy with international financial portfolio in international financial markets (see subchapter 5.2), minimal Value at Risk hedging strategy with normal distribution returns of financial portfolio in China stock exchange (see subchapter 5.3), non-linear risk for Delta-Gamma hedging strategy in US financial market (see subchapter 5.4) and linear risk for Beta hedging strategy in Hong Kong stock exchange (see subchapter 5.5). Then summary and discussion (see subchapter 5.6), the final conclusion is in
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International Financial Markets Description

- US Financial Market Description
- European Financial Markets Description

US financial market leads in terms of total Dollar transactions volume. US have the largest financial market of the globe. People across US are highly interested to invest in shares to make fast money. Most of the US companies have provided rich dividends to the potential investors. People from different corners of the world invest in US financial market. New York financial market started in the year 1817 and since then it has attracted leading financial investors. Many global stock traders are maximizing profits by investing in the US financial market.

The EU bond market has experienced spectacular growth since the introduction of the euro and is now matching the US bond market in size. The bulk of euro-denominated bonds are issued by euro area issuers. Although the share of corporate bonds in all euro-denominated bonds outstanding has risen, government bonds still form the most important market segment. The importance of equity finance in the EU is growing, although there are large differences across exchanges. The market capitalization of Euronext and the London Stock Exchange, which are the biggest exchanges in terms of turnover, are much higher than those of other exchanges in the EU. Despite the increase in equity finance, public-equity markets play a limited role as a source of new funds for corporations that raise external financing generally via bank loans or debt securities.

China Financial Market Description

- Reform of Chinese Financial System
- China Stock Markets (Shanghai Stock Exchange, Shenzhen Stock Exchange, Hong Kong Stock Exchange)
- Outlook of China Financial Market

For the past few decades, the People's Bank of China has exercised the functions and powers of a central bank, as well as handling industrial and commercial credits and savings business; it was neither the central bank in the true sense, or a commercial entity conforming to the law of the market economy. But since reform and opening-up began in 1979, China has carried out a series of significant reforms in its banking system, and strengthened its opening to the outside world. Consequently, the finance industry has made steady development. At the end of 2004, the balance of domestic and foreign
currency savings deposits stood at 25,318.8 billion Yuan and the balance of domestic and foreign currency loans came to 18,856.6 billion Yuan. Now China has basically formed a financial system under the regulation, control and supervision of the central bank, with its state banks as the mainstay, featuring the separation of policy-related finance and commercial finance, the cooperation of various financial institutions with mutually complementary functions.

A modern financial system that supports the initiative of both central and local authorities should be set up. A communique issued the Third Plenary Session of the 18th Communist Party of China (CPC) Central Committee (2013). China needs to improve its budget management and taxation systems in a bid to make responsibilities of government agencies match properly with what they spend. It is essential that China improves related legislation, ascertains government bodies’ responsibilities, reforms the taxation system and ensures budgeting is transparent.

In 1990 of November and December, China set up stock exchanges in Shanghai and Shenzhen. In the past decade, the Chinese stock market has completed a journey that took many countries over a century to cover; China's stock market today has capital approaching 3,705.6 billion Yuan, 1,377 listed companies and 72.16 million investors.

Hong Kong stock exchange is a leading global operator of exchanges and clearing houses based in Hong Kong, Asia’s premier international financial center, and one of the world’s largest exchange groups by market capitalization. April 2014 BOAO Forum for Asia Annual Conference, China plans to connect the stock exchanges of Hong Kong and Shanghai, allowing a combined 23.5 billion Yuan ($3.8 billion) of daily cross-border trading. The limits may be adjusted in the future, and preparations for the link will take about six months, according to a statement from the regulator.

Comparison between China Financial Market and US Financial Market

- **Comparison of Development Process**

  the US government to strengthen the stock market after the 1929 economic crisis legislation to regulate and control the whole market into the specification stage of development, the US stock market thus quickly become the world’s largest stock market, the China government to reform and opening-up financial market began in 1979, China has carried out a series of significant reforms in its banking system and strengthened its opening to the outside world.

- **Comparison of Investment Products**

  US have investment products of stocks, stock indexes of stock and stock index futures and options,
convertible bonds, trust certificates and other species, China have A-shares, B-shares, convertible bonds spot trading and other varieties.

- Comparison of Issuance Market

US stock market is an international market issue, issue size and capacity are very large, and China stock market is only for domestic enterprises, B-share market as a place to raise foreign capital.


- Comparison of Financial Market Structure: Agency vs. Retail

- Comparison of Financial Market Function Oriented: High-tech, High-services Industry vs.

Wine Industry

Description of Financial Derivatives and Instruments

Financial instrument is a contract involving a financial obligation. Examples are stocks, bonds, loans and derivatives. Derivative is the price of which has a strong relationship with an underlying commodity, currency, economic variable, or financial instrument. The different types of derivatives are futures contracts, forwards, swaps and options. They are traded on markets or over-the-counter (OTC). The market-traded derivatives are standard, while the OTC trades are specific and customized. The main market-traded derivatives are futures and options.

