Received: 15 December 2018 | Revised: 20 April 2020 | Accepted: 27 July 2020 | Published on: 2 September 2020

DOI: 10.1002/smj.3224

RESEARCH ARTICLE

STRATEGIC MANAGEMENT JOURNAL WILEY

Risk management and corporate social responsibility

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[Correction added on 15 September 2020, after first online publication: the affiliation 'College of Business, Hankuk University of Foreign Studies, Seoul, Republic of Korea' has been added as the first affiliation and link to the author Sol Kim. The succeeding affiliations have been renumbered as well as their corresponding affiliation links to the authors.]

Abstract

Research Summary: We introduce an innovative method of identifying the risk-management benefit of corporate social responsibility (CSR). Option-implied volatility captures the financial markets' expectations of a firm's future risk, so if CSR is related to risk-management benefits, it should be related to lower implied volatility. We find that CSR is associated with low implied volatility and that CSR's insurance benefit is larger for firms that have high leverage, growth opportunities, or uncertainty. However, CSR as an insurance mechanism is less beneficial to firms that are already sound (i.e., those that have high market value and good accounting and financial performance). The results reveal the "terms" of a CSR-as-insurance contract, confirm that CSR creates risk-management benefits, and suggest that financial markets price this benefit in economically significant ways.

Managerial Summary: We suggest a practical technique of evaluating a firm's CSR policy. For example, a manager would simply check how a firm's implied volatility changes as its CSR policy changes. Or, the manager can compare a firm's and its comparable firms' implied volatilities to knowhow financial markets perceive the firm's CSR differently. Option implied

volatilities could guide a firm to identify proper CSR-based risk-management policies because they have the advantage of being ex ante, real-time, and objectively observable market-pricing information in identifying the risk-management benefit of CSR. Our results also illustrate how a financial expert can use the valuable insight of strategic management literature about CSR-as-insurance to price derivative contracts.

KEYWORDS

CSR, CSR-as-insurance, implied volatility, option market, risk management

1 | INTRODUCTION

The strategic management literature highlights the role of corporate social responsibility (CSR) in reputational insurance (Godfrey, 2005; Koh, Qian, & Wang, 2014; Minor & Morgan, 2011; Shiu & Yang, 2017). Whether such reputational insurance exists and is significant is ultimately an empirical question. The literature shows that CSR mitigates the damage from realized risks (Christensen, 2015; Godfrey, 2005; Godfrey, Merrill, & Hansen, 2009; Klein & Dawar, 2004), but we know far less how to identify the risk-management benefit of CSR ex ante or under what conditions CSR acts as insurance. As far as we know, no paper presents clear evidence of the existence and size of CSR-as-insurance either ex ante or ex post. The ex ante value of CSR-as-insurance has not been measured properly, although ex ante valuation is essential when a firm decides whether to undertake CSR (Koh et al., 2014). Even the ex post measures in the literature are subject to sample selection (Hawn & Kang, 2018; Siegel & Vitaliano, 2007), measurement (Koh et al., 2014), and conflicting logic regarding market efficiency (Minor & Morgan, 2011). Our new approach fills this gap in the literature.

To estimate CSR's risk-management benefits, we use information on the prices of options to purchase public companies' equity. Option prices are widely used in the finance literature, as they have the advantage of being ex ante, real-time, and objectively observable market-pricing information. Option prices also often provide superior information about or lead the fair value of the underlying assets in terms of information quality and speed because of professional option traders' private information (Chowdhry & Nanda, 1991; Grossman, 1992), leverage preference (Black, 1975; Easley, O'Hara, & Srinivas, 1998), short-sale constraints and costs (Danielsen & Sorescu, 2001), and expectations about future volatility (Black & Scholes, 1973; Christensen & Prabhala, 1998; Goyal & Saretto, 2009).

Option data are useful in measuring the significance of CSR-as-insurance. For example, a put option contract presents its owner the right to sell an asset at a pre-determined "strike price" within a pre-determined time frame, so it offers the benefit of downside protection for a certain period. In that case, an insurance contract is a put option in which the insurance payment is the strike price and the premium is the value of the option. The insurance premium quantifies the risk of an insured entity, such as that a healthy person pays lower insurance premium to an insurer than a sick person does. Similarly, the put-option "premium," the value of

the put option on a stock, quantifies the risk of the stock and, along with it, the risk of the firm that issues it. Hence, the demand for a put option written for a "healthy" firm should be low.

Therefore, if CSR influences a firm's risk, it should also affect the value of the option. In particular, CSR-as-insurance should render the put option (insurance) redundant and less useful, reducing its value. This simple intuition allows us to address the following questions: *How are CSR's insurance benefits quantified? Does a put option's value reflect CSR's insurance benefits?* We use "implied volatility" because it is the normalized (and most popular) representation of an option price, and it signals the market consensus on future risks. Derivative traders also quote option prices in terms of implied volatility. Hence, implied volatility reveals option values, which reveal a firm's future risk, which is associated with the value of CSR-as-insurance. Just as a person's health should be negatively correlated with his/her health insurance premium, CSR should be negatively correlated with the insurance premium that a firm's implied volatility reveals.

