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ABSTRACT

Hedge Fund Activism is a proactive investment strategy to earn better returns in stock price through involving the corporate governance of target firms. Annual profits generated from this approach are far better than that from the traditional "buy and wait" approach. Due to this reason, more and more hedge fund companies are coming to engage in this business. However, this approach involves complicated multi-criteria decision making processes. Target firm selection is the first critical decision that fund managers need to make. According to the financial literatures, most fund managers picking targets mainly based on their past experience which is quite subjective. After selecting a list of target firms, fund managers have to decide which action they would take to push the stock price in a least costly way. This is evident that IS can help, but no IS researcher has worked on this before.

In this study, we focus on the target selection process only and aim to use Bayesian Networks to support this complicated and uncertain decision making process. Since fund managers have to evaluate and select target firms by conveying necessary uncertain information among other fund managers, a multi-agent system is constructed to present that scenario.

Keywords

Bayesian belief network, hedge fund activism, multi-agent system, target selection.

INTRODUCTION

Hedge Fund Activism is expanding so fast in the U.S. market. Referring to the U.S. Securities and Exchange Commission (SEC) filings, there are an increasing number of hedge funds joining this business of significant high leveraged returns. The Annual Corporate Governance Review shows that up to 2005, the number of shareholder resolutions on corporate governance issues has increased steadily more than seven-fold over the last two decades. This figure shows that shareholders, especially hedge funds become more active to strive for better returns with the strategy. Furthermore, many financial analysts proclaimed that though most of the activism has taken place in the United States and Canada now, yet more attention will be devoted to Europe and Asia in later stage (Rho, 2007).

As an activist fund, that is a hedge fund which uses of hedge fund activism as one of its investment strategies, invests in companies that has specifically identified as underperforming and acquires a significant ownership position (basically larger than 5%). Once they have confirmed to invest in a particular underperforming stock, they acquire up to a significant position at an optimal price aggressively to influence management and the board of directors to pay attention to its proposals. Unlike traditional investors, activist investors are not content to hold the stock and wait for the price to rise.

The workflow of hedge fund activism starts with target firm selection. The next step is position acquisition, and finally deciding action(s) to be taken. Each step may be iterated if needed. All steps contribute to the success of the campaign. The first decision is comparably important because if a wrong target is selected, e.g. selecting a stock in which its stock price would never grow up no matter whatever action(s) you have taken, then the activist fund might loss money which is not expected. Currently, fund managers picking targets mainly based on their own experience that is quite subjective. Each fund manager value the performance of candidate firms quite differently without a standardized metric. To some extent, some fund managers take exogenous factors such as other funds' strategies into account when making decision. A common fact is that fund managers consider a number of factors to make decision. As such, the decision making process is quite complicated, involving a lot of decision making factors which might be interrelated with each other. As such, this study focuses on how to improve the decision quality of target selection decision.

The paper proceeds as follows. First, background research on hedge fund activism, its target selection process, and Bayesian network-based multi-agent system are discussed. Second, methodology used to develop the Bayesian network-based multi-agent system for target selection is presented. Last, a case scenario is used to prove the usability of the proposed system. The final section summarizes the contribution of the paper and future work of the study.

LITERATURE REVIEW

Hedge Fund Activism

Hedge fund activism is a strategy to target for a better market return by actively involving in the corporate governance of the target companies whilst other funds just acquire a position and then wait for the price to grow. This strategy has inherited the characteristics of traditional hedge funds, such as lack of regulation, lack of transparency, use of high leverage for financing, and the feature of short-selling. Hedge funds indeed are able to initiate any campaign on a firm when they have a significant ownership position of 5 or more percent of the firm. Possible actions that activists might take include a lot. For examples, demands for change in strategic operations, redirections of investments, share repurchases of the firm, scuttling an existing merger proposal, or being acquired by another firm (Klein and Zur, 2006) and so on. Rational investors would likely to invest in the firm if its governance structure is strengthened somehow. However, the ultimate goal of hedge fund activists is not to improve the firm's policies, but is to increase the market return to shareholders, through the acts.