Futures and Forwards Instruments Description

- Futures and Forwards Characterization

- Futures and Forwards Contracts Comparison

- China Financial Futures Markets Profile (Zhengzhou Commodity Exchange, Dalian Commodity Exchange, Shanghai Futures Exchange, China Financial Futures Exchange, Hong Kong Exchanges and Clearing, Hong Kong Mercantile Exchange)

A futures contract is an agreement between a buyer and a seller, in which the buyer agrees to take delivery of something at a specified price at the end of a designated period of time; the seller agrees to make delivery of something at a specified price at the end of a designated period of time.

The main differences between forward and futures contracts are summarized in Table 4.1. Both contracts are agreements to buy or sell an asset for a certain price at a certain future time. A forward contract is traded in the over-the-counter market and there is no standard contract size or standard delivery arrangements. A single delivery date is usually specified and the contract is usually held to the end of its life and then settled. A futures contract is a standardized contract traded on an exchange. A
range of delivery dates is usually specified. It is settled daily and usually closed out prior to maturity.

Table 4.1 Comparison of Forward and Futures Contracts

<table>
<thead>
<tr>
<th></th>
<th>Forward</th>
<th>Futures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Private contract between two parties</td>
<td>Traded on an exchange</td>
</tr>
<tr>
<td></td>
<td>Not standardized</td>
<td>Standardized contract</td>
</tr>
<tr>
<td></td>
<td>Usually one specified delivery date</td>
<td>Range of delivery dates</td>
</tr>
<tr>
<td></td>
<td>Settled at end of contract</td>
<td>Settled daily</td>
</tr>
<tr>
<td></td>
<td>Delivery or final cash settlement usually</td>
<td>Contract is usually closed out prior to</td>
</tr>
<tr>
<td></td>
<td>place</td>
<td>maturity</td>
</tr>
<tr>
<td></td>
<td>Some credit risk</td>
<td>Virtually no credit risk</td>
</tr>
</tbody>
</table>

Source: Hull (2006)

Options Description

- Options and Futures Contracts Comparison
- US Options Market Description
- Outlook of China Options Market

US options market mature variety. April 26, 1973, the Chicago Board Options Exchange (CBOE) was established, options entered standardization, standardization stage of comprehensive development. 1980s, Fisher Black and Myron Scholes option pricing academic achievements into practice, rapid development of commodity options trading. The US commodity options trading covering cereals, soft commodities (coffee), industrial metals, oil and other varieties. Crude oil, natural gas and other energy commodities traded options most active, followed by agricultural commodity options. Due to the high leverage investment in stocks, stock options were growth spurt in 2007-2009, currently the largest volume, accounting for 31.18% of the U.S. derivatives trading volume, ETF options, followed by other options accounted for a relatively small species. Since the development of a long time, with a complete system of hedging transactions, with a strong linkage between the spot markets, investor sentiment is relatively weak.

Europe's oldest options market, the 17th century "Tulip" avid option would be widely applied. European markets, Brent crude oil futures options are the most actively traded commodity options varieties, followed by industrial metal species in the LME trading. The late 1970s, the London Stock Exchange opened LTOM, Netherlands established EOE, formed the prototype of financial futures and
options. Eurozone monetary system formed, bringing profound changes to the index options market. After the integration of the exchange, Eurex, Euronext Options Exchange to become the most important.

Asia is the fastest growing market in South Korea's stock index options. South Korea launched in 1997 stock index options, subject to Kospi200, initially less volume, from 2000 to 2004 entered a rapid development period, quickly became the world's largest futures contracts. 2005 Korea Stock Exchange, Korea Futures Exchange and the Korea GEM merged KRX. Kospi200 index futures contracts is on the CME Globex electronic trading platform Exchange in November 2009. 2011 Korean stock index options volume accounted for 64.3% of global proportions. Money options in recent months with its high leverage, low royalties, occupied most of the Korean stock index options market.

China was launch simulated trading in stock index option on 8th November 2013, as regulators move to enhance risk hedging options to support further financial reforms. Among other developments under consideration, the Shanghai Stock Exchange is planning to launch individual stock options for blue-chip stocks as early as year of 2013, in a bid to provide more hedging tools for institutional and wealthy individual investors.

**Hedging Approaches and Methodologies**

- Minimum Variance Partial Hedging Strategy (Domestic and International Financial Portfolio)
- Minimal Value at Risk Hedging Strategy
- Delta-Gamma Hedging Strategy
- Beta Hedging Strategy

**Applications and Verifications of Hedging Strategies**

- Estimation of Financial Portfolio Partial Hedging Strategy in China Stock Exchange
- Hedging Strategy with International Financial Portfolio in International Financial Markets
- Application of Minimal Value at Risk Hedging Strategy with Normal Distribution Returns of Financial Portfolio in China Stock Exchange
- Delta-Gamma Hedging Strategy in US Financial Market
- Beta Hedging Strategy in Hong Kong Stock Exchange
5 Methods Applied in Doctoral Dissertation

It is applied five problems that the methodologies for hedging strategies applications and verifications, which include minimum variance partial hedging optimization for both domestic financial portfolio and international financial portfolio, minimal Value at Risk hedging strategy with normal distribution returns, Delta-Gamma hedging strategy and Beta hedging strategy. The verification of doctoral dissertation consists in chosen hedging strategies on domestic and international financial portfolio that estimating parameters of in-sample period and evaluate out-of-sample period.