Indeed, our results indicate a one-to-one negative relationship between implied volatility and CSR, consistent with the risk-management view of CSR, so we conclude that CSR is related to risk-management benefits and that implied volatility captures the benefits well. In addition, CSR's risk-management benefit is greater for firms with high leverage, growth opportunities, or uncertainty. However, the mechanism of CSR-as-insurance is less effective for firms that are already healthy (i.e., those that have high market value and good accounting and financial performance). The results are consistent with the literature and remain robust in a lagged relationship; that is, CSR even predicts future implied volatility.

The results have implications for strategic management because they present an innovative way of measuring the insurance-like benefit of CSR. Scholars, too, can apply our empirical design to evaluate whether and to what degree a strategic action affects a firm's risk. Managers also use our approach to estimate the impact of CSR ex ante in making decisions about whether to undertake CSR in consideration of its future risk.

The rest of this paper is organized as follows. First, we present a numerical example. Second, we review the relevant literature and explain its limitations. Third, we describe the data and empirical approaches. Fourth, we present the empirical results. Concluding remarks are presented in the final section. The Appendix presents robustness checks using predictive regressions and interaction terms.

2 | NUMERICAL EXAMPLE

A simple example reveals how a decrease in an underlying asset's price volatility will affect put price and implied volatility. Suppose that there is a European put on a stock with price S at the current time t, and the exercise price and maturity are $0.95S$ and T, respectively. In addition, at T, the stock price must be $0.9S$, S, or $1.1S$. In this case, the put option holder will exercise the option only if the underlying stock price equals $0.9S$ at T so the holder can earn $0.05S = (0.95S - 0.9S)$ by exercising the put, assuming zero trading cost. If we assume the probability of the three values as 20, 60, and 20% for $0.9S$, S, and $1.1S$, respectively, the expected payoff at maturity is $20\% \times 0.05S$.

Given that we consider the CSR effect on stock price volatility, and not on the expected stock return, the expected stock price is assumed to be S. In this way, we can control for the effect of the stock return. In other words, we assume that the stock price has the same probability of equaling $0.9S$ or $1.1S$ at T. Now suppose the probability that the stock price equals $0.9S$ or

1.1S at T decreases from 20 to 10% because an increase in the CSR level decreases uncertainty. In that case, the probability changes as follows:

$$\text{Before CSR (high implied volatility)} : \{20\%, 60\%, 20\%\} \text{ for } \{0.9S, S, 1.1S\}$$

$$\text{After CSR (low implied volatility)} : \{10\%, 80\%, 10\%\} \text{ for } \{0.9S, S, 1.1S\}$$

The expected value is assumed to remain as S regardless of CSR.

With the decrease in stock price volatility, the fair price of the put option is likely to decrease because the probability that the stock price will fall below 0.9S decreases. In this example, the expected payoff of the put option decreases from $0.20 \times 0.05S$ to $0.10 \times 0.05S$, as the implied volatility decreases because of CSR. Hence, CSR and implied volatility should have a negative "concurrent" correlation if CSR is associated with an insurance-like benefit.

Ceteris paribus, the option's implied volatility is positively correlated to option price, so the implied volatility of the put decreases as well when the put price goes down, and vice versa. The put option price can change even when there is no change in the expected underlying stock return because an option has an asymmetric payoff structure such that the probability that the stock price will separately become S or 1.1S at T does not matter as long as it does not affect the downside risk, that is, the risk that the stock price will become 0.9S at T.

3 | LITERATURE REVIEW

The literature contains various conceptualizations and operationalizations of CSR-as-insurance. Husted (2005) derives CSR-as-insurance by regarding CSR as a real option, the small investment that offers the flexibility to decide whether to continue an investment based on its downside risk. While Husted (2005) highlights real options to logically explain how to use CSR for risk management, we examine financial options to empirically estimate whether CSR is associated with risk-management benefits.

Godfrey (2005) theorizes that corporate philanthropy produces reputational moral capital that presents insurance-like protection for relationship-based intangible assets, such as how stakeholders assess a firm's activities. Since firms generate revenues through their relationships with stakeholders, the moral capital accumulated via corporate philanthropy protects shareholder wealth. Similarly, Peloza (2006, p. 68) writes, "CSR can provide incremental gain during good times and subsequent mitigation of negative publicity," so a firm can use CSR as insurance for financial performance. Peloza also argues that engaging in CSR activities is similar to purchasing insurance for a firm's reputation.

Minor and Morgan's (2011) argument extends those of Godfrey (2005) and Peloza (2006). Minor and Morgan describe CSR as reputation insurance. For example, when a negative event occurs in a firm that has a high CSR score, stakeholders would ascribe the negative event to bad luck rather than to bad management. Minor and Morgan argue that avoiding negative CSR (avoiding harm) is related more closely to reputation insurance than is doing the right thing. In contrast, Godfrey et al. (2009) focus on doing good, suggesting that altruistic CSR is an investment in moral capital, which signals managers' competence and generates an insurance payoff that a firm can use when negative events arise. Minor and Morgan (2011) criticize Godfrey

et al. (2009), arguing that incompetent managers can more easily imitate doing good than avoiding harm. Thus, avoiding harm can separate competent managers from incompetent ones more effectively, resulting in larger moral capital than doing good does. To use the terminology of signaling theory, the cost gap between competent and incompetent managers is larger for avoiding harm than doing good, so avoiding harm can accomplish a separating equilibrium more effectively. However, even if avoiding harm is more costly to imitate than doing good, *why would avoiding harm cost more than both doing good and avoiding harm*? Intuitively, since doing good is not costless, *combining both should always cost more than avoiding harm alone*, the combined effort should accomplish a separating equilibrium even better.