There are an increasing number of hedge funds involving in hedge fund activism (Bray et al., 2006). First, the performance of hedge fund activism campaign is quite attractive. It can be traced indirectly from the filings of Schedule 13D in which the position holdings by institutional holders as well as the corresponding market values of firms are available in quarterly basis. The filing reveals that an activist fund's investment in a target firm results in average of 7 to 8 percent of abnormal returns during the (-20, +20) announcement window (Bray et al., 2008). The returns are affected by the nature of the acts. For example, board change would affect the price more. Second, contracts governing investment in hedge funds typically lock up investor capital for at least one year or more normally. Hedge funds in average hold an over 5 percent position of a firm for twenty months. Sufficient sources of fund enable this strategy.

The workflow for hedge fund activism is shown in Figure 1. First step is that hedge fund manager picks one or more target companies according to the past experience and the investment strategy of the fund company (Lampert, et al., 2006). Budget is not a major concern to hedge fund companies due to the high leverage characteristic of hedge fund. Once a target company is selected, the next thing that the hedge fund managers have to consider is the stock position to be acquired. The prerequisite to take any further action on the target companies is to position 5 or more percent of stock on hand. The decision of the stock position to be acquired is highly correlated with the current stock price, timing to take action and the action to be taken. The preferable action to hedge fund managers is direct discussion with the management and the board of the target company. Normally, hedge fund managers (that is the activist) keep on discussion with the management and the board of the target company until a settlement is reached. This campaign is mostly iterative. If a settlement cannot be reached, the situation would further deteriorate. In the worst case, a proxy contest might happen. Proxy contest is a lengthy process. The entire campaign process takes as few as a couple of months to several years. Hedge fund managers are not willing to run the campaign for too long as the costs required is increasing as the period gets longer.

Throughout the whole process, fund managers are required to make lot of decisions. For instances, which firms should be targeted, how many position should be acquired at the moment, what action should be taken and so on. In this study, we aim at one of the decision making processes: target selection only.

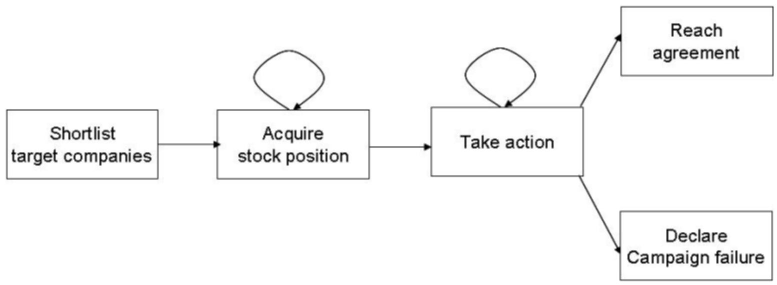

Figure 1. Workflow of Shareholder Activism

Target Selection

Activist funds target companies mainly depend on its own fund nature and the target's financial and legal characteristics (Fama et al., 1969). Almost all activism literatures mention that the primary reason for activist funds to target a company is because the actual stock price of this company is significant undervalued. Target selection is a complex process involving a lot of diverge information and investment tactics. Finance theory indicates that a company's stock prices contain or represent implications of managerial decisions on net cash flows quite visibly (Fama and Jensen, 1983). Macroscopically, stock prices are determined by two factors. They are overall market conditions and events particular to the firm respectively (Fabozzi, Modigliani, and Ferri, 1994). If the shareholders of a firm beat the market and gain a certain amounts of stock returns, the earnings are not due to market-wide influences but company-specific factors (Brown and Warner, 1980). This rationale shows that if the stock returns of one company are far below other comparable firms for a certain period, then there exists a very strong belief that the managers of the company had performed less well than those in other comparable firms.

Hedge fund managers mainly based on their own experience to determine which firms should be targeted. Some of them target companies which they think is over-capitalized, have poor strategic moves, or have under-utilized assets etc (Lampert et al., 2006). They are less likely to target some large listed corporations as the costs for position acquisition and running a campaign is huge. A summary of target selection criteria is shortlisted in Table 1. People are having different criteria to judge the firm performance.

