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## Implementing Quantitative Risk Management and VaR in a Chinese Investment Bank

Jasper Wang<sup>1</sup> was puzzled. Three months after returning to his native China to accept an intriguing job offer, the situation was turning out to be very different from his expectations.

After a stellar academic career and rapid rise through the ranks of financial risk management, Jasper had gained confidence in his abilities to understand risk and use quantitative tools to control it. He had enjoyed working in the United States and had spent ten years there working for two major investment banks. Born and raised in Shanghai, he had always envisioned returning to China to work. In late 2013, when he was persuaded by the CEO of a Shanghai-based investment bank to head their Risk Management Department, he had eagerly accepted.

Following an initial “honeymoon” period in the new job, Jasper began to encounter resistance from his colleagues on the trading desk. They expressed increasing skepticism for the new market risk control framework that he proposed based on the Value at Risk (VaR) measure. In a volatile market and with few controls on trading activities, the trading group appeared to be at risk of large losses – precisely what Jasper had been hired to prevent. He had to decide how to push a more quantitative risk and control framework within the organization in the face of domain issues, dismissal of risk management measures used outside of China, and basic cultural differences.

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<sup>1</sup> The names of people and companies used in this case are fictional. Any similarities to actual persons or companies are coincidental and are not the intent of the Thompson Center for Business Case Studies.

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*Ellen Orr prepared this case under the supervision of Dr Allen Kuo solely as a basis for class discussion. The authors have disguised certain data to protect confidentiality. Cases are written in the past tense; this is not meant to imply that all practices, organizations, people, places or facts mentioned in the case no longer occur, exist, or apply. Cases are not intended to serve as endorsements, sources of primary data, or illustration of effective or ineffective handling of a business situation.*

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## Jasper's rapid rise in risk management

Jasper was bright, creative, highly quantitative, and accustomed to succeeding. Growing up in Shanghai, he excelled at mathematics and particularly enjoyed statistics and data management. He graduated from the prestigious Fudan University in Shanghai in the late 1990s, and then went to the United States in 2000 to study for a PhD in advanced mathematics.

After earning his PhD in 2004, Jasper went to work for a top US investment bank, which was seeking to add quantitative expertise to its risk management function. . Jasper was initially unfamiliar with risk management, but soon realized that the function made good use of his statistical expertise. His team's role was to measure the degree of risk in the bank's activities and to set policies that would limit the bank's losses to acceptable levels.

Jasper found the work suited him and he was well regarded at the bank. With his boss's encouragement, he earned the Financial Risk Manager (FRM) qualification in 2006. This qualification boosted Jasper's professional standing and enhanced his credibility as a risk management expert. Soon, he was given increased responsibility for making risk policy at the bank.

The financial crisis of 2007 to 2008 produced great upheaval in the investment banking industry. Many observers felt that the crisis was caused in part by insufficient attention to risk management, leading to large unanticipated losses by banks and other financial institutions. As a result, investment banks began to devote additional resources to risk management, even as they were cutting jobs elsewhere in the industry. Seasoned risk professionals such as Jasper found their career opportunities expanding.

In 2009, Jasper received an offer with a substantial salary increase to move to a competing US investment bank as a vice president. He became one of four vice presidents reporting to the head of Risk Management [see **Exhibit 1** for the organization structure of a typical Western investment bank].

Jasper's key focus was on measuring and monitoring VaR. [See **Appendix** for an explanation of VaR]. VaR was one of the core risk metrics recommended by international banking regulators (Basel rules) and was widely adopted to calculate banks' minimum capital requirements. While this regulatory emphasis made Jasper's work indispensable to the bank, he was keen to take on even more responsibility and become involved in the firm's overall strategic risk management.

By 2012, Jasper realized it would still be many years before he would play a leading role in risk management at any major US investment bank. At the same time, China was booming. The government was deregulating the securities market and the market seemed to be becoming more sophisticated.

