

Bayesian Network Analysis for the Dynamic Prediction of Financial Performance Using Corporate Social Responsibility Activities

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<Abstract>

This study analyzes the impact of Corporate Social Responsibility (CSR) activities on financial performances using Bayesian Network. The research tries to overcome the issues of the uniform assumption of a linear function between financial performance and CSR activities in multiple regression analysis widely used in previous studies. It is required to infer a causal relationship between activities of CSR which have an impact on the financial performances. Identifying the relationship would empower the firms to improve their financial performance by informing the decision makers about the different CSR activities that influence the financial performance of the firms. This research proposes General Bayesian Network (GBN) and presents Markov Blanket induced from GBN.

It is empirically demonstrated that all the proposals presented in this study are statistically significant by the results of the research conducted by Korean Economic Justice Institute (KEJI) under Citizen's Coalition for Economic Justice (CCEJ) which investigated approximately 200 companies in Korea based on Korean Economic Justice Institute Index (KEJI index) from 2005 to 2011. The Bayesian Network to effectively infer the properties affecting financial performances through the probabilistic causal relationship. Moreover, I found that there is a causal relationship among CSR activities variable; that is Environment protection is related to Customer protection, Employee satisfaction, and firm size; Soundness is related to Total CSR Evaluation Score, Debt-Assets Ratio. Though the what-if analysis, I suggest to the sensitive factor among the explanatory variables.

Key Words: Corporate Social Responsibility Activities, Markov Blanket Financial Performances, Bayesian Network,

I. Introduction

In this study, relationships between CSR activities and financial performances (e.g. company's value, profitability, etc.) of a corporation are analyzed. A company accomplishes its business activities through interactions with the society within the framework of the society. In other words, a company creates profit by utilizing the human and material resources of the society into its business activities, and returns the created profit to the society. In this process, the company and the society co-develop.

In the past, however, companies used to concentrate on maximizing stockholders' gain, that resulted in social problems such as nature destruction, income polarization, etc. As stakeholders surrounding a company become diverse due to development of information communication technology, enhancement of rights and interests of civil organizations and consumers, etc. social conflicts have deteriorated to the level at which the survival of corporation is threatened. Consequently, companies start to conduct CSR activities required by their societies to adapt to the changes in business environment (Swanson 1999; Paine 2002).

Meanwhile, in 2010, International Organization for Standardization (ISO) launched ISO 26000, a voluntary guidance standard with respect to 'CSR of economic behaviors'. The purpose of enacting ISO 26000 is to reach an agreement on issues and implementation methods of CSR in the international society,

which consists of corporate governance structure, human rights, custom of labor relations, environment, fair business practices, consumer issues, participation and development of local society and so on as key clauses. It shows that CSR is one of the essential business activities for a company to survive rather than an optional choice in the current business environment. Therefore ISO 26000 is likely to spread among all the companies in Korea. A company cannot neglect its financial performance, the source of its survivorship and development in an environment where CSR activities are considered important. However, there have been no studies on the various factors of CSR activities that have a significant impact on a company's financial performances, thus putting the corporate managers in a dilemma about which CSR activities to focus on.

Many managers perceive CSR activities as an investment rather than as cost because the importance of CSR activities is widely interpreted in the changing business environment. Since they cannot concentrate on all the elements of CSR activities because of limited resources, they need to concentrate on a few CSR activities related to their financial performances. The purpose of this research is to investigate the relationship between CSR activities of a firm and its financial performance. Many studies performed on CSR activities, exhibit two limitations. First, previous studies analyzed whether there CSR activities are closely related to the financial performance of a firm. (e.g. company's value,

profitability, etc.) (Aupperle et al. 1985; Chun and Kim, 2011; Hillman and Keim 2001; McWilliams and Siegel 2000; Na and Hong, 2011; Pava and Krauz 1996; Shin and Hong, 2012; Waddock and Graves 1997), but none of the studies present the causal relationships between the factors of CSR activities and financial performance, thus providing no implications for the managers. Second, there are no studies conducted on relationships between CSR activities that can improve corporate financial performances dramatically. Since the financial performance of a firm can be influenced by a variety of factors and by the associations/interactions between the factors, the financial performance cannot just be explained based on the fact that a firm performs CSR activities. For this reason, a research on what factors of CSR activities influence the financial performance of a firm is called for.

This study, therefore, is purported to identify the hidden causal relationships between CSR activities and financial performances and to overcome the limitations of the preceding studies. To attain this goal, a General Bayesian Network (GBN) is proposed along with the Markov Blanket induced from GBN. Influential CSR activities are identified by conducting a What-If analysis.

Bayesian Network is used in this study, which is known as a rigid statistical tool that can display interdependence of attributes that affect the classification of uncertain data set predict classes precisely (Neapolitan, 2004). Multiple regression analysis that has been

used widely in previous studies assumes only a uniform linear function between dependent and explanatory variables. This study, thus, purposes to overcome the issues of the previous studies. In other words, it is possible to examine the cause and effect relationships and to provide managerial implications to enhance the financial performance of a firm.

Studies on Bayesian Network have been conducted actively since Naïve Bayesian Network (NBN), a simpler form than any other Bayesian Networks, flexed out to be very accurate in classification problems (Langley et al., 1992). Nevertheless, GBN regards class nodes (or dependent/outcome variables) equal to other normal nodes while NBN regards class nodes different from other normal nodes. Friedman et al. (1997) studies GBN in a more effective way and applies it to a variety of problems.

This study examines how CSR activities influence financial performances by looking at 200 listed companies in Korea inspected by Korean Economic Justice Institute (KEJI) under Citizen's Coalition for Economic Justice (CCEJ) from 2005 to 2011. It particularly investigates how CSR activities are related to each other. This research is believed to be unique as it contributes practically to the efficient decision-making of managers by informing them on which CSR activities to concentrate on for better financial performances. The study also functions as an interdisciplinary study given that research methodology of Management Information System (MIS) is being applied to the study

fields (e.g. financial management, accounting, sociology, etc.).

The organization of the paper is as follows. First, it starts with a literature review and theoretical background. Also, the section would introduce Bayesian Network and related studies. The following section would describe the methodology including research procedure, data and the variables. The fourth section will interpret the results of the research. Lastly, the fifth section would present the conclusion.

II. Backgrounds and Literature Review

1. Corporate Social Responsibility (CSR) Activities

Discussion on CSR began 1950s, producing diverse studies on the issue from various aspects. Answers to whether CSR activities improve business performances have been confused. Some researchers argued that the company's value could be decreased if their target is to maximize their stockholders' profit (Pava and Krauz 1996), whereas others insist that CSR heightens company's value when the target is expanded from stockholders to stakeholders (Hillman and Keim 2001).