Problem A Partial Hedging Optimization Model

<table>
<thead>
<tr>
<th>Objective Function</th>
<th>$\min \sigma^2_{p_r} = x^T \cdot \hat{C} \cdot \hat{x}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constraints</td>
<td>$f = k$</td>
</tr>
<tr>
<td></td>
<td>$u \geq z_l \geq -l$</td>
</tr>
</tbody>
</table>

where the objective function states the minimized variance of partial hedging portfolio, $\sigma^2_{p_r}$ is variance of partial hedging portfolio, $\hat{x}^T$ is vector of variables $\hat{x} = [\hat{f}; \hat{z}]$ is the structure of partial hedging portfolio, consists of two components, the vector $\hat{f}$ which states the amount of newly purchased options and the vector $\hat{z}$ states the initial portfolio of held derivatives with partial risk (number of hedged assets). Symbol C depicts covariance matric of returns. The minimum variance hedging portfolio under partial risk, which expressed variable parameter $r \in (0;1])$. The parameter $r$ means, what part of the risk should be hedged. If the $r$ equal 1, it means the whole risk is hedged, if it is less than 1, it is only a partial hedged. And $l$ is number of short position, $u$ is number of long positions, $k$ is number of risk assets.

Problem B Hedging International Portfolio Optimization

<table>
<thead>
<tr>
<th>Objective Function</th>
<th>$\min \sigma^2_{p_r} = x^T \cdot A \cdot C \cdot A^T \cdot \hat{x}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constraints</td>
<td>$f = k$</td>
</tr>
<tr>
<td></td>
<td>$u \geq z_l \geq -l$</td>
</tr>
</tbody>
</table>

where the objective function states the minimized variance of partial hedging international portfolio, $\sigma^2_{p_r}$ is the variance of partial hedging international portfolio, $\hat{x}^T$ is vector of variables, thus $\hat{x} = [\hat{f}; \hat{z}]$ is the structure of partial hedging international portfolio, consists of two components, the
vector $\mathbf{z}$ which states the amount of risk assets and the vector $\mathbf{f}$ states the amount of hedged assets.

Symbol $A$ is the matrix of risk factor, symbol $C$ is the covariance matrix, then $l$ is number of short position, $u$ is number of long position, $k$ is number of risk assets.

**Problem C Minimal Value at Risk Hedging with Normal Distribution Returns**

| Objective Function | $\min \ VaR = -E(r_p) - \Phi^{-1}_\alpha \cdot \sigma_p$ | (E1) |
| Constraints | $f = k$ | (C1) |
| | $u \geq z_i \geq -l$ | (C2) |

where $E(r_p)$ and $\sigma_p$ are the mean value and the standard deviation of the assets return, $\Phi^{-1}_\alpha$ is an inverse function of normal distribution function on a given significance level $\alpha$ and $x_i$ is the amount of money invested into assets.

**Problem D Options Hedging Strategy for Financial Portfolio (Delta-Gamma Hedging Strategy for Financial Portfolio)**

| Objective Function | $\min \ \sum_i \ price_i \cdot z_i$ | (E1) |
| Constraints | $f = k$ | (C1) |
| | $u \geq z_i \geq -l$ | (C2) |
| | $\sum_i \ delta_i \cdot x_i = 0$ | (C3) |
| | $\sum_i \ gamma_i \cdot x_i = 0$ | (C4) |
| | $\sum_i \ vega_i \cdot x_i = 0$ | (C5) |

The vector of variables $\mathbf{x}$ which is states the structure of the hedging portfolio. The objective function expresses the minimization of the costs on setting up of the optimal portfolio, where $\text{price}_i$ is the price of the newly purchased option $i$ and $z_i$ is the amount of the options in the portfolio. Constraints (C3) and (C4) define hedging against the risk of the underlying asset price change. Here, the constraint (C3) specify the risk of the first order, parameter Delta ($\Delta$) and constraint (C4) specify the risk of the second order, parameter Gamma ($\Gamma$). The constraint (C5) defines hedging against the risk of the volatility change expressed by the parameter Vega ($\varsigma$).
Problem E Financial Portfolio Hedging Strategy with Systematic Risk (Beta Hedging Strategy with Financial Portfolio)

<table>
<thead>
<tr>
<th>Objective Function</th>
<th>$\sum_{i} f_i \cdot s_{f_i} \cdot \beta_{f_i} + \sum_{i} z_i \cdot s_{z_i} \cdot \beta_{z_i} = 0$ (E1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constraints</td>
<td>$u_{z_i} \leq z_i \leq -l_{z_i}$ (C1)</td>
</tr>
</tbody>
</table>

where the objective function expresses the portfolio hedging with systematic risk, $f_i$ and $z_i$ are the portfolios with prices $s_{f_i}$ and $s_{z_i}$, $\beta_{f_i}$ and $\beta_{z_i}$ are the systematic risk beta coefficient for portfolios.
6 Summary of Results and Conclusion


Suppose there are three financial assets portfolios (portfolio A, Portfolio B and portfolio C) from China Stock Exchange. Each portfolio includes 10 assets. Goal is to hedge the assets against financial risk. The historical prices are by daily (from 25th January 2013 – 24th January 2014) of financial assets, the currency determined in CNY (Chinese Yuan). Suppose the partial risk is 100%, 80%, 60% 40% and 20%. The task is to determine the optimal portfolio of available financial assets to hedge the shares in China Stock Exchange.

