Technological Forecasting & Social Change xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

Can social responsibility reduce operational risk: Empirical analysis of Chinese listed companies

Chunguang Zhao [a], Hang Song [a,*], Wanyi Chen [b]

[a] Shanghai National Accounting Institute, China
[b] Shanghai University of Finance and Economics, China

ARTICLE INFO

Article history:
Received 2 January 2016
Received in revised form 3 June 2016
Accepted 24 August 2016
Available online xxxx

Keywords:
Social responsibility
Operational risk
Information disclosure
Sustainable growth

ABSTRACT

After 30 years of rapid development, China has made great strides in economic growth but at the expense of high environmental and social costs. Listed companies should fulfill their social responsibilities not only to meet the expectations of stakeholders but also to improve management effectiveness, cultivate competitive advantage, create a good image, and achieve sustainable development. Because the influence of corporate social responsibility is expanding gradually in China, the relationship among listed companies' fulfillment of social responsibilities, information disclosure, and operational risk needs to be explored further. This study uses data on Chinese A-share listed companies from 2007 to 2009 and makes four main findings. First, listed companies improving their social responsibilities fulfillment face significantly lower operational risk. Second, listed companies publishing independent social responsibility reports face significantly increased operational risk. Third, high risk companies improving social responsibility fulfillment can significantly reduce their operational risk, while publishing independent social responsibility reports leads to significantly increased operational risk. Finally, low risk companies improving their social responsibilities fulfillment and publishing independent social responsibility reports experience changes in operational risk; however, the direction of the change varies by company. Companies with different operational risk have different effect because the company's majority shareholder is individual who lack of distinguishing news ability and CSR format is unified that is not enough to emphasize important disclosure issues.

1. Introduction

The idea of corporate social responsibility (CSR) formed in the early 20th century was initially linked to industrialization in the United States. However, as large companies with increased power in the economy and society have emerged, CSR has become a matter of concern for all companies. Firm's expansion makes the public pay attention not only the profit but also CSR. (KPMG, 2013) Indeed, since the 1990s, CSR ideology and stakeholder theory have presented a combined trend. Stakeholder theory provides not only a theoretical basis for the study of CSR, but also a suitable method for measuring CSR performance. The combination of these two theories thus dominates the traditional business objective of maximizing profit for shareholders and prompts companies to rather maximize the interests of all stakeholders (Freeman and Reed, 1983).

The past 30 years of rapid economic development in China has come at the expense of environmental and social costs. Therefore, the effectiveness of this development model needs to be reexamined thoroughly. For example, too much emphasis has been placed on economic growth, encouraging competition, and efficiency at the cost of fairness. In economic development, there is no corresponding emphasis on social development issues, which increases the risk of social unrest. Further, extensive economic development has entailed high energy consumption and high pollution and many local governments have exploited natural resources, damaging the ecological environment and even threatening national health.

To provide adequate growth while sustaining natural, economic, and social resources, China has proposed that publicly listed companies, as the most important part of the national economy, should become exemplars of social responsibility. A listed company that actively fulfills its social responsibility not only meets the expectations and requirements of stakeholders but also improves the efficiency and efficacy of its management, cultivates competitive advantage, creates a good image, and achieves sustainable development. CSR is not only the main way for companies to be involved in building a harmonious society but also an important guarantee of sustainable development. With the gradual expansion of the idea of CSR, the government's positive advocacy, and the community's active promotion, there is a positive trend among listed companies to fulfill their social responsibilities; indeed, the number of listed companies independently disclosing social responsibility reports is increasing annually.

* Corresponding author.
E-mail address: songhang@snai.edu (H. Song).

http://dx.doi.org/10.1016/j.techfore.2016.08.023
0040-1625/

In China's capital markets, fulfilling social responsibility and reporting CSR performance started rather late compared with in western markets and a relatively large gap between the expectations of numerous stakeholders and market investors remains. Chinese scholars have successfully measured the correlations among listed companies fulfilling social responsibility and information disclosure, financial performance, valuation, profitability, and cost of capital. However, there are no studies of the correlation between CSR and operational risk. Based on the empirical evidence from listed companies in China, we examine the relationship between listed companies fulfilling social responsibility and disclosing the related information and operational risk as reflected by financial indicators. We also analyze whether high operational risk has a greater impact on fulfilling social responsibility and reporting disclosure information compared with low operational risk.

In this study, we use operational risk affected by internal and external stakeholders as the starting point and examine the correlation with CSR. This proposition expands the research perspective of social responsibility fulfillment and information disclosure and enriches the content of social responsibility accounting theory. The conclusion we reach is that the better companies fulfill their social responsibilities, the lower their operational risk is. Further, the voluntary publication of a social responsibility report has a significant impact on companies with relatively high operational risk. It helps listed companies actively improve and fulfill their social responsibilities.

From the perspective of operational risk control, this study provides strategic advice for disclosing the social responsibility reports of high risk companies. It highlights the important practical significance of encouraging Chinese listed companies to effectively fulfill their social responsibilities, improve governance, promote healthy and sustainable development, increase the efficient allocation of resources, raise the transparency of capital markets, and create a more harmonious capital market environment.

This paper has three contributions. First, Compared with the existing researches that focus on corporate value and financial performance, this paper focus on company's business risk, which has important practical significance. Second, corporate social responsibility management is divided into fulfillment and disclosure. This study shows that fulfillment can reduce the company's operating risk, however disclosure cannot. Third, the company should decide social responsibility management measures according to their characteristics, which means high business risks companies should pay more attention to social responsibility fulfillment.

The rest of the paper is organized as follows. The second section presents the theoretical analysis and research hypotheses, the third section discusses the research design, the fourth section presents the empirical results and analysis, and the fifth section concludes.

2. Theoretical analysis and research hypotheses

2.1. Literature review

2.1.1. CSR and stakeholder theory

CSR and stakeholder theory have developed as two mutually independent fields. The former discusses the company's responsibility to society and the latter is related to the relationship between various stakeholders and the company. Since the 1990s, these two theories have become fully integrated. On the one hand, stakeholder theory provides a theoretical basis for the study of CSR; on the other hand, research on CSR offers an empirical approach for stakeholder theory. Since the 1990s, many scholars have incorporated CSR into stakeholder theory as the basis for the empirical study of important issues such as the relationships between social responsibility and a firm's financial performance (profitability) and between social responsibility and firm value.

Johnson (2003) indicated that within a certain range, social responsibility can increase firm profits and enhance firm value. Socially undesirable and irresponsible behavior has negative effects on financial performance. Margolis et al. (2009) found a small positive correlation between CSR and financial performance, although they did show that this relationship is weak.

However, some research has reported the opposite conclusions. Elliott et al. (2013), for example, found that firm value is negatively associated with CSR. Lys et al. (2014) investigated the causality of CSR and financial performance to identify whether CSR is an investment or a signal. They found a positive correlation between CSR and future earnings and cash flows from operations but no statistically significant correlation between CSR and stock returns. They then showed that the positive correlation between CSR and earnings performance is driven by deviations from expected CSR. This finding is consistent with managers increasing CSR to signal their private information about strong expected future financial performance.

Much of the recent literature on the consequences of CSR provides evidence of the mechanisms by which CSR performance relates to firm value. Cho et al. (2013) examined the correlation between CSR performance and information asymmetry and found that both negative and positive CSR activities can reduce information asymmetry. This association only exists in firms with fewer institutional investors, suggesting that informed investors act upon information on CSR performance. Clarkson et al. (2013) showed that voluntary environmental disclosure can increase firm value by providing incremental information about the firm's competitiveness and expected future performance. Thus, environmental disclosure can be seen as a signal to investors (see also Lys et al., 2014).