When narrowed down to previous studies on financial information in CSR activities field, the topics of this can be classified into two categories: 1) analyzing whether CSR activities are related to financial

performances, and 2) investigating whether CSR activities are related to the quality of financial information reported by a company. Firstly, results of the studies that examine the relationships between CSR activities and financial performances are controversial. Some of the studies show that companies fulfilling CSR activities have good financial performances (Chun and Kim, 2011; Na and Hong, 2011; Shin and Hong, 2012; Waddock and Graves1997), while others conclude that there is no significant relationship between financial performances and high level of CSR activities (Aupperle et al. 1985; McWilliams and Siegel 2000). Meantime, it has been reported that companies that conduct CSR activities incessantly show better financial performances and higher value than those who perform CSR activities intermittently (Chun and Kim, 2011; Na and Hong, 2011). Furthermore, Luo and Bhattacharya (2006) show that firms with limited innovation capability and CSR activities are likely to decrease consumers' satisfaction, which implies that CSR activities are related to customer satisfaction.

In the previous studies on CSR activities and the quality of financial information, Kim et al. (2012) have shown that social corporations are likely to decrease earnings management and unlikely to be subject to SEC investigations and that ethical concern enhances the quality of financial information. On the other hand, according to Prior et al.(2008), CSR activities are highly related

to earnings management creating negative impacts on business performances.

2. Korean Economic Justice Institute Index (KEJI index)

Discussion on CSR began 1950s, producing diverse studies on the issue from various aspects. Answers to whether CSR activities improve business performances have been confused. Some researchers argued that the company's value could be decreased if their target is to maximize their stockholders' profit (Pava and Krauz 1996), whereas others insist that CSR heightens company's value when the target is expanded from stockholders to stakeholders (Hillman and Keim 2001).

The most common index for CSR activities in Korea is the Korean Economic Justice Institute (KEJI) index measured by Korean Economic Justice Institute (KEJI) under Citizen's Coalition for Economic Justice

(CCEJ). The KEJI index was developed by Korean Economic Justice Institute (KEJI) in 1991, which measures corporate contributiveness to the society of about 200 listed companies in Korea. The index is similar to CEP (The Council on Economic Priorities) in the U.S., Domini 400 Social Index, KDLI (Kinder, Lydenberg, Domini Index), BSI (Bilian Social Index) in France, CSID (Canadian Social Investment Database), and AGFI (Asahi Glass Foundation Index) in Japan.

The KEJI index offers quantitative evaluation of a company's CSR activities in 7 sectors: soundness, fairness, contribution to social service, customer protection, environment protection, employee satisfaction, and contribution to economic development. Each sector consists of detailed indicators as subsections, each of which is given different weighted values, offering objective and fair evaluations. Details of the sectors and subsections are given in Table 1.

<Table 1> The KEJI Index in 7 Sectors

| Sector (Score) | Subsection (Score) |
|------------------------------------|--|
| Soundness(20) | ·Soundness of stockholder's structure (7) ·Soundness of investment (3) ·Soundness of fundraising (10) ·Accounting fraud, tax evasion, additional tax charging (-3) |
| Fairness (11) | · Fairness (3): Fair trade, Concentration of economic power ·Transparency (8): Unfaithful disclosure, Propriety of business report, Outside-director activity ·①Ownership of press corporations, ②Ownership of financial companies, ③ violation of small business area (-1 per case, max -2) |
| Contribution to social service (7) | ·Protection of a neglected class of people (4): Employment rate of disabled& female, Employment support for disabled &female ·Social contribution (3): Donation, Social welfare support(e.g. employee, citizen, civil organization) |

| | |
|--|---|
| Customer protection(7) | <ul style="list-style-type: none"> · Consumer right protection (2): Certification of excellence in service quality, New investment rate on customer satisfaction, Awards for customer satisfaction · Quality (3): Certification related to qualities · Advertisement (2): Improvement of excessive expense on advertisement |
| Environment protection (10) | <ul style="list-style-type: none"> · Environment improvement effort(4): Disclosure of environment accounting, Energy efficiency · Environment friendliness(3): Environmental certificate or award · Violation or contamination (3): Water quality, Atmospheric dust, Pollutant contamination condition |
| Employee satisfaction (10) | <ul style="list-style-type: none"> · Certification for workplace health and stability(2): Certificate or award for workplace health or stability · Human resource investment (4): Training cost per head, Rate of training cost increase · Wage and welfare(4): Level of wage compensation, Welfare · Stock-sharing for employees(-1): Employee ownership of stocks |
| Contribution to economic development(10) | <ul style="list-style-type: none"> · R&D effort (3): R&D expense, Patent or Jang Young Sil award · Management performances and economic contribution (7): Profitability, Business growth, Equipment investment, Rate of employment increase, Tax payment, Dividend ratio, Rate of labor productivity increase, Level of export contribution |

Korean Economic Justice Institute (KEJI) selects around 200 companies, which are conducting some CSR activities, for the KEJI index every year. In other words, performing CSR at a certain level is fundamental for a company to be selected for the KEJI index. The selected companies need to go through a complicated investigation process that requires to answer questionnaires and to disclose their internal information. Thus, the selected companies for KEJI index can be regarded as the companies that have been actively fulfilling CSR activities and strategically utilizing their CSR activities.

3. Bayesian Network

Bayesian Network has been utilized as an excellent quantitative tool that can show a

nonlinear interdependence between highly-uncertain attributes of the data and predict classes precisely (Jensen 1996; Calado, Silva, Laender, Ribeiro-Neto, and Vieira, 2004; Denoyer, and Gallinari, 2004; Noh, Lee, Oh, Hwang, and Cho, 2012). The Bayesian Network enables to explain both quantitative and qualitative aspects of variables as well as to display joint probability distribution between the variables when given an observable set of discrete stochastic variables (Baesens 2004). According to Pearl (1988), a quantitative aspect refers to the parts where a Bayesian Network stipulates a conditional probability between variables while a qualitative aspect refers to the parts where conditional independence or dependence between variables is represented.

Bayesian Network can be explained as a

model to identify relationships between bivariate values when the data on specific variables is given and to discover the probability of those relationships to occur. The form of Bayesian Network simply consists of two parts as shown in 'B = <G, Θ >'. In the equation, G refers to a directed acyclic graph comprised of nodes and arcs. Nodes stand for variables that belong to a set of specific data such as X_1, X_2, \dots, X_n , and an arc is the line to present the dependency relation between the variables. Θ in the second part means the probability distribution. Probability distribution means a parameter in the form of $\Theta_{x_i} = PB(x_i | \Pi_{x_i})$, where the value of X_i can be defined when the combination between the value of variable X_i and its direct parent variable Π_{x_i} , is known, and Π_{x_i} represents the set of parent variables of X_i in G. The network B, therefore, has the joint distribution as below.

$$PB(X_1, X_2, \dots, X_n) = \prod PB(X_i | \Pi_{X_i}) = \prod \Theta_{x_i} | \Pi_{x_i}$$

There are several types of Bayesian Networks including Naïve Bayesian Network (NBN) which is the most general type, Tree Augmented Naive Bayesian Network (TAN) which was expanded in a tree form from NBN, BN Augmented Naive Bayesian Network which is a tree form structure derived from NBN, Bayesian Multi-net (MN) and General Bayesian Network (GBN).