Here is the input data of financial portfolios assets in following Figure 6.1, Figure 6.2 and Figure 6.3 are showing the prices trends of each portfolio in China Stock Exchange.

**Figure 6.1: Price Trends of Portfolio A**

Source: Own elaboration (2014)

**Figure 6.2: Price Trends of Portfolio B**

Source: Own elaboration (2014)
Mathematical formulation of partial hedging optimization model is due to the Problem A. According the Problem A, the objective function (E1), it can define the constraints (C1) to (C2) are

**Objective Function**

\[
\min \sigma_{p,r}^2 = r' \hat{x}^T \cdot C \cdot \hat{x}
\]  

(E1)

**Constraints**

\[
f = k
\]  

(C1)

\[
20 \geq z_i \geq -20
\]  

(C2)

The parameter \( k \) means 30 financial assets portfolio. The objective function (E1) express the minimization of the variance of partial optimal portfolio. The constraint (C1) expresses the hedged assets for three portfolios under partial risk, -2, -4, -6, -8 and -10 units each. By constraints (C2) is stated limits for the short positions (20 units) and the long position (20 units).
6.2 Hedging Strategy with International Financial Portfolio in International Financial Markets

Suppose that there is international financial portfolio, these risk financial assets include 10 financial assets denominated in the domestic currency (CNY; $s_1$...$s_{10}$), 10 financial assets denominated in the foreign currency (USD; $sf_1$...$sf_{10}$), and 10 financial assets denominated in the foreign currency (EUR; $sf_{11}$...$sf_{20}$). All factors are normally distributed. Task is to determine the hedging optimal international financial portfolio with foreign exchange rate.
Here is in Figure 6.7 by the input data of risk assets price trends from 25th January 2013 to 24th January 2014.

**Figure 6.7: Input Data Prices Trend**

![Image of Figure 6.7]

Source: Own elaboration (2014)

In following Figure 6.8 is foreign exchange for CNY/USD and CNY/EUR from 25th January 2013 to 24th January 2014.

**Figure 6.8: Foreign Exchange Rate CNY/USD and CNY/ EUR**

![Image of Figure 6.8]

Source: Oanda (2014)

Mathematical formulation of hedging international portfolio optimization applying the Problem B, according to the objective function (E1), it is defined the constraints (C1) to (C2) are.
Objective Function

$$\min \sigma^2_{\text{pr}} = \bar{x}^T \cdot A \cdot C \cdot A^T \cdot \bar{x}$$  \hspace{1cm} (E1)

Constraints

$$f = k$$  \hspace{1cm} (C1)

$$20 \geq z_j \geq -20$$  \hspace{1cm} (C2)

The procedures of hedging strategy with international portfolio includes following steps. Setting up the matrix A and transposes the matrix $A^T$ which the influence foreign exchange rate. Then to calculate of the covariance matrix C for covariance is between the factors (domestic assets, foreign assets and foreign exchanges).

According the objective function (E1) is calculated the hedging portfolio minimum variance. It supposed that hedging the risk assets which are influenced with foreign exchange rate. It means influence the risk factor matrix A by the foreign exchange E1, E2 and the hedging international portfolio should be affected.

Figure 6.9: Sensitivity Foreign Exchange Rate Risk Factor

Source: Own elaboration (2014)

Figure 6.10: Verification of Partial Hedging Influence with Foreign Exchange Rate

Source: Own elaboration (2014)
Based on the verification results of partial hedging strategy with international portfolio, the results of hedged is less than no hedge for both influences with and without foreign exchange rate, which means this hedging strategy is successful to reduce risk.

6.3 Application of Minimal Value at Risk Hedging Strategy with Normal Distribution Returns of Financial Portfolio in China Stock Exchange

Suppose there are three financial assets portfolios (portfolio A, Portfolio B and portfolio C) from China Stock Exchange, 10 units each. Each portfolio includes 10 assets. To hedge the assets is against financial risk. The historical prices by daily (from 25th January 2013 – 24th January 2014) of financial assets, the currency of determined in CNY (Chinese Yuan) as same data with subchapter 5.1 Problem A. Expected returns $E(r_p)$ and standard deviations of returns $\sigma(r_p)$ are known. It is also supposed that the returns are normal distribution (According to Q-Q Plot is possible approximately the returns of assets by normally distribution). The task is to determine the optimal composition of the portfolio significance by virtue of the Value at Risk Minimization for 1% and 5% probability level.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>Financial Assets</th>
<th>$E(r_p)$</th>
<th>$\sigma(r_p)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portfolio A</td>
<td>601857.ss</td>
<td>-0.000183451</td>
<td>0.009359232</td>
</tr>
<tr>
<td></td>
<td>601398.ss</td>
<td>-0.001111549</td>
<td>0.007948661</td>
</tr>
<tr>
<td></td>
<td>601939.ss</td>
<td>-0.00071888</td>
<td>0.011998123</td>
</tr>
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<td></td>
<td>601288.ss</td>
<td>-0.000203663</td>
<td>0.012340678</td>
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<tr>
<td></td>
<td>601988.ss</td>
<td>-0.00050164</td>
<td>0.009964082</td>
</tr>
<tr>
<td>Symbol</td>
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<td>0.022987089</td>
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<td>0.017064673</td>
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<td>0.00142552</td>
<td>0.019715068</td>
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<td>0.012655049</td>
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<td>600900.ss</td>
<td>-0.000969629</td>
<td>0.009328314</td>
<td></td>
</tr>
</tbody>
</table>

