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Innovative Applications of O.R.

A margin scheme that advises on when to change required margin

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ABSTRACT

The purpose of a margin requirement is to protect a clearinghouse from members' defaults resulting from big losses due to adverse movement of futures prices. To decide on how much a margin is required, a clearinghouse may refer to a benchmark margin defined as a constant multiple of the forecasted volatility. However, a benchmark margin only advises on a desirable margin level. It gives no advice on whether a clearinghouse should alter existing required margin. This paper proposes a margin scheme that can advise on when to change the required margin and if a change is recommended, to what level it should be changed. The proposed margin scheme can be devised so that the coverage probability and change frequency are controlled at target levels deemed appropriate by the clearinghouse. The proposed margin scheme needs a volatility forecast as input. This paper shows that among a large number of volatility forecasts, implied volatility gives the best results. This confirms a conjecture that implied volatility may have more information content than other volatility forecasts as far as margin setting is concerned.

1. Introduction

In all financial markets, the institutions responsible for clearing and settlement are the exchange and the clearinghouse, particularly the latter. Bernanke (1990) points out that in some markets, the clearinghouse is a part of the exchange; otherwise, it is a separate nonprofit corporation. Also, all clearinghouses function as an association of the clearing members. Being members of the clearinghouse, private firms acquire the right to clear trades (of futures or options) of their own customers and for non-member firms. Furthermore, members can also do proprietary trading and clear trades on their own. Consequently, a clearing member may end up with a net position. The clearinghouse stands in the centre of the settlement process, disbursing payments and receiving payments to and from clearing members. Thus a clearinghouse acts as a centralized counter-party and assumes the default risk of its clearing members. This setup greatly reduces the members' counter-party risk since the clearinghouse should be prudent in risk management like requiring the members to pay up substantial margin money and is backed up by a substantial amount of reserve funds.

Being a centralized counter-party, a clearinghouse normally bears no market risk since at all times, the market values of the long and the short positions cancel each other. However, a clearinghouse is exposed to its members' default risk. When a clearing member defaults, the clearinghouse needs to liquidate the members' position. A clearing member defaults because its clients do so, or because the loss in its own proprietary account forces it to do so. To manage members' default risk, a clearinghouse may adopt various measures. It may require a member to have a minimum capital level, pay up a guarantee fund, or report regularly its firm capital, to name just a few. Among all the risk management measures, the most substantial one is to put up an initial/maintenance margin, and to require members to do likewise for their clients. Required margin from clearing members plays a frontline role in a clearing house's risk management policy.

An initial margin is required from an investor when a contract is freshly started and the investor has to maintain margin money to be above a maintenance level throughout the life of the futures contract. By requiring a substantial maintenance margin, a clearinghouse can protect itself from big losses due to members' defaults. In our discussion below, a maintenance margin is simply referred to as the required margin since it is the maintenance margin which is more important for risk management purposes. For the required margin to be sufficient to cover the future price swing with a large probability, Duffie (1989) suggested statistical methods to determine a margin level to guard against the possibility of a default. For example, if the required margin is set as 6% of the contract value, then the clearinghouse would run no risk at all unless the market moves more than 6%. The probability that the clearinghouse is totally immuned from market risk is called the coverage probability. It can also be interpreted as the probability that a market participant will run a loss less than the existing maintenance margin. In the earlier literatures, normality assumption was usually adopted for calculating an appropriate margin

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to attain a prescribed coverage probability. Later, Warshawsky (1989) showed that the usual normality assumption is inappropriate. In lieu of the normal assumption, Kofman (1993), Longin (2000) and Cotter (2001) used extreme-value theory to determine an appropriate margin level. Booth et al. (1997) and Booth and Broussard (1998) documented that the use of extreme-value statistical techniques to various futures contracts may be beneficial to the margin-setting committee which holds the final authority in margin determination.

While a margin committee of a clearinghouse would not follow a mechanical formula in setting the margin, they do compute some benchmark margins as a reference in their decision on required margin. Since statistical theory suggests that whether margin money can cover losses depends on market volatility, such benchmark margin invariably includes a volatility forecast as one of the key determinants in a benchmark value. According to Lam et al. (1999) and Lam et al. (2004), the benchmark margins computed by some futures exchanges are set to be equal to a constant multiple of a volatility forecast. For instance, if a clearinghouse adopts a multiplier equal to 3 and if the daily volatility is forecasted to be 2%, the benchmark margin per contract is suggested to be $3 \times 2\% = 6\%$ of the contract value. Different clearinghouses would adopt different constant multipliers to arrive at a benchmark margin, depending on how much coverage probability they want to achieve. Needless to say, the larger the multiplier, the larger the coverage probability will become. In view of the fact that the normality assumption is not valid, it is difficult to determine *k a priori* to achieve a certain coverage probability. A more realistic way to determine the constant multiplier *k* to be used in benchmark margin computation is through historical simulation to the effect that the coverage probability is controlled at a high level deemed comfortable by the margin committee.