Minor and Morgan (2011) test their proposition, first, by regarding product recalls as negative events and collecting recall information from the *Wall Street Journal*. Then, they use KLD data to measure CSR activities. Finally, they examine how the variations in KLD scores affect abnormal stock returns after product recalls. In particular, they classify firms into four groups: Doing Harm Only, Doing Good Only, Doing Neither, and Doing Both. They find that the mean returns after product recalls are 0.90% for the Doing Harm Only group, +1.10% for the Doing Good Only group, −0.50% for the Doing Neither group, and −2.51% for the Doing Both group. They argue that doing both signals inconsistent behavior and increases investors' skepticism about managers' competence, so it results in more negative response when a product recall happens. Based on this finding, they argue that avoiding harm has a great effect on moral capital.

However, Minor and Morgan's (2011) approach contains several problems. First, whether the differences in returns are statistically significant is not certain, as the authors do not report *t*-values or standard errors. Second, the study does not control for firm characteristics in regressing abnormal returns. Third, their application of signaling theory contains errors in logic. Let us clarify the third issue in detail.

In signaling theory, which Minor and Morgan (2011) invoke, an agent with information strategically sends signals to a principal who does not have information. Signaling is a strategy that addresses information asymmetry about possible future events, such as product recalls, ex ante. However, Minor and Morgan use signaling theory to explain ex post CSR activities' effect on stock price in response to product recalls, which suggests a reverse-causality issue, as signaling theory is more appropriate in explaining ex ante the emergence of particular CSR activities in relation to asymmetric information about future events (e.g., negative events) in equilibrium. Specifically, CSR activities are signals of expected future events, logically suggesting reverse causality in the regression between CSR and the stock price's response to negative events. This equilibrium relationship is more a joint determination than simple one-way causality, suggesting Minor and Morgan's empirical methods are subject to endogeneity, or at least inconsistent with signaling theory.

For example, suppose that signaling decisions (i.e., CSR activities) are optimally chosen for expected future states. In that case, the movement of stock prices in response to product recalls would be, on average, a rational outcome. If a firm chooses a different combination of doing both good and harm, deviating from its optimal signaling strategy, it could perform worse when negative events occur. Therefore, some firms do both good and harm, even though their stock returns are apparently reduced by product recalls. Forcing them to do harm alone would not improve their stock returns.

We discuss Minor and Morgan (2011) in detail because Godfrey et al. (2009) have exactly the same empirical and theoretical problems. To them, CSR is a *signal* that "the firm is not completely self-interested, that its leaders can, do, and will consider impacts on others or the social good in their decisions" (p. 428). Thus, as a signal, CSR creates the moral capital that leads stakeholders to ascribe negative events to maladroitness, rather than malevolence, which

provides insurance-like protection against stakeholders' negative reactions to negative events. To test their argument, Godfrey et al. use *Wall Street Journal* reports to identify negative events, stock prices to measure the reactions to negative events, and KLD to assess CSR activities. This theoretical (signaling theory) and empirical (ex post response) setting is similar to that which Minor and Morgan (2011) use, so it includes the same problems.

Godfrey et al. (2009) and Minor and Morgan's (2011) approach extends to Shiu and Yang (2017), who define CSR-as-insurance in nearly the same manner: "the preservation of shareholder and bondholder wealth" (p. 456) on the occurrence of negative events. Their empirical methods are also similar, except that Shiu and Yang analyze bond data. In line with their definition of CSR-as-insurance, Shiu and Yang analyze how short-term and long-term CSR engagement affects the abnormal returns of stock and bonds around negative events. Short-term CSR engagement is the ratio between a firm's and its industry's KLD scores, while long-term CSR engagement is the weighted average of asset returns over 3 days before and after the most recent short-term CSR engagement. Using a keyword search in the *Wall Street Journal* to define negative events, Shiu and Yang find that only long-term CSR engagement protects stock and bond prices from negative reports in the journal.

Shiu and Yang's (2017) measure is based on ex post loss of wealth realized, not the ex ante loss, as ours is, so it suffers from the same empirical problems of prior research, as well as selection bias. Rational firms buy insurance (i.e., undertake CSR) at the optimal amount required to protect wealth. Suppose that firms with "small expected loss given negative event (small exposure)" undertake CSR, while those with "large expected loss given negative event (large exposure)" do not. Then, even when CSR does not produce any insurance-like benefit, we observe a positive correlation between wealth preservation and CSR, just as Shiu and Yang (2017) find. Then, under what circumstances do firms with large exposure reduce CSR, while those with small exposure increase it? The former will happen if CSR does not produce an insurance benefit for significant exposure, while the latter will happen if CSR is such a luxury so only safe firms can afford to acquire it or if greenwashing can mitigate only minor offenses. This view clearly rejects the concept of CSR-as-insurance. Therefore, while Shiu and Yang's and others' analyses enrich our understanding about CSR-as-insurance, their results do not directly support it. Such a sample-selection issue is not easily overcome if realized loss is used to identify the effect of CSR-as-insurance, but a direct ex ante measure of risk can lessen the problem.

