Empirical Study of China Stock Market Liquidity Risk Based on VaR

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Abstract: This paper researched the measurement of China stock market liquidity risk based on the model of including both bid-ask spread and volume combined with the indicator of turnover ratio and we also introduced the idea of VaR. We finally get the conclusion that the liquidity risk value significantly enlarged after adding the indicator of turnover ratio by studying 30 shares of 8 fields. The investor should fully consider the impact factors of liquidity risk.

Keywords: VaR, liquidity risk, turnover ratio, bid-ask spread

1 Introduction

China stock market is developing and needs to expand, in the result of limited investment tools provide to investors there are so many idle funds enter into stock market and make it stay at the situation of less supply. As a result the stock market liquidity risk is not concerned. But with the development of China Stock market especially the rapid expansion and good performance of listed corporations, there are more and more institutional investors participate into it and the liquidity risk is appeared gradually. The participation may certainly cause to hold a huge position and transactions which strongly assaults the market, and the liquidity will directly impact the investors’ profits and loss when the extreme cases (rise or collapse suddenly and sharply) appears. So it is very important to research the liquidity risk.

There is no precise definition of liquidity, Kyle (1985) thought the reason was liquidity includes many features of different markets, BIS’s said it reflect multi-faced features of market. O’Hara (1985) thought the liquidity is the price of immediacy. Grossman and Miller (1988) pointed out that the level of liquidity is decided by the in-time supply and needs. Amihud and Mendelson(1989b)thought the liquidity as a cost which is need when accomplish a transaction in a certain time or as a time which is need to find a reasonable price. Schwartz (1988) took it as a capability that can rapidly clinch a transaction in a reasonable price. Lippman and McCall (1986) pointed that if the asset can be sold quickly in an expected price then it has liquidity. We can summaries the features of liquidity from the above, they are as follows:

<table>
<thead>
<tr>
<th>Features</th>
<th>Maker market</th>
<th>Free compete market</th>
</tr>
</thead>
<tbody>
<tr>
<td>width</td>
<td>Bid-ask</td>
<td>Optimal bid-ask</td>
</tr>
<tr>
<td>depth</td>
<td>The quantity of transaction in an available price</td>
<td>The quantity of transaction in a certain price which may not be impacted</td>
</tr>
<tr>
<td>timeliness</td>
<td>Good liquidity market means it may well satisfied investors to transact</td>
<td></td>
</tr>
<tr>
<td>flexibility</td>
<td>The volatile of price disappeared speed caused by a certain quantity of transaction</td>
<td></td>
</tr>
</tbody>
</table>

We definite the liquidity as a capability that investors can make a big transaction under the situation of impacting price at the least. But the investors may probably face the problems and higher cost of transaction when they buy or sell stocks, even more they may fail to transact. The research is the initial status in our country, with the development of our stock market the liquidity problem is appearing more and more, so it is important to study liquidity to help our market grow up.

2 The model of measurement on liquidity risk based on VaR method

2.1 The definition of VaR
VaR means value at risk. It is a statistic evaluation for the portfolio in the market of normal fluctuation. VaR is a method which uses statistical technology to measure financial risk of portfolio. It’s mathematical definition is $P (\Delta P \leq VaR ) = \delta$, $\Delta P$ means the market value changes of a certain portfolio in $\Delta t$.

2.2 Proposing the liquidity risk measurement model Combine with turnover ratio
The main indicators for measuring liquidity are bid-ask and volume, the smaller spread the lower cost and the better market liquidity. Volume is another important one which can reflect whether one big transaction concluded and the impact to the price. The bigger volume with small spread the better liquidity. There is negative correlation between liquidity risk and turnover ratio from the experience, we can definite liquidity risk as follows:

$$L = \frac{(P_{\text{max}} - P_{\text{min}})}{V (T_m)}$$

(4-1)

$P_{\text{max}}$: Day highest price
$P_{\text{min}}$: Day lowest price
$V$: Day turnover
$T_m$: Turnover ratio

The molecule of this indicator is the day volatility of stock price and it also be considered as day spread. Then we can consider $L$ as the rate of price change caused by unit concluded amount in a trading day.

The cure work is to fit the statistical distribution of these indicators because the time series of spread and volume which included in the liquidity risk indicator $L$. We can calculate the value after the distribution of $L$ was determined under a certain confidence level and then calculate the stock’s liquidity risk.

We can definite liquidity risk value $(L_{VaR})$ referenced to the definition of VaR: The maximum possible loss caused by underselling a quantity of stock or portfolio in future specific time. The formula is

$$\Pr (\Delta A < L_{VaR} ) = \alpha$$

$\Pr (\Delta A < L_{VaR} )$: The rate that the loss of asset’s value is less than the top possible loss
$L_{VaR}$: The value of liquidity risk under the confidence level $\alpha$ — top possible loss
$\alpha$: The given probability — confidence level

We can clearly get the liquidity cost because of the reduction of task by using the value of $L_{VaR}$ under a certain confidence level and time. In order to facilitate the process, we consider taking $L$ as the natural logarithm, so that division of the two indicators can be converted to the subtraction. Re-definite as follows:

$$L' = \ln(L) = \ln \left( \frac{P_{\text{max}} - P_{\text{min}}}{P_{\text{min}}} \right) - \ln(V) - \ln(T_m)$$

(4-2)

Now the distribution of $L$ is converted to that of $L'$, then the $L_{VaR}$ of market index can be calculated under a certain confidence level.