Table 1. Summary of Target Selection Criteria

Selection criteria	Reference
Depend on the nature of the activist fund and target's financial and legal characteristics.	(Lampert, et al., 2006)
Have relatively large shareholdings by other institutional investors and low levels of ownership by insiders and unaffiliated blockholders.	(Smith, 1996; Karpoff et al., 1996; Bizjak and Marquette, 1998; Carleton et al., 2007; John and Klevin, 1995)
Perceive to be a poor governance structure by investors.	(Huson, 1997)
Firms with more negative press releases.	(Johnson and Shackell, 1997)
Firms with rich cash holdings, share-term investments and have low debt capacities.	(Klein and Zur, 2008)
Believe to be over-capitalized, have made bad strategic decisions, or have non-core, under-utilized or extraneous assets.	(Lampert, et al., 2006)
With characteristics include high cash balances, M&A activity with questionable rationale, under-exploited asset values, depressed valuation multiples, earnings underperformance or the presence of disparate businesses with limited strategic underpinning wrapped within a single entity.	(Lampert, et al., 2006)

Use of financial performance indicators to conduct event studies. Indicators employ vary from market-to-book ratio to operating income, sales, return on assets and return on equity.	(Smith, 1996; Strickland et al., 1996; Karpoff et al., 1996; Bizjak and Marquette, 1998; Johnson and Shackell, 1997)

According to the data provided by the Economist Intelligence Unit (EIU), New York Stock Exchange (NYSE) is the largest stock exchange in the world in terms of the market value as of 2007, with 2,764 listed securities. In order to compile the result, various data sources, such as the Center for Research in Security Prices (CRSP) database, SEC Form 13-D filings, and other financial related data are referred. This process is hard to be manipulated manually as huge amount of data are involved and humans have limited information processing ability to process such huge amount of data. Furthermore, fund activists do not process the data by one single means. They may have their own strategy like having different selection criteria with different weights. Some huge fund companies are still using spreadsheet to manipulate the data. This makes the doubt about the quality of decision.

Smith (1996) uses the logistic regression model to model the target selection event. The independent variables in his model include log of the market value of equity for the firm, percent of insider holdings, percent of shares held by institutional holders, the five-year cumulative abnormal return and market-to-book. Since individual fund managers select target with their own metrics which varies a lot from each other, the real situation cannot be described simply by a logit model.

Bayesian Network-based Multi-agent System

Agent technology has been widely applied in many domains. Each agent has its own responsibilities, can work in an autonomous way and can work under dynamic environment in order to achieve the goals defined by the system designer (Wooldridge and Jennings, 1995). Furthermore, agents can work interactively with each other to accomplish a complicated task. The interactivity of agents opens a communication channel for the participants to deal with the model. Agents are designed to stimulate the human thinking and are able to make decision based on dynamic requirements.

Apart from analyzing the market data and financial data of the potential target firms, some fund managers would consider other external factors such as other hedge funds' holdings in order to make decisions. Unfortunately, fund managers would not know each other's position holdings officially unless any holders have had 5 or more percent position holding as the filings of SEC Form 13-D just keep track of all position holding which is 5 or more percent. Alternatively, fund managers may have their personal contacts with other fund managers working in other companies. Furthermore, some fund managers evaluate and infer other fund managers' current holdings via their historic attempts and then decide how to react to their target selection and acquisition strategy. Previous research (Smith, 1996; Karpoff et al., 1996; Bizjak and Marquette, 1998; Carleton et al., 2007; John and Klevin, 1995) supports that the joint force of fund companies towards one target is much cost effective and efficient.