Our approach of measuring risk ex ante overcomes the common limitations of Godfrey et al. (2009), Minor and Morgan (2011), Shiu and Yang (2017), and others when they attempt to identify CSR-as-insurance. Our negative relationship between CSR and expected risk (i.e., implied volatility) is concurrent as well as predictive, which shows that CSR accomplishes a separating equilibrium between high-risk and low-risk firms. This result is a clean fit with CSR-as-insurance because high-CSR firms do not have to pay high insurance premium (i.e., high put-option price represented by implied volatility) since CSR already provides insurance-like benefits, just as healthy people pay low health-insurance premiums and good drivers pay low car-insurance premiums. We address this point in detail in the mathematical discussion at Appendix 2 (Supporting information).

Shiu and Yang's (2017) result about bonds is also somewhat inconsistent with CSR-as-insurance, as they find smaller insurance effects in bond prices than they do in stock prices and argue that, since bondholders have a senior claim, the result is consistent with CSR-as-insurance. However, in a standard bond contract, the best scenario is a no-default situation in which investors can receive coupons and face value on time, so the upside potential of bonds is limited. Therefore, bond prices tend to be more sensitive to downside risk than they are to upside

risk. As the purpose of an insurance contract is downside protection, the insurance effect should be more pronounced in bond prices than stock prices.

Other scholars produce results similar to those of Godfrey et al. (2009), Minor and Morgan (2011), and Shiu and Yang (2017), arguing that CSR boosts reputation and intangible assets, which become a cushion against crises (Christensen, 2015; Fombrun & Shanley, 1990; Gardberg & Fombrun, 2006; Hull & Rothenberg, 2008; Waddock & Graves, 1997). Bansal and Clelland (2004) propose that CSR mitigates stakeholders' negative impressions of firms' illegal activities. According to Klein and Dawar (2004), CSR discourages consumers from blaming firms when a product-level crisis occurs.

Koh et al.'s (2014) study is the most similar to ours because the former also addresses CSR's ex ante insurance-like value. In their analysis, they first apply Godfrey's (2005) moral capital logic. Then, they set up a linear regression model in which the dependent variable is the year-end stock price per share and the independent variables are the book value of equity per share, earnings per share, the KLD score, industry dummies, and year dummies. Next, they run the linear model in various classes of firms to determine how the coefficients for KLD scores vary in the classes. Finally, they find large KLD coefficients for litigation industries but small ones for financially distressed firms and socially contested industries.

Koh et al.'s (2014) study is subject to five primary limitations. First, their model is not ex ante, although they write, "To our knowledge, no previous study has examined the role of CSP as a risk management mechanism from an ex ante perspective" (p. 1478). Many earlier papers run similar regression models in which the dependent variable is asset price (e.g., stock or bond values) and the core independent variable is KLD. Koh et al. argue that their model is ex ante because they derive it using a residual income model. However, since their model does not differ in any meaningful way from earlier models, their residual model would logically render all earlier models also ex ante if the residual model makes Koh et al.'s model ex ante. In contrast, our approach is novel because no strategy paper uses implied volatility in analyzing the strategic behavior of a firm.

Second, citing a residual income model does not automatically make a model ex ante. In Koh et al.'s (2014) theoretical version of a residual income model, stock price is a linear combination of book value, profit, and *growth opportunity*. In Koh et al.'s empirical version, stock price is a linear combination of book value, profit, and *KLD*. Just replacing growth opportunity with KLD does not make a regression about CSR-as-insurance ex ante because we cannot rule out the possibility that CSR affects growth opportunity via numerous revenue-enhancing mechanisms, rather than risk management. In contrast, our option-implied volatility is a genuine ex ante indicator of a firm's risk, at least until the option matures.

Third, Koh et al.'s (2014) approach is equivalent to using an interaction term between KLD and the classes of firms (e.g., litigation, financial distress, social contest) in explaining stock price (i.e., moderating effect), an indirect way of inferring CSR-as-insurance. In contrast, we use a direct measure of a firm's risk, implied volatility, as the dependent variable. Koh et al.'s measure is indirect because stock price in their study includes both a firm's risk and its opportunity, while our measure is direct because it indicates the firm's future volatility. To rephrase, unlike our explicit measure, in Koh et al., risk is only a hidden mediating variable. Their hypothesis states that, ceteris paribus, *the positive relationship between CSP and firm value is weaker for firms at greater risk of financial distress, stronger for firms in industries with higher level of litigation risk, and weaker for firms operating in socially contested industries*. They reason that CSR's *hidden* risk-management benefits explain their findings at firm-class level, while we explicitly measure the relationship between CSR and risk reduction at the firm level, so we do not have

to assume that regulated industries or distressed firms are less sensitive to risk management in order to derive hypotheses or empirical designs.