## The new role in China

In 2013, the Shanghai-based Guang Guo Investment Bank was creating a formal risk management function and looking for an overseas Chinese candidate to head it.

Having been formed through the merger of several smaller domestic securities firms, Guang Guo aimed to become a true international investment bank based in China. The bank's culture and working language were Chinese, so it considered a Chinese national desirable. However, there were relatively few senior risk management experts in mainland China, so the bank sought an overseas trained Chinese candidate. Guang Guo's CEO, Charles Pan, found Jasper through his market contacts and approached Jasper to explore the possibility of taking on this role.

Jasper was intrigued by the possibility of building Guang Guo's risk management function. In his current job, he had limited ability to create change or build something new. In contrast, during his conversations with Charles, Jasper felt empowered and confident that he would be able to influence the strategic direction of the firm.

In late 2013, Jasper accepted the job with Guang Guo. His mandate from Charles was to introduce "international standards" in risk measurement and management to Guang Guo.

### Chinese investment banks/securities firms

Chinese investment banks, often called securities firms, performed similar functions to Western investment banks but there were important differences in ownership, culture, and business models.

Many securities firms in China were originally owned by government entities, and often the culture of government ownership was slow to change. Decision making was hierarchical, with junior staff typically deferring to bosses rather than expressing their own points of view.<sup>2</sup>

Securities sales and trading formed the biggest source of income for Chinese securities firms. In contrast, Western brokerages had more diversified income streams, with major contributions from investment banking and asset management as well as sales and trading. According to the accounting firm KPMG, in 2013 brokerage and proprietary investments accounted for about 70% of all income in Chinese securities firms, compared to less than half of Goldman Sachs, Morgan Stanley, and UBS's income.<sup>3</sup>

Brokerage and proprietary trading were profitable in the growing and rising markets that China experienced in the late 1990s. In the early 2000s, as China's equity markets declined [see **Exhibit 2**], some securities firms felt pressure to maintain profitability. Nomura Securities observed: "Although the securities industry has grown rapidly, it also has many problems. Many of these problems have become particularly evident since June 2001, when share prices entered a sustained period of weakness. Illegal activities were rampant, including the misappropriation of client funds, the guaranteeing of yields in discretionary accounts, proprietary trading in violation of rules, and market manipulation."<sup>4</sup>

Despite their efforts, many securities firms experienced losses during the early 2000s [see **Exhibit 3**]. In 2004, China's 130 securities firms posted a combined loss of more than 15 billion yuan, then equivalent to roughly USD1.84 billion. Only about 30 of the firms had financially healthy businesses. Most of the others were poorly managed and some were technically insolvent.

To stabilize the sector, the government stepped in to restructure the industry. In 2005, regulators divided securities firms into tiers, arranging for the weakest firms to be taken over by stronger competitors. The better capitalized, well managed firms in the top tier were designated as "pilots" and allowed broader business scopes.<sup>5</sup>

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<sup>2</sup> Takeshi Jingu and Suiyo Ri, Nomura Capital Market Review 9 (4) (2006): pages 52-53.

<sup>3</sup> KPMG China, "Mainland China Securities Survey 2014," pages 10,12.

<sup>4</sup> Jingu and Ri, "The Restructuring of China's Securities Industry," page 52.

<sup>5</sup> *China Daily*, "Brokerage Heavyweight Takeover," August 2, 2005, China.org.cn, accessed May 30, 2015.

Guang Guo was formed during this process and achieved the top tier “pilot” status. This status allowed the firm to experiment with new products and business areas that increased their profit potential and highlighted the need for strong internal controls.

Guang Guo and the other pilots developed commercial mentalities and profit-driven behavior. As in Western investment banks, the individuals who earned large profits through their trading activities tended to accrue significant power in their organizations. Since its formation in 2005, Guang Guo had never posted an annual loss.

## The Chinese stock markets

Modern stock markets opened in China in the early 1990s and had a volatile history. Market movements tended to be driven by rumor and momentum rather than fact-based valuation of a company’s fundamentals.