2. Methodology to maintain margin at a stable level

It is pointed out in the introduction that the coverage probability can be controlled at a constant level if a clearinghouse sets the required margin equal to the benchmark value. However, no clearinghouse will require a margin strictly equal to the benchmark margin. This is because the benchmark margin changes everyday due to the time varying market volatility. To maintain a certain stability in margin level, a margin committee may not like to have the required margins changed so frequently as investors may be caught unprepared when required margin goes up suddenly. As remarked by Fenn and Kupiec (1993), it may be costly to alter margin requirements. They pointed out that in a sample period of 7 years, required margins were changed 10 times on the S& P500, seven times on the NXSE Composites. Also within a span of five years, MMI changes its required margin 11 times. However, not all futures exchange would like to entertain changes in required margin. In fact some exchanges simply impose a constant required margin on futures contract. For example, for KOSPI 200, the Korean Exchange sets margin at a flat 10% of the contract value.

If a clearinghouse adopts a constant required margin, there is no need to consider any change in margin level, but coverage probability will vary daily. As a result, there may be days in which the coverage probability becomes excessively high. However, if a clearinghouse decides to control the coverage probability at a constant level, they have to require a margin equal to the benchmark margin. This entails a change of required margin everyday, which a clearinghouse is reluctant to do. Thus unless a clearinghouse adopts a constant required margin approach, they have to deal with the following question everyday: how large a difference between benchmark margin and existing margin they would allow before they decide to change the required margin. To help the margin committee to decide whether a change of required margin is warranted or not, we need to go beyond a simple benchmark margin. Benchmark margin has a shortcoming that it only advises on a desirable margin level but gives no advice on whether a clearinghouse should alter the existing required margin. This paper proposes a margin scheme that can advise on when to change the required margin and if a change is recommended, to what level it should be changed. The proposed margin scheme can be devised so that the coverage probability and change frequency are controlled at target levels deemed appropriate by the clearinghouse.

Our proposed margin scheme is motivated by the following remark in Fenn and Kupiec (1993): "The margin committee might set initial margin higher on average and not reset margin until it has a higher degree of confidence that volatility has substantially changed." Under this approach although a volatility forecasting model may suggest an increase of volatility, the margin committee may still hold the margin at its current level, unless the increase is substantial. In other words, the proposed margin scheme should calculate not only a recommended margin but should also produce a band around this recommended value. To implement this idea, we introduce two parameters $k(k \geqslant 0)$ and $b(0 \leqslant b \leqslant 1)$ in the proposed scheme in which k controls the desirable margin level and b controls the width of the band for making margin changes. Specifically, at day one when the futures closes at f_1 and volatility forecast is $\hat{\sigma}_1$, we set required margin as $f_1 k \hat{\sigma}_1$ and in the same time introduce a margin band $f_1 k \hat{\sigma}_1 (1 \pm b)$. The required margin as well as the margin band will remain unchanged until at one day, say day t, the volatility forecast $\hat{\sigma}_t$ gives a value $f_t k \hat{\sigma}_t$ which falls outside the existing margin band. If $f_t k \hat{\sigma}_t$ exceeds the upper level of the margin band, or if $f_t k \hat{\sigma}_t$ is smaller than the lower level of the margin band, reset the required margin as $f_t k \hat{\sigma}_t$ and reset the margin band as $f_t k \hat{\sigma}_t (1 \pm b)$. The updated required margin and the margin band will remain unchanged until the next breakout. Obviously k controls the coverage probability and b controls the frequency of margin changes. The key problem now is to find a suitable combination of k and b so that both coverage probability and frequency of margin changes are controlled at prescribed levels. The choice of k and b would be at the discretion of the margin committee. They should, at the start, have an idea on how much coverage they want and on how many changes per year is desirable. Once they have set these target values, they can choose k and b using historical simulation method. Specifically, for each k, b combination, we use historical data to simulate margin levels and choose the combination to attain a prescribed historical coverage probability and historical frequency of margin changes. We apply this idea to the HSIF market in Hong Kong. Using historical volatility as a volatility forecast, to achieve an average coverage probability of 99% and to maintain an expected change frequency equal to six times a year in historical simulation method in Section 4 suggests that we should implement a margin scheme with $k = 2.518$ and $b = 0.352$. Notice that the parameters $k = 2.518$ and $b = 0.352$ work well when historical volatility is used as a forecast of future volatility. When other volatility forecasts are used, the parameters that achieve the same prescribed goals will be different. In this paper, we will devise these margin schemes for the Hang Seng Index Futures market in Hong Kong. A brief description on that market will be given in Section 3. Since the margin scheme needs a volatility forecast, we also describe in Section 3 what those forecasts are and how they are computed.

In Section 4, we propose suitable margin schemes using various volatility forecasts as inputs. For each volatility forecast, we report the corresponding (k, b) combination to achieve a target coverage probability and a target change frequency. The margin committee is at their liberty to set these targets. Since the proposed margin scheme involves a volatility forecast, we would further investigate which volatility forecast would serve as the best input to the