NBN, the simplest form, is known for its outstanding performance in practical world

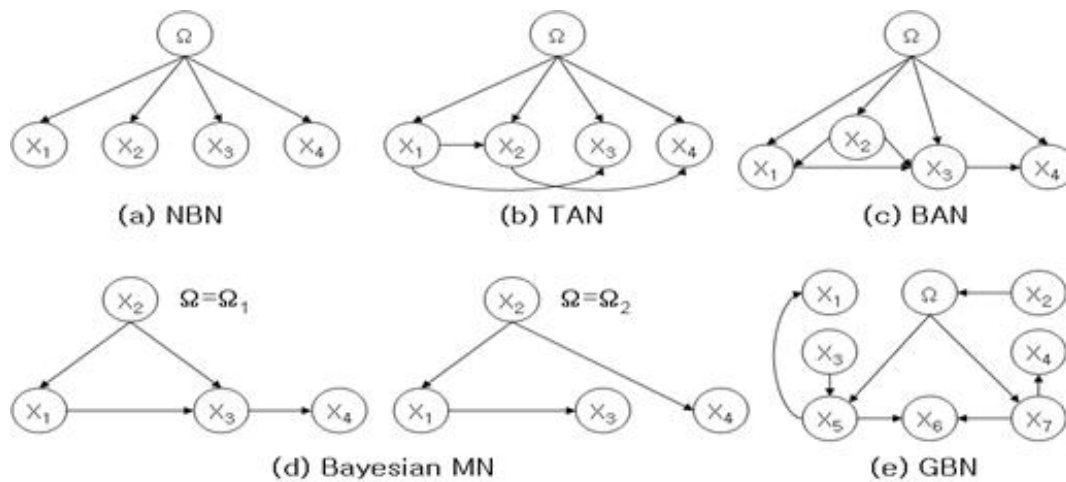
despite its simplicity (John and Langley 1995). What makes NBN concise is the assumption that class node variables are conditionally independent from the other variables. However, NBN has been criticized for its excessive assumption of independency between variables considering class nodes distinctive from the other nodes, which seemed inappropriate to reflect phenomenon in reality. Modified models have been proposed to overcome the drawback of the assumption.

TAN is a Bayesian Network introduced by Friedman et al. (1997), which devises to complement the NBN's assumption that nodes are independent of each other. The efficiency of TAN has been examined by Friedman et al. (1997) and Cheng and Greiner (1999). Unlike NBN, BAN assumes that attribute nodes, the explanatory variables have interdependency with each other, and expands NBN networks to be able to encode the interdependency among attribute nodes into a GBN. Bayesian MN was first introduced by Geiger and Heckerman (1995). Later empirical studies on Bayesian MN were conducted by Friedman et al. (1997). It is characterized by its strongest explanatory power among the Bayesian Network types, displaying various networks differentiated by each class node value under the assumption that the relationships between daughter nodes change according to the values of Bayesian class nodes.

GBN is the most generalized form of Bayesian Networks, and there have been a few studies on learning methods and efficiency of GBN (Friedman et al. 1997; Cheng and

Greiner 1999). Unlike other existing Bayesian Networks, it expresses interdependency between all nodes in a single Bayesian Network, not differentiating class nodes from other normal attribute nodes (Bouckaert 1995). Consequently, it has an advantage that it can

show a probabilistic causal relationship or interdependency between variables in decision making problems most naturally because class nodes also can have parent nodes (Lee and Choi 2007).



<Fig. 1> Major Types of Bayesian Networks Source: Lee and Choi (2007)

Markov Blanket, another feature of Bayesian Networks, is used widely as a feature-selective technique that extracts the minimum number of meaningful variables in decision making problems (Koller and Sahami 1996; Tsamardinos et al. 2003). It means that the probability distribution of the class nodes as result variable can be determined if you have knowledge on the variables belonging to Markov Blanket. Thus, a statistically-accurate classification of class nodes in a given decision making problem can be made through causal relationships between Markov Blanket variables if the Markov Blanket can be

identified precisely.

Nodes represent uncertain variables. The attribute of each node is shown and the probability distribution tables of each are presented. These nodes are called 'Prior Nodes' because they do not have parent nodes, and the distribution tables are called 'Prior Distributions' which present the degree of knowledge about each variable. The probability distribution table of credit rating, nodes of those which have parent nodes, shows a conditional probability distribution that comprises of the combinations with prior distributions. It is also called a 'likelihood

function' because it expresses the likelihood of variable states when a specific state of parent variables is given (Vahid et al. 2007).

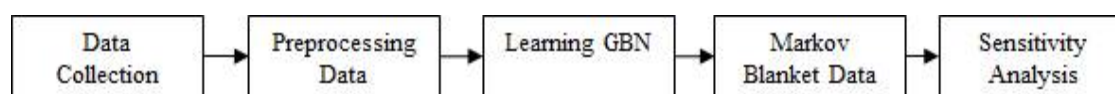
III. Methodology

1. Research Procedure

A General Bayesian Network (GBN) is used in this study to identify critical explanatory variables of CSR activities that affect financial performance (e.g. company's value, profitability, etc.) and to comprehend correlations between the variables. A sensitivity analysis is conducted to infer the meaning of various CSR activities. For this purpose, the study concentrates on apprehending hidden relationships between attributes of the variables that have CSR activities using GBN. When Markov Blanket, the set of variables that affect class nodes, is deduced, the level of probabilistic effect between class nodes (dependent variables) and explanatory variables can be apprehended based on the knowledge of

the Markov Blanket variables. Consequently, a sensitivity analysis on the Markov Blanket variables is carried out using WEKA, the software for Bayesian Networks. The degree of impact that the change of a certain variable has on the dependent variable through a probabilistic causal relationship is also investigated by the sensitivity analysis. Various assumptions of scenarios over the attributes of each independent variable are made

WEKA, the widely used tool for Bayesian Network analyses, is utilized in learning GBN. A variety of CSR activities is analyzed through a What-If analysis using the explanatory variables after the Markov Blanket is deduced. The variables deduced from the Markov Blanket can help managers conduct a variety of sensitivity analyses for comprehending which activities of CSR is linked to the financial performances (e.g. company's value, profitability, etc.) - the final response variables - through causal relationships with other explanatory variables. The research procedure is summarized in <Fig. 2>.



<Fig. 2> Research Procedure

2. DATA and Variables

2.1 DATA

The data used in this study are collected

from companies whose CSR activities are evaluated by Korean Economic Justice Institute (KEJI) from 2005 to 2011 (except 2008). The selected companies meet the following criteria.