Research on CSR and business risk has not been extensive. Dhaliwal et al. (2011, 2012) examined the cost of capital and showed that CSR disclosure can attract more analysts and institutional investors and reduce analyst forecast error, prompting a reduction in the cost of equity capital. However, Clarkson et al. (2013) did not find an association between environmental disclosure and the cost of capital.

Similar studies have been conducted in China. Li (2006) used data on 521 companies listed on the Shanghai Stock Exchange to study the relationship between CSR activities and firm value. The results showed that the higher the commitment of enterprises to social responsibility, the lower is firm value; however, in the long-term, social responsibility does not reduce firm value.

In sum, several domestic and foreign scholars have empirically examined the impact of social responsibility fulfillment and information disclosure on firm value, the cost of capital, and financial performance. Further, domestic scholars have identified the features that affect and measures that reflect operational risk. However, no domestic research has examined the relationship between listed companies' social responsibility fulfillment and information disclosure and operational risk. This study attempts to provide meaningful empirical results for this proposition.

2.1.2. CSR and corporate business risk

Research on social responsibility and corporate business risk has not been extensive. Casey and Grenier (2015) find potential benefits of CSR assurance to U.S. firms, including lower cost of equity capital, analyst forecast errors, and dispersion. Dhaliwal et al. (2011, 2012) examined cost of capital and showed that CSR disclosures can attract more analysts and institutional investors, avoid analyst forecast error, and reduce the cost of equity capital. However Clarkson et al. (2013) did not find an association between environmental disclosures and the capital cost. The difference between Clarkson et al. (2013) and Dhaliwal et al. (2011, 2012) suggests that CSR disclosure affects capital cost in a way that environmental disclosure does not.

The above study shows that several domestic and foreign scholars have empirically examined the impact of CSR fulfillment and information disclosure on enterprise value, capital cost, and financial

Please cite this article as: Zhao, C., et al., Can social responsibility reduce operational risk: Empirical analysis of Chinese listed companies, Technol. Forecast. Soc. Change (2016), http://dx.doi.org/10.1016/j.techfore.2016.08.023

performance. Domestic scholars have identified the features that affect operational risks and the measures that reflection of operational risk. However, there is no relationship among listed companies social responsibility fulfillment, information disclosure and operational risks. This article attempts to provide meaningful empirical results for this proposition.

2.2. Research hypotheses

Combined with Freeman and Reed's (1983) generalized definition of stakeholders, recognizable organizations and individuals who may affect or be affected by the achievement of business goals are likely to be linked to the company's operational risk. If the company focuses only on the interests of shareholders and creditors, without paying attention to social responsibility, the interests of employees, communities, the local environment, and other stakeholders can become damaged, leading to trade unions forming, community and government environmental departments protesting, or legal actions against the company being initiated, which can increase operational risk. This fact implies that the company's operational risk is related to CSR fulfillment. Hence, we propose the first hypothesis:

H1. The better a firm fulfills its social responsibility, the lower its operational risk is.

Signaling theory states that in conditions of asymmetric information, companies having good investment opportunities choose to deliver information through the declaration of dividend policy to investors. Elfakhani and Merville (1995) examined the dividend signal value and showed that the signal value of the dividend depends on three factors: the change in the direction of the dividend (increase or decrease), the nature of the signal (good or bad), and the role of the signal (acknowledge, clarify, or confuse). The market is more concerned about the nature of dividend signals than the change in dividend direction. Therefore, transferring positive information leads to a positive dividend reaction in the market, whereas bearish information leads to negative reactions. This dividend signal effect is consistent with the company's disclosure approach. If the information disclosed by the company is sufficient to reveal and highly consistent with the company's operating conditions, the impact of the dividend signal on the market is not strong because the unexpected information is too little to have a significant impact. However, if the company discloses less information or the consistency of the information disclosure is not strong, then the value of the information delivered by the dividend signal is higher because it helps eliminate the investor uncertainty, which arouses more market reactions. According to the above theory, an independent social responsibility report is an important way for the company to deliver firm information to the market. When determining operational risk, apart from considering the nature of the released signal (i.e., whether social responsibility performance is good or bad), we need to consider the role of the signal (acknowledgment, clarify, or confuse) of social responsibility fulfillment. The second hypothesis is thus proposed as follows:

H2. Publishing an independent social responsibility report affects the company's operational risk.

Generally, high risk companies receive more attention in the market, and even a small amount negative news can cause investors and creditors to panic. For example, by analyzing the company's conduct or released signals, the market expects its operational risk to rise, which causes investors to sell the company's shares and creditors to ask for debt repayment immediately. Under this chain reaction, the company suffers a more serious impact than it would under a normal amount of business risk. This means that when the company has higher operational risk, any production or management problems cause great concern for the related parties, which amplifies the impact on operational risk. Based on the above analysis, we believe that the impacts of high risk and low risk companies' behaviors and signals on operational risk are different. Therefore, we propose a third hypothesis:

H3. The quality of the company's social responsibility fulfillment and whether a social responsibility report is provided independently has a greater impact on companies having higher operational risk.

3. Research design

3.1. Sample selection and data sources

To study the impact of listed companies' social responsibility fulfillment and information disclosure on operational risk, this study chooses public disclosure in the annual reports and social responsibility reports of A-share listed companies, with a total of 4848 observations from the Shanghai and Shenzhen Stock Exchanges covering 2007 to 2009 as the initial sample. To ensure the consistency and effectiveness of the selected data, the initial sample was preliminarily selected in accordance with the following three steps. First, since the growth enterprise market (GEM) was founded late and time period is not available, we exclude GEM-listed companies. Second, the special nature of the financial and insurance industry leads us to exclude financial and insurance companies. Finally, we exclude the missing data on the listed companies.

Further the data processing sub-model is as follows:

1. The observed data extracted from the regression model (1.1) was processed as follows: (1) to control for the effects of extreme values, all continuous variables were treated according to the vertical Winsorize 1% quantile. Finally, we obtained 4,564 observations and treated this set of observation data as Sample 1.
2. The observed data extracted from the regression model (2.1) was processed as follows: (1) in accordance with the definition of operating leverage (*DoL*), normal $DoL > 1$ and thus we exclude observations where $DoL \le 1$; (2) to control for the effects of extreme values, we exclude observations with $DoL > 30$; (3) except for *DoL*, all independent continuous variables are Winsorized in accordance with the upper and lower 1% quantiles. We finally get 2,067 observations and these observed data are defined as Sample 2.

The social responsibility index (*Socialindex*) scores of companies in the sample come from the "China Listed CSR Report" compiled by the Shanghai National Accounting Institute and other data come from the Wind database. We use SAS software for data processing and analysis.

3.2. Model design

To increase the robustness of the research conclusions, this study measures operational risk by building four models and eight regressions to test the hypotheses. In regressions 1 to 4, we use annual income coefficient of variance (*Stdevc*) to measure operational risk. In regressions 5 to regression 8, we use *Dol* to measure operational risk.