Prospective domestic investors had few alternatives to the stock market. When Jasper accepted the position at Guang Guo in late 2013, overseas investment was difficult because of China’s currency controls. Domestic bank deposits paid low capped rates of interest that were frequently below the inflation rate. Property investment required a large amount of capital and was illiquid. The stock market tended to be the default destination for individuals and small businesses with spare cash.

Domestic investors, particularly individuals, lacked investment experience. Many individuals considered stocks to be appealing simply if their prices had risen rapidly in the past on high volume. The strategy was essentially speculative—to buy the stock without regard to any asset fundamentals, that is, even if currently “overpriced”—with the prime intention of selling it for an even higher price to someone else.<sup>6</sup>

As well as a large speculative element, China’s markets were characterized by state domination. Governments worldwide were actively involved in stock markets, typically as regulators and policymakers. In China, though, the government held multiple roles: regulator, majority owner of listed companies, lender to listed companies, and owner of intermediaries such as securities firms. These multiple roles led to a perception among some investors that the government controlled the market’s direction. Fortune magazine described a group of retirees at a securities trading hall in Shanghai: “These stock-crazed seniors capture the mania – the obsession, some would say – that is the investment game in China. They buy and sell frequently, often on the flimsiest of rumors. ‘Everyone knows,’ whispered Hong Feng, a former schoolteacher ‘that the government wanted the stock market to go up this year. But now they think it might be getting too hot. It might be time to sell.’”<sup>7</sup>

The combination of investors’ inexperience, lack of investment alternatives, and the reliance on government signals to gauge the market’s direction meant that stock market movements could be sharp be , with exaggerated upward and downward trends and sudden reverses of direction. This tendency towards sharp movements made the market difficult for large international institutions to analyze. The Wall Street Journal commented: “Big international investors need a better domestic trading environment before

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<sup>6</sup> “The price of an asset can be decomposed into two components: the fundamental valuation . . . and a speculative component generated by the asset owner’s option to sell the share for a speculative profit.” – Mei Jianping, Jose Scheinkman and Wei Xiong, “Speculative Trading and Stock Prices: Evidence from Chinese A-B Share Premia,” NBER Working Paper 11362, May 2005

<sup>7</sup> “Playing the China Boom,” *Fortune Investor’s Guide 2010* (December 11, 2009).

committing to the market in scale. Cracking down on insider trading and building stronger, more credible investing institutions within China would be signals of change.”<sup>8</sup>

### Jasper’s first few months at Guang Guo

Jasper moved to China in March of 2014 and started his job as head of Risk Management for Guang Guo Securities. CEO Charles Pan was quick to introduce Jasper to all of the key personnel while emphasizing Jasper’s risk management expertise. His new colleagues gave Jasper a warm welcome. Jasper initially focused on learning the mechanics of the Chinese markets and the firms’ trading strategies, operating procedures, and attitudes towards risk. This learning process involved frequent exchanges of ideas with other department heads, particularly Jianguo Lu, who was in charge of trading strategy and asset allocation [see **Exhibit 4** for the organization structure of Guang Guo Securities].

After a few months on the job, Jasper found his welcome reception slowly wearing off. With China’s economy booming, there were plenty of domestic investment opportunities, and the traders at Guang Guo did not seem as interested in his knowledge base as he had initially expected. Jianguo listened politely to Jasper’s ideas on such things as implementing simple trading limits and daily P&L reporting, but ignored Jasper’s attempts to implement these measures.

In general, Jasper found a low awareness of risk measurement and management at Guang Guo and realized his job of effecting change would be more difficult than he expected. Traders seemed to focus solely on the profit or loss realized from their trades, and back office staff focused on processing trades and completing paperwork. No one analyzed the range of possible outcomes before each trade, nor did they compare the profit or loss from particular types of trades to the capital that was put at risk, that is, staff were not evaluated on the risk-adjusted returns. Since the trading function continued to have strong total revenues, neither traders nor back office staff saw any need for a formal risk management system.