Source: Own elaboration (2014)

The objective function (E1) and constrains (C1) and (C2) due to Problem C, characterizes the analytical formulation of the Value at Risk minimization for a given probability level. The constraint (C1) is the identification equation for overall investments into the portfolio of assets. Constraints (C2)
states financial limits on investments into particular assets. The constraints for this problem calculation are

Objective Function
\[ \min \ VaR = -E(r_p) - \Phi^{-1}_\alpha \sigma_p \]  

Constraints
\[ f = -10 \]  
\[ 20 \geq z_i \geq -20 \]

Figure 6.12: Composition of Invest Assets with Probability Level 0.01 and 0.05

Table 6.2: Verification of Minimal Value at Risk Hedging Strategy

<table>
<thead>
<tr>
<th>Significance Level</th>
<th>0.01</th>
<th>0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variance of Hedged</td>
<td>0.833639833</td>
<td>0.833516969</td>
</tr>
<tr>
<td>Variance of No Hedge</td>
<td>0.988754262</td>
<td>0.988754262</td>
</tr>
<tr>
<td>Effect of Hedging</td>
<td>0.155114429</td>
<td>0.155237293</td>
</tr>
</tbody>
</table>

Source: Own elaboration (2014)

Based on the verification results of minimal Value at Risk hedging strategy, the results of hedged is less than no hedge, which means this hedging strategy is successful to reduce risk.

6.4 Non-Linear Risk: Delta-Gamma Hedging Strategy in US Financial Market

Suppose a bank which has just sold (short position) three types of financial derivatives from US financial market (currency USD). The values of instruments’ parameters Delta, Gamma and Vega are known. The bank wants to hedge these sold derivatives against specified risk by 10 call options and 10 put options on the same underlying asset. It is supposed that factors against which the bank wants to hedge the portfolio are the underlying asset price and its volatility. This implies that the portfolio must
be hedged against the risk of change in the underlying asset price (parameters Delta and Gamma) and the volatility (Vega). Suppose that these options are appraised by the Black-Scholes model. The task is to determine the optimal least-cost portfolio of available financial products to hedge the derivatives. Known data is about the financial derivatives. There are in Table 6.3 the following parameters of financial derivatives.

**Table 6.3: Parameters of Financial Derivatives**

<table>
<thead>
<tr>
<th>Financial Derivatives</th>
<th>Symbol</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Delta</td>
</tr>
<tr>
<td>Facebook</td>
<td>f1</td>
<td>0.501994703</td>
</tr>
<tr>
<td>The Home Depot</td>
<td>f2</td>
<td>0.503989356</td>
</tr>
<tr>
<td>Bristol-Myers Squibb Company</td>
<td>f3</td>
<td>0.50598391</td>
</tr>
<tr>
<td>Microsoft Corporation</td>
<td>f4</td>
<td>0.507978314</td>
</tr>
<tr>
<td>International Game Technology</td>
<td>f5</td>
<td>0.509972518</td>
</tr>
<tr>
<td>The Dow Chemical Company</td>
<td>f6</td>
<td>0.511966473</td>
</tr>
<tr>
<td>Bank of America Corporation</td>
<td>f7</td>
<td>0.51396013</td>
</tr>
<tr>
<td>Halliburton Company</td>
<td>f8</td>
<td>0.515953437</td>
</tr>
<tr>
<td>Cliffs Natural Resources</td>
<td>f9</td>
<td>0.517946346</td>
</tr>
<tr>
<td>Exelon Corporation</td>
<td>f10</td>
<td>0.519938806</td>
</tr>
</tbody>
</table>

Source: Own elaboration (2014)

The objective function (E1) and constrains (C1) and (C5) are faced on Problem D. In order to determine $v^*(a)$ it can apply the Excel function.
Objective Function

\[
\min \sum_i price_i \cdot z_i
\]  \hspace{1cm} \text{(E1)}

Constraints

\[ f = -10 \]  \hspace{1cm} \text{(C1)}

\[ 10 \geq z_i \geq -7 \]  \hspace{1cm} \text{(C2)}

\[ \sum_i \delta_i \cdot x_i = 0 \]  \hspace{1cm} \text{(C3)}

\[ \sum_i \gamma_i \cdot x_i = 0 \]  \hspace{1cm} \text{(C4)}

\[ \sum_i \nu_i \cdot x_i = 0 \]  \hspace{1cm} \text{(C5)}

Figure 6.13: Composition of Hedging Financial Portfolio

![Figure 6.13: Composition of Hedging Financial Portfolio](image)

Source: Own elaboration (2014)

Table 6.3: Verification of Delta-Gamma Hedging Strategy

<table>
<thead>
<tr>
<th></th>
<th>Hedged</th>
<th>No Hedge</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \xi(R) )</td>
<td>0.155269832</td>
<td>-0.069289952</td>
</tr>
<tr>
<td>( \sigma^2 )</td>
<td>0.740495327</td>
<td>1.04786821</td>
</tr>
<tr>
<td>( \sigma )</td>
<td>0.860520381</td>
<td>1.023654341</td>
</tr>
</tbody>
</table>