1. Regression 1: using model (1.1) to test Hypotheses 1 and 2
   (1) We use the *Stdevc* of the current year's total revenue in the four quarters as substitute variables for operational risk and use the current year's social responsibility index (*Socialindex*) as an alternative variable to measure the quality of social responsibility fulfillment and thus test the relationship between social responsibility fulfillment and a company's operational risk.
   (2) We examine the regression results of the independent social responsibility report variable (*Announce*) and operational

Please cite this article as: Zhao, C., et al., Can social responsibility reduce operational risk: Empirical analysis of Chinese listed companies, Technol. Forecast. Soc. Change (2016), http://dx.doi.org/10.1016/j.techfore.2016.08.023

risk (*Stdevc*) to determine whether an independent social responsibility report affects the company's operational risk.

$$\begin{aligned}\text{Stdevc}_{i,t} = {} & \alpha_0 + \beta_1 \cdot \text{Socialinde}\ x_{i,t} + \beta_2 \cdot \text{Growth}_{i,t} + \beta_3 \cdot \text{Roa}_{i,t} \\ & + \beta_4 \cdot \text{Size}_{i,t} + \beta_5 \cdot \text{Lev}_{i,t} + \beta_6 \cdot \text{Year07}_{i,t} \\ & + \beta_7 \cdot \text{Year08}_{i,t} + \beta_8 \cdot \text{Sic1}_i + \beta_9 \cdot \text{Sic2}_i \\ & + \beta_{10} \cdot \text{Announce}_{i,t}\end{aligned} \tag{1.1}$$

If CSR score (Socialindex) coefficient β1 is significantly negative, indicating that the better a company fulfills its social responsibility, the lower its operational risk is, which accept Hypothesis 1. If independent social responsibility report (Announce) coefficient β10 is significant, indicating that the company independent social responsibility report has impacts on operational risk, which accept Hypothesis 2.

2. Regressions 2 to 4: using models (1.1) and (1.2) to test Hypothesis 3
   (1) *Stdevc* = 20 is the boundary; thus, observations *Stdevc* ≥ 20 constitute the high risk business group and observations *Stdevc* < 20 are the low operational risk group. By examining whether there are significant differences between the two groups' operational risk (*Stdevc*) using the social responsibility index score (*Socialindex*), we can determine whether the quality of the company's social responsibility fulfillment has a larger impact on high operational risk companies. Further, by examining the differences between the regression results of the independent social responsibility report variable (*Announce*) and operational risk (*Stdevc*), we can determine whether independently publishing a social responsibility report has a larger impact on high operational risk companies.

$$\begin{aligned}\text{Stdevc}_{i,t} = {} & \alpha_0 + \beta_1 \cdot \text{Socialinde}\ x_{i,t} + \beta_2 \cdot \text{Growth}_{i,t} + \beta_3 \cdot \text{Roa}_{i,t} \\ & + \beta_4 \cdot \text{Size}_{i,t} + \beta_5 \cdot \text{Lev}_{i,t} + \beta_6 \cdot \text{Year07}_{i,t} \\ & + \beta_7 \cdot \text{Year08}_{i,t} + \beta_8 \cdot \text{Sic1}_i + \beta_9 \cdot \text{Sic2}_i \\ & + \beta_{10} \cdot \text{Announce}_{i,t} + \beta_{11} \cdot \text{Dum}_{i,t} \\ & + \beta_{12} \cdot \text{Dum}_{i,t} \cdot \text{Socialindex}_{i,t}\end{aligned} \tag{1.2}$$

If the coefficient β11 of dummy variable (DUM) which shows operational risk level or coefficients β12 of cross-multiplying term are not significant, indicating that both CSR index and independent social responsibility report have different effect on high and low operating risk companies, which accept the Hypothesis 3.

3. Regression 5: using model (2.1) to test Hypotheses 1 and 2
   (1) We use *Dol* for the current year as the substitute variable for operational risk and use *Socialindex* in the current year as an alternative variable to social responsibility performance to examine the relationship between social responsibility fulfillment and operational risk.
   (2) We examine the differences between the regression results of the independent social responsibility report (*Announce*) and operational risk (*Dol*) to determine whether an independent social responsibility report has an impact on a company's operational risk.

$$\begin{aligned}\text{Dol}_{i,t} = {} & \alpha_0 + \beta_1 \cdot \text{Socialinde}\ x_{i,t} + \beta_2 \cdot \text{Growth}_{i,t} + \beta_3 \cdot \text{Roa}_{i,t} \\ & + \beta_4 \cdot \text{Size}_{i,t} + \beta_5 \cdot \text{Lev}_{i,t} + \beta_6 \cdot \text{Year07}_{i,t} + \beta_7 \cdot \text{Year08}_{i,t} \\ & + \beta_8 \cdot \text{Sic1}_i + \beta_9 \cdot \text{Sic2}_i + \beta_{10} \cdot \text{Announce}_{i,t}\end{aligned} \tag{2.1}$$

Same as regression (1.1), if coefficient β1 is significantly negative, we accept Hypothesis 1 and if coefficient β10 is significant, we accept Hypothesis 2.

4. Regressions 6 to 8: using models (2.1) and (2.2) to test Hypothesis 3
   (1) *Dol* = 5 is the boundary; thus, observations with *Dol* ≥ 5 are treated as the high operational risk group and observations with *Dol* < 5 are the low operational risk group. By examining whether these two operational risk groups have significant differences as reflected by *Socialindex*, we can determine whether the quality of social responsibility fulfillment has a greater impact on higher operational risk companies. Then, by examining the differences between the regression results of *Announce* and *Dol*, we can determine whether an independent social responsibility report has a greater impact on high operational risk companies.

$$\begin{aligned}\text{Dol}_{i,t} = {} & \alpha_0 + \beta_1 \cdot \text{Socialinde}\ x_{i,t} + \beta_2 \cdot \text{Growth}_{i,t} + \beta_3 \cdot \text{Roa}_{i,t} \\ & + \beta_4 \cdot \text{Size}_{i,t} + \beta_5 \cdot \text{Lev}_{i,t} + \beta_6 \cdot \text{Year07}_{i,t} + \beta_7 \cdot \text{Year08}_{i,t} \\ & + \beta_8 \cdot \text{Sic1}_i + \beta_9 \cdot \text{Sic2}_i + \beta_{10} \cdot \text{Announce}_{i,t} + \beta_{11} \cdot \text{Dum}_{i,t} \\ & + \beta_{12} \cdot \text{Dum}_{i,t} \cdot \text{Socialinde}\ x_{i,t}\end{aligned} \tag{2.2}$$

Same as regression (1.2), if the coefficient β11 or β12 are not significant, we accept the Hypothesis 3

3.3. Definition of the variables

3.3.1. Explained variables

In a narrow sense, operational risk emanates from commercial activities. Therefore, it is always linked with a company's business activities and is an inherent risk. Because operational risk is formed mainly by the company's business activities or direct manipulation, the most direct reflection of operational risk is the measure of a company's operating revenue- and operating profit-related indicators. We use the coefficient of variance in the company's total revenue in the same year from the four quarters as the first indicator of annual operational risk.

When the company has a fixed cost, if sales change, operating results change correspondingly; indeed, the degree of change is greater than the degree of sales change. This phenomenon is known as operating leverage, defined as the ratio of the change in sales to the change in earnings before tax and interest (EBIT). This definition can be used to measure operational risk. Therefore, we use operating leverage as the second measure of annual operational risk.

3.3.2. Explanatory variables

The social responsibility index score (*Socialindex*) uses the Analytic Hierarchy Process and refers to the SA8000 standard, GRI3 reporting guidelines, and performance GC ten principles of action. Hence, we summed eight categories and 36 subclass indexes to build the index system of CSR information disclosure, compiled from listed companies' annual reports, media information, survey results, and other information. Independent information on listed companies publishing a social responsibility report (*Announce*) was derived from statistics on all listed companies' annual reports. The differences between the index scores (Dum · *Socialindex*) of the high and low risk groups were obtained by multiplying the social responsibility index score by the dummy variable representing the value range.