- ① The closing day is on 31st December.
- ② The business field is not in finance such as banking, investment finance, stock, insurance, etc.
- ③ Available for empirical analysis.

The closing day is confined to 31st December to increase the homogeneity of samples, and financial businesses are excluded. The reason for the exclusion of financial businesses is that financial companies have different characteristics from general manufacturing companies in terms of management environment, management strategy, accounting standards and financial structure. Meantime, Korean Economic Justice Institute (KEJI) index estimated by Korean Economic Justice Institute (KEJI) under Citizen's Coalition for Economic Justice (CCEJ) is utilized for CSR activity indicator, the major variable of this study. Through this sample selection procedure, 1,079 (firms-years) samples are chosen and analyzed.

2.2 Variables

2.2.1 Company's Value

Tobin's Q is used to measure company's value. It is a principle to calculate Tobin's Q by dividing the market value of a company by its replacement cost. The value of Tobin's Q is high if the company's value evaluated in the market is high, hence having a high intrinsic value. Meantime, the book to market value ratio is used since it is hard to calculate the replacement cost of assets (Chung and Pruitt 1994; Jang and Choi 2010; Na and Hong,

2011). Also, market value of debt is used as book value due to little difference between market value and book value as well because of the difficulty in estimating the market value of debt (Jang and Choi 2010; Na and Hong, 2011).

The Tobin's Q has strong advantages in terms of comparability between companies and predictability of future profitability as it reflects the shares of stockholders and is not influenced by accounting methods such as depreciation.

2.2.2 Profitability

In the study, the profitability is measured using the Return on Assets (ROA). The ROA is a financial performance indicator that shows how efficiently assets (or capital) are used to create profits. The numerator of the ratio refers to a flow in a term while the denominator represents a balance of the assets at a certain time. Therefore it is more appropriate to measure the total asset (denominator) with the average value during a certain term (Song et al., 2014).

2.2.3 Variables for Bayesian Network

Classification

The variables used in this study in order to identify relations between CSR activities and financial performances are shown in Table 2. Tobin's Q and ROA are used as substitutive values to represent financial performances. The financial performances are categorized into two groups by median because each variable needs to be encoded with a categorical value to use

Bayesian Networks. CSR activities, also, are categorized into three groups after standardized on the basis of 100 points for each activity. The variables of firm’s characteristics (e.g.

size, debt–assets ratio, sales growth rate, etc.) related to financial performances are also categorized into three groups.

<Table 2> Definition and Categorization of Variables

| Indicator | Name of Variable | Definition of Variable | Categorization |
|------------------------|------------------|--------------------------------------|------------------|
| Financial Performances | TobinQ | Company’s Value | Binary |
| | ROA | Return on Assets | Binary |
| CSR Activities | CSR1_20 | Soundness | 3 equal interval |
| | CSR2_11 | Fairness | 3 equal interval |
| | CSR3_7 | Contribution to Social Service | 3 equal interval |
| | CSR4_7 | Customer Protection Satisfaction | 3 equal interval |
| | CSR5_10 | Environment Protection Satisfaction | 3 equal interval |
| | CSR6_10 | Employee Satisfaction | 3 equal interval |
| | CSR7_10 | Contribution to Economic Development | 3 equal interval |
| | CSR_75 | Total CSR Evaluation Score | 3 equal interval |
| Firm’s Characteristic | SIZE | Log of Total Assets | 3 equal interval |
| | LEV | Debt–Assets Ratio | 3 equal interval |
| | SG | Sales Growth Rate | 3 equal interval |

IV. Results and Evaluation

1. Descriptive Statistics of Variables

The means of soundness (CSR1_20) and fairness (CSR2_11) in the KEJI index are 0.757 and 0.763 respectively, which are relatively higher than the means of other activities. On the other hand, the means of customer protection satisfaction (CSR4_7) and contribution to economic development (CSR7_10) are 0.478 and 0.496 respectively,

showing substantially low values compared to the means of other variables. It shows that the companies have been fulfilling CSR activities well in regarding with soundness and fairness, whereas the companies’ customer protection satisfaction and contribution to economic development are still unsatisfactory. It also appears that standard deviations of contribution to social service (CSR3_7) and employee satisfaction (CSR6_10) are 0.160 and 0.122 respectively, which infers that volatility of those CSR activities by companies is large.

<Table 3> Descriptive Statistics of Variables

| Variable | Mean | Std.Dev | 25% | Median |
|----------|--------|---------|--------|--------|
| CSR1_20 | 0.757 | 0.074 | 0.707 | 0.767 |
| CSR2_11 | 0.763 | 0.076 | 0.695 | 0.777 |
| CSR3_7 | 0.569 | 0.16 | 0.446 | 0.571 |
| CSR4_7 | 0.478 | 0.055 | 0.43 | 0.49 |
| CSR5_10 | 0.597 | 0.094 | 0.525 | 0.57 |
| CSR6_10 | 0.563 | 0.122 | 0.471 | 0.559 |
| CSR7_10 | 0.496 | 0.078 | 0.439 | 0.496 |
| CSR_75 | 0.632 | 0.034 | 0.606 | 0.627 |
| LEV | 0.466 | 0.214 | 0.304 | 0.469 |
| SIZE | 26.522 | 1.524 | 25.459 | 26.249 |
| SG | 0.156 | 0.994 | -0.025 | 0.079 |
| TobinQ | 1.518 | 0.707 | 1.165 | 1.344 |
| ROA | 0.032 | 0.114 | 0.008 | 0.038 |