Source: Own elaboration (2014)

Based on the verification results of Delta-Gamma hedging strategy, the results of hedged \( \sigma \) is less than no hedge \( \sigma \) (0.860520381 < 1.023654341), which means this hedging strategy is successful to reduce risk.
Linear Risk: Financial Portfolio Hedging Strategy with Systematic Risk (Beta Hedging Strategy) in Hong Kong Stock Exchange

Suppose the investor is holding two portfolios, each portfolio has 20 financial assets, the financial assets portfolio $\tilde{f}$ and $\tilde{z}$ are from Hong Kong Stock Exchange (currency HKD). The beta coefficient is known. The task is to determine the optimal portfolio $\tilde{f}$ to hedge the portfolio $\tilde{z}$ in Hong Kong Stock Exchange. Following Table 6.4 and Table 6.5 are the input data of risk assets portfolios.

Table 6.4: Input Data of Risk Assets Portfolio $\tilde{f}$ in Hang Seng Index

<table>
<thead>
<tr>
<th>Financial Assets</th>
<th>Symbol</th>
<th>Beta</th>
<th>$\tilde{f}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lenovo Group</td>
<td>0992.hk</td>
<td>0.847659871</td>
<td>10</td>
</tr>
<tr>
<td>Hang Lung Properties</td>
<td>0101.hk</td>
<td>0.00258308</td>
<td>10</td>
</tr>
<tr>
<td>Sino Land</td>
<td>0083.hk</td>
<td>0.494614802</td>
<td>10</td>
</tr>
<tr>
<td>China Unicom Hong Kong</td>
<td>0762.hk</td>
<td>0.366683712</td>
<td>10</td>
</tr>
<tr>
<td>Tingyi Cayman Islands Holding Corp</td>
<td>0322.hk</td>
<td>0.09487772</td>
<td>10</td>
</tr>
<tr>
<td>Want Want China Holdings</td>
<td>0151.hk</td>
<td>0.195034558</td>
<td>10</td>
</tr>
<tr>
<td>Bank of Communications</td>
<td>3328.hk</td>
<td>0.256453907</td>
<td>10</td>
</tr>
<tr>
<td>China Petroleum &amp; Chemical Corp</td>
<td>0386.hk</td>
<td>0.780369535</td>
<td>10</td>
</tr>
<tr>
<td>COSCO Pacific</td>
<td>1199.hk</td>
<td>0.388614726</td>
<td>10</td>
</tr>
<tr>
<td>China Resources Enterprise</td>
<td>0291.hk</td>
<td>0.179802936</td>
<td>10</td>
</tr>
<tr>
<td>Cheung Kong Holdings</td>
<td>0001.hk</td>
<td>0.249392949</td>
<td>10</td>
</tr>
<tr>
<td>Sands China</td>
<td>1928.hk</td>
<td>0.563257292</td>
<td>10</td>
</tr>
<tr>
<td>China Resources Power Holdings</td>
<td>0836.hk</td>
<td>0.036927142</td>
<td>10</td>
</tr>
<tr>
<td>CNOOC</td>
<td>0883.hk</td>
<td>0.053541382</td>
<td>10</td>
</tr>
<tr>
<td>Hong Kong Exchanges and Clearing</td>
<td>0388.hk</td>
<td>0.357293168</td>
<td>10</td>
</tr>
<tr>
<td>Hang Seng Bank</td>
<td>0011.hk</td>
<td>0.33672856</td>
<td>10</td>
</tr>
<tr>
<td>Sun Hung Kai Properties</td>
<td>0016.hk</td>
<td>0.583433116</td>
<td>10</td>
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<td>PetroChina</td>
<td>0857.hk</td>
<td>0.819470082</td>
<td>10</td>
</tr>
<tr>
<td>New World Development</td>
<td>0017.hk</td>
<td>0.447913286</td>
<td>10</td>
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<tr>
<td>Boc Hong Kong Holdings</td>
<td>2388.hk</td>
<td>0.280758441</td>
<td>10</td>
</tr>
</tbody>
</table>

Source: Own elaboration (2014)
Table 6.5: Input Data of Portfolio $\tilde{z}$ in Hang Seng Index

<table>
<thead>
<tr>
<th>Financial Assets</th>
<th>Symbol</th>
<th>Beta</th>
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</thead>
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<tr>
<td>Cathay Pacific Airways</td>
<td>0293.hk</td>
<td>0.285986991</td>
</tr>
<tr>
<td>Swire Pacific</td>
<td>0019.hk</td>
<td>0.201328894</td>
</tr>
<tr>
<td>HSBC Holdings PLC</td>
<td>0005.hk</td>
<td>0.500856346</td>
</tr>
<tr>
<td>MTR Corp</td>
<td>0066.hk</td>
<td>0.389435698</td>
</tr>
<tr>
<td>Kunlun Energy</td>
<td>0135.hk</td>
<td>0.716322262</td>
</tr>
<tr>
<td>Henderson Land Development</td>
<td>0012.hk</td>
<td>0.132678104</td>
</tr>
<tr>
<td>Bank of China</td>
<td>3988.hk</td>
<td>0.53021595</td>
</tr>
<tr>
<td>Li &amp; Fung</td>
<td>0494.hk</td>
<td>0.573911757</td>
</tr>
<tr>
<td>China Overseas Land &amp; Investment</td>
<td>0688.hk</td>
<td>0.149005458</td>
</tr>
<tr>
<td>China Construction Bank Corp</td>
<td>0939.hk</td>
<td>0.494739062</td>
</tr>
</tbody>
</table>

Source: Own elaboration (2014)

The mathematical formulation of portfolio hedging with systematic risk is faced on application the Problem E with objective function (E1) and constraint (C1). The constraint expresses the hedged asset from portfolio with systematic risk, which is determined between $[-20; 20]$.