3.3.3. Control variables

To control for the other important factors that affect operational risk, the study added growth (*Growth*), profitability (*Roa*), firm size (*Size*), financial leverage (*Lev*), Year (*Year*), and industry (*Sic*) as the control variables. All the variables from the regression model are shown in Table 1.

According to the Pollution Category List from the environmental ministry document entitled "On the issuance of notice 'environmental inspection of listed companies classified management industry

Please cite this article as: Zhao, C., et al., Can social responsibility reduce operational risk: Empirical analysis of Chinese listed companies, Technol. Forecast. Soc. Change (2016), http://dx.doi.org/10.1016/j.techfore.2016.08.023

Table 1
Variable definitions.

Variable type	Variable name	Variable symbol	Variable definition
Explained variable	Operational risk	$Stdevc_{i,t}$	Company's total revenue standard slip in year t (total operating income standard deviation in a single quarter/mean of total operating income in a single quarter)
		$Dol_{i,t}$	Company i's operating leverage in year t (EBIT changes during the year/total operating revenue changes)
Explanatory variables	CSR index	$Socialindex_{i,t}$	Company's CSR index in year t
	Independent release of a social responsibility report	$Announce_{i,t}$	Dummy variable, if company i in year t disclosed a social responsibility report, $Announce_{i,t} = 1$, otherwise $Announce_{i,t} = 0$
	Dummy variable of operational risk level division	$Dum_{i,t} \cdot Socialindex_{i,t}$	Interaction term of the CSR index scores and virtual variable values, which represent the explanatory variable range
Control variables	Growth index	$Growth_{i,t}$	Total revenue growth of company i in year t
	Profitability index	$Roa_{i,t}$	Return on assets of company i in year t
	Company size	$Size_{i,t}$	Logarithm of the total assets of company i in year t
	Financial leverage	$Lev_{i,t}$	Assets and liabilities of company i in year t
	Year	$Year07_{i,t}$	Dummy variable. If the year is 2007, $Year07_{i,t} = 1$, otherwise $Year07_{i,t} = 0$
		$Year08_{i,t}$	Dummy variable. If the year is 2008, $Year08_{i,t} = 1$, otherwise $Year08_{i,t} = 0$
	Industry	$Sic1_{i}$	Dummy variable. If the company is in a moderately polluting industry, $Sic1_{i} = 1$, otherwise $Sic1_{i} = 0$
		$Sic2_{i}$	Dummy variable. If company i is in a highly polluting industry $Sic2_{i} = 1$, otherwise $Sic2_{i} = 0$
	Explanatory variable range	$Dum_{i,t}$	Dummy variable. In model (1.2), if the company in year t, $Stdevc_{i,t} \geq 0.2$, $Dum_{i,t} = 1$, otherwise $Dum_{i,t} = 0$. In model (2.2), if the company in year t $Dol_{i,t} \geq 5$, $Dum_{i,t} = 1$, otherwise $Dum_{i,t} = 0$

directory' (Huan Office letter [2008] No. 373)," we specify companies by the degree of contamination. The specific classification is shown in Table 2.

4. Empirical results and analysis

4.1. Descriptive statistics

In Sample 1, the median *Stdevc* of listed companies' annual revenue is 21.509 %(Table 3), which is less than the average (31.048), indicating that in most cases earnings volatility is lower than the average level of the sample. The standard deviation is 29.703, which is closer to the average. The maximum value is 188.138, which is about 75 times the minimum value of 2.481.

From Table 4, we use the 20% level of income volatility (*Stdevc*) as the boundary. The sample is divided into high and low risk groups. The average income volatility of the low risk group is 12.54%, which is far less than that of the high risk group (46.95%). The low risk group's standard deviation is 4.577, which is also far less than that of the high risk group (32.793). However, the means and standard deviations of the two observation groups' social responsibility index scores (*Socialindex*) are very close, implying no significant difference.

Table 5 shows that the listed companies in Sample 2 have median operating leverage (*Dol*) of 2.683, which is less than the average (4.972), indicating that most companies' operating leverage is lower than the average of the sample. The standard deviation is 5.529, which is closer to the average. The maximum is 29.827, which is 30 times the minimum (1.00).

From Table 6, we use five times operating leverage (*Dol*) as the boundary. Sample 2 is then divided into high and low risk groups. The average operating leverage in the low risk group is 2.262 times, which is far less than the 11.806 times in the high risk group. The standard deviation of the low risk group is 1.036, which is also far less than that of the high risk group (6.302). However, the means and standard deviations of *Socialindex* for the two observation groups are very close, which means there is no significant difference.

The descriptive statistics (Tables 3 and 5) show that the distributions of operational risk in the two observed samples are generally similar and that the operational risk of most companies is below the average sample level. However, the extreme value difference is relatively large. The descriptive statistics (Tables 4 and 6) show that after dividing the observed sample into high and low risk groups, the operational risk of the two observed samples also reflects a relatively similar distribution trend. There is a larger difference between the average levels of operational risk in the high risk and low risk groups; however, the means and standard deviations of the social responsibility index scores in the groups are very close, which means there is no significant difference.

Table 7 shows the results of the variables in Sample 1 by using the Pearson correlation test, in which the correlation coefficient of *Socialindex* and *Announce* is 0.667, indicating a high correlation between these two variables at the 1% significance level. The correlation coefficient of Year08 and Year07 is −0.479 at the 1% level. The correlation

Table 2
Industry pollution division results.

Pollution degree	Industry (code)
Heavy pollution	Extractive industry (B)
	Manufacturing (C)
	– Food and drink (C0)
	– Textiles, clothing, fur (C1)
	– Paper and printing (C3)
	– Petroleum, chemical, plastic (C4)
	– Metal and nonmetal (C6)
	– Medicine and biological products (C8)
	Electricity, gas, water production and supply industry (D)
	Building industry (E)
	Real estate (J)
Moderate pollution	Agriculture, forestry, animal husbandry, fishery (A)
	Manufacturing
	– Wood, furniture (C2)
	– Electronics (C5)
	– Machinery, equipment, instruments (C7)
	– Other manufacturing (C99)
	IT industry (G)
	Social services (K)
	Miscellaneous (M)
Slight pollution and non-pollution	Transportation and warehousing industry (F)
	Wholesale and retail trade (H)
	Communication and cultural industry (L)

Note: Except the manufacturing industry, we use the SFC two-level classification criteria; for other industries, we use the SFC one-level classification criteria.

Table 3
Variable descriptive statistics in Sample 1.

Variable	Number of observations	Median	Average	Standard deviation	Minimum	Maximum
Stdevc	4564	21.509	31.048	29.703	2.481	188.138
Socialindex	4564	0.346	0.373	0.179	−0.064	0.972
Growth	4564	10.433	15.272	48.197	−81.438	440.369
Roa	4564	3.967	4.310	9.133	−42.800	43.375
Size	4564	9.269	9.342	0.619	7.982	11.727
Lev	4564	51.389	55.460	41.062	5.348	416.619

Please cite this article as: Zhao, C., et al., Can social responsibility reduce operational risk: Empirical analysis of Chinese listed companies, Technol. Forecast. Soc. Change (2016), http://dx.doi.org/10.1016/j.techfore.2016.08.023

Table 4
Grouping of the variable descriptive statistics in Sample 1.

Variable (number of observations)	Average			Standard deviation		
	High risk group (2454)	Low risk group (2110)	All samples (4564)	High risk group (2454)	Low risk group (2110)	All samples (4564)
Stdevc	46.950	12.543	31.048	32.793	4.577	29.703
Socialindex	0.373	0.374	0.373	0.181	0.177	0.179
Growth	18.932	11.014	15.272	58.694	31.388	48.197
Roa	4.249	4.381	4.310	10.149	7.787	9.133
Size	9.271	9.423	9.342	0.584	0.649	0.619
Lev	58.376	52.068	55.460	46.141	33.916	41.062

Table 5
Variable descriptive statistics in Sample 2.

