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The Influences of CSR's Multi-Dimensional Characteristics on Firm Value Determination by a Fusion Approach

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Abstract: Corporate social responsibility (CSR) implementation has been widely acknowledged as playing a key part in enhancing firm value as well as achieving sustainable development. However, up to now the extant works in the literature have yielded non-conclusive results regarding the relationships between CSR and firm value. One of the possible reasons is that the studies ignore the multi-dimensional characteristics of CSR—that is, they merely utilize a singular synthesized indicator as a proxy to represent the corporate's CSR performance as being unreliable and problematic. Thus, this study breaks down CSR into numerous dimensions and further examines each dimension's impact on firm value. By doing so, managers can allocate their firm's valuable resources to suitable areas so as to increase its reputation and value. In addition, this research sets up an artificial intelligence (AI)-based fusion model, grounded by fusion learning theory that aims at complementing the error made by a singular model, to examine the relationship between CSR's multidimensional characteristics and firm value. Through different combinations of adopted strategies, users can realize the most representative features from an over-abundant database.

Keywords: artificial intelligence; corporate social responsibility; decision making; firm value

1. Introduction

Forecasting corporate financial troubles has become an essential topic of interest over the past few decades due to its great impact on publicly listed companies, current and potential stakeholders, and even a country's economy [1]. Financial resource providers need to evaluate the financial risk of a corporate before they make a financing decision or grant credit judgments on firms in order to avoid or prevent any tremendous financial shock and/or loss. Corporate suppliers and partners that conduct credit transactions with corporates also require a more detailed illustration of their financial status. If a prediction model is useful, then top-level managers can initiate some initial prevention such as adjusting their capital structure or modifying their financial leverage to avoid any deterioration in corporate status before financial trouble erupts. Current and potential investors can also utilize such a model to change their investment strategy as well as allocate monetary resources to more profitable places [2].

Multivariate discriminant analysis (MDA) was the most frequently utilized forecasting model before the 1980s. Altman [3] introduced a very famous forecasting architecture, the "Z-score", that incorporated MDA with five financial ratios (i.e., working capital to total assets, retained earnings to total assets, earnings before interest and taxes to total assets, market value of equity to book

value of total liabilities, and sales to total assets) so as to discriminate between healthy corporates and non-healthy corporates. Although this model performs a satisfactory job in forecasting quality, it also comes with some statistical challenges, such as linear separability, independent predictors, and multivariate normality that usually do not hold in real applications. To overcome these obstacles, the literature has proposed the linear probability model (LPM) and logit or probit regression models. Meyer and Pifer [4] employed LPM to handle the task of the corporate financial bankruptcy forecasting task. Martin [5] assessed banks' financial troubles by relying on a logit model. Dimitras et al. [6] provided a detailed review of statistical-based approaches in financial crisis forecasting, indicating that the logit model achieves optimal forecasting performance.

In contrast with those studies that have broadly examined financial crisis prediction and credit risk forecasting, very few have looked into firm value forecasting. Poor firm management is widely recognized as being the main trigger for a financial crisis, and thus firm value can appropriately reflect the quality of corporate management. If managers can run their business with efficiency and target maximizing shareholders' wealth, then investors will likely pay more than average to own their stock. The higher the firm value is, the stronger and more developed it is.

How to increase firm value as well as sound a corporate's competitive edge turns out to be an essential task in this highly turbulent economic atmosphere. Although coming up with some generally accepted conclusions is quite difficult, it is widely acknowledged that corporates with good corporate social responsibility (CSR, which considers the voluntary integration of social and environmental concerns in a business operation and its interaction with stakeholders such as investors, shareholders, employees, suppliers, bankers, and regulators) have the prescribed means for addressing the challenge of globalization and increasing their competitive advantages (Organization for Economic Co-operation and Development, OECD). That is the reason why so many executives and researchers have devoted considerable amount of time and efforts to investigate the influence of CSR on firm value.

Although there are many different types of definitions and dimensions of CSR in the extant studies, Carroll [7–9] defined four CSR dimensions: a corporate should (1) obey the laws and regulations announced by governments in its daily operations, (2) make products or provide services for customers to achieve suitable profitability in the process, (3) meet shareholders' expectations and protect their wealth, and (4) strengthen and increase human welfare or firm reputation. Based on these perspectives, CSR consists of numerous factors, such as community involvement, labor security, environmental protection, human rights, and business standards. CSR may also function similarly to advertising, by enlarging a firm's profit spread, increasing the demand for products and services, eliminating buyers' price sensitivity, and solidifying consumer loyalty [10–12].