Each agent only has partial knowledge about the domain. If the domain is too complicated that involving too many variables, then a simple multi-agent system cannot support anymore because of limited amount of communication. Bayesian Belief networks (BBNs) can help under this situation as it is good at representing and reasoning with uncertainty (Lam and Bacchus, 1994). Each agent's belief can be represented by Bayesian probability. This kind of model has learning capability, storing probabilistic information about the data, and evidence propagation scheme. The relationships between variables are represented with conditional probabilities in graphical format which is easy to understand.

In this study, a BBN is used to model the target selection criteria and to construct the inference ability of agent about their relationship and communication. The methods to set up the BBN and how to configure the Bayesian Network-based multi-agent system are presented in the following sections.

METHODOLOGY

In this section, the method to construct the multi-agent target selection system is proposed. By applying a probabilistic approach, a multi-agent communication framework between fund managers is also described.

Determining Target Selection Decision Factors for a Single Agent

Many target selection criteria are available from the activism literatures. Since this project is sponsored by one U.S. hedge fund company, so the fund managers in this company has provided us with their criteria in estimating the financial performance of a firm in general. In short, the target selection decision factors are divided into three categories: market performance of the firm, financial performance of the firm, and other activists' holding. Two simplified models are presented in Table 2 & 3.

Table 2. Target Selection Decision Factors of Fund Manager Agent 1

Fund Manager Agent 1		
Market Performance	*Financial Performance*	*Other Activists' holding*
Stock Price (current month) (SP0)	Free Cash Position (FCP)	Number of activists with this target (NAWT)
	Return on Assets (ROA)	Aggregated percentage of activist holding (APAH)
	Cash Flow Ratio (CFR)	
	Debt to Equity Ratio (DTER)	
	Profit/Earnings Ratio (PER)	
	DOI (DOI)	

Table 3. Target Selection Decision Factors of Fund Manager Agent 2

Fund Manager Agent 2		
Market Performance	*Financial Performance*	*Other Activists' holding*
Stock Price (current month) (SP0)	Free Cash Position (FCP)	Number of activists with this target (NAWT)
Stock Price (3 months) (SP3)	Return on Assets (ROE)	Aggregated percentage of activist holding (APAH)
	Gross Profit Margin (GPM)	
	Cash Flow Ratio (CFR)	
	Debt to Equity Ratio (DTER)	

Discretization of continuous variables

All the continuous variables have been discretized into two distinct groups: either (1) high or low or (2) yes or no.

Data about one potential firm has to compare with that of at least one comparable group in order to be discretized. Comparable groups can be either the stock market, the industry to which the firm belongs, or control firms selected. In this study, we use the hybrid of the industry-adjusted model and the control firm model. The comparable group is the firm with similar market capital (that is similar in company size) from the same industry. The industrial financial data are available from the Center for Research in Security Prices (CRSP) database (Smith, 1996; Strickland et al., 1996). First, we divide firms into two types: high market capital and low high capital. For each type, a comparable firm, that is one firm with the averaging performance, is selected. Univariate comparison is then used to check for the differences in a single performance indicator between the two groups, that are the target firms and a comparable group (Rho, 2007). Each performance indicator of the target firm is then discretized with respect to comparable group.

Configuring the Single Agent through Bayesian Network Learning

Some individual factors among three categories are conditionally interdependent. An optimization process is implemented by using heuristic search techniques to find the best network. The procedure is listed as follows:

STEP 1: Initialization. Relate the variables with arc according to the knowledge of fund managers.

STEP 2: Fitness Evaluation. Select arc (A→B) with maximum increase of scoring function when the arc is inserted. Insert the arc (A→B) into direct acyclic graph (DAG). The joint distribution is calculated by using the formula: $P(X_1, \ldots, X_n) = \prod_{i=1}^{n} P(Xi \mid Parents(Xi))$ with new arc is inserted. Detect and remove cycles.

STEP 3: Iteration. Repeat the STEP 1 to 2 until there is no further improvement or no arc inserted.

Propagating from Single agent architecture to Multi-agent system architecture

The inference network that is the BBN, with several decision variable nodes connected with arcs is obtained by the procedure in previous section. The BBN consists of joint probability distribution of the parent nodes and their corresponding child nodes. The BBN structure for one fund manager agent is presented as Figure 2. Type 1, 2, 3 and 4 are qualitative representations of a combination of criteria. For example, type 1 represents a conditional probability of taking FCP and ROA into consideration at the same time.