Variable	Number of observations	Median	Average	Standard deviation	Minimum	Maximum
Dol	2067	2.683	4.972	5.529	1.000	29.827
Socialindex	2067	0.345	0.372	0.179	−0.800	0.968
Growth	2067	10.429	10.556	36.276	−84.013	193.320
Roa	2067	4.582	5.645	9.744	−43.173	55.384
Size	2067	9.263	9.309	0.573	7.920	11.260
Lev	2067	49.795	52.584	34.027	4.714	388.615

coefficient of Sic1 and Sic1 reaches −0.787 at the 1% significance level. The correlation coefficient between the other variables is relatively low. Hence, we can determine that there is no serious multicollinearity problem among the variables in Sample 1. After making the same correlation test program, we found that there is a serious multicollinearity problem among the variables in the high and low risk groups in Sample 1.

Table 8 shows the variable results in Sample 2 by using the Pearson correlation test, in which the correlation coefficient of *Socialindex* and *Announce* is 0.653 at the 1% significance level, indicating high correlation between the two variables. The correlation coefficient of Roa and Growth is 0.466 at the 1% significance level. That of Year07 and Year08 is −0.475 at the 1% significance level. The correlation coefficient of Sic1 reaches −0.793 at the 1% significance level. The correlation coefficients between the other variables are relatively low. Therefore, we can determine that there is no serious multicollinearity among the variables in Sample 2. After making the same correlation test program, we found that there is a serious multicollinearity problem among the variables in the high and low risk groups in Sample 2.

From the above multicollinearity test of the variables in the two samples, there is a similar correlation between the observed two variables' sample coefficients in the high and low risk groups.

4.2. Regression analysis

4.2.1. Using Stdevc to measure operational risk

As shown in Table 9, the expansion factor of most model variables (vif) is less than 3, which again proves there is no significant multicollinearity problem between the variables of each model.

Regression 1 shows that the social responsibility index coefficient is −8.728 and the T value is −2.70 at the 1% level of significance, indicating a significantly negative correlation between the CSR index score and *Stdevc*; the higher the CSR index score, the lower is the company's operational risk. Therefore, the better a company fulfills its CSR, the lower operational risk is. Hence, Hypothesis 1 is supported.

Regression 1 shows that the *Announce* coefficient is 2.901 and the T value is 1.92 at the 10% significance level, indicating a significantly positive correlation between an independent social responsibility report and *Stdevc*. In other words, if the company releases an independent social responsibility report, it significantly increases operational risk. Therefore, releasing an independent social responsibility report affects the company's operational risk. Hence, Hypothesis 2 is supported.

Regression 2 shows that the coefficient of *Socialindex* of the high risk group is −16.224 and the T value is −3.37 at the 1% significance level. There is thus a significantly negative correlation between the high risk group's CSR index score (*Socialindex*) and income volatility (*Stdevc*); that is, if high risk companies improve their social responsibilities fulfillment, it significantly reduces operational risk. Regression 3 shows that the *Socialindex* coefficient of the low risk group is 0.753 and the T value is 0.98, which is not significant. There is no significantly positive correlation between the *Socialindex* of the low risk group and *Stdevc*; that is, if low risk companies improve their social responsibilities fulfillment, their operational risk is not reduced significantly. Because the *Socialindex* coefficients of both the high and the low risk groups are −16.224 and 0.753, respectively, when high and low risk companies improve their social responsibilities fulfillment synchronously, the operational risk levels of the two change in opposite directions. High risk companies' operational risk declines significantly, whereas that of low risk companies increases slightly. Therefore, the quality of CSR fulfillment has a greater impact on high risk companies.

Regression 2 shows that the *Announce* coefficient for the high risk group is 4.179 and the T value is 1.85 at the 10% significance level. Hence, there is a significantly positive correlation between high risk groups' independent social responsibility reports (*Announce*) and a company's volatility level (*Stdevc*). Therefore, if high risk companies release independent social responsibility reports, it would significantly increase their operational risk.

Regression 3 shows that the *Announce* coefficient for the low risk group is −0.755 and the T value is −2.10 at the 5% significance level. There is a significantly negative correlation between the independent social responsibility reports (*Announce*) of low risk groups and income volatility (*Stdevc*); that is, if a low risk company releases an independent social responsibility report, it will significantly reduce its operational

Table 6
Grouping of the variable descriptive statistics in Sample 2.

Variable (number of observations)	Average			Standard deviation		
	High risk group (587)	Low risk group (1480)	All samples (2067)	High risk group (587)	Low risk group (1480)	All samples (2067)
Dol	11.806	2.262	4.972	6.302	1.036	5.529
Socialindex	0.367	0.373	0.372	0.188	0.175	0.179
Growth	−0.091	14.779	10.556	28.326	38.177	36.276
Roa	1.971	7.102	5.645	10.566	8.995	9.744
Size	9.248	9.333	9.309	0.529	0.588	0.573
Lev	54.986	51.632	52.584	35.521	33.381	34.027

Please cite this article as: Zhao, C., et al., Can social responsibility reduce operational risk: Empirical analysis of Chinese listed companies, Technol. Forecast. Soc. Change (2016), http://dx.doi.org/10.1016/j.techfore.2016.08.023

Table 7
Pearson correlation coefficient matrix in Sample 1.

	Socialindex	Growth	Roa	Size	Lev	Year07	Year08	Sic1	Sic2	Announce
Socialindex	1.000									
Growth	0.022	1.000								
Roa	0.107***	0.238***	1.000							
Size	0.087***	0.116***	0.031**	1.000						
Lev	−0.131***	−0.047***	−0.275***	−0.044***	1.000					
Year07	−0.093***	0.154***	0.085***	−0.039***	0.029**	1.000				
Year08	0.093***	−0.055***	−0.055***	−0.035**	0.011	−0.479***	1.000			
Sic1	−0.043***	−0.006	0.076***	0.006	−0.004	−0.036**	0.009	1.000		
Sic2	0.056***	0.007	−0.068***	−0.037**	0.024	0.025*	−0.007	−0.787***	1.000	
Announce	0.667***	−0.033**	0.027*	0.058***	−0.072***	−0.267***	0.155***	−0.023	0.008	1.000

* Represents significance at the 10% level.
** Represent significance at the 5% level.
*** Represent significance at the 1% level.

risk. The *Announce* factors of the high and low risk groups are 4.179 and −0.755, respectively, which means that when high and low risk companies release independent social responsibility reports at the same time, the operational risk of the two groups moves in opposite directions. High risk companies' operational risk increases significantly, while that of low risk companies decreases significantly. Therefore, a company releasing a social responsibility report independently has a greater impact if it is a high risk company.

Regression 3 shows that the *Socialindex* coefficient of the low risk group is 0.753 (not significant). To enhance the robustness of the conclusions, we built model (1.2) for regressing Sample 1. Regression 4 shows that the Dum· *Socialindex* coefficient is −13.213 and the T value is −3.38 at the 1% significance level, indicating a significant difference in revenue volatility level (*Stdevc*). Therefore, whether CSR fulfillment is good or bad has a greater impact on high risk companies.

The above conclusions suggest that the quality of social responsibility fulfillment and independently disclosing social responsibility reports have a greater impact on high risk companies. Hypothesis 3 is thus supported.