Most research works attempt to identify the link between CSR and firm value in order to examine why firms engage in CSR [13,14]. Unfortunately, there is no conclusive theory that can explain the relation between CSR and firm value, although two dominant theories do exist. The agency theory [15] indicates that corporates performing CSR activities see a decrease in firm value when managers use the firm's limited resources to draw benefits of personal reputation at the expense of shareholders [16]. On the other hand, the conflict resolution theory notes that corporates with high CSR activities can lead to higher firm value by mitigating conflicts of interest between managers and investors, raising firm reputation, and enhancing firm profitability [17]. It also views CSR as a strategic investment to increase a firm's competitive edge. The existing research on the relation between CSR and firm value is mixed and sometimes confusing [18]. One of the possible reasons for not reaching a consensus conclusion comes from the effect of the quality–quantity trade-off among each one of the CSR dimensions [2,19,20]. CSR encompasses economic, environmental, business, and social behaviors. Only using one synthesized indicator as a proxy to depict a corporate's CSR performance is not reliable and trustworthy. Therefore, there is an urgent requirement to decompose CSR into some dimensions and further examine the impact of each dimension on firm value.

How to determine the most essential dimension on firm value is quite similar to handling the task of feature selection. The fundamental concept of feature selection is identifying a subset from the

original set of features without impeding the model's forecasting performance as well as improving the quality of the data and facilitating the calculation efficiency [21]. However, most related works that considered feature selection are based on one pre-decided method. It is widely deemed that different method adoptions are likely to yield different outcomes (i.e., different selected features). If we can apply a number of dissimilar feature selection approaches and then combine the selection results, then we not only can realize the most essential feature that all the feature selection approaches "agree" on, but also enhance the model's forecasting accuracy over utilizing one feature selection approach [22].

This basic idea of combining multiple feature selection approaches is inspired by the ensemble learning theory—that is, the combination strategy is able to complement the error made by a singular method. By doing so, decision makers can realize which dimension of CSR has the greatest influence on firm value. Managers can then consider the potential implications to allocate valuable resources to an appropriate place so as to maximize stakeholders' wealth and sustain the firm's reputation. The selected outcome can then be entered into an emerging neural network-based model, namely support vector machine (SVM), to construct the firm value forecasting model. SVM [23], grounded on statistical learning theory, produces an optimal separating hyperplane to discriminate two dissimilar class labels. There are some benefits in performing SVM [24]: (1) there are only two parameters to be decided, (2) the solution of SVM is optimal and unique, and (3) the model has greater tolerance on extreme values. Due to these advantages, SVM was performed by this study. Investors can take the proposed model as a roadmap to adjust their investment portfolios so as to reach the goal of sustainable development.

The rest of this article is organized as follows. Section 2 reviews the existing literature of CSR's impact on firm value. Section 3 proposes our research design. Section 4 shows the experimental results. Section 5 concludes.

2. Literature Review

Corporate Social Responsibility and Firm Value

McWilliams and Siegel [25] indicated that corporate social responsibility (CSR) is deemed as "actions that appear to further some social good, beyond the interests of the firm and that which is required by law". Based on this description, CSR activities not only have influence on investing stakeholders such as bankers, suppliers, stockholders, and debt holders, but also have an impact on non-investing investors such as buyers, community, public sectors, and others. CSR-related research topics have been discussed for the last three decades or so with most of the discussions centered on one question: Does CSR help to enhance firm value?

The "overinvestment hypothesis" indicates that the relation between CSR activities and firm value is negative [16]. The agency cost theory stems from the separation of ownership and control when top-level executives/managers have insufficient residual claims on a firm. Based on this theory, executives/managers tend to use corporate resources to enhance their personal reputation and to be entrenched as socially responsible managers at the expense of shareholders—that is, the managers have an incentive to overinvest CSR beyond the optimal level, further resulting in destruction of firm value. Galakiewicz and Burt [26] indicated that CEOs investing in philanthropy will result in acquiring reputation and influential relations with local business elites. In the work done by Werbel and Carter [27], they stated that CEOs' membership in charitable institutes is positively related to corporate giving. Barnea and Rubin [16] found that executives prefer to overly invest in CSR when they do not bear any cost, but instead enjoy the benefits of increased personal reputations in the community.

According to the "conflict resolution hypothesis", "stakeholder theory", or "reputation-building hypothesis" [28–30], one can contend that CSR enhances firm value by balancing the interests of all stakeholders (i.e., investing stakeholders and non-investing stakeholders) and by eliminating the risk of resource acquisitions [31]. Ruf et al. [32] indicated that the changes in CSR status are positively related to firm financial performance. Wang and Choi [33] argued that a firm with good stakeholder

relations will contribute largely to its financial performance. Crifo et al. [34] stated that CSR activities help to eliminate the impact of information asymmetry. Thus, CSR activities can increase firm value by reducing the conflict of interest between managers and non-investing stakeholders.

Even if many existing studies conclude that the relation between CSR and firm value is positive, there is no concrete consensus so far [34]. One of the possible reasons is that CSR activities are multi-dimensional and consist of social, environmental, ethics, and business behaviors. Merely performing a synthesized indicator for CSR performance could lead to a confused result about the relation between CSR and firm value [35]. Thus, there is an urgent need to decompose CSR into some dimensions and further examine the influence of each dimension on firm value.