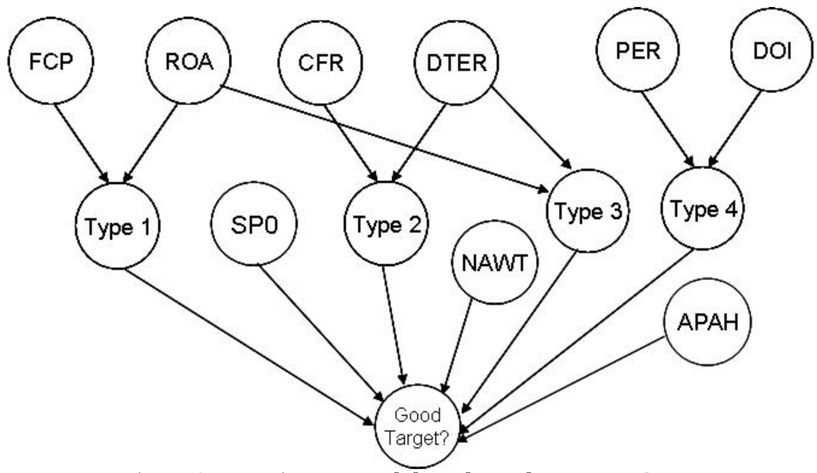

Figure 2. Bayesian Network based Fund Manager Agent

The domain knowledge of one agent is represented as a directed acyclic graph (DAG). Each hypernode represents one agent, consisting of decision factors, which becomes a subnet of the BBN structure in the multi-agent system. In order to combine individual DAGs into the multi-agent system, a hypertree is formed by taking the union of all the DAGs as shown in Figure 3. The communication channels among each agent are represented as hyperlink, which are defined as d-sepsets (Xiang, 1996). This d-sepset would render any pair of subnets conditionally independent. That is, there is an assumption that each node is conditionally independent from its nonparent node. Hypernodes can communicate directly only with their intersecting variables. Therefore, if there exists any intersecting variables between any hypernode pair, then we can connect them and the multi-agent system would eventually formed.

Within each agent's subdomain, the joint probability distribution (JPD) is obtained from $p_{iJPD}(A_i \mid p_i)$ for all A_i belongs to the interception linkage between two hypernodes.

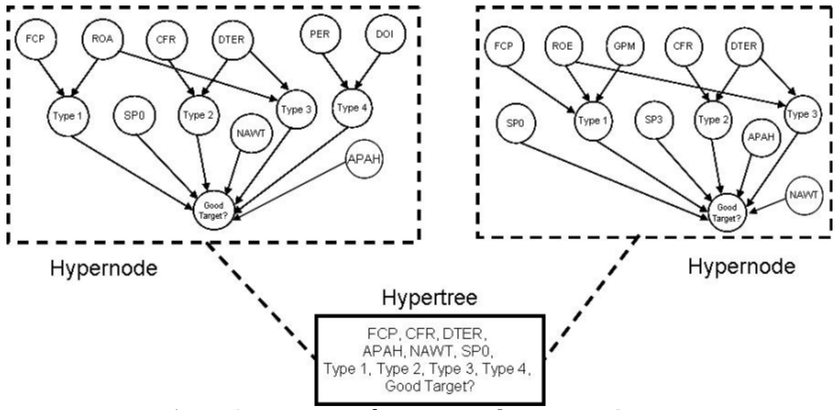

Figure 3. Hypertree for two Fund Manager Agents

CASE ILLUSTRATION

In this section, the proposed Bayesian network-based target selection multi-agent system is demonstrated by an example in which two fund managers communicate with each other to improve the decision quality.