4.2.2. Approach of measuring operational risk by using Dol

As shown in Table 10, most of the expansion factors of the model variables (vif) are less than 3, verifying that there is no significant multicollinearity problem among the variables of each model.

Regression 5 shows that the *Socialindex* coefficient is −1.559 and the T value is −1.77 at the 10% significance level, indicating a significantly negative relationship between the CSR index score and *Dol*; that is, the higher the CSR index score, the lower are the company's business risks. Therefore, the better a company fulfills its CSR, the lower is its operational risk. Hypothesis 1 is thus supported.

Regression 5 shows that the *Announce* coefficient is 0.862 and the T value is 2.07 at the 5% significance level, indicating a significant positive correlation between the publishing of an independent social responsibility report and *Dol*. If a company releases an independent social responsibility report, this significantly increases its operational risk. Therefore, whether a company releases a social responsibility report independently affects its operational risk. Hypothesis 2 is thus supported.

Regression 6 shows that the *Socialindex* coefficient of the high risk group is −3.799 and the T value is −2.05 at the 5% significance level. There is a significantly negative correlation between the high risk group's CSR index score (*Socialindex*) and operating leverage (*Dol*). If high risk companies improve their social responsibilities fulfillment, it significantly reduces operational risk. Regression 7 shows that the *Socialindex* coefficient of the low risk group is −0.442 and the T value is −2.16 at the 5% significance level. There is also a significantly negative correlation between low risk CSR index score (*Socialindex*) and the company's operating leverage (*Dol*); that is, if a low risk company improves its social responsibilities fulfillment, this will significantly reduce operational risk. The *Socialindex* coefficients of the high and low risk groups are −3.799 and −0.442, respectively, which means that when high and low risk companies improve their social responsibilities fulfillment synchronously, their operational risk changes in the same direction but the range of variation is different. High risk companies' operational risk is greatly reduced, while that of low risk companies declines significantly. Therefore, the quality of CSR fulfillment has a greater impact on high risk companies' operational risk.

Regression 6 shows that the *Announce* coefficient of the high risk group is 2.305 and the T value is 2.55 at the 5% significance level. There is a significantly positive correlation between high risk groups publishing independent social responsibility reports (*Announce*) and operating leverage (*Dol*). In other words, if high risk companies release independent social responsibility reports, this will significantly increase operational risk. Regression 7 shows that the *Announce* coefficient of the low risk group is 0.204 and the T value is 2.13 at the 5% significance level. There is a significantly positive correlation between a low risk company publishing an independent social responsibility report (*Announce*) and its operating leverage (*Dol*); that is, if a low risk company independently releases a social responsibility report, this will

Table 8
Pearson correlation coefficient matrix in Sample 2.*

	Socialindex	Growth	Roa	Size	Lev	Year07	Year08	Sic1	Sic2	Announce
Socialindex	1.000									
Growth	0.064***	1.000								
Roa	0.104***	0.466***	1.000							
Size	0.073***	0.154***	−0.02091	1.000						
Lev	−0.141***	−0.182***	−0.319***	−0.043**	1.000					
Year07	−0.105***	0.277***	0.177***	−0.044**	0.005	1.000				
Year08	0.086***	−0.139***	−0.081***	−0.072***	0.00801	−0.475***	1.000			
Sic1	−0.062***	0.064***	0.152***	−0.141***	−0.052**	0.01665	−0.02832	1.000		
Sic2	0.073***	−0.069***	−0.135***	0.091***	0.061***	−0.02321	0.03386	−0.793***	1.000	
Announce	0.653***	−0.029	−0.003	0.069***	−0.078***	−0.303***	0.144***	−0.041**	0.025	1.000

* Represents significance at the 10% level.
** Represent significance at the 5% level.
*** Represent significance at the 1% level.

Please cite this article as: Zhao, C., et al., Can social responsibility reduce operational risk: Empirical analysis of Chinese listed companies, Technol. Forecast. Soc. Change (2016), http://dx.doi.org/10.1016/j.techfore.2016.08.023

Table 9
The results of regressions 1 to 4.

Model and regression	Model (1.1)						Model (1.2)	
	Regression 1		Regression 2		Regression 3		Regression 4	
Variable	Sample 1	vif	High risk group	vif	Low risk group	vif	Sample 1	vif
Socialindex	−8.728*** (−2.70)	1.89	−16.224*** (−3.37)	1.89	0.753 (0.98)	1.90	−1.001 (−0.29)	3.10
Growth	0.119*** (12.97)	1.09	0.098*** (8.62)	1.11	0.015*** (4.33)	1.17	0.081*** (10.68)	1.11
Roa	0.093* (1.87)	1.17	0.132** (1.98)	1.12	−0.034** (−2.35)	1.34	0.097** (2.36)	1.17
Size	−5.784*** (−8.35)	1.03	−3.077*** (−2.73)	1.06	−0.651*** (−4.21)	1.03	−2.181*** (−3.78)	1.05
Lev	0.128*** (11.86)	1.10	0.133*** (9.25)	1.08	−0.001 (−0.29)	1.22	0.096*** (10.76)	1.11
Year07	−2.611** (−2.39)	1.43	1.386 (0.84)	1.41	−0.644** (−2.50)	1.51	0.055 (0.06)	1.44
Year08	−1.804* (−1.77)	1.31	−0.177 (−0.12)	1.29	−0.564** (−2.30)	1.38	−0.606 (−0.72)	1.31
Sic1	−3.228** (−2.25)	2.65	−5.251** (−2.36)	2.76	−0.549* (−1.68)	2.55	−3.323*** (−2.80)	2.65
Sic2	0.291 (0.21)	2.65	−1.597 (−0.75)	2.75	0.178 (0.57)	2.56	−0.83397 (−0.73)	2.66
Announce	2.901* (1.92)	1.96	4.179* (1.85)	1.96	−0.755** (−2.10)	1.96	1.872 (1.50)	1.96
Dum	–	–	–	–	–	–	37.706*** (23.20)	5.41
Dum·Socialindex	–	–	–	–	–	–	−13.213*** (−3.38)	6.57
Number of samples	4564	–	2452	–	2110	–	4564	–
R-Square	0.081	–	0.078	–	0.026	–	0.374	–
Adj R-Sq	0.079	–	0.074	–	0.021	–	0.372	–
F Value	40.01	–	20.62	–	5.51	–	226.58	–
Pr > F	<.0001	–	<.0001	–	<.0001	–	<.0001	–

* Represents significance at the 10% level.
** Represent significance at the 5% level.
*** Represent significance at the 1% level.

significantly increase its operational risk. The *Announce* coefficients of the low and high risk groups are 2.305 and 0.204, respectively. When high and low risk companies release independent social responsibility reports at the same time, the operational risk of both changes in the same direction but the range of variation is different. High risk companies' operational risk increases significantly, while low risk companies experience only a slight increase. Therefore publishing an independent social responsibility report has a greater impact on companies having high operational risk.

To enhance the robustness of the conclusions, we built model (2.2) of Sample 2 and regressed again. Regression 8 shows that the Dum · *Socialindex* coefficient is −1.543 and the T value is −1.69 at the 10% significance level, indicating significant differences between the operating leverage (*Dol*), represented by the CSR index scores (*Socialindex*) of the high and low risk groups. We again prove that the quality of CSR fulfillment has a greater impact on high risk companies.

Summing up the above conclusions, the quality of a company's social responsibility fulfillment and the independent disclosure of a social responsibility report has a greater impact on high risk companies. Hypothesis 3 is thus supported.

