1. Introduction

Many financial holding companies have been consecutively founded in Taiwan's financial sector. By pooling the resources and capital for banking, insurance, and securities, these financial holding companies can integration information resources from subsidiary companies for cross-selling and providing the customers with bundling of financial products and services. Cross-selling, which develops the bigger market with the mutual complement products of each sub-company, is a globalization trend. The previous research in [34] presents that there are four aspects of affected efficacy on information technology integration of cross-selling: Organization of information resources and establishment of customer relations management, Development of composite financial products to satisfy customer needs, Channels integration and sales force automation system and Establishment of enterprise portal with at least Single-sign-on functionality to reduce cost efficiently. Given the ability to reveal the relationships between items in database, association rule plays an important role among some of above aspects.

Association rules provide a very simple but useful form of rule patterns for data mining [6], and have proved to be successful for developing cross-selling strategies, for product recommendations in on-line shopping environment and for product assortment decisions in a retail setting [29]. For example, if 52% of customers who bought fund also bought product X together, we can reduce the registered fee of fund, while raising the service fee of X to make more profit.

Traditional association rules can give us the information such as "customer who bought computer always bought printer together". This kind of rules doesn't care about the distribution of the transactions which really contain both computer and

printer, but assume that the rules are effective in database thoroughly which obviously doesn't work in the majority of cases. On the other hand, since the support of an association rule varied with different intervals of each dimension, we can discover different association rules if different parts of database are considered. If we only conduct the mining task based on whole database, we will lose some valuable rules which are only hold in parts of database. For example, rose and chocolate may be contained in many transactions before Saint Valentine's Day, but seldom sold together on usual days.

We may only need to know "customer who bought computer always bought printer together" in the traditional process of mass-marketing. But the traditional process of mass-marketing is being challenged by the approach of one-to-one marketing [5]. That is, the old model of a product-oriented view is being replaced by a customer-oriented view. If we not only have the rules, but further address where, when and what kind of environments these rules hold, we can make more accurate and profitable strategies in today's customer-oriented market.

In classical association rule mining, records in a transaction database contain only items and are identified by their TIDs [8]. Actually, the transaction data involving time, position, and other attributes, is a multi-dimension data. Sales and related information are usually stored in a relational database or data warehouse today. Data warehouse provides on-line analytical processing (OLAP) tools for the analysis of multi-dimensional data of varied granularities, and association rules can be integrated with OLAP operations to enhance mining of knowledge at multiple levels of abstraction. That is, we can use the function "dice" to dice a sub-cube by performing a selection on the dimensions which we are interested, and then conduct the mining process in this sub-cube. However, this process needs user's prior

knowledge to determine how to dice the sub-cube. Certainly, we can test all the combinations of different dimensions and granularities, but this will lead to massive redundant database scans.

In this paper, we use a concept hierarch to present possible values at varying levels of abstraction in each dimension, and then produce multi-dimension patterns automatically from the concept hierarchies. We propose a new method based on the concept in [33] to discover all association rules for every multi-dimension pattern. Our contribution in this paper is proposing a new method to discover multi-dimension association rules from a set of multi-dimension transactions. This method can discover association rules from different zones in database, and discover more precise association rules efficient and effective for making more accurate strategies

The rest of this paper is organized as follows. We introduce some related works in section 2. In section 3, we define multi-dimension rules in terms of multi-dimension patterns produced from a set of concept hierarchy trees. And then propose a method to discover all multi-dimension association rules in section 4. At last, we present the experimental result of our algorithm in section 5, and conclude the paper in section 6.