3. Research Design

3.1. The Research Sample

China has experienced amazing and admirable economic growth and improvement since the 1980s, but this growth comes with high social costs and environmental pollution. In order to overcome the challenges, the China government has encouraged firms publicly listed on the Shenzhen and Shanghai Stock Exchanges to engage in CSR and provided some incentives to motivate firms to do so, including the "green loan policy" and "green securities" [36]. Moreover, in September 2006 the Shenzhen Stock Exchange provided guidance called "Shenzhen Stock Exchange Social Responsibility Introductions to Listed Companies" for encouraging listed firms to perform CSR activities and list them in their financial reports, while Shanghai Stock Exchange yields guidelines requested the listed companies to disclose CSR issues, including "Notice on Strengthening Listing Companies' Assumptions of Social Responsibility" and "Guideline on Listed Companies' Environmental Information Disclosure" launched in May 2008. Stated-owned companies controlled by the central government still need to follow the regulation provided by State-Owned Assets Supervision and Administration Commission of the State Council (SASAC) [37]. In light of the CSR guidelines or regulations, the volume of CSR report disclosures or CSR activities has been growing dramatically since 2008 [38]. Furthermore, some managers viewed CSR activities as strategic investments. By doing CSR activities, firms can gain some benefits and competitive edges. To examine the relation between CSR and firm value, this study takes the top 100 companies in China as a research sample. The data were gathered from the Taiwan Economic Journal (TEJ) databank and Research Report on Corporate Social Responsibility of China for the period 2013–2015.

3.2. The Dependent Variable

According to previous research works done by Sheikh [14], Lee, and Heo [39] and Buchanan et al. [17], the firm value is determined by Tobin's Q, which is computed as the market value of assets divided by the book value of assets. The market value of assets is the market value of equity plus the book value of assets minus the book value of common equity net of deferred taxes. It is the most widely implemented measure of firm value [40]. Based on the information of Research Report on Corporate Social Responsibility of China, we can see the top 100 companies' CSR performance. The top 50% of firm values are designated as 1 "good performance", while the other 50% are designated as 0 "bad performance". By doing so, this problem has been transformed into a traditional binary classification task.

3.3. Combination Strategy

Due to the data being gathered from financial statements, some of them may be contaminated by some degree of error, and thus data cleaning is an inevitable pre-process. Because decision tree (DT) has the merits of being easy-to-use, is comprehensive, and automatically shifts through large, complex databases in searching for and isolating essential features, two different kinds of DT (C4.5 and CART) were conducted. A relative emerging soft computing technique, namely rough set theory (RST)

that can handle data with impreciseness, uncertainty, and vagueness, was proposed by Pawlak [41]. It has demonstrated its usefulness in feature selection, knowledge reasoning, and granular computing, and it also performed a satisfactory job in numerous research domains. However, no current research, grounded on the fusion learning theory, has constructed an advanced model to examine the relationships between each CSR dimension and firm value. To examine the effectiveness of the fusion learning theory, this study introduces three different kinds of combination strategies: isolation, combination, and union. The conceptual structures of the three different combination strategies are represented in Figure 1.

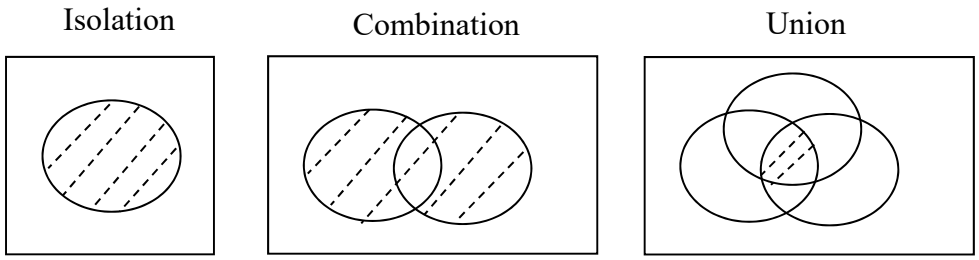

Figure 1. The combination strategies.

3.4. Variable Definition

There are many methods to measure firm value, such as Tobin's Q, economic added value, etc. Because Tobin's Q can be used to measure the values of tangible and intangible assets and the figures calculated by it are closest to the market price, this study used Tobin's Q as a method to measure firm value. Tobin's Q is defined as the market value of an enterprise divided by its assets. The higher the value is, the better the investment opportunities and competitive advantages an enterprise has.

The calculation formula of Tobin's Q is as follows:

$$\text{Tobin's } Q_{it} = \frac{(MV_{it} + PS_{it} + DEBT_{it})}{TA_{it}} \quad (1)$$

MV: a multiplication of the closing price of ordinary stock at the end of period t with the number of outstanding common shares during period t. PS: a multiplication of the closing price of special shares at the end of period t with the number of outstanding special shares during period t. DEBT: is equal to current liabilities during period t minus current assets during period t, plus long-term liabilities during period t. TA: is the total assets during period t.

Previous studies have yielded non-conclusive results regarding the relation between CSR and firm value. One of the possible reasons is they ignored CSR's multi-dimensional characteristics. To reach a more conclusive and precise result, this study followed the "Research Report on Corporate Social Responsibility of China" and divided CSR performance into four dimensions (see Figure 2).

The control variables are represented as follows (see Table 1).