These results are closely related to Chinese CSR management conditions. From government departments to the media and public, CSR is paid increasingly attention during these years. Companies' increasing CSR investment reduces the operational risk, which has also been recognized by shareholders. However, as one of the society liability management tools, CSR disclosure also increases the operational risk, especially for high operational risk companies. It is mainly due to two reasons. First the company's majority stakeholder is individual such as community residents, employees and individual investors who do

Table 10
Result from Regressions 5 to 8.

Model and regression	Model (2.1)						Model (2.2)	
	Regression 5		Regression 6		Regression 7		Regression 8	
Variable	All samples	vif	High risk group	vif	Low risk group	vif	Coefficient	vif
Socialindex	−1.55)* (−1.77)	1.83	−3.799** (−2.05)	1.90	−0.442** (−2.16)	1.81	−1.129* (−1.77)	2.29
Growth	−0.008** (−2.06)	1.41	0.011 (0.98)	1.64	−0.003*** (−3.52)	1.35	0.001 (0.43)	1.41
Roa	−0.133*** (−9.32)	1.43	−0.108*** (−3.22)	1.98	−0.008** (−2.46)	1.32	−0.046*** (−4.87)	1.48
Size	−0.971*** (−4.61)	1.08	−1.326*** (−2.71)	1.05	0.007 (0.15)	1.11	−0.429*** (−3.14)	1.09
Lev	−0.002 (−0.52)	1.14	0.007 (0.91)	1.28	−0.000 (−0.02)	1.11	0.003 (1.35)	1.14
Year07	−0.581* (−1.95)	1.54	−0.999 (−1.53)	1.44	−0.007 (−0.10)	1.58	−0.356* (−1.84)	1.54
Year08	−0.609** (−2.06)	1.31	−0.878 (−1.41)	1.26	−0.071 (−1.03)	1.35	−0.331* (−1.73)	1.32
Sic1	−0.397 (−1.00)	2.75	−0.697 (−0.77)	2.69	−0.022 (−0.25)	2.77	−0.088 (−0.34)	2.75
Sic2	0.378 (0.99)	2.72	−0.585 (−0.69)	2.68	0.110 (1.26)	2.71	−0.061 (−0.25)	2.72
Announce	0.862** (2.07)	1.94	2.305** (2.55)	1.98	0.204** (2.13)	1.94	0.830*** (3.07)	1.94
Dum	–	–	–	–	–	–	9.808*** (25.80)	5.20
Dum · socialindex	–	–	–	–	–	–	−1.543* (−1.69)	5.49
Number of samples	2067	–	587	–	1480	–	2067	–
R-square	0.095	–	0.0758	–	0.0342	–	0.620	–
Adj R-sq	0.091	–	0.0598	–	0.0276	–	0.618	–
F value	21.65	–	4.73	–	5.20	–	279.71	–
Pr > F	<.0001	–	<.0001	–	<.0001	–	<.0001	–

* Represents significance at the 10% level.
** Represent significance at the 5% level.
*** Represent significance at the 1% level.

Please cite this article as: Zhao, C., et al., Can social responsibility reduce operational risk: Empirical analysis of Chinese listed companies, Technol. Forecast. Soc. Change (2016), http://dx.doi.org/10.1016/j.techfore.2016.08.023

Table 11
Robustness test results 1.

Group	10% fluctuation level		30% fluctuation level		40% fluctuation level		50% fluctuation level		60% fluctuation level	
Variables	High risk	Low risk	High risk	Low risk	High risk	Low risk	High risk	Low risk	High risk	Low risk
Socialindex	−10.760***			0.607	−22.591***	0.942	−23.499**	1.065	−21.808**	1.275
Dum – Socialindex	−10.241		−15.679***		−14.465***		−13.65***		−13.109***	
Announce	3.977**	−0.399	4.490	0.197	7.699*	0.108	7.936*	−0.089	7.274	−0.179

* Represents significance at the 10% level.
** Represents significance at the 5% level.
*** Represents significance at the 1% level.

not make in-depth analysis on CSR and cannot distinguish the news, for example once the company is high operational risk, all news released will be considered as bad. Second the CSR disclosure normally has basic standard format that lack of company's own important issues emphasis, resulting in the content of the report unfocused and useless. Meanwhile, the low operational risk company' is relatively stable and less uncertainty, therefore shareholders do not have sensitive reaction on the market, which will not lead to significant operational risk variation.

4.3. Robustness test

Based on the test of Hypothesis 3, we use *Stdevc* = 20 and *Dol* = 5 as the boundary to divide the high and low risk groups, which inevitably means a certain degree of subjectivity. To make the Hypothesis 3 testing conclusions more reliable, we use the following two-group robustness tests.

4.3.1. Approach of measuring operational risk by Stdevc

We use 10%, 30%, 40%, 50%, and 60% fluctuations in annual income as the boundaries of the high and low risk groups and use models (1.1) and (1.2) for the multiple regression of Sample 1. The results are presented in Table 11.

As shown in Table 11, when high and low risk companies simultaneously improve their social responsibility fulfillment, operational risk moves in opposite directions. High risk companies' operational risk decreases significantly, while that of low risk companies may increase slightly. There are also significant differences between income volatility (*Stdevc*) reflected by high and low risk CSR index score (*Socialindex*) defined by 30%, 40%, 50%, and 60% of annual income volatility. Therefore, the conclusion that the quality of CSR fulfillment has a greater impact on high risk companies is robust.

However, when we use 10%, 30%, 40%, 50%, and 60% of annual income volatility level as a boundary, there is a significant difference between operational risk volatility caused by the independent social responsibility reports published by high and low risk groups; low risk group volatility is significantly lower than that of the high risk group. Judging from the direction of risk change, the operational risk of the high risk group increases, but the direction of the low risk group does not lead to a consistent conclusion. Most of the regression results do not reflect sufficient significance. Therefore, the conclusion that publishing a social responsibility report independently has a greater impact on a high risk company is not robust.

4.3.2. Approach of measuring operational risk by operating leverage (Dol)

We use three times, four times, six times, seven times, and eight times the level of operating leverage as the boundary to divide the high and low risk groups and use models (2.1) and (2.2) for the multiple regressions of Sample 2. The results are in Table 12.

As shown in Table 12, when both high and low risk companies improve their social responsibility fulfillment, operational risk changes in the same direction. High risk companies' operational risk is greatly decreased, while that of low risk companies decreases slightly. There are also significant differences between operating leverage (*Dol*) reflected by the high and low risk CSR index score (*Socialindex*), which is divided by six times, seven times, and eight times operating leverage. Therefore, the conclusion that the quality of CSR fulfillment has a greater impact on high risk companies is robust.

However, the differences between the volatility of operational risk level for high and low risk groups' independent social responsibility reports are obvious. Low risk group volatility is significantly lower than that of the high risk group. Judging from the risk direction, high and low risk groups' operational risk increases. However, only the test grouped by the six times level reaches significance. Therefore, the conclusion of whether publishing an independent social responsibility report has a greater impact on high risk companies is not robust.

5. Conclusions and implications

This study uses data on Chinese A-share listed companies from 2007 to 2009 as the sample and adopts annual income volatility and operating leverage as the operational risk measures. We analyze the influence of social responsibility and disclosing relevant information on operational risk. We show that companies that improve their social responsibilities fulfillment significantly reduce operational risk; the better CSR fulfillment, the lower is operational risk. Moreover, listed companies publishing independent social responsibility reports face slightly higher operational risk regardless of whether publishing an independent social responsibility report affects the company's operational risk.

Table 12
Robustness test results 2.