Fourth, while earlier papers use return (the ratio of current to past stock prices), Koh et al. (2014) use unnormalized stock price per share as the dependent variable, an idiosyncratic setting that creates multiple econometric problems. Their dependent variable is on a per-share basis, while their core independent variable, KLD, is on a per-firm basis. Therefore, if we run their model using a per-*N*-shares basis, the results change whenever we change *N*. "Share" is just an arbitrary way to slice firm value, so unless the slicing is strategic (which Koh et al. do not model), how a firm's equity value is sliced (e.g., stock split, reverse split, stock dividend) should not change the firm's underlying economics, especially not the value of CSR-as-insurance. Stock price per share is not a proper measure of corporate financial performance (CFP) either because corporate actions like paying dividends can change stock price per share, regardless of CFP, which is inconsistent with that Koh et al.'s approach is to investigate the relationship between CFP and KLD in various classes of firms to infer CSR's insurance benefits. Koh et al. also should have controlled for past stock prices per share because stock prices are highly persistent (e.g., Martingale), although stock returns are usually not. For instance, if a stock's price is $1,000 today, its stock price tomorrow is likely to be around $1,000. In contrast, our implied volatility is scale-free.

Finally, Koh et al.'s (2014) interpretation of their results is problematic. For example, they find that a one-standard-deviation increase in CSP is associated with a larger increase in mean CFP (8.31%) in a litigious sector than it is in other sectors (4.55%). Therefore, they argue that the insurance value of CSP is high in litigious sectors, although economists may interpret their results in exactly the opposite way. Their results show that the marginal effect of "investment in insurance" (p. 1467) is larger in litigious sectors. However, if we assume decreasing returns to scale, as most economists do, a large marginal effect indicates a small stock of investment in insurance. Therefore, we can reason that litigious sectors invest less in CSR-as-insurance, which is at odds with Koh et al.'s theory that the stock of moral capital is more important in litigious sectors than in other sectors. The same logic can be applied to their findings about financial distress and social contests. In contrast, we provide transparent logic about our empirical setting and interpretation using a mathematical formulation, which is detailed in Appendix 2 (Supporting information).

4 | DATA

4.1 | CSR data

Following Chatterji, Levine, and Toffel (2009), Ioannou and Serafeim (2012), and Cheng, Ioannou, and Serafeim (2014), we use Thompson Reuters' ASSET4 to measure CSR. ASSET4 evaluates a firm's performance in 18 categories and summarizes them into 3 ESG pillars: environmental, social, and corporate governance. It then assigns one *z* score per firm for each pillar. The data are available from 2002, and our data period is from 2002 to 2008.

We use two scores to measure CSR: the social score and the CSR index. The social score (*so*) indicates social performance, so it excludes environmental performance and corporate governance performance. The CSR index (*csr*) is the average of the three ESG indices. We use *csr* for the main analysis and *so* for the robustness analysis. Environmental performance and corporate governance performance are likely to be subject to industry effects (e.g., natural resources vs. banking), markets (e.g., public vs. private), and firm characteristics, so we control for *firm-fixed effects* in all the regressions. We also use KLD for our robustness analysis.

4.2 | Options data and implied volatility

Practitioners quote the value of implied volatilities as the price of options. Major stock markets even have indices and exchange traded funds for implied volatilities in major stock markets. For example, the Chicago Board Options Exchange's Volatility Index (VIX) is the weighted average of listed S&P 500 index options' implied volatilities. VIX provides information on future market uncertainty, so it is often called the "fear index." Some economists have used it to measure investor sentiment (e.g., Baker & Wurgler, 2006, 2007).

We use IvyDB OptionMetrics to calculate the implied volatility of out-of-the-money (OTM) options on the stocks of the firms in our CSR data sample. Given that individual equity options are American,[1] we employ Cox, Ross, and Rubinstein's (1979) binomial tree model to calculate implied volatility numerically using the bid-ask midpoint of daily closing prices. Both OTM and in-the-money (ITM) options exist for options' strike prices, which can be a call and a put for the same strike price,[2] so collecting only the OTM options' implied volatility options will result in little loss of information if the put-call parity holds. Generally, OTM options markets are more liquid than ITM options markets are, so we choose OTM over ITM options to maximize the implied volatility estimation's accuracy. Table 1 presents the correlation matrix.

Table 1 shows a negative correlation between implied volatility (*iv*) and the CSR variables (*so*, *csr*) in both concurrent and predictive relationships. These correlations remain primarily negative, whether we use the differences (Δ) in implied volatility and the CSR variables or not. This finding suggests that the relationships are robust. The concurrent and predictive relationships remain robust in a variety of multivariate regressions, datasets, and specifications, so (a) *CSR and implied volatility exhibit a joint negative relationship*, and (b) *the higher the level of a firm's CSR performance*, *the lower the implied volatility*. The results confirm that CSR is related to risk-management benefits and that the financial markets price them.

Intuitively, the higher the risk, the higher the value of an insurance contract (a put option). Mathematically, the risk and value of an insurance contract forms a one-to-one relationship. Therefore, if an insurance contract's value is known, its "implied" risk can be calculated. Volatility is a measure of that risk, so "implied" volatility can be computed from the option price. In short, analyzing implied volatility can identify the option's value, which indicates a firm's risk, which ultimately conveys CSR-as-insurance's contribution to the firm. TABLE 1 confirms this intuition.

5 | EMPIRICAL RESULTS

5.1 | Fixed effects regression

Using an OLS regression that controls for firm-fixed effects, this section investigates whether CSR explains implied volatility. Table 2 reports the regression results. The relationships between CSR and implied volatility are statistically significant.