1. DEBT: Modigliani and Miller [18] pointed out that debt financing affects a firm's tax shield—the more the enterprise financing, the higher the tax savings benefit, which can create firm value. Therefore, this study considered it as one of the variables affecting firm value.
2. AGE: The measure method is to take the period from the establishment year to the current year of the sample company as AGE. Calantone et al. [42] indicated that a company with a larger AGE is more efficient in responding to market information and has better corporate performance compared to that with a smaller AGE.
3. R&D: Grabowski and Mueller [43] and McWilliams and Siegel [25] suggested that more research and development expenses imply better firm business performance. Therefore, this study regarded it as one of the variables affecting firm value.

4. SALESG: Mak and Kusnadi [44] and McWilliam and Siegel [25] indicated that an enterprise's revenue growth could affect the business performance of an enterprise. Therefore, this study regarded it as one of the variables affecting firm value.
5. ROA: Sakhartov and Folta [45] showed that the return on assets is an overall effect index of enterprise capital operations, as higher profits denote higher firm value.

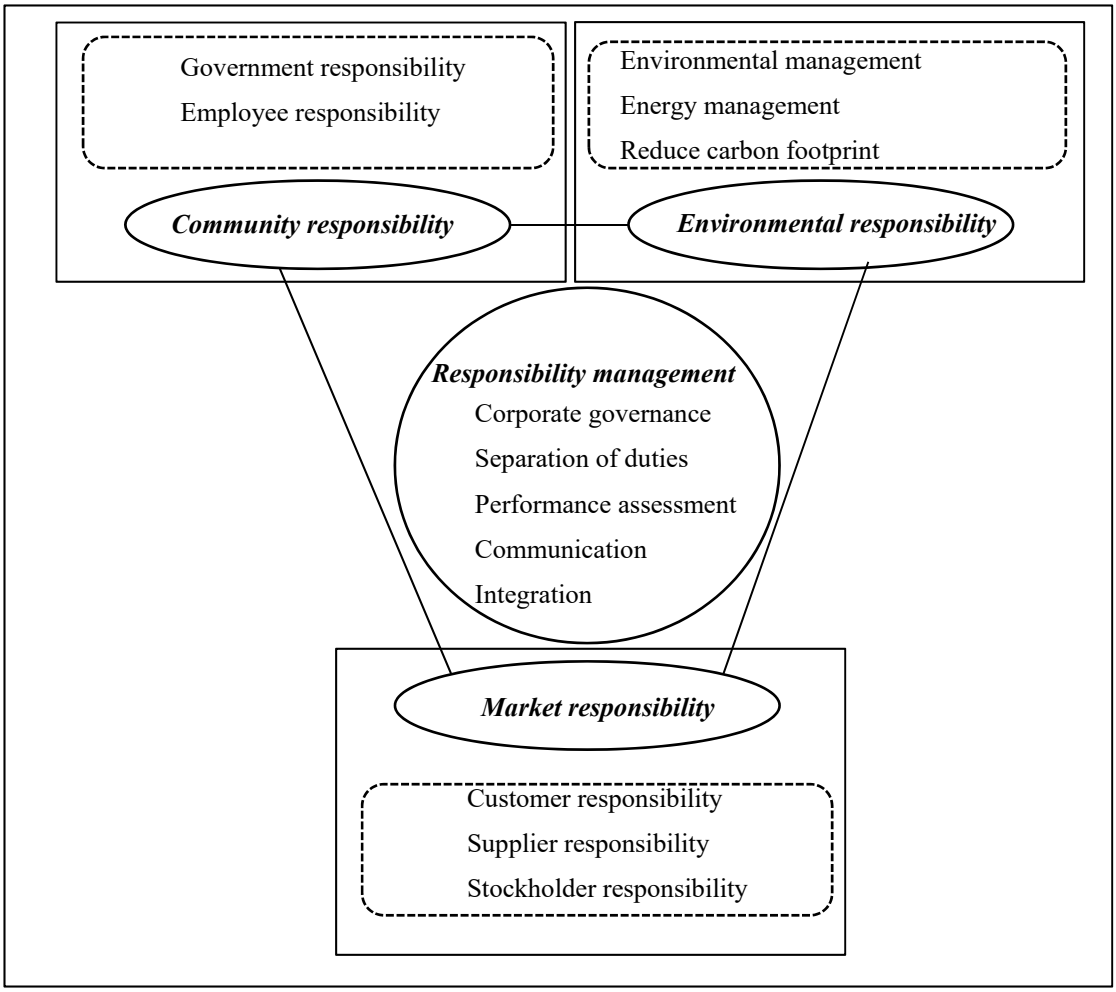

Figure 2. The corporate social responsibility (CSR) multi-dimensional structure.

Table 1. Independent variables.

