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Using genetic algorithm based knowledge refinement model for dividend policy forecasting

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ABSTRACT

Dividend policy is one of most important managerial decisions affecting the firm value. Although there are many studies regarding decision-making problems, such as credit policy decisions through bankruptcy prediction and credit scoring, there is no research, to our knowledge, about dividend prediction or dividend policy forecasting using machine learning approaches in spite of the significance of dividends. For dealing with the problems involved in literature, we suggest a knowledge refinement model that can refine the multiple rules extracted through rule-based algorithms from dividend data sets by utilizing genetic algorithm (GA). The new technique, called "GAKR (genetic algorithm knowledge refinement)", aims to combine the advantages of both knowledge consolidation and GA. The main result of the cross-validation procedure is the average accuracy rate of prediction in the five sets over the five iterations. The experiments show that GAKR model always outperforms other models in the performance of dividend policy prediction; we can predict future dividend policy more correctly than any other models. The major advantages of GAKR model can be summarized as follows: (1) Classification process of GAKR can be very fast with a compact set of rules. In other words, fast training mechanism of GAKR is possible regardless of data set sizes. (2) Multiple rules extracted by GAKR development process are much simpler and easier to understand. Moreover, GAKR model can discriminate redundant rules and inconsistent rules.

1. Introduction

Bankruptcy prediction and credit scoring have long been regarded as critical topics and have been studied extensively in the accounting and finance literature. And it is well-known fact that artificial intelligence and machine learning techniques have been widely used to solve those financial decision-making problems (Anandarajan, Lee, & Anandarajan, 2001; Atiya, 2001; Charalambous, Chartious, & Kaourou, 2000; Chen & Huang, 2003; Grice & Dugan, 2001; Pendharkar, 2005). For example, logistic regression (LR), linear discriminant analysis (LDA), multiple discriminant analysis (MDA), k-nearest neighbor (k-NN), artificial neural networks (ANN), decision tree-based models (CHAID, CART, QUEST, and C5.0) are popular tools used for financial decision-making problems.

In the last few years, extensive research has been made to develop better methods and to achieve higher classification accuracy than traditional classifiers. One of the most exciting ideas was to combine classification (multiple classifiers) and the other most widely applied data mining method, knowledge consolidation model. Knowledge consolidation is a methodology in accordance with rules derived from rule-based algorithms with training data sets. Each of these rule-based algorithms is transformed into *n* different rule sets. These rules are merged into one integrated model. By combining separate knowledge in the form of *If–then* rules induced from different data set, it builds one meta model. Each rule in this model serves as an agent. Moreover, knowledge consolidation model can effectively integrate multiple rule sets into one centralized knowledge base.

The simple integration of extracted rules from above heterogeneous models, however, does not necessarily improve the classification accuracy, and these cumulative rule set or multiple rules have redundancy and inconsistency problems. To solve those problems, there is in progress in such research that searches for the most valuable decision rule or optimal rule set using genetic algorithm (GA) with powerful search mechanism (Chen & Hsu, 2006; Tang, Quek, & Ng, 2005).

Although GA based rule generation approaches have been applied successfully, the selection of significant predictors has never been considered. In the literature, the predictors were all user-specified without identifying significant independent variables through the build basis functions when many potential variables are considered. Moreover, the rules generated by GA based

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approaches are obtained by selecting the first n best-fit rules within a GA' evolutionary searching process. Theoretically, those best n rules are the rules which are not converged to the best one. While more generations are taken without high range of mutation, all the individuals in an evolutionary process will be converged into an identical individual. Actually, these multiple rules are useless to mutually enhance the prediction accuracy.

For dealing with the above issues, we suggest a knowledge refinement model that can refine the multiple rules extracted through rule-based algorithms from dividend data sets using GA. The new technique, called "GAKR (genetic algorithm knowledge refinement)", aims to combine the advantages of both knowledge consolidation and GA. We compare the classification accuracy performance between the above GAKR model and rule-based algorithms, and suggest a better dividend policy forecasting model to help a chief executive officer (CEO) or a board of directors (BOD) make better decisions in a corporate dividend policy. Since dividend policy is closely related to the firm value according to finance literature, it is important to predict future dividend policy of a firm to properly evaluate the value of a firm. This knowledge of dividend policy can be widely used for the purposes of investment decision and financial decision making. In other words, the main goal of this paper is to propose a GAKR model in order to discover knowledge about the future dividend policy. This knowledge is expressed in the form of rules derived from dividend data sets.

Finally, we need to explain the reason why we apply GAKR model to dividend policy. It is well-known fact that dividend policy is one of most important managerial decisions affecting the firm value. Although there are many studies regarding decision-making problems, such as credit policy decisions through bankruptcy prediction (Anandarajan, Lee, & Anandarajan, 2001; Atiya, 2001; Charalambous, Chartious, & Kaourou, 2000; Pendharkar, 2005) and credit scoring (Chen & Huang, 2003; Tsai & Wu, 2008), there is no research, to our knowledge, about dividend prediction or dividend policy forecasting using machine learning approaches, even though dividend policy is so significant. This strongly motivates us to do this research.