A multi-agent system with fund manager 1 and fund manager 2 is used to demonstrate the communication procedure in the proposed system. Please note that the agents communicate with agent communication language (ACL) as usual. The fund manager 1 is now going to estimate whether a firm is a good target, so he initially exhibits the evaluations according to the objective market data and financial data, which are given in Table 4.

Table 4. Initial value of decision factors provided by fund manager 1

Fund Manager Agent 1		
Market Performance	*Financial Performance*	*Other Activists' holding*
SP0 = low	FCP = high	NAWT = low
	ROA = low	APAH = low
	CFR = high	
	DTER = high	
	PER = high	
	DOI = low	

The conditional probabilities are calculated as follows:

$P(A = a_i) = p\ P(A = a_i \mid \text{Parent}(A))$, where a_i = high or low.

P(good target = yes) = P(good target = yes | SP0 = low) x P(good target = yes | Type 1 = yes)
x P(good target = yes | Type 2 = no) x P(good target = yes | Type 3 = yes)
x P(good target = yes | Type 4 = no) x P(good target = yes | APAH = low)
x P(good target = yes | NAWT = low)
= 1 x 0.224 x 0.048 x 0.168 x 0.144 x 0.125 x 0.125
= 0.000004064256

P(good target = no) = P(good target = no | SP0 = low) x P(good target = no | Type 1 = yes)
x P(good target = no | Type 2 = no) x P(good target = no | Type 3 = yes)
x P(good target = no | Type 4 = no) x P(good target = no | APAH = low)
x P(good target = no | NAWT = low)
= 1 x 0.336 x 0.072 x 0.252 x 0.216 x 0.6 x 0.6
= 0.00047405481984

Where P(good target = yes | SP0 = low) = 1 as all data in the sample dataset are having a undervalued stock price; Type 1 = yes if and only if FCP = high and ROA = low; Type 2 = yes if and only if CFR = high and DTER = low; Type 3 = yes if and only if DTER = high and ROA = low; and Type 4 = yes if and only if PER = low and DOI = low.

Then, the evaluation result of whether this firm is a good target is determined to be no as P(good target = no) is having a higher probability.

If fund manager 1 does not have the actual figures of other funds' holding of this firm, he may go and consult fund manager 2 as he knows that fund manager 2 might have personal contacts with related parties. After communicating with fund manager 2, the firm profile is then updated to NAWT = high and APAH = high. Fund manager 1 would re-evaluate whether this firm is a good target again.

P(good target = yes) = P(good target = yes | SP0 = low) x P(good target = yes | Type 1 = yes)
x P(good target = yes | Type 2 = no) x P(good target = yes | Type 3 = yes)
x P(good target = yes | Type 4 = no) x P(good target = yes | APAH = yes)
x P(good target = yes | NAWT = yes)
= 1 x 0.224 x 0.048 x 0.168 x 0.144 x 0.58 x 0.58
= 0.0000875018059776

P(good target = no) = P(good target = no | SP0 = low) x P(good target = no | Type 1 = yes)
x P(good target = no | Type 2 = no) x P(good target = no | Type 3 = yes)
x P(good target = no | Type 4 = no) x P(good target = no | APAH = yes)
x P(good target = no | NAWT = yes)
= 1 x 0.336 x 0.072 x 0.252 x 0.216 x 0.235 x 0.235
= 0.0000727213261824

Finally, the evaluation result of whether this firm is a good target is determined to be yes as P(good target = yes) is having a higher probability. Our project sponsor comments that the granularity of the decision quality is higher than before. In next study, the new profile and the controlled profile will be compared in terms of cumulative returns generated.

CONCLUSION

This study introduces a Bayesian network-based multi-agent system to improve the decision quality in target selection. The case in the previous section shows that the decision quality can be improved through the communication of agents. The probabilistic approach towards the decision making process avoid fund managers to be too subjective as well as improve the accuracy of the estimation. Our project sponsor appreciates this improvement too.

One limitation of this study is that we have an assumption that the decision making processes in the workflow of the hedge fund activism are independent. In future study, we will examine this issue in detail and target at improving the decision quality for the whole campaign instead of a single decision making process.

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