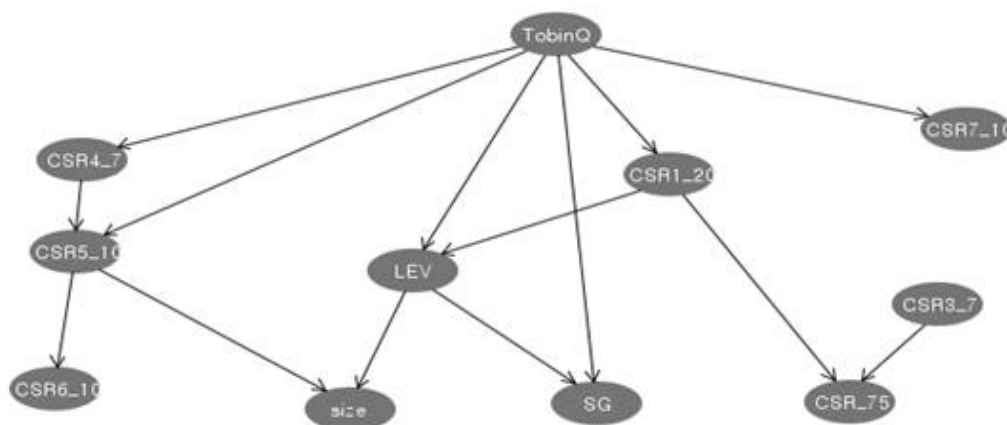
2. Results of GBN and What-If Analysis

2.1 The Causal Relationship through GBN

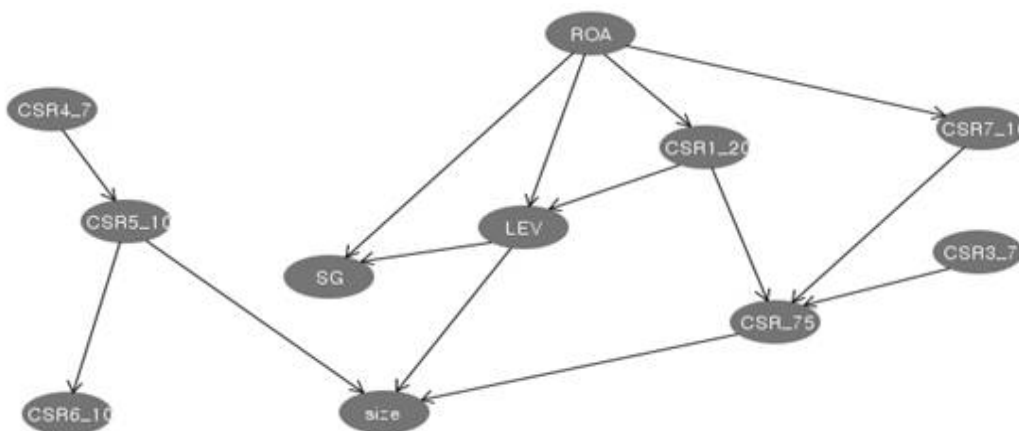
As shown in prior studies, GBN is a very useful method for deducing causal relationships between variables hidden in a given data set (Cheng et al. 2002). The causal relationship between the variables of this study obtained by GBN is presented in Fig. 3.

As mentioned above, Markov Blanket deduced from a Bayesian Network can show causal relationships by calculating the conditional probabilistic values of the variables

(Dzeroski 2002). When it comes to relationships between CSR activities and company's value, soundness (CSR1_20), consumer protection satisfaction (CSR4_7), environmental protection satisfaction (CSR45_10) and contribution to economic development (CSR7_10) of KEJI index they have a direct relationship with company's value while fairness (CSR2_11), contribution to social service (CSR3_7) and employee satisfaction (CSR6_10) have no direct correlation with the company's value (Fig.3 Panel A). Fairness (CSR2_11), especially, shows no causal relation with CSR activities as well as company's value.



Panel A: GBN by Tobin's Q as Financial Performance



Panel B: GBN by ROA as Financial Performance

<Fig. 3> The Causal Relationship through GBN

Causal relationships are also found between CRS activities. To be specific, consumer protection satisfaction (CSR4_7) and environment protection satisfaction (CSR5_10) and employee satisfaction (CSR6_10) indicate direct correlations. On the contrary, contribution to economic development (CSR7_10) has no correlation with any other

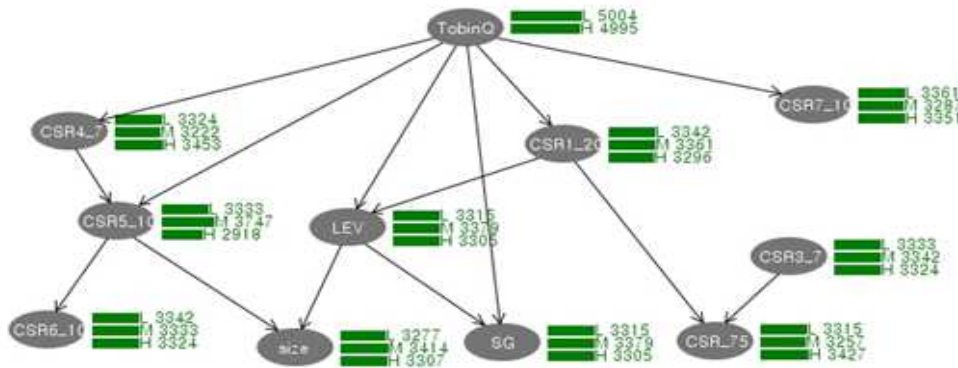
CRS activities. Soundness (CSR1_20) and contribution to social service (CSR3_7) show a direct cause-and-effect relationship with the total CSR evaluation score, which infers that those two activities (CSR1_20, CSR3_7) have a direct effect on the total CSR evaluation scores. Meanwhile, firm size (SIZE) and environment protection satisfaction (CSR5_10)

have a direct causal relation. It implies that bigger companies are playing an active role in environment protection. The company's value that appears on the future financial performance, ROA is a current performance measure for determining how efficiently assets are used to create profits. The relationships between the CSR activities and ROA, only soundness (CSR1_20) and contribution to economic development (CSR7_10) have a direct causal relationship with ROA, whereas fairness (CSR2_11), contribution to social service (CSR3_7), consumer protection satisfaction (CSR4_7), environment protection satisfaction (CSR5_10) and employee satisfaction (CSR6_10) show no direct relationship with ROA. Likewise, fairness (CSR2_11) shows no cause-and-effect relationship with ROA and other CSR activities.

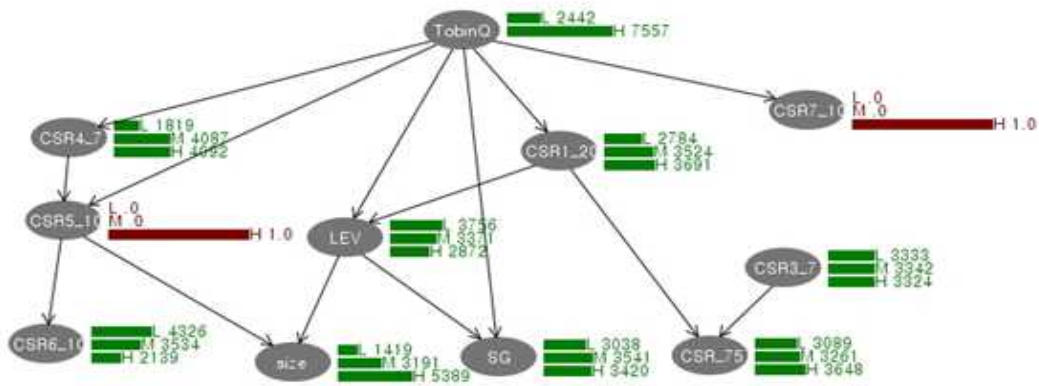
To summarize the results, soundness (CSR1_20) and contribution to economic development (CSR7_10) show a direct causal relationship with financial performances. On the other hand, fairness (CSR2_11) has no relationship with financial performances and other CSR activities. The total CSR evaluation score (CSR_75) is expected to have correlations with all the CSR activities, but

only soundness (CSR1_20) and contribution to social service (CSR3_7) have a direct causal relationship with the total CSR score unlike the other CSR activities. Besides, consumer protection satisfaction (CSR4_7), environment protection satisfaction (CSR5_10) and employee satisfaction (CSR6_10) have direct and indirect causal relationships with each activity, which indicates that they influence each other.