Symbol	Illustration
X1: Responsibility management	Disclose the current situation of an enterprise's responsibility management
X2: Market responsibility	Disclose the performance of an enterprise's market responsibility
X3: Community responsibility	Disclose the corporate's community responsibility performance
X4: Environmental responsibility	Disclose the performance of an enterprise's environmental responsibility
X5: DEBT	Total liabilities/total assets
X6: AGE	Current year—establishment year
X7: RD	R&D expenditure/net sales revenue
X8: SALESG	(Net sales income for the current year—sales revenue for the previous year)/sales revenue for the previous year
X9: ROA	Net profit after tax + Interest * (1 − tax rate)/average total assets

4. Empirical Examinations

4.1. Data

This study collected 900 CSR variables of the top 100 state-owned enterprises, private enterprises, and foreign enterprises from 2013 to 2015 in the Research Report on Corporate Social Responsibility of China and gathered the variables related to firm value by TEJ according to the above-mentioned samples. Because the foreign enterprises of China are not listed in China, it was difficult to collect the variables related to firm value from the China part of TEJ. Therefore, 300 samples of Chinese foreign-funded enterprises from 2013 to 2015 were excluded. As the state-owned enterprises in China and private enterprises of China include unlisted enterprises, we had a total of 270 samples in this study after deducting unlisted enterprises and ones that lacked data (see Table 2).

Table 2. Sample selection rule.

Sample Selection Process	Sample Number
Sample number of top 100 state-owned enterprises, private enterprises, and foreign enterprises issued by the Blue Book of Corporate Social Responsibility of China from 2013 to 2015	900
Minus: the number of enterprises that are not listed or ones in which the relevant financial information is not able to be found in the Taiwan Economic Journal (TEJ)	630
Final sample number	270

4.2. Descriptive Statistics

The descriptive statistics of this study's relevant variables are shown in Table 3. With regard to the dependent variables, the median of firm value is 366.21. Based on whether it is greater or less than this median, this study set the firm value as 0 or 1, where 0 represents the enterprise with a worse firm value and 1 represents the enterprise with a better firm value. In the aspect of the independent variables, among four indicators included in CSR, the maximum value of responsibility management and market responsibility is 100, and the minimum value is 0, indicating that the highest score in Chinese enterprises is 100 and the lowest score is 0 in these two indicators. The maximum value of social responsibility is 95.5 and the minimum value is 0, showing that the highest score of Chinese enterprises is 95.5 and the lowest score is 0 in this indicator. The maximum value of environmental responsibility is 100 while the minimum value is 0, implying that the highest score obtained by Chinese enterprises is 100, and the lowest score is 0 in this indicator.

Table 3. Descriptive statistics of the variables.

Variable	AVG	S.D.	Q1	Median	Q3	Max	Min
X1	40.1	33.63	10	34.65	70	100	0
X2	43.61	27.78	18.3	47.35	65	100	0
X3	40.31	27.27	13.7	42.65	64	95.5	0
X4	33.78	28.1	6.7	31.1	58	100	0
X5	64.29	20.52	50.24	66.79	79.44	94.86	9.14
X6	22.84	20.24	14	17	24	107	0
X7	2.46	17.60	0	0.25	2.1	288.17	0
X8	1.16	17.80	−0.04	0.06	0.14	292.54	−0.41
X9	3.84	4.04	1.42	2.81	5.51	19.05	−13.33
Y	45,562.7	324,778.23	147.68	366.21	760.99	4,674,101.35	0.07

Y denotes the firm value; AVG: average; S.D.: standard deviation; Max: maximum; Min: minimum.

The average value of DEBT (X5) is 64.29, indicating the average ratio of total liabilities of sample enterprises to total assets, while the median is 66.79, which indicates that the DEBT (X5) of half of the

sample enterprises is 66.79; the average value of AGE is 22.84, indicating the average AGE (X6) of sample enterprises; the median of RD (X7) is 0.25, which indicates that RD (X7) of half of the sample enterprises is up to 0.25; the average number of SALESG (X8) is 1.16 while the median is 0.06 and at least the SALESG (X8) of one half of the sample enterprises is up to 6%; the average value of ROA (X9) is 3.84.

4.3. Results

To examine the effectiveness of the introduced fusion mechanism, this study divided the experiments into three different scenarios: isolation, combination, and union. How to determine a model's forecasting quality is an essential topic in practical applications, with accuracy or error rate being one of the most widely adopted assessment criteria. However, only relying on one assessment criterion to identify a model's forecasting quality is not reliable and robust. To overcome this problem, two other assessment criteria—namely, type I error and type II error—were considered.

Table 4 shows the essential variables under three different scenarios. We can see that the most essential variables are X4 (Environment responsibility) and X5 (DEBT). This finding is in accordance with previous research studies [46,47], which stated that the debt ratio has the most significant impact on firm value. In addition, Konar and Cohen [46] indicated that a firm with better environmental responsibility normally has higher firm value, because these firms will focus on green production and offer products with less CO_2 emissions, thus helping out the firm's reputation while also increasing its profitability. Through a fusion strategy, users can realize the most representative features from an over-abundant database. Managers also may consider the potential implications of allocating valuable resources to suitable places and to formulating future policies that can reach sustainable development.

Table 4. The selected variables under three different scenarios (all samples).