Jasper was struck by the apparent disconnect between the CEO’s enthusiasm and the trading and operation teams’ lack of interest in risk management. Still, his job was to push Guang Guo in the direction of international risk management standards. He decided he would make the statistical VaR framework the key centerpiece of his efforts. The key issue would be how he would obtain local buy-in for this effort.

Jasper called a meeting with Jianguo and his traders to discuss a new VaR limit framework. VaR would be used to quantify risks of the different trading desks at Guang Guo. Activities with a higher VaR – riskier activities – should require a higher return for a given level of capital invested. Furthermore, the amount of capital exposed to a particular type of risk would be subject to predefined limits. This policy would ensure that the firm was earning adequate risk-adjusted returns on its activities.

However, Jianguo remained skeptical of this proposal. He argued that no VaR model could replace his years of experience in Chinese markets and that “Chinese markets are different from Western markets.” Jianguo asserted that the Shanghai equity markets were dominated by speculative retail investors and prone to unpredictable movements that could never be adequately captured by statistical models. He pointed out that despite all of their sophisticated models, the United States and Europe had recently suffered from a severe financial crisis caused in part by the poor pricing of risk.

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<sup>8</sup> Wall Street Journal Heard on the Street “Shanghai Stocks Best Left to Thrill Seekers,” December 9, 2014,

Jasper found it difficult to formulate a satisfactory response to Jianguo's challenges during the meeting and, in private, started to wonder whether VaR was even applicable to Chinese markets. He fell back on the Basel international regulatory rules, which showed that the validity of any VaR model lay in its ability to pass a "VaR backtest." [See **Appendix**.] Jasper would indeed have to backtest his VaR model in the context of Chinese markets and let the results and evidence speak for themselves.

Charles Pan, the CEO, was watching the dynamic between the risk management and trading departments closely. Although he was aware that trading profits needed to be better rationalized and he understood the concepts of return on equity and risk adjusted returns, he did not want to antagonize Jianguo. As the head of a profit center that generated significant earnings, Jianguo was a powerful figure at the firm, so Charles was loath to intervene directly. Indeed, one of the reasons Charles had hired Jasper was to have a real risk management expert be the one to interact with Jianguo on a daily basis and to help push the firm in the direction of international standards. Since Charles' ultimate goal was to eventually establish overseas branches of Guang Guo, internationalization was imperative.

## APPENDIX 1: VALUE AT RISK

Value at risk (VaR) is the maximum loss that a portfolio of financial assets is likely to lose over a fixed time horizon, for example, one trading day.

A maximum loss can only be *estimated* by using a *model*. Because a stock's price fluctuates randomly and unpredictably in time, the daily "loss" of a portfolio of financial assets is a random quantity. As such, one can only talk of "maximum loss" in a statistical sense. In other words, one can only state with 95% (or some high percentage) confidence that a portfolio will not lose more than X million dollars in one day. Thus to fully specify VaR, one also needs to specify this "confidence level."

One of the simplest VaR models is called "variance-covariance VaR" and is based on the same theory more commonly associated with "Markowitz portfolio theory." In this approach, the maximum loss of a portfolio of assets at a given confidence level is proportional to the *volatility* of the portfolio returns.

A variance-covariance VaR model first requires one to calculate the *historical* standard deviation,  $\sigma$ , as a measure of volatility. This calculation is based on a judicious choice of a past time window of a portfolio's returns. So a very basic assumption of the model is that historical volatility will be a good predictor of *future* volatility.

Next, assuming that the daily financial asset returns follows a normal probability distribution with mean equal to zero, the VaR (at confidence level  $c$ ) is calculated as:

$$\text{VaR}_c = z * \sigma ,$$

where  $z$  is a constant equal to the number of standard deviations below the mean, above which  $c\%$  of observations lie. For a normal probability distribution, a 95% confidence level corresponds to  $z = 1.645$ . This  $z$  value implies that 95% of the return observations will be greater than  $-\text{VaR}_{.95} = -1.645 * \sigma$  (see Figure 1 below), and 5% of the returns will be below this number. Remember VaR represents a "maximum loss" so VaR is always a positive number or zero, while  $-\text{VaR}$  is typically a negative number.

