

# AN EXECUTIVE INFORMATION SYSTEM FOR SECURITIES BROKER'S RISK MANAGEMENT WITH DATA WAREHOUSING AND OLAP

Yung-Hsin Wang, Shing-Han Li

*Department of Information Management, Tatung University, Taipei, Taiwan*

Kuo-Lung Sun

*Oriental Securities Corporation, Taipei, Taiwan*

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**Abstract:** With the open domestic financial market, the targets of investment and money management are toward diversity. The competition from internationalization makes the stock market no more flourishing as usual. The risk of margin trading becomes important information that securities firms try to analyze and get controlled. According to current regulations and working process, this study constructs an executive information system with the application of data warehouse and online analytical processing (OLAP) to help securities brokers make decisions in the operation of risk management for margin purchase and short sale of securities. The result solves the problem that managers of margin trading usually face when using traditional account systems.

## 1 INTRODUCTION

In the past years, the securities industry in Taiwan has developed vigorously. However, with the open domestic financial market and internationalized competition, the targets of investment and money management are toward diversity, which makes the stock market no more flourishing in recent years. Due to price reduction to compete with others, the profit of handling fee of the stock trading is not as good as usual, and the margin trading becomes the key business of security firms.

What is margin trading? According to Article 2 in "Regulations Governing Margin and Stock Loans by Securities Firms" (TSEC, 2006) stipulated by Taiwan Stock Exchange Corporation (TSEC), the term "margin loan" means that a securities firm provides monetary financing to its customers; the term "stock loan" means that a securities firm lends securities to its customers. Article 16, in addition, stipulates that when a securities firm dealing with margin loan and short stock loan extends monetary financing to a customer, it shall collect the margin for margin purchase based on the ratio prescribed by the SFC (Securities & Futures Commission), and all

the securities procured through margin purchase shall be used as collateral; when extending stock loan to a customer, the securities firm shall collect a margin for short sale in accordance with the percentage prescribed by SFC, and the proceeds from the short selling shall be used as collateral.

However, the stock market is to vary at any time. To ensure the creditor's right of security firm, Article 17 regulates that "A securities firm dealing with margin loan and stock loan shall calculate the ratio of the value of collateral in each credit account to the customer's debt on daily basis. If the ratio is lower than the required ratio, the securities firm shall immediately notify the customer to make up the difference within a prescribed time limit." The above-mentioned ratio, called "maintenance ratio," is one of the most important indexes to measure the loan state of the customers for securities firms.

Securities brokers usually will face a risk that only when the collateral maintenance ratio of the customers is lower than 120%, the credit extension organization can send out notification of payment (margin call), and in the third day the target stocks can be disposed of. By calculating with the current 7% greatest price fluctuation per day, if that finance (stock) rises or falls everyday, the surplus money

will be unable to compensate creditor's right. On the other hand, even the customer maintenance ratio for a stock looks good and everything seems normal, yet there still is a hidden worry of higher centralization. At this moment, if that stock falls suddenly and rapidly, it might cause a severe loss to the customers and affect the creditor's right of security dealer.

Most current securities brokers count on their account systems to present statistic data after closing quotation which has the following shortcomings:

- In the aspect of data integration: Users have to check several reports (forms) in order to have an overall understanding of current status.
- In the aspect of portability: It is inconvenient for the manager of margin trading to carry the forms everywhere to discuss with others or report to a superior when an anomaly is found.
- To alert the anomaly of key indexes: The closing form is usually used to make account check and is hard to alert for the anomaly.
- To judge the trend of some key indexes: The margin trading manager cannot know the previous data simply from today's account balance (need comparisons to historical data).

Thus, our objective of this study is to design and implement an Executive Information System (EIS) for managing the risk of margin purchase and short sale of securities. We will first construct a data warehouse for margin trading of securities brokers, and then choose KPIs (Key Performance Indicators) and analysis dimensions according to practical requirements for the data cube to be analyzed using OLAP (Online Analytical Processing) technique (Chaudhuri and Dayal, 1997; Inmon, 1996; Turban and Aronson, 2001). Note that MDX (Spofford, 2001) is used in this study to inquire cube data.

## 2 SYSTEM DESIGN

### 2.1 Data Model Setup

Three dimensions are required as shown in Table 1:

- Customer Dimension: The entire company data is used to query situation of all customers to understand current quality of margin loan. Since customers and the trading volume are different in different locations, with the branch level we can compare business performance of each branch. For the level of customer account, the analysis target is a single customer.