Figure 1 shows the strong negative relationship between the CSR variables and implied volatility, which result is consistent with the regression results. Figure 1 summarizes this study's novel findings.[3]

[1]An American option allows holders to exercise the option at any time, up to its expiration date.

[2]An option is classified as ITM if an immediate exercise of the option is profitable, and OTM if not.

[3]Table S7 in the Supporting information reports the results for quantile regression.

TABLE 1 Correlation matrix

	$iv(t)$	$iv(t-1)$	$\Delta iv(t)$	$\Delta iv(t-1)$	$so(t)$	$so(t-1)$	$\Delta so(t)$	$\Delta so(t-1)$	$csr\_i(t)$	$csr\_i(t-1)$	$\Delta csr\_i(t)$	$\Delta csr\_i(t-1)$
$iv(t)$	—	0.543	0.675	0.330	−0.166	−0.112	−0.019	−0.004	−0.144	−0.096	0.003	−0.024
$iv(t-1)$	0.543	—	−0.254	−0.080	−0.263	−0.251	0.004	−0.006	−0.249	−0.242	0.002	−0.016
$\Delta iv(t)$	0.675	−0.254	—	0.464	0.071	0.085	−0.024	0.005	0.045	0.094	0.002	−0.016
$\Delta iv(t-1)$	0.330	−0.080	0.464	—	0.062	0.094	−0.084	−0.039	0.025	0.108	−0.098	−0.030
$so(t)$	−0.166	−0.263	0.071	0.062	—	0.826	0.293	0.161	0.890	0.781	0.229	0.148
$so(t-1)$	−0.112	−0.251	0.085	0.094	0.826	—	−0.297	0.291	0.737	0.888	−0.196	0.214
$\Delta so(t)$	−0.019	0.004	−0.024	−0.084	0.293	−0.297	—	−0.219	0.194	−0.181	0.719	−0.112
$\Delta so(t-1)$	−0.004	−0.006	0.005	−0.039	0.161	0.291	−0.219	—	0.140	0.197	−0.105	0.730
$csr\_i(t)$	−0.144	−0.249	0.045	0.025	0.890	0.737	0.194	0.140	—	0.862	0.282	0.169
$csr\_i(t-1)$	−0.096	−0.242	0.094	0.108	0.781	0.888	−0.181	0.197	0.862	—	−0.244	0.267
$\Delta csr\_i(t)$	0.003	0.002	0.002	−0.098	0.229	−0.196	0.719	−0.105	0.282	−0.244	—	−0.180
$\Delta csr\_i(t-1)$	−0.024	−0.016	−0.016	−0.030	0.148	0.214	−0.112	0.730	0.169	0.267	−0.180	—

Note: This table presents the correlation matrix of implied volatility and the two CSR variables employed herein, where *iv* is the annual mean implied volatility calculated for each firm-year, *so* is the social score for each firm-year, and *csr* is the CSR index (average ESG indexes) that ignores the missing values in scores for each firm-year.

Dependent: iv_t	Coefficients
$csr(i,t)$[a]	−0.109
	(−10.72)
$iv(i,t-1)$	0.643
	(47.68)
Adj. R^2	0.743
N	1,928

TABLE 2 Regression of implied volatility on CSR

Note: This table reports the results of the regressions of implied volatility on the CSR variables, where $iv(i,t)$ is the annual mean implied volatility of firm i in year t, $so(i,t)$ is the social score of firm i in year t, and $csr(i,t)$ is the CSR index that ignores the missing values in scores of firm i in year t. The t-statistics are in parentheses. We control for firm-fixed effects.
[a]The coefficients and t-values of $so(i,t)$ are −0.085 (−11.66).

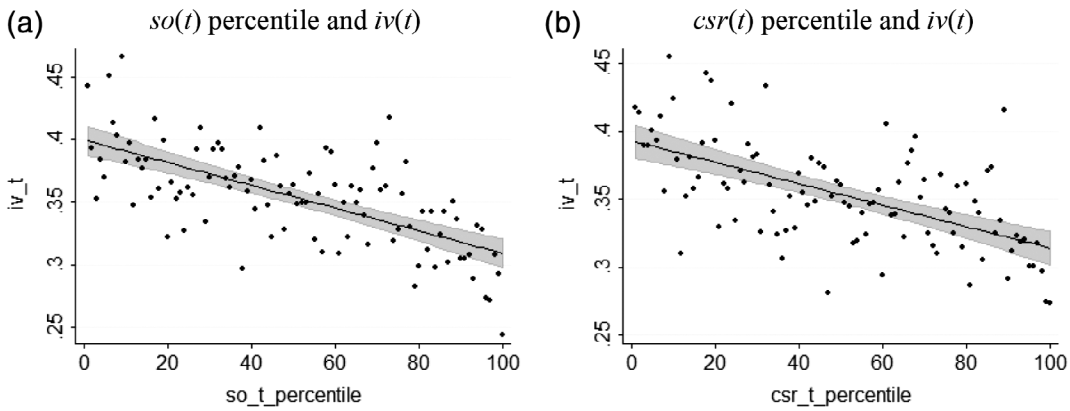

FIGURE 1 Concurrent between CSR and implied volatility. This figure illustrates the relationship between the CSR variables and implied volatility using two-way scatterplots of the mean implied volatility for each CSR variable percentile. The figure summarizes the concurrent relationship by plotting the mean implied volatility in month t for each CSR variable percentile in month t. (a) $so(t)$ percentile and $iv(t)$. (b) $csr(t)$ percentile and $iv(t)$