The outline of the remaining paper is as follows. Section 2 reviews some research background about dividend policy and multiple classifiers. Section 3 presents the operations of the proposed GAKR model for optimal rule set mining. Section 4 explains data sampling and preprocessing. Some experimental results are presented and analyzed in Section 5, and finally concluding remarks are given in Section 6.

2. Literature review

2.1. Dividend policy

In finance area, '*dividend policy*' generally means the decision about the relative proportion of dividends out of earnings or the decision about changes in dividends over time, while '*dividend*' itself means the absolute amount of dividend paid to stockholders. Many studies regarding dividend payouts show that dividend policy is irrelevant in all instances regardless of the existence of growth or corporate taxes. It has no effect on stockholder's wealth. Only when personal taxes are introduced do we have a result that dividend payouts matter. For stockholders who pay high taxes on dividends than on capital gains, the preferred dividend payout is zero; they would rather have the company distribute cash payments via the share repurchase mechanism (Ross, Westerfield, & Jordan, 2010).

In reality, there are some alternative forms of payout policies for a firm, such as cash dividends, stock dividends, stock repurchases, stock splits, and others. In this paper, however, we focus on cash dividend method not only because it is one of the most widely used form of payout policy in practice still, but because the effect of a payout policy on the firm value is not significantly affected by the specific form of payout policies. For example, except personal tax and EPS (Earnings Per Share) effect, both cash dividend and stock repurchase policy have almost same effect on the wealth of stockholders and P/E (Price/Earnings) ratio which are most important factors considered by investors (Ross et al., 2010). Although Grullon and Michaely (2002), find that stock repurchase is a good substitution for cash dividend and hypothesize that firms are financing repurchases with funds that would otherwise have been used to increase cash dividends, Brown and O'Day (2005) refute this hypothesis by finding the evidence that firms are not substituting from dividends towards repurchases.

In addition, Fama and Keneth (2001), DeAngelo, DeAngelo, and Skinner (2004), Brav, Graham, Harvey, and Michaely (2005) and others find that aggregate cash dividends in the markets grew from $31.3 billion in 1978 to $101.6 billion in 2000, while the number of dividend-paying firms declined over the same period. They explain this paradoxical phenomenon as 'concentration effect', meaning that dividend payments are heavily concentrated in a relatively small set of large firms. Julio and Ikenberry (2004) also argue that cash dividends are reappearing as a major form of a payout policy.

In general, in finance, there are three different methods of valuation for a firm or an asset, such as DCF (Discounted Cash Flow) method, relative valuation method by comparing a company's value with similar peer companies, and OPM (Option Pricing Method). The latter two methods are especially useful when DCF cannot be applied because of the lack of cash flow (dividend) information. Since DCF is a most widely used and conventional method for the valuation of a firm due to its simplicity and theoretical advantages (for example, DCF is consistent with no arbitrage condition and the time value of money principle), we mainly use the DCF concept to emphasize the importance of dividend prediction in this paper. Since the correct valuation of a firm is very important issue in investments, financing and M&A (Merge and Acquisition), it is so natural that the exact prediction of future dividends (cash flows) of a firm be essential for the correct valuation. In this process of prediction, we need to understand the existence of optimal dividends for a firm. If there is an optimal level of dividend and we know any method to find the optimal level, it will be very useful to predict future dividends.

There may be optimal dividend policy which results from a trade-off between the costs and benefits of paying dividends as Rozeff (1982) suggests. The list of possible costs includes tax advantages of receiving income in the form of dividends rather than capital gains and the cost of raising external capital if dividends are paid out. On the other hand, the possible benefits of dividend payouts are higher perceived corporate value because of the signaling content of dividend, the lower agency costs of external equity, and the ability of dividend payments to help complete markets. In other words, there is the possibility that we can derive the optimal payout policy of an individual firm under some conditions imposed by the financing and investment policy of the firm[1]. Therefore, we

[1] Three major theories about determination of the optimal dividend policy are competing as follows: Firstly, Hansen, Kumar, and Shome (1994) argue that agency cost of dividends is one of the major factors affecting decision making of payouts. Secondly, Bhattacharya (1979), Miller and Rock (1985), and Nissim and Ziv (2001) suggest an 'information content hypothesis' that dividends serve to signal to stockholders the firm's current and future performance. Thirdly, Kim, Lewellen, and McConnell (1979) propose a 'clientele-effect hypothesis' that those individuals in high tax brackets are likely to prefer either no or low dividends, and vice versa. In addition, Gordon (1959), Gordon (1962), Lintner (1962), Black and Scholes (1974), Litzenberger and Ramaswamy (1979), Shiller (1981), Hakansson (1982), Miller and Scholes (1982), Hess (1983), Eades, Hess, and Kim (1984), Marsh and Merton (1987), DeAngelo, DeAngelo, and Skinner (1996), Benartzi, Michaely, and Thaler (1997), Nissim and Ziv (2001) and others argue about the relevancy of dividend policy, implying the importance of dividends in the business policy.