Scenario	Selected Variables
Isolation	
C4.5	X1: Responsibility management, X4: Environmental responsibility, X5: DEBT, X7: RD, X8: SALESG
CART	X2: Market responsibility, X4: Environmental responsibility, X5: DEBT, X6: AGE, X8: SALESG
RST	X1: Responsibility management, X4: Environmental responsibility, X5: DEBT, X6: AGE, X9: ROA
Combination	
C4.5∩CART	X4: Environmental responsibility, X5: DEBT, X8: SALESG
C4.5∩RST	X1: Responsibility management, X4: Environmental responsibility, X5: DEBT
CART∩RST	X4: Environmental responsibility, X5: DEBT, X6: AGE
Union	
C4.5∩CART∩RST	X4: Environmental responsibility, X5: DEBT

Table 5 shows the model's forecasting quality under three different combination strategies. Support vector machine (SVM) was taken as a forecasting model. We see that the introduced fusion model (i.e., union strategy) not only reaches the optimal forecasting accuracy, but also presents less biased outcomes. This finding correlates to the concept of the fusion learning theory, which aims at complementing the error made by a singular method [48]. It also has been widely deemed as one of the most efficient ways to increase a model's forecasting quality. Even a fraction of forecasting accuracy improvement can translate into large future savings. Thus, constructing a forecasting model grounded on the fusion learning theory is an urgent requirement in today's highly competitive environment.

Table 5. The forecasting results (all samples).

Scenario	Assessment Criteria		
	Accuracy	**Type I Error**	**Type II Error**
	Isolation		
C4.5	64.07	37.04	34.81
CART	62.22	40.74	34.81
RST	70.00	27.41	32.59
	Combination		
C4.5∩CART	72.96	27.41	26.67
C4.5∩RST	72.22	29.63	25.93
CART∩RST	74.44	25.93	25.19
	Union		
C4.5∩CART∩RST	82.96	17.78	16.30

To reach a more robust outcome, we further divided all the samples into two different groups: (1) group 1 contains all the state-owned enterprises, and (2) group 2 contains all the private enterprises. The selected features from each group are expressed in Table 6. We can see that the X4: Environmental responsibility still poses considerable influence on firm value. The state-own enterprises invested considerable amount of resource in R&D development so as to upgrade its industrial level. The private enterprises focused more on profitability to reach a goal of shareholder's wealth maximization.

Table 6. The selected variables from two different groups under three different scenarios.

Group	Scenario	Selected Variables
Group 1 (all state-own enterprises)	Isolation	
	C4.5	X3: Community responsibility, X4: Environmental responsibility, X5: DEBT, X7: RD, X8: SALESG
	CART	X1: Responsibility management, X4: Environmental responsibility, X5: DEBT, X7: RD
	RST	X2: Market responsibility, X4: Environmental responsibility, X5: DEBT, X6: AGE, X7: RD, X9: ROA
	Combination	
	C4.5∩CART	X4: Environmental responsibility, X5: DEBT
	C4.5∩RST	X4: Environmental responsibility, X7: RD
	CART∩RST	X4: Environmental responsibility, X5: DEBT, X7: RD
	Union	
	C4.5∩CART∩RST	X4: Environmental responsibility, X7: RD
Group 2 (all private enterprises)	Isolation	
	C4.5	X3: Community responsibility, X4: Environmental responsibility, X6: AGE, X8: SALESG, X9: ROA
	CART	X2: Market responsibility, X4: Environmental responsibility, X5: DEBT, X6: AGE, X9: ROA
	RST	X3: Community responsibility, X4: Environmental responsibility, X6: AGE, X7: RD, X9: ROA
	Combination	
	C4.5∩CART	X4: Environmental responsibility, X6: AGE, X9: ROA
	C4.5∩RST	X3: Community responsibility, X4: Environmental responsibility, X6: AGE, X9: ROA
	CART∩RST	X4: Environmental responsibility, X6: AGE, X9: ROA
	Union	
	C4.5∩CART∩RST	X4: Environmental responsibility, X6: AGE, X9: ROA

5. Conclusions and Further Research

The many empirical research works up to date have identified no conclusive pattern in the relation between CSR and firm value. Ignoring CSR's multi-dimensional characteristics is one of the possible reasons for this absence of a consensus conclusion. Given this concern, this study followed the "Research Report on Corporate Social Responsibility of China" to decompose CSR into four dimensions and further examine the impact of each CSR's dimension on firm value. The focus of previous studies has been to identify "the single best" mechanism that is most precise for a pre-decided financial task, but this reliance on a single mechanism may be misguided and could contain some biases. To reach a more sound research outcome, a multiple combination strategy, grounded on the ensemble learning theory, was conducted herein. The basic idea of the ensemble learning theory is to complement the error made by a singular mechanism. Through different combinations of adopted strategies, users can realize the most representative features from an over-abundant database and find the most influential dimension on firm value.

The results herein indicate that X4: Environmental responsibility is the most essential element on firm value determination. The reason is because the Chinese government has placed much more emphasis on environmental protection and retains "vote power" over major decisions. In other words, if a corporate pollutes the environment, then the government has the right to delist the corporate regardless of major investors' decisions. Managers of firms can consider the potential implications of these results and allocate valuable resources to an appropriate place in order to enhance their firm's CSR performance, increase firm value, and reach the goal of sustainable development. Investors can look to invest in firms that have better resource utilization efficiency so as to maximize their wealth under anticipated risk exposure.