Table 1: Structures for the dimension hierarchy.

Dimension	Structure	Details
Customer	Star Schemas	Entire Company -> Branch -> Account No.
Stock	Star Schemas	All Shares -> Securities Class Stocks -> Securities Code
Time	Star Schemas	Year -> Month -> Day

- Stock Dimension: By matching with other dimensions, the level of all shares can be used to inquire the entire situation of all stocks. Stocks of the same class might not have the same operating status, yet their natures might be the same. The level of securities code is the individual stock. With the account number, it can reveal data for balance of stock loan and margin loan of the stock held by that customer.
- Time Dimension: It is necessary for analyzing time variation of the balance of margin loan. Since the data processed in our system is balance, "day" is most popularly used. The other two are used to calculate mean value.

### 2.2 Data Warehouse Establishment

In this study, we need one Fact Table and three Dimension Tables to finish data cube for the OLAP. Note that according to this study's measurement indexes shown in Table 2, the measurements for the Fact Table will be defined.

- Fact Table: Based on the Balance of Margin and Stock Loan file of the customers in the account system, it transforms directly the branch code, customer's account, security code, balance of margin purchase, balance of margin loan, balance of short selling, balance of collateral and balance of margin of stock loan, and adds some fields such as that of shareholding ratio and market share, etc.
- Stock Dimension Table: Based on the main securities file, it transforms the security code, stock name, security class stocks and market type, and imports the field of Balance of Margin Loan from the external data form.
- Customer Dimension Table: Based on the main file of customers, it transfers directly the company's code, customer's account, customer's name and executive code.
- Time Dimension Table: To avoid the error of placing the date information of non-trading day, this table will use system date as the format for data transformation.

Table 2: The measurement and description for the indexes.

Index	Description	Measurement
Balance of Margin Loan	The amount lent by a company (i.e., customer borrows) and is not paid off	Has different criteria according to the specification of each stock; usually analyzed with other measurement.
Maintenance Ratio	The index for measuring the credit right of customer	The higher the ratio is, the better the result is. The warning value is 120% of that currently regulated.
Customer Shareholding Concentration	Ratio for the customer shareholding and the total balance of margin loan in specific stock	The lower the ratio is, the better the result is. The warning value is 50%.
Company Margin Loan Concentration	Ratio for the shares in margin loan and that in market for a company	The lower the ratio is, the better the result is. The warning value is 10%.
Margin and Stock Loan Ratio	The short sale utilization rate of the stock for margin loan	To look after both risk and circulation, the ratio of listed stock is better not over 70% and GTSM not over 50%.

### 3 SYSTEM DEVELOPMENT AND EVALUATION

This section discusses the implementation and evaluation for the EIS system of credit transaction risk management. The data warehouse is complete through DTS (Data Transformation Service) of SQL Server 2000. Since the Balance data of Stock Loan and Margin Loan during trading time will distort depends on the operation of specifying trading or day-trading, the system is designed to close price everyday. The transaction data will be transformed automatically after confirming the account is settled.

The first phase of DTS is to copy the original extracted data to the data warehouse host. Since data in the account host is specifically designed according to account requirement that some data tables and presentation ways may not fit the data warehouse, part of the data needs to be transformed while some have to be pruned and organized first. The second phase is to merge the extracted data into data warehouse; the mission is to transform the copied data into data warehouse. Finally, the third phase then processes dimensions and data tables. Since source data table has been updated, the Cube cannot operate normally before such processing.

#### 3.1 System Functions and Interface

The system starts with a dashboard and has four function groups. Each time entering the system it shows the margin loan balance chart of current month. We shall explain each function and their sub-functions in what follows (due to space limits this paper cannot demonstrate all the screenshots; only a couple of figures are presented for illustration):

- KPIs: There are three sub-functions:

1. Overall Index: Shows branches whose Balance of Margin Loan, Balance of Stock Loan and Balance of Margin Loan surpass the setting threshold (see Figure 1).
2. Single Securities Index: Market percentage of margin purchase stocks, Margin and Stock Loan Ratio and Top 5 Margin Loan Net Buy & Sell (as shown in Figure 2).
3. Self Selecting Data Query: Using the function design provided by Microsoft PivotTables, the manager can choose freely the operating interface of dimension and measurement to query.
  - The rank of top thirty shares for each index: It lists the sorted shares with four sub-functions:
    1. Balance of Margin Loan Descending: allows users to drill down to understand and check the stock with higher finance balance.
    2. Close Price Descending: allows users to watch out the risk of high-price stock.
    3. Close Price Ascending: allows users to watch out the risk of garbage stock.
    4. Maintenance Ratio Ascending: allows users to understand and check the stock of lower maintenance ratio.
  - Comparison of Historical Data: It shows three indexes for that day and the previous four trading days to carry out dynamic analysis.
    1. Balance of Margin Loan (Margin Purchase)
    2. Balance of Stock Loan (Short Sale)
    3. Maintenance ratio
  - Query for Specific Data: Users can query for the specific data such as the following:
    1. Shareholding Concentration
    2. Balance Check for Single Share
    3. Balance Check for Individual Customer

**Overall Index**

**Margin Loan Status**

Branch	Share Balance of Margin Loan	Share Difference of Margin Loan	Amount Balance of Margin Loan	Amount Difference of Margin Loan
All Company	76,334,000	-153,000	1,197,373,000	-79,558,000

**Stock Loan Status**

Branch	Share Balance of Stock Loan	Share Difference of Stock Loan	Amount Balance of Stock Loan	Amount Difference of Stock Loan
All Company	601,000	51,000	28,602,280	9,585,930

**Maintenance Ratio**

Branch	Maintenance Ratio	Difference with Yesterday
All Company	166.09%	1.67%

**Amount Balance of Margin Loan > 180,000,000**

Branch	Share Balance of Margin Loan	Amount Difference of Margin Loan
C	11,858,000	189,588,000
H	29,296,000	467,327,000

Figure 1: Overall index of margin loan balance KPI.

**Single Security Index**

**Market Share of Margin Loan >10%**

Stock Code	Share Balance of Margin Loan	Amount Balance of Margin Loan	Market Share
1532	1,843,000	42,070,000	11.03%
6201	191,000	3,494,000	10.92%
9930	307,000	5,101,000	12.32%

**Ratio of Long and Short > 50%**

Stock Code	Share Balance of Margin Loan	Share Balance of Stock Loan	Ratio of Long and Short
3006	49,000	30,000	61.22%
3081	11,000	14,000	127.27%
6288	27,000	15,000	55.56%
9904	40,000	34,000	85.00%

**Top 5 Stocks for Margin Loan Balance Increase**

Stock Code	Share Balance of Margin Loan	Share Difference of Margin Loan	Amount Balance of Margin Loan	Amount Difference of Margin Loan
2418	1,114,000	1,107,000	7,195,000	7,149,000
3214	1,118,000	1,106,000	19,147,000	18,894,000
2206	669,000	546,000	6,974,000	5,584,000
2834	1,389,000	435,000	7,600,000	2,126,000
3051	741,000	433,000	19,383,000	11,044,000

Figure 2: Individual stock index of balance KPIs.

**3.2 System Test and Evaluation**

The system being developed was tested and evaluated by margin trading and IT managers, and is confirmed of the following advantages:

- In the aspect of data integration: With OLAP and drill-down, the system can check the aggregated and detailed information at the same time. Take maintenance ratio control as an example. When the manager of credit risk management finds out abnormal condition appearing on the total maintenance ratio of the company at that trading day, he can use the system to investigate maintenance ratio data for every branch, even a single customer, to figure out the problem source.

- In the aspect of system portability: With the web-based interface, users can use browser to inquire information via the Intranet without additional installation of other software.
- In the aspect of key index alert: To assist the manager to easily find the anomaly, alert threshold is set for some KPIs, e.g., the maintenance ratio for one stock or customer which is less than 120% will be highlighted.
- In the aspect of historical data comparison: The system will reveal the historical data of the previous trading day and the discrepancy against three measurement indexes, Balance of Margin Loan, Balance of Stock Loan and Maintenance Ratio. This comparison data is critical to find the trend of those KPIs.

**4 CONCLUSIONS**

This study has achieved our goal to design and implement an EIS for controlling and managing the risk of margin purchase and short sale of securities. A data warehouse for margin trading of securities brokers to integrate their transaction accounts has been developed and used for efficient analysis of predefined KPIs using OLAP technique. One future work direction is to combine the customer transaction log and balance data to study the model of customer transaction. The other direction could be the consideration of real-time risk control.

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