Group	3 times operating leverage		4 times operating leverage		6 times operating leverage		7 times operating leverage		8 times operating leverage	
Variables	High risk	Low risk	High risk	Low risk	High risk	Low risk	High risk	Low risk	High risk	Low risk
Socialindex	−1.276	−0.162	−2.445	−0.320*	−5.046**	−0.497**	−4.455**	−0.251	−4.509**	−0.143
Dum – Socialindex	−0.554		−1.526		−2.059**		−2.433***		−1.851**	
Announce	0.948	0.034	1.255	0.092	2.699***	0.210*	2.094**	0.060	2.541**	0.085

* Represents significance at the 10% level.
** Represents significance at the 5% level.
*** Represents significance at the 1% level.

Please cite this article as: Zhao, C., et al., Can social responsibility reduce operational risk: Empirical analysis of Chinese listed companies, Technol. Forecast. Soc. Change (2016), http://dx.doi.org/10.1016/j.techfore.2016.08.023

Further, high risk companies improving their social responsibility performance can significantly decrease their operational risk, while the independent social responsibility report leads to significantly increased operational risk. The reason is that high risk company is paid more attention from shareholders and, actively improve CSR fulfillment can significantly increases the shareholders benefit, reduce agency problem, thereby significantly reduce the company's operational risk. Independently publishing CSR increase operating risks because of two reasons. First the company's majority shareholder is individual who lack of screening information ability. Second disclosure format is standard which lack of emphasis in important issue, resulting in report unfocused and useless.

On the contrary, low risk companies improving their social responsibilities fulfillment and releasing an independent social responsibility report experience only slight changes in operational risk. However, the direction of risk change does not lead to the same conclusion. As the operations of a low risk company are relatively stable and its relationships with stakeholders more cordial, there may be less management uncertainty and the market may have more understanding of the low risk of the company's business situation. Therefore, the information passed by improving social responsibility fulfillment and reporting social responsibility is consistent with the company's operating state. These signals send out unintended information; however, it does not cause a strong market response and does not change operational risk significantly. Overall, we believe that the quality of social responsibility fulfillment and disclosing a social responsibility report independently have a greater impact on high risk companies; however, the robustness of this conclusion needs to be tested in future research.

Based on the conclusions of this study, from a macro point of view, first the regulatory authorities should not only encourage CSR but also reduce the company's operational risk, which is conducive to the society harmonious development. Second CSR disclosure rule should be improved and give company more freedom in report format, for example GRI4 sustainability reporting rules can be used as reference. Third shareholder should be trained and educated more to increase comprehension ability of CSR in order to reduce misunderstanding. From the micro point of view, efforts to improve social responsibility tend to be effective at improving business performance. Although taking more social responsibility increases operating costs, it also enhances the company's social image and greatly improves its internal and external business environments, thus creating favorable conditions for long-term healthy development. Depending on their operational risk level, high risk companies should improve their social responsibilities fulfillment to enhance the welfare of stakeholders, improve the business environment, and reduce operational risk. Meanwhile, before high risk companies plan to disclose an independent social responsibility report, they should carefully analyze the content of the report. If it passes to the market more unintended negative information, one should consider publishing social responsibilities in the annual report instead. On the contrary, low risk companies should publish a social responsibility report separately in addition to continuing to fulfill social responsibilities seriously. These companies can put dispersed good news together to transmit to the market in order to further reduce information asymmetry, strengthen good operating signals, and lower operational risk.

This paper studies the Chinese CSR fulfillment and disclosure affects on the firm's operational risk. Chinese social responsibility regulatory system is changing and the issues of whether system improvement affect the CSR need to be further discussed especially in different operational risk companies.

This study has the following three limitations. The first centers on the issue of how to measure operational risk. We use the annual income volatility and operating leverage levels as indicators of operational risk; however, more appropriate indicators to measure operational risk need to be considered. Second, the time interval of the observed sample is relatively short (2007–2009). Because the notion of CSR in China started only recently, few listed companies provide independent social responsibility reports. However, a short time series may not fully describe the impact of social responsibility on operational risk. Third, there is a selection problem in the sample data. The second method in this study uses *Dol* to measure operational risk. From the definition of operating leverage, this must be greater than 1. Hence, when selecting Sample 2, we deleted all observations where operating leverage is less than or equal to 1. This approach undermines the linear regression of the dependent variable with the implicit assumption of a normal distribution, which may bias the conclusions.

References

Casey, R., Grenier, J., 2015. Understanding and contributing to the enigma of corporate social responsibility (CSR) assurance in the United States. Audit. J. Pract. Theory 34 (1), 97–130.

Cho, S., Lee, C., Pfeiffer, R., 2013. Corporate social responsibility performance and information asymmetry. J. Account. Public Policy 32 (1), 71–83.

Clarkson, P., Fang, X., Li, Y., Richardson, G., 2013. The relevance of environmental disclosures: are such disclosures incrementally informative? J. Account. Public Policy 32 (5), 410–431.

Dhaliwal, D., Li, O., Tsang, A., Yang, Y., 2011. Voluntary nonfinancial disclosure and the cost of equity capital: the initiation of corporate social responsibility reporting. Account. Rev. 86 (1), 59–100.

Dhaliwal, D., Radhakrishnan, S., Tsang, A., Yang, Y., 2012. Nonfinancial disclosure and analyst forecast accuracy: international evidence on corporate social responsibility (CSR) disclosure. Account. Rev. 87 (3), 723–759.

Elfakhani, S., Merville, L.J., 1995. Dividend policy, asymmetric information and signaling: an empirical test. Adv. Financ. Plan. Forecast. 5, 201–225.

Elliott, W., Jackson, K., Peecher, M., White, B., 2013. The unintended effect of corporate social responsibility performance on investors' estimates of fundamental value. Account. Rev. 89 (1), 275–302.

Freeman, R.E., Reed, D.L., 1983. Stockholders and Stakeholders: A New Perspective on Corporate Governance. Calif. Manag. Rev. Vol. 25 (3), 88–106. http://dx.doi.org/10.2307/41165018 SPRING.

Johnson, H.H., 2003. Does it pay to be good? Social responsibility and financial performance. Bus. Horiz. 46 (6), 34–40.

KPMG, 2013. The KPMG survey of corporate responsibility reporting 2013 Available at: www.kpmg.com/sustainability.

Li, Z., 2006. Study on the relationship between corporate social responsibility and corporate value - empirical evidence from shanghai stock exchange listing corporation. Chin. Ind. Econ. 2, 77–83.

Lys, T., Naughton, J., Wang, C., 2014. Signaling Through Corporate Accountability Reporting. Working Paper. Northwestern University.

Margolis, J., Elfenbein, H., Walsh, J., 2009. Does it pay to be good? A meta-analysis and redirection of research on the relation between corporate social and financial performance. Working Paper. Harvard University.

Chunguang Zhao is a professor at Shanghai National Accounting Institute. He received his PhD in accounting from Shanghai University of Finance and Economics. His current research interests include accounting standards, environmental accounting, corporate social responsibility and sustainable development. His current works have been published in major international journal Ecological Indicators.

Hang Song is an Associate Professor at Shanghai National Accounting Institute. He received his PhD in accounting from Shanghai University of Finance and Economics. His current research interests include accounting standards, taxation, corporate social responsibility and sustainable development. His current works have been published in major international journals such as Ecological Indicators and Energy Systems.

Wanyi Chen is making her PhD now in financial management from Shanghai University of Finance and Economics. Her current research interests include corporate government and environmental accounting.

Please cite this article as: Zhao, C., et al., Can social responsibility reduce operational risk: Empirical analysis of Chinese listed companies, Technol. Forecast. Soc. Change (2016), http://dx.doi.org/10.1016/j.techfore.2016.08.023