Certainly, this study has some limitations. First of all, this research was an exploratory study carried out with a high level of technology and a small sample. Larger samples with greater explanatory power will allow for more complex assessments in the future. Second, the effects of corporate social responsibility implementation include economic, social, and environmental impacts. All of these effects have short-term and long-term effects. Furthermore, some companies have implemented corporate social responsibility for some time, but some companies have begun to implement corporate social responsibility in accordance with government regulations. Although this study only attempts to explore the impact of stock prices (Tobin Q). Future research can continue to explore the long-term effectiveness of CSR through long-term concepts such as customer loyalty and/or sustainable value index. Finally, other studies combining and using different multiple attributes decision makings (MADMs) can provide insight into the unrecognized facets of CSR in this study. Future research can use different research methods such as time series analysis and prediction method to continue to study this issue.

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References

1. Wanke, P.; Barros, C.P.; Figueiredo, O. Measuring efficiency improvement in Brazilian trucking: A Distance Friction Minimization approach with fixed factors. *Measurement* **2014**, *54*, 166–177. [CrossRef]
2. Lin, S.J.; Hsu, M.F. Decision making by extracting soft information from CSR news report. *Technol. Econ. Dev. Econ.* **2018**, *24*, 1344–1361. [CrossRef]
3. Altman, E. Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *J. Financ.* **1968**, *23*, 589–609. [CrossRef]
4. Meyer, P.A.; Pifer, H.W. Prediction of bank failures. *J. Financ.* **1970**, *25*, 853–868. [CrossRef]

5. Martin, D. Early warning of bank failure. A logistic regression approach. *J. Bank. Financ.* **1977**, *1*, 249–276. [CrossRef]
6. Dimitras, A.I.; Zanakis, S.H.; Zopounidis, C. A survey of business failures with an emphasis on prediction methods and industrial applications. *Eur. J. Oper. Res.* **1996**, *90*, 487–513. [CrossRef]
7. Carroll, A.B. A three-dimensional model of corporate performance. *Acad. Manag. Rev.* **1979**, *4*, 497–505. [CrossRef]
8. Carroll, A.B. The pyramid of corporate social responsibility: Toward the moral management of organizational stakeholders. *Bus. Horiz.* **1991**, *34*, 39–48. [CrossRef]
9. Carroll, A.B. The four faces of corporate citizenship. *Bus. Soc. Rev.* **1998**, *100*, 1–7. [CrossRef]
10. Aguinis, H.; Glavas, A. What we know and don't know about corporate social responsibility a review and research agenda. *J. Manag.* **2012**, *38*, 932–968. [CrossRef]
11. Dahlsrud, A. How corporate social responsibility is defined: An analysis of 37 definitions. *Corp. Soc. Responsib. Environ. Manag.* **2008**, *15*, 1–13. [CrossRef]
12. Farrington, T.; Curran, R.; Gori, K.; O'Gorman, K.D.; Queenan, C.J. Corporate social responsibility: Reviewed, rated, revised. *Int. J. Contemp. Hosp. Manag.* **2017**, *29*, 30–47. [CrossRef]
13. Lindgreen, A.; Swaen, V. Corporate social responsibility. *Int. J. Manag. Rev.* **2010**, *12*, 1–7. [CrossRef]
14. Sheikh, S. Corporate social responsibility, product market competition, and firm value. *J. Econ. Bus.* **2018**, *98*, 40–55. [CrossRef]
15. Jensen, M.C.; Meckling, W.H. Theory of the Firm: Managerial Behavior, Agency Cost and Ownership Structure. *J. Financ. Econ.* **1976**, *3*, 305–360. [CrossRef]
16. Barnea, A.; Rubin, A. Corporate social responsibility as a conflict between shareholders. *J. Bus. Ethics* **2010**, *97*, 71–86. [CrossRef]
17. Buchanan, B.; Cao, C.X.; Chen, C. Corporate social responsibility, firm value, and influential institutional ownership. *J. Corp. Financ.* **2018**, *52*, 73–95. [CrossRef]
18. Modigliani, F.; Merton, H.M. Corporate Income Taxes and the Cost of Capital: A Correction. *Am. Econ. Rev.* **1963**, *53*, 433–443.
19. Cavaco, S.; Crifo, P. CSR and financial performance: Complementarity between environmental, social and business behaviours. *Appl. Econ.* **2014**, *46*, 3323–3338. [CrossRef]
20. Pope, S.; Wæraas, A. CSR-washing is rare: A conceptual framework, literature review, and critique. *J. Bus. Ethics* **2015**, *137*, 173–193. [CrossRef]
21. Zhang, Y.; Zhang, Z. Feature subset selection with cumulate conditional mutual information minimization. *Expert Syst. Appl.* **2012**, *39*, 6078–6088. [CrossRef]
22. Tsai, C.F.; Hsiao, Y.C. Combining multiple feature selection methods for stock prediction: Union, intersection, and multi-intersection approaches. *Decis. Support Syst.* **2010**, *50*, 258–269. [CrossRef]
23. Vapnik, V. *The Nature of Statistical Learning Theory*; Springer: New York, NY, USA, 1995.
24. Shin, K.S.; Lee, T.S.; Kim, H. An application of support vector machines in bankruptcy prediction model. *Expert Syst. Appl.* **2005**, *28*, 127–135. [CrossRef]
25. McWilliams, A.; Siegel, D. Corporate social responsibility: A theory of the firm perspective. *Acad. Manag. Rev.* **2001**, *26*, 117–127. [CrossRef]
26. Galaskiewicz, J.; Burt, R.S. Interorganization contagion in corporate philanthropy. *Adm. Sci. Q.* **1991**, *36*, 88–105. [CrossRef]
27. Werbel, J.D.; Carter, S.M. The CEO's influence on corporate foundation giving. *J. Bus. Ethics* **2002**, *40*, 47–60. [CrossRef]
28. Freeman, R.E. *Strategic Management: A Stakeholder Approach*; Pitman Publishing: Boston, MA, USA, 1984.
29. Jo, H.; Harjoto, M. Corporate governance and firm value: The impact of corporate social responsibility. *J. Bus. Ethics* **2011**, *103*, 351–383. [CrossRef]
30. Makni, R.; Francoeur, C.; Bellavance, F. Causality between corporate social performance and financial performance: Evidence from Canadian firms. *J. Bus. Ethics* **2009**, *89*, 409–422. [CrossRef]
31. Backhaus, K.; Stone, B.A.; Heiner, K. Exploring the relationship between corporate social performance and employer attractiveness. *Bus. Soc.* **2002**, *41*, 292–318. [CrossRef]
32. Ruf, B.M.; Muralidhar, K.; Brown, R.M.; Janney, J.J.; Paul, K. An empirical investigation of the relationship between change in corporate social performance and financial performance: A stakeholder theory perspective. *J. Bus. Ethics* **2001**, *32*, 143–156. [CrossRef]