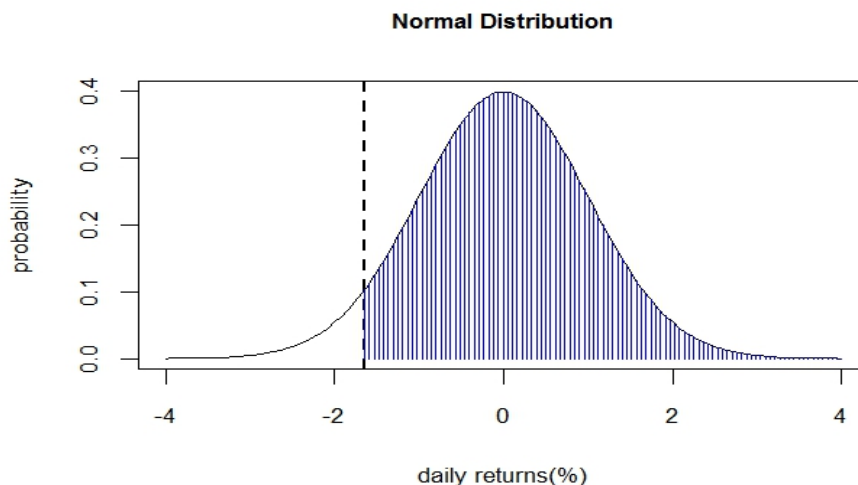


Figure 1: Probability distribution of the daily returns of a portfolio, assuming returns are normally distributed with mean equal to zero. The daily standard deviation  $\sigma$  of returns is 1% in this example, and the shaded area to the right of the dotted line (plotted at return = -1.645%) is 95% of the total area under the normal curve. Thus the one day (1D) 95% confidence VaR of this portfolio is  $1.645 * \sigma = 1.645\%$ .

### VaR Backtesting

The fundamental question is whether a VaR model built based on a past history of returns was actually able to predict worst case losses *in the future*. This is a question of *model validation*, and for VaR models the validation is called “backtesting.”

VaR backtesting involved comparing the VaR estimates with the actual returns observed over a given historical period. So for example, consider a one day (1D) 95% confidence VaR model that we wished to backtest over a historical period of 250 trading days. Each of the 250 days was associated with (a) an actual, observed, daily return and (b) a VaR model estimate, made the day prior to each observed daily return (note: do not confuse the historical period used to estimate VaR on a given day with the total historical days used for the backtest- these are separate quantities). If the VaR model were accurate, then the expectation was that approximately 12 or 13 out of the 250 trading day returns ( $250 * 5\% = 12.5$ ) would have greater losses than the VaR estimate for that day.

If 90 cases were observed where the daily returns were more negative than the VaR estimates (90 “VaR exceptions”), then the VaR model would clearly fail the backtest. If zero VaR exceptions were observed, then this would also signify failure of the backtest: the VaR model estimates were so large that an exception was never seen (recall it would take no skill to predict an equity portfolio’s maximum loss was 100%!).

A case where 9 or 15 exceptions were observed would make it more difficult to draw conclusions. For these cases, formal statistical tests have been adopted by banking regulators to determine whether to accept or reject a VaR model. For a 250 trading day backtest, a 95% VaR model could be rejected with “high confidence” if fewer than six or more than 19 exceptions exist. Otherwise, the VaR model could be accepted.<sup>9</sup>

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<sup>9</sup> Paul H. Kupiec, “Techniques for Verifying the Accuracy of Risk Measurement Models,” *Journal of Derivatives*, 3 (2) (1995): 73–84.