It is known that the distribution and parameters of $L'$ at $t$, and then the $L_{VaR}$ can be deduced according to the relationship of function between $L_{VaR}$ and $L'$. We take 99% as the confidence level the following calculations (Due to the instability of financial market and control strictly with the risk we chose 99% as the confidence level), the details of derivation processes are as follows:

$$P (\Delta L' < L_{VaR} ) = 99\%$$

When $L'$ follows normal distribution

Then

$$P (\Delta L' > \mu - a \sigma ) = 99\%$$

$\sigma$: The multiples of $\sigma$ in related to the confidence level of $\alpha$ (such as under the normal distribution,
when $\alpha = 95\%$ then $a = 1.65$, when $\alpha = 99\%$ then $a = 2.33$

$\mu$: Sample mean of $L^*$

$\sigma$: Sample standard deviation of $L^*$

Then we can define $L_{VaR}$ in relation to the mean as follows:

$$L_{VaR} = E(L) - L_*$$

$E(L)$: mean of $L$

$L_*$: The lowest value under the confidence level of $\alpha$

When $\alpha = 99\%$

$$L_* = e^{\mu - 2.33\sigma}; \quad E(L) = e^{\mu + 1.65\sigma}$$

$$\therefore L_{VaR} = e^{\mu + 1.65\sigma} - e^{\mu - 2.33\sigma}$$

(4-3)

3 Empirical study of China stock market liquidity risk

Using the proposed model above we made empirical analysis by using 30 stocks of 8 trades from SSE. In this paper the data taken from Fortune Securities Analysis System from March 2, 2004 to June 2, 2009. We will abandon some data because of the reception problems of the system. Now we can take empirical study and the processes are as follows:

1. Selecting appropriate forecast window. We choose 50 as the forecast window because this number is obtained from a lot of experimental analysis.

2. Using rolling algorithm to calculate the $\mu$ and $\sigma$.

3. Making normal test for $L^*$

4. If the $L^*$ submit the normal distribution then calculate the $L_{VaR}$ by using the mean and variance according to the process 3.

There are some empirical results (because of the space is limited we choose Jinrongjie Shanxijiaohua and Haiyougongcheng to show) as follows:

![Figure 1 Predictions of $L^*$](image)

The model proposed is based on the hypothesis of normal distribution and now we use the software SPSS to test it be true. We get the value Skewness & Kurtosis are all between -0.5 and 0.5. That means the distribution of $L^*$ is basically follow the normal distribution and the model is effective.

Now we begin to test the negative correlation between $L^*$ and turnover ratio. There are the chosen projects’ scatter figures:
The scatter figures showed that ordinate liquidity risk value reduced when the abscissa turnover ratio increasing. Then the model’s validity is proved again.

From the above we can see that the $L_\text{VaR}_1$ shows some certain convergence and the abscissa between 600 and 900 the liquidity is obviously very low that is because of the financial crisis. Then we can say this empirical analysis submits the truth basically.

Now we show some ranks to contrast the old model to this paper’s ($L_\text{VaR}_1$: this paper proposed and the $L_\text{VaR}_2$: pre-model’s)

<table>
<thead>
<tr>
<th>Stock code</th>
<th>$L_\text{VaR}_2$</th>
<th>$L_\text{VaR}_1$</th>
<th>New rankings</th>
</tr>
</thead>
<tbody>
<tr>
<td>001161</td>
<td>7.57E-09</td>
<td>2.32E-06</td>
<td>10</td>
</tr>
<tr>
<td>000002</td>
<td>1.71E-10</td>
<td>5.04E-08</td>
<td>3</td>
</tr>
<tr>
<td>000024</td>
<td>6.33E-10</td>
<td>1.53E-07</td>
<td>6</td>
</tr>
<tr>
<td>600005</td>
<td>1.87E-10</td>
<td>2.75E-08</td>
<td>2</td>
</tr>
<tr>
<td>000825</td>
<td>6.86E-10</td>
<td>2.29E-07</td>
<td>7</td>
</tr>
<tr>
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<td>4.14E-07</td>
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<tr>
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<td>9</td>
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<td>1</td>
</tr>
<tr>
<td>600740</td>
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<td>1.17E-07</td>
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<tr>
<td>000800</td>
<td>7.62E-10</td>
<td>1.26E-07</td>
<td>5</td>
</tr>
</tbody>
</table>

4 Conclusion

This paper analysis the liquidity risk issue which is popular concerned in the financial market and uses the idea of VaR to measure the liquidity risk of China stock market. It measures the liquidity risk and synthesized and objectively to help investors fully analysis the market and reduce the loss by using the indicators of price, bid-ask spread, volume and the innovation turnover ratio in this paper on contrary to the used single or simple ones. Although $L_\text{VaR}$ is a risk measuring way of intuition and quantified it is a necessary way not the fully one. When we measure the liquidity risk of stock market some other
indicators and methods should be considered and only in this way we can form a liquidity risk management system.

References