5.2 | Further interpretation[4]

Firms generally avoid volatile performance and hedge against it. CSR is a risk-management tool that can reduce volatility, but it can be costly, so there is a trade-off between CSR's benefits and cost. Firms must choose between reducing costs and reducing risks, as it is generally not possible to accomplish low cost (low CSR) simultaneously with low volatility. CSR and volatility should balance each other, as they are strategic substitutes. Where a firm resides on the curve of the negative relationship between volatility and CSR depends on the firms' characteristics and preferences. The firm's exact location on the curve depends on the ratio of the marginal

[4]A mathematical explanation is provided in Appendix 2 (Supporting information).

cost of undertaking CSR to the marginal benefit of reducing volatility, which is determined by the firms' characteristics and preferences.

The value of a put option is a one-to-one function of its implied volatility. Therefore, if CSR has a put-option value (risk-management benefit), then *this value should appear as part of the put option's implied volatility in the concurrent relationship, and not in the predictive (causal) relationship*. Therefore, any empirical test of the risk-management benefit should start from the concurrent relationship. Causality is of secondary importance. (The predictive regression is examined in the Appendix.) In short, our empirical relationship corresponds to the conjecture that CSR represents a put option or insurance value.

Moreover, the negative concurrent relationship supports the instrumental view of CSR (strategic CSR) in which firms balance the trade-off between the benefits and costs of undertaking CSR. Hence, in equilibrium, firms that conduct CSR are better off continuing to do so, while firms that avoid CSR are better off not taking it up (Hawn & Kang, 2018; Siegel & Vitaliano, 2007). Because of this trade-off between CSR's benefits (e.g., low implied volatility) and costs, firms choose between "high CSR, low implied volatility" and "low CSR, high implied volatility," generating a negative empirical pattern, as our results confirm.

5.3 | Robustness check 1: Fama–MacBeth regression

Implied volatility is the normalized price of options, so the relationship between implied volatility and CSR refers to whether CSR is associated with the pricing of derivatives. Therefore, we apply a traditional method of testing an asset-pricing relationship as a robustness check. Using Fama and MacBeth's (1973) regressions at a monthly frequency with additional control variables, we investigate the relationship between implied volatility and the CSR variables. In the Fama–MacBeth regressions, the monthly mean implied volatility for each month t is set as the dependent variable. In addition to the main independent variables *so* and *csr*, we include (a) firm size (log of each year's firm size), (b) leverage (the annual leverage ratio), (c) the market-to-book ratio (market value of equity over the book value of equity calculated at the fiscal year-end), (d) realized volatility, and (e) financial performance (ROA, stock return). The independent and control variables are measured in month t for the *concurrent* regressions and at $t - 1$ for the *lagged* regressions, as shown in the Appendix.

Table 3 reports the regression results. The coefficients are the means of the coefficients from the monthly cross-sectional regressions. The t-statistics are calculated based on Newey and West's (1987) adjusted standard errors with 6-month lags, whose length is determined by Newey and West's (1994) automatic lag selection. The table reveals the negative relationships between implied volatility and the CSR variables, even after controlling for other factors and considering the lagged independent variables. The results are *highly significant* in that they remain robust to various alternative specifications.

As expected, firm size is negatively related to concurrent implied volatility because small firms' stock prices are more volatile than those of large firms. Leverage tends to increase implied volatility, suggesting that the higher the debt, the greater the volatility. The market-to-book ratio is negatively related to implied volatility, a finding that is consistent with the value premium, which states that stocks that have a low market-to-book ratios (value stocks) have a larger risk premium because they are riskier than stocks that have a high market-to-book ratio (growth stocks). Realized volatility predicts implied volatility (i.e., past volatility predicts future volatility) (volatility clustering). Financial performance lowers implied volatility because good

TABLE 3 Fama–MacBeth regressions

***Dependent*: iv_t**	
Intercept	0.128
	(9.21)
csr[a]	−0.028
	(−1.60)
Firm size	−0.006
	(−2.11)
Leverage	0.000
	(1.95)
Market-to-book ratio	−0.002
	(−3.56)
Realized vol	0.009
	(12.36)
ROA	−0.001
	(−5.53)
Annual stock return	−0.000
	(−2.00)
Adj. R^2	0.567
N	30,486

Note: This table reports the results of the Fama and MacBeth (1973) regressions of implied volatility on CSR and the other control variables. The dependent variable *iv* is the monthly mean implied volatility for each month *t* in the sample period from 2002 to 2008. The variables *so*, *csr*, *firm size*, *leverage*, *market-to-book ratio*, and *vol* are the social scores; CSR index, firm size, leverage ratio, market-to-book ratio, and realized volatility, respectively. The CSR index ignores the missing values in scores. The independent variables are measured in month *t* for the concurrent regressions. The *t*-statistics are calculated based on Newey and West's (1987) adjusted standard errors with 6-month lags, the length of which is determined by Newey and West's (1994) automatic lag selection. The *t*-statistics are in parentheses. The predictive results are described in the Appendix.