**APPENDIX 2: HOW TO USE EXCEL SPREADSHEET WITH JASPER'S VAR BACKTEST MODEL**

The Excel spreadsheet contains daily returns from the S&P500 Index and the Shanghai Composite Index from 1999-2014.

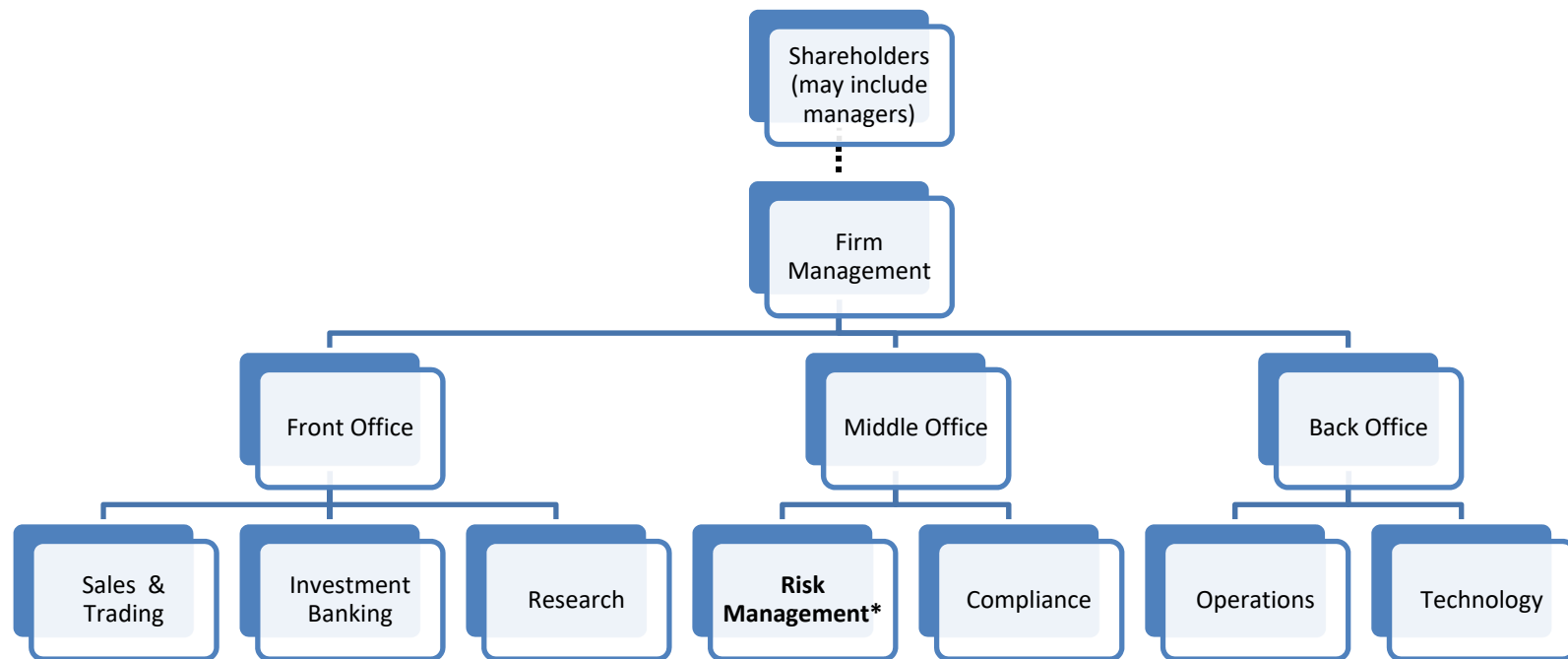
Column C contains the daily returns. Column D shows the daily 95% confidence VaR estimates based on a historical lookback period between 1 and 12 months. The lookback period may be input (yellow cell), and the spreadsheet will automatically calculate the number of exceptions in each year starting from the year 2000.