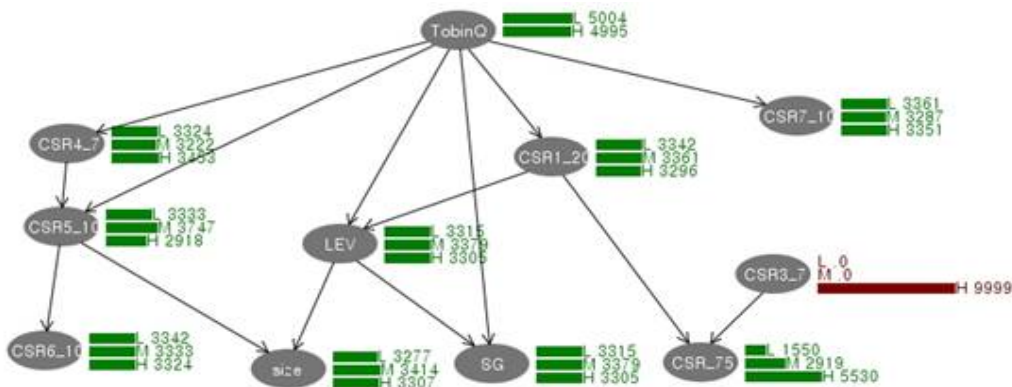
This study analyzes the impact of Corporate Social Responsibility (CSR) activities on financial performances using Bayesian Network, and to analyze the causal relationship among the CSR activities. The multiple regression analysis method used in previous studies related to financial performances assumed only a uniform linear function between financial performance and CSR activities, and it created a problem. This study attempts to overcome this problem. It is necessary to draw the causal relationship existing between the explanatory variables affecting Financial Performance. It can inform decision-makers what variables affect Financial Performance through a direct or indirect causal relationship with what other variables, and thus supports more effective decision-making.



Panel A: Prior Probability

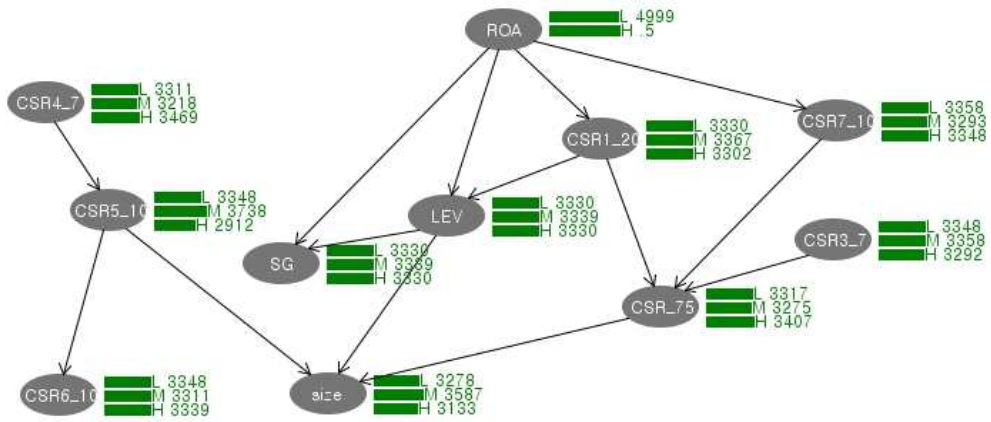


Panel B: Changes in Posterior Probability with Improvement of Soundness and Contribution to Economic Development

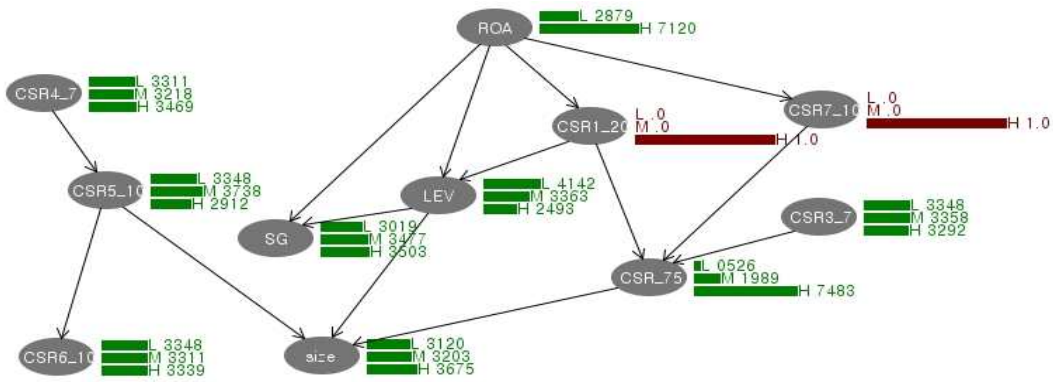


Panel C: Changes in Posterior Probability with Improvement of Environment Protection Satisfaction

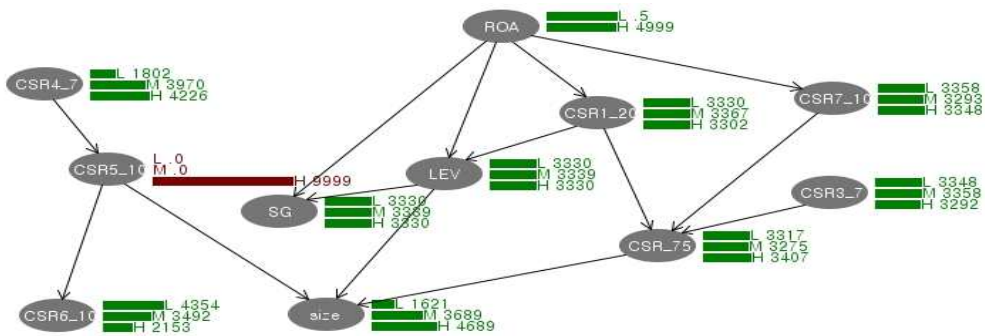
<Fig. 4> What-If Analysis: Tobin'Q as Financial Performance



Panel A: Prior Probability



Panel B: Changes in Posterior Probability with Improvement of Soundness and Contribution to Economic Development



Panel C: Changes in Posterior Probability with Improvement of Environment Protection Satisfaction

Fig. 5. What-If Analysis: ROA as Financial Performance

2.2 Results of What-If Analysis

The graphs of causal relationships enable a manager to conduct a variety of sensitivity analyses. The manager can understand which CSR activities among the KEJI index are linked to the financial performance nodes through direct or indirect relationships with the other CSR activities. In other words, a sensitivity analysis offers decision-makers with a very useful decision-making support tool.