33. Wang, H.; Choi, J. A new look at the corporate social–financial performance relationship. *J. Manag.* **2013**, *39*, 416–441. [CrossRef]
34. Crifo, P.; Diaye, M.A.; Pekovic, S. CSR related management practices and firm performance: An empirical analysis of the quantity–quality trade-off on French data. *Int. J. Prod. Econ.* **2016**, *171*, 405–416. [CrossRef]
35. Surroca, J.; Trib, J.A.; Waddock, S. Corporate responsibility and financial performance: The role of intangible resources. *Strateg. Manag. J.* **2010**, *31*, 463–490. [CrossRef]
36. Kao, E.H.; Yeh, C.C.; Wang, L.H.; Fung, H.G. The relationship between CSR and performance: Evidence in China. *Pac.-Basin Financ. J.* **2018**, *51*, 155–170. [CrossRef]
37. Li, Q.; Luo, W.; Wang, Y.; Wu, L. Firm performance, corporate ownership, and corporate social responsibility disclosure in China. *Bus. Ethics* **2013**, *22*, 159–173. [CrossRef]
38. Marquis, C.; Qian, C. Corporate social responsibility reporting in China. *Organ. Sci.* **2014**, *25*, 127–148. [CrossRef]
39. Lee, S.; Heo, C.Y. Corporate social responsibility and customer satisfaction among US publicly traded hotels and restaurants. *Int. J. Hosp. Manag.* **2009**, *28*, 635–637. [CrossRef]
40. Bebchuk, A.; Cohen, A.; Ferrell, A. What Matters in Corporate Governance? *Rev. Financ. Stud.* **2009**, *22*, 783–827. [CrossRef]
41. Pawlak, Z. Rough Sets. *Int. J. Comput. Inf. Sci.* **1983**, *11*, 341–356. [CrossRef]
42. Calantone, R.J.; Tamer Cavusgil, S.; Zhao, Y. Learning orientation, firm innovation capability, and firm performance. *Ind. Mark. Manag.* **2002**, *31*, 515–524. [CrossRef]
43. Grabowski, H.G.; Mueller, D.G. Industrial research and development, intangible capital stocks, and firm profit rates. *Bell J. Econ.* **1978**, *9*, 328–343. [CrossRef]
44. Mak, Y.T.; Kusnadi, Y. Size Really Matters: Further Evidence on the Negative Relationship between Board Size and Firm Value. *Pac. Basin Financ. J.* **2005**, *13*, 301–318. [CrossRef]
45. Sakhartov, A.V.; Folta, T.B. Getting beyond relatedness as a driver of corporate value. *Strateg. Manag. J.* **2015**, *36*, 1939–1959. [CrossRef]
46. Konar, S.; Cohen, M.A. Does the market value environmental performance? *Rev. Econ. Stat.* **2001**, *83*, 281–289. [CrossRef]
47. Wahba, H. Does the market value corporate environmental responsibility? An empirical examination. *Corp. Soc. Responsib. Environ. Manag.* **2008**, *15*, 89–99. [CrossRef]
48. Hsu, M.F.; Yeh, C.C.; Lin, S.J. Integrating dynamic Malmquist DEA and social network computing for advanced management decisions. *J. Intell. Fuzzy Syst.* **2018**, *35*, 231–241. [CrossRef]