Whether the VaR model passes or fails the backtest in a given year is given in column L, based on a statistical test described by Kupiec (1995).<sup>10</sup>

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<sup>10</sup> Kupiec, Paul H. 1995. Techniques for verifying the accuracy of risk measurement models, *Journal of Derivatives*, 3 (2), 73–84.

**EXHIBIT 1: ORGANIZATION STRUCTURE OF RISK MANAGEMENT FUNCTION IN A TYPICAL WESTERN INVESTMENT BANK**

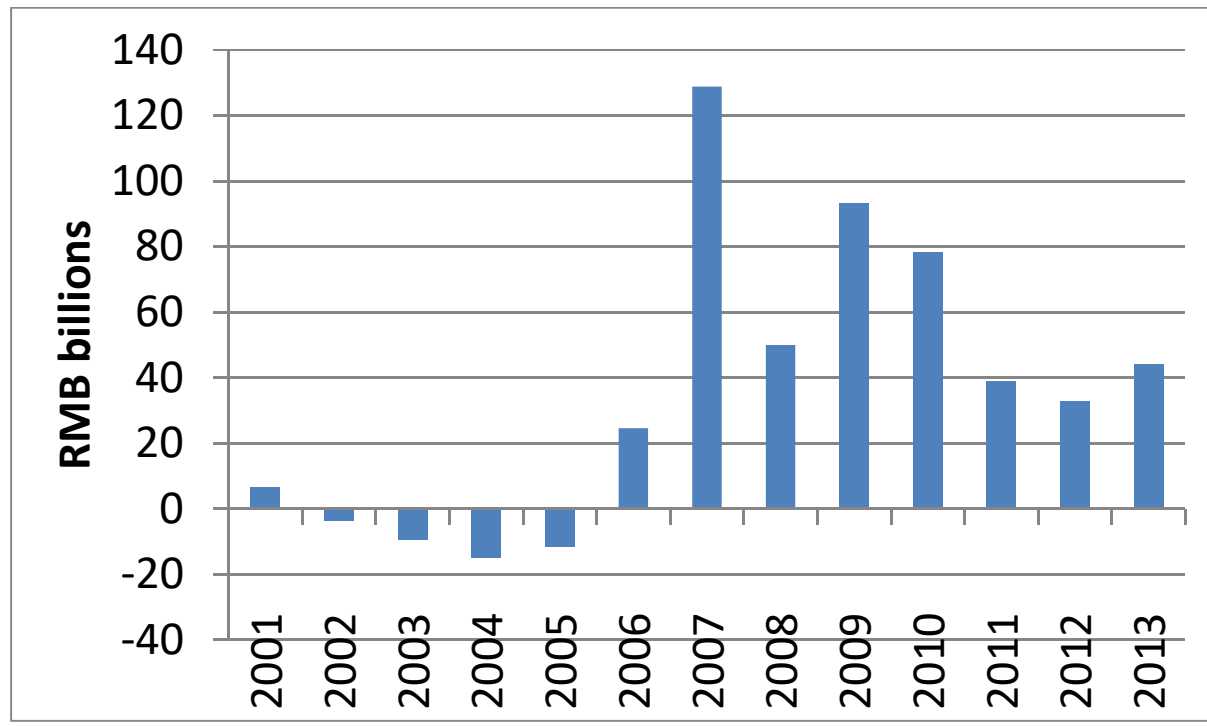


\*All bank staff are expected to manage risk in their own area of responsibility. The risk management department is responsible for measuring, monitoring and controlling overall risk in the bank. The risk management function encompasses all risk management activities, in the risk management department as well as in the revenue producing areas of the bank

**EXHIBIT 2: SHANGHAI STOCK EXCHANGE COMPOSITE (YEAR END)**



**EXHIBIT 3: CHINESE SECURITIES FIRMS' AGGERATE PROFITS**



Source: “Mainland China Securities Survey 2014”, KPMG China. <http://www.kpmg.com/cn/>

**EXHIBIT 4: ORGANIZATION STRUCTURE OF GUANG GUO SECURITIES**