The result of the sensitivity analysis using What-If analysis where the values of prior probability and posterior probability between each variable are input as the result of GBN is given in Fig. 4. Firstly, Panel A of Fig. 4 presents the prior probability of the causal relationships deduced from Tobin's Q. Since Tobin's Q is binarized by median (Table 2), the probability for Tobin's Q to be low(L) and high(H) is about 50% each. Likewise, as the CSR activities and firm's characteristics are categorized into three groups, the prior probability of each group is approximately 33%.

It is shown that the probability that Tobin's Q is greater than the median is increased from 50% to 75.57% when the scores of environment protection satisfaction (CSR5_10) and contribution to economic development (CSR7_10) are in the top 33%. However, in the case that the score of contribution to social service (CSR3_7) - which has no direct relationship with Tobin's Q - is in the top 30%, the probability that the total CSR evaluation score is in 'High' group rises to 55.3% from 34.27% and the posterior

probability of Tobin's Q shows no change, which implies that the contribution to social service (CSR3_7) has no significant impact on company's value (Tobin's Q) (Panel C).

Next, Panel A of Fig. 5 presents the prior probability of the causal relationship graph deduced from ROA. It is found that the probability that ROA is above the median is increased from 50% to 71.2% if the scores of soundness (CSR1_20) and contribution to economic development (CSR7_10) - which have a direct relationship with ROA - are in the top 33%. Furthermore, the probability to be in the group with high total CSR evaluation scores mounts more than twice from 34.07% to 74.83%.

On the contrary, if the score of environment protection satisfaction (CSR5_10) - which has no direct causal relationship with ROA - is high (top 30%), there are changes only in the posterior probabilities of consumer protection satisfaction (CSR4_7) and employee satisfaction (CSR6_10) but not in the posterior probability of ROA. It infers that environment protection satisfaction (CSR5_10) has no significant impact on ROA (Panel C). The what-if analysis, I suggest to the sensitive factor among the explanatory variables.

V. Conclusion

This study suggests a Bayesian Network methodology as the effective tool for decision-making for effective CSR activities accompanying enhancement of financial

performances. The study purposes to support a manager's decision-making by identifying which CSR activity is closely related to financial performance. To achieve the purpose, CSR activities that explain financial performances are extracted, and a GBN analysis and What-If analysis are conducted by investigating 1,079 companies evaluated by Korean Economic Justice Institute (KEJI), part of the Citizens Coalition of Economic Justice (CCEJ), from 2005 to 2011. The results of this study can be summarized as follows.

First, soundness (CSR1_20) and contribution to economic development (CSR7_10) have a direct cause-and-effect relationship with financial performances while fairness (CSR2_11) has no relations with both financial performances and CSR activities. Only soundness (CSR1_20) and contribution to social service (CSR3_7) have a direct causal relationship with the total CSR evaluation scores unlike the expectation that the total CSR evaluation scores (CSR_75) will correlate with all CSR activities. Consumer protection satisfaction (CSR4_7), environment protection satisfaction (CSR5_10) and employee satisfaction (CSR6_10) have direct and indirect causal relationships with each CSR activity, implying their impact on each other.

Second, the study uses What-If analysis to investigate the ultimate influence of changes in posterior probability of each explanatory variable upon the dependent variables when the prior probability of a certain explanatory

variable changes.

Compared to the previous studies, the major contributions of this research are as follows. First, it extracts the minimum number of CSR activities that influence financial performances applying Markov Blanket of GBN. It also offers the managers of companies a means of decision-making by helping them to select useful CSR activities and to improve the firm's financial performances by presenting the causal relationships between the CSR activities in a graph. Such a causal relationship graph that explains relationships between CSR activities is unprecedented, which is believed to help the managers with decision-making for the improvement of financial performances from the user's aspect.

Second, this study performs a sensitivity analysis (What-If analysis) using the causal relationships between explanatory variables and result variables in Markov Blanket. The sensitivity analysis enables a systematic analysis of changes in financial performances when the prior probability of a certain CSR activity changes. Though the what-if analysis, I suggest to the sensitive factor among the explanatory variables. The What-If analysis performed in this study, thus, is the unique contribution unprecedented in the previous studies on CSR fields.

Reference

1. 박선화(2013), 사회적기업의 성장에 관한 양적 분석 - 2007~2010년 경제적 성과를 중심으로. *경영과정정보연구*, 1-22.
2. 36. 나영·홍석훈(2011), 기업규모에 따른 CSR활동과 기업가치에 대한 실증분석, *회계저널*, 125-160.
3. 37. 장석인·성연옥·임상호(2015), 사회적기업의 금융지원 활성화를 위한 임팩트투자 연구 -영국과 미국 사례를 중심으로 -, *영정보연구*, 1-20.
4. 38. 장지인·최현섭(2010), 기업의 사회적 책임(CSR)과 재무성과와의 관계, *대한경영학회지*, 633-648.
5. Aupperle, K. E., Carroll, A. B., and Hatfield, J. D.(1985), "An empirical examination of the relationship between corporate social responsibility and profitability," *Academy of Management Journal*, 28(2), 446-463.
6. Baesens, B., Verstraeten, G., Van den Poel, D., Michael, E. P., Kenhove, P. V., and J. Vanthienen(2004), "Bayesian network classifiers for identifying the slope of the customer life cycle of long-life customers," *European Journal of Operational Research*, 156(6), 508-523.
7. Bouckaert, R.(1995), Bayesian belief Networks: From construction to inference. Doctorial dissertation. University of Utrecht. The Netherlands.
8. Calado, P., Silva A. D, Laender, A., Ribeiro-Neto, B. A., and Vieira, R. C.(2004), "A Bayesian network approach to searching Web databases through keyword-based queries," *Information Processing & Management*, 40(5), 773-790.
9. Cheng, J., and Greiner, R.(1999), Comparing bayesian network classifiers. Proc. of the 15th Conf. on Uncertainty in Artificial Intelligence, Morgan Kaufmann Publishers, 101-107.
10. Chun, M. L., and Kim, C. S.(2011), "The effect of sustaining corporate social responsibility on relationship between CSR and financial performance," *Korea Accounting Information Review*, 29(3), 351-374.
11. Chung, K. H., and Pruitt, S. W.(1994), "A simple approximation of Tobin's Q," *Financial Management*, 23(3), 70-74.
12. Denoyer, L., and Gallinari, P.(2004), "Bayesian network model for semi-structured document classification." *Information Processing & Management*, 40(5), 807-827.
13. Friedman, N., Geiger, M., and Goldszmidt, M. (1997), "Bayesian network classifiers," *Machine Learning*, 29(2-3), 131-163.
14. Geiger, D., and Heckerman, D.(1995), A characterization of the dirichlet distribution with application to learning bayesian networks. In Proceedings of Eleventh Conference on Uncertainty in Artificial Intelligence, Montreal, QU. Morgan Kaufmann.
15. Heckerman, D.(1997). "Bayesian networks for data mining," *Data Mining and Knowledge Discovery*, 1(1), 79-119.
16. Hillman, A. J., and Keim, G. D.(2001), "Shareholder value, stakeholder