Objective Function

$$\sum_{i} f_i \cdot s_{fi} \cdot \beta_{fi} + \sum_{i} z_i \cdot s_{zi} \cdot \beta_{zi} = 0$$

(E1)

Constraints

$$20 \leq z_i \leq -20$$

(C1)

The procedures of calculation are to be following steps. The first step is to calculate the beta and portfolio $f$ with beta. After that is to set up the variables of hedging portfolio. Next step is to calculate the beta and portfolio $\tilde{z}$ with beta, according the constraint given to set up the variables of the hedging portfolio greater than 20 and less than -20.

Figure 6.14: Composition of Portfolio in Beta Hedging Strategy

Source: Own elaboration (2014)
Table 6.6: Verification of Beta Hedging Strategy

<table>
<thead>
<tr>
<th></th>
<th>Hedged</th>
<th>No Hedge</th>
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<tbody>
<tr>
<td>$E(R)$</td>
<td>0.098223807</td>
<td>-0.021312711</td>
</tr>
<tr>
<td>$\sigma^2$</td>
<td>0.415524371</td>
<td>1.133113016</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>0.644611799</td>
<td>1.064477814</td>
</tr>
</tbody>
</table>

Source: Own elaboration (2014)

Based on the verification results of Delta-Gamma hedging strategy, the results of hedged $\sigma$ is less than no hedge $\sigma$ ($0.644611799 < 1.064477814$), which means this hedging strategy is successful to reduce risk.

### 6.6 Conclusion

The doctoral dissertation presents the applications and verifications of financial portfolio hedging strategies in international financial markets. The objective of doctoral dissertation is verify the result of find the optimal financial portfolio (domestic and international financial portfolio) composition by minimum variance hedging strategy, minimal Value at Risk hedging strategy, Delta-Gamma hedging strategy and Beta hedging strategy in international financial markets that successfully decrease or reduce financial risk.

In the doctoral dissertation are described the financial markets (see chapter 2) and the international financial markets (see subchapter 2.1) of the US financial market (see subchapter 2.2.1), the European financial markets (see subchapter 2.2.2) and the China financial market (see subchapter 2.2.3). And specialized markets of stock exchanges, futures and commodity markets and options markets. Also it is make comparison between China financial market and US financial market (see subchapter 2.3). From side of development process (see subchapter 2.3.1), the US government to strengthen the stock market after the 1929 economic crisis legislation to regulate and control the whole market into the specification stage of development, the US stock market thus quickly become the world’s largest stock market, the China government to reform and opening-up financial market began in 1979, China has carried out a series of significant reforms in its banking system and strengthened its opening to the outside world. Compare the side of investment products (see subchapter 2.3.2), US have investment products of stocks, stock indexes of stock and stock index futures and options, convertible bonds, trust certificates and other species, China have A-shares, B-shares, convertible bonds spot trading and other varieties. Compare the side of issuance market (see subchapter 2.3.3), US stock market is an international market issue, issue size and capacity are very large, China stock market is only for
domestic enterprises, B-share market as a place to raise foreign capital. Difference between US financial market size and China financial market size is equal to make difference between the market-based and bank-based (see subchapter 2.3.4). Compare between financial market structure of US and China that is different between agency market and retail market (see subchapter 2.3.5). In the financial market function oriented (see subchapter 2.3.6), US holds much investment products in high-tech, high-services industry, China has investment products in wine industry.

Trading derivatives plays important role in financial markets activities. Derivative is the price of which has a strong relationship with an underlying commodity, currency, economic variable, or financial instrument. The different types of derivatives are futures contracts, forwards, swaps and options. They are traded on markets or over-the-counter (OTC). The market-traded derivatives are standard, while the OTC trades are specific and customized. The main market-traded derivatives are futures and options. The doctoral dissertation described the futures and forwards (see subchapter 3.1), options (see subchapter 3.2) and option pricing (see subchapter 3.3) of the Black-Scholes model (see subchapter 3.3.1) and the binomial model (see subchapter 3.3.2).

The methodologies applied are the partial hedging strategy variance minimization for domestic and international portfolio in the international financial markets (see subchapter 4.1), minimal Value at Risk hedging strategy (see subchapter 4.2), the Delta-Gamma hedging strategy (see subchapter 4.3) and Beta hedging strategy (see subchapter 4.4). Hedging is the practice of purchasing and holding derivatives and instruments specifically to reduce portfolio risk. Hedging is most effective if used when investors believe risks are higher than normal. Such as partial hedging which means it take some risk out of portfolio and cover a piece of it, or full hedging, where the goal is to eliminate all risk, closely resembling the effects of going to cash. It can also hedge constantly or only hedge when feel risks are higher than normal.