- management, and social issues: What's the bottom line?," *Strategic Management Journal*, 22, 125-139.
17. Jang, G. I., and Choi, H. S.(2010), "The relation between corporate social responsibility and financial performance," *Korea Business Review*, 23(2), 633-648.
 18. Jensen, F. V.(1996), *An Introduction to Bayesian Networks*. UCL Press, London.
 19. John, G.H., and Langley, P.(1995), Estimating continuous distributions in bayesian classifiers. Proceedings of the Eleventh Conference on Uncertainty in Artificial Intelligence (UAI), (pp.338 - 345). Montreal, Quebec, Canada: Morgan Kaufmann.
 20. Kim, Y., Park, M. S., and Wier, B.(2012), "Is earnings quality associated with corporate social responsibility?," *The Accounting Review*, 87, 761-796.
 21. Koller, D., and Sahami, M.(1996), Toward Optimal Feature Selection. Proceedings 13th International Conf. Machine Learning, 284-292. Stanford, CA.
 22. Langley, P., Iba, W., and Thompson, K. (1992), An analysis of bayesian classifiers. Proceedings of the Tenth National Conference on Artificial intelligence, (pp.223-228). San Jose, CA.
 23. Lee, K. C., and Choi, K.(2007), "A study on the classification properties of firms to be subject to accounting disclosure reviews and investigations: comparison of bayesian network, c5.0, and ensemble prediction methods," *Korea Business Research*, 36(3), 705-737.
 24. Luo, X., and Bhattacharya, C. B.(2006), "Corporate social responsibility, customer satisfaction, and market value." *Journal of Marketing*, 70, 1-18.
 25. McWilliams, A., and Siegel, D.(2000), "Corporate social responsibility and financial performance: correlation or misspecification?," *Strategic Management Journal*, 21, 603-609.
 26. Na, Y., and Hong, S. H.(2011), "An empirical analysis on value relevance of corporate social responsibility activities by firm size." *Korea Journal of Accounting*, 20(5), 125-160.
 27. Neapolitan, R. E.(2004), *Learning bayesian networks*, Pearson Prentice Hall. Upper Saddle River, NJ.
 28. Noh, H., Lee, J., Oh, S., Hwang, K., and Cho, S.(2012), "Exploiting indoor location and mobile information for context-awareness service." *Information Processing & Management*, 48(1), 1-12.
 29. Paine, L. S.(2002), *Value shift*, New York: McGraw-Hill.
 30. Pava, M., and Krauz, J.(1996), "The association between corporate social responsibility and financial performance: The paradox of social cost." *Journal of Business Ethics*, 15(3), 321-357.
 31. Pearl, J.(1988), *Probabilistic reasoning in intelligent systems: networks of plausible inference*, Morgan Kaufmann, San Francisco.
 32. Prior Diego, Surroca, J., and Tribo, J. A. (2008), "Are socially responsible managers really ethical? Exploring the relationship between earnings management and

- corporate social responsibility.” *Corporate Governance*, 16(3), 160–177.
33. Shin, I. S., and Hong, J. W.(2012), “A study on the relationship between corporate social responsibility activities and the financial performance.” *Korea Commerce Education Review*, 26(2), 267–297.
 34. Song, I. M., Yun, S. S., and Choi, K. (2014), *Intermediate Accounting*, ShinYoungSa. Mapo, Seoul.
 35. Swanson, D. L.(1999), “Toward an integrative theory of business and society: A research strategy for corporate social performance.” *Academy of Management Review*, 24(3), 506–521.
 36. Tsamardinos, I., Aliferis, C. F., and tatnikov, A.(2003), Time and sample efficient discovery of markov blankets and direct causal relations. The 9th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (pp. 24–27), Washington, DC,
 37. Vahid, K., Norman, F., and Martin, N. (2007), “Project scheduling: improved approach to incorporate uncertainty using bayesian networks.” *Project Management Journal*, 38(2), 39–49.
 38. Waddock, S. A., and Graves, S. B.(1997), “The corporate social performance–financial performance link,” *Strategic Management Journal*, 18(4), 303–319.

국문요약

베이지안 네트워크를 이용한 기업의 사회적 책임활동과 재무성과

선은정*

본 연구는 기업의 사회적 책임(CSR: corporate social responsibility)활동이 재무성과에 미치는 영향을 베이지안 네트워크를 통해 분석하였다. 본 연구에서는 선행연구에서 널리 사용되어 온 분석방법인 다중회귀분석방법의 종속변수와 설명변수간에 확실적인 선형함수만을 가정하는데에서 나오는 문제점을 극복하고자 한다. 즉, 기업의 재무성과에 영향을 미치는 경영자의 사회적 책임활동간에 존재하는 인과관계를 도출할 필요가 있다. 이는 어떤 변수가 다른 어떤 변수와 직접 또는 간접적 인과관계를 통하여 기업의 재무성과에 영향을 주는지를 의사결정자에게 알려줌으로써 보다 효과적으로 기업의 재무성과를 개선시킬 수 있도록 지원할 수 있다. 이를 위하여 본 연구에서는 일반 베이지안 네트워크 (GBN: General Bayesian Network)을 제안하고 GBN에서 유도되는 마코프 블랭킷 (Markov Blanket)을 제시한다.

본 연구는 경제정의실천시민연합 산하 경제정의연구소에서 조사한 한국의 대표적 기업 약200개의 2005년부터 2011년까지 경제정의지수(Korean economic justice institute index: KEJI index)를 기초로 실험한 결과 기업성과측정치에 따라 차이는 보이지만 건전성(CSR1_20)과 경제발전기여도(CSR7_10)는 모든 기업의 재무성과에 직접적인 인과관계를 나타내었으며, 소비자보호만족도(CSR4_7), 환경보호만족도(CSR5_10) 및 종업원만족도(CSR6_10)는 각 측정지표간의 직·간접적인 인과관계를 나타내어 서로에게 중요한 영향을 미치고 있음을 나타내었다. 또한, what-if 민감도 분석을 통해 기업재무성과에 직접적인 인과관계가 있는 변수들의 사전확률이 변할 때 사후확률의 변화를 분석하여, 본 연구에서 제안한 방법이 모두 통계적으로 유의한 결과를 제공한다는 것이 실증적으로 검증되었다.

핵심주제어: 사회적 책임활동, 재무성과, 베이지안 네트워크, 마코프 블랭킷

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