Based on the methodologies that leads five problems for hedging strategies applications, Problem A (see subchapter 4.1.1, page 50), Problem B (see subchapter 4.1.2, page 52), Problem C (see subchapter 4.2, page 54), Problem D (see subchapter 4.3, page 56) and Problem E (see subchapter 4.4, page 59). The applications of doctoral dissertation according those five problems to calculation of estimation financial portfolio partial hedging strategy in China stock exchange (see subchapter 5.1), hedging strategy with international financial portfolio in international financial markets (see subchapter 5.2), minimal Value at Risk hedging strategy with normal distribution returns of financial portfolio in
China stock exchange (see subchapter 5.3), Delta-Gamma hedging strategy in US financial market (see subchapter 5.4) and Beta hedging strategy in Hong Kong stock exchange (see subchapter 5.5). The verifications of doctoral dissertation applied on historical data of returns in a chosen in-sample period, evaluate criterion in out-of-sample period, and summarize individual performances in a statistical manner for the hedging strategy of minimum variance hedging strategy on domestic financial portfolio (see subchapter 5.1.2) and international financial portfolio (see subchapter 5.2.2), Value at Risk minimization hedging strategy (in subchapter 5.3.2), Delta-Gamma hedging strategy (in subchapter 5.4.2) and Beta hedging strategy (in subchapter 5.5.2), that chosen hedging strategies should be successfully applied in international financial markets that possible to decrease or reduce the financial risk. The results for the applications and verifications of hedging strategies summarized in subchapter 5.6.

Application of hedging strategy is find optimal positions that lower the risk profile of the portfolio. Verifications for hedging strategies (see subchapter 5.1.2, subchapter 5.2.2, subchapter 5.3.2, subchapter 5.4.2 and subchapter 5.5.2) are verifying the hedging strategies (minimum variance hedging strategy, minimal Value at Risk hedging strategy, Delta-Gamma hedging strategy and Beta hedging strategy) investigated should be successfully applied in international financial markets which are possible to decrease or reduce financial risk.

Application of partial hedging strategy for domestic financial portfolio and international financial portfolio is calculated by the minimum variance optimization model. The result of partial hedging risk portfolio composition both for domestic financial portfolio (see subchapter 5.1.1) and international financial portfolio (see subchapter 5.2.1) show that under different risk, accompanied the hedging risk increasing (partial hedging risk of 20%, 40%, 60%, 80% and full hedging risk of 100%), the financial portfolio increasing too. Whether financial portfolio influenced by risk factor of foreign exchange rate or not. The result of foreign exchange rate risk of hedging strategy shows that hedging portfolio should be influenced by risk factors of foreign exchange rate, the result of portfolio variance without foreign exchange rate is higher than the portfolio variance with foreign exchange rate.

Application of minimal Value at Risk hedging strategy (see subchapter 5.3.1) is calculated by probability level of 1% and 5%. The result of optimal value of Value at Risk means the forecasted loss will be higher or equal to the amount with probability level, in other words to say that the profit will be lower or equal to the amount with probability level.
Application of Delta-Gamma hedging strategy (see subchapter 5.4.1) result shows the minimal costs to hedge the portfolio. Since short positions dominate, the hedging leads into positive cash flow.

Application of Beta hedging strategy (see subchapter 5.5.1) result shows that should be possible to be the negative or positive, that means it exist the long position and short position of hedging.

Verifications’ result for hedging strategies (minimum variance hedging strategy, minimal Value at Risk hedging strategy, Delta-Gamma hedging strategy and Beta hedging strategy) show the hedged is less than no hedge, which means the hedging strategy is successful to reduce risk in international financial markets.

There were verified that applications of chosen hedging strategy leads to decreasing or reducing the financial risk in the international financial markets. Hedging strategies are important in international financial markets that means for eliminating the financial risk and decrease loss when operating the investment.
7 List of References

Books


Journal papers and Conferences Proceedings
TICHÝ, Tomáš. (2004). Replication methods in the pricing and hedging of barrier options. Finance a

**Electronic Sources**


8 List of Author’s Publications and Research


Projects

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9 Summary

The objective of hedging consists of taking positions that lower the risk profile of the portfolio. Buying financial derivatives and instruments as a hedge is one kind of hedging, it is long position, and in other words it is a position held in derivatives such that a rise in the market increases the value of the position. Otherwise, in short hedging position, something is sold to cover a risk. The doctoral dissertation presents the applications and verifications of financial portfolio hedging strategies in international financial markets. The methods of minimum variance partial hedging strategy, minimal Value at Risk hedging strategy, Delta-Gamma hedging strategy and Beta hedging strategy are applied on domestic and international financial portfolio in international financial markets (China, US and European financial markets). It was verified that hedging strategies investigated should be successfully applied in international financial markets and decrease or reduce the financial risk of financial institutions.

Keywords: Hedging Strategy, International Financial Markets, Financial Derivatives and Instruments, Minimum Variance Partial Hedging strategy, Minimal Value at Risk hedging strategy, the Greek Letters, Delta-Gamma Hedging strategy, Beta Hedging strategy (systematic risk)