[a]The coefficients and *t*-values of *so*(*i*,*t*) are −0.027 (−2.17).

financial performance is an effective risk-management strategy. In summary, the signs of the control variables' coefficients are consistent with those in the finance literature, suggesting that our results are highly robust. Our results are also economically significant, as a one-standard-deviation increase in the *csr* score leads to a 1.53% decrease in implied volatility. This size is slightly larger than the news announcement effect Donders and Vorst (1996) report, where the GMM regression coefficients for implied volatility are 0.987% in response to a news announcement and 0.079% in response to after-the-event period dummy variables. These figures are also similar to those in Patell and Wolfson (1984).

5.4 | Robustness check 2: using KLD

There are concerns that ASSET4 measures do not correlate well (and sometimes even negatively correlate) with some other measures of CSR (Chatterji, Durand, Levine, & Touboul, 2016). Issues related to measurement errors that are inherent in any measure built on observable proxies are also known, so measurement errors must be addressed (Carroll, Primo, & Richter, 2016), which requires robustness checks using alternative datasets.

We follow Cai, Jo, and Pan (2012) in using the KLD CSR variables for a robustness check. For each strength and concern activity in the subcategories, the KLD database presents a binary indicator to show whether a company has engaged in the activity. We use the binary indicators to construct two variables, as in Cai et al. (2012) (i.e., aggregate CSR [*CSR*] and net CSR [*NETCSR*]). *CSR* is the mean value of Equation (1) over five subcategories: community, environment, diversity, employee relations, and product.

$$CSR = \frac{\begin{array}{c}(\text{All strength items engaged in}) - (\text{All concern items engaged in}) \\ + (\text{All concern items available})\end{array}}{(\text{All strength items available}) + (\text{All concern items available})}. \quad (1)$$

NETCSR is defined as the number of all strength items in which a company has engaged, minus the number of all concern items in which it has engaged. Table 4 presents the correlation matrix of the three variables for the same set of firm years. The correlation matrix suggests that the previous results remain robust. Implied volatility (*iv*) and the CSR variables (*CSR*, *NETCSR*) have a negative concurrent correlation, and future implied volatility and the CSR variables have a negative predictive correlation. Most of these correlations remain negative, whether we use the differences (Δ) in implied volatility or the CSR variables.

Table 5 replicates Table 3 to report the regression results. The table reveals the concurrent negative relationships between implied volatility and *NETCSR* even after controlling for other factors, although we do not find a statistically significant relationship between implied volatility and *CSR*. Why is *NETCSR* significant while *CSR* is not? Since the former measures the difference, while the latter is a ratio; since the ratio is bounded, it has limited variations. The ratio also does not capture the size of the "CSR gap." The descriptive statistics show that *NETCSR* varies more than *CSR*, which increases *NETCSR*'s statistical power and captures the pattern that a simple ratio does not. Hence, the amount of CSR is more important than the ratio, an intuitive result since, from beneficiary stakeholders' perspective, the (dollar) amount is of greater interest than the ratio. What is more, *NETCSR* is on a time dimension (i.e., per-year basis), while *CSR* is dimensionless. Since the dependent variable (implied volatility) is on a time dimension, it is desirable to match the dimensions and to use *NETCSR* to avoid spurious results.

There are numerous examples of CSR-as-insurance. Nike mentions that one of the objectives of CSR reporting is to demonstrate the company's risk-management capability. Cases of CSR-as-insurance abound in the asset management industry. For example, the Norwegian fund, the largest sovereign wealth fund, incorporates CSR into its investment decision-making. The fund divested more than $13bn from the fossil fuel sector, arguing that the divestment helps the firm manage the climate risk that will affect most firms and economies—typical CSR-as-insurance. For similar reasons, the fund avoids investing in socially irresponsible firms because such firms are exposed to social risks, which lead to financial risks. Canadian credit unions also use

TABLE 4 Correlation matrix: KLD CSR variable

	$iv(t)$	$iv(t-1)$	$\Delta iv(t)$	$\Delta iv(t-1)$	$CSR(t)$	$CSR(t-1)$	$\Delta CSR(t)$	$\Delta CSR(t-1)$	$NETCSR(t)$	$NETCSR(t-1)$	$\Delta NETCSR(t)$	$\Delta NETCSR(t-1)$
$iv(t)$	—	0.543	0.675	0.330	−0.034	−0.028	−0.015	0.007	−0.069	−0.052	−0.053	−0.044
$iv(t-1)$	0.543	—	−0.254	−0.080	−0.046	−0.042	−0.013	−0.014	−0.116	−0.108	−0.030	−0.040
$\Delta iv(t)$	0.675	−0.254	—	0.464	0.052	0.053	0.045	−0.034	0.036	0.057	0.023	−0.032
$\Delta iv(t-1)$	0.330	−0.080	0.464	—	0.049	0.040	0.025	0.053	0.030	0.027	0.009	0.034
$CSR(t)$	−0.034	−0.046	0.052	0.049	—	0.910	0.254	0.248	0.913	0.839	0.259	0.245
$CSR(t-1)$	−0.028	−0.042	0.053	0.040	0.910	—	−0.171	0.296	0.846	0.915	−0.113	0.295
$\Delta CSR(t)$	−0.015	−0.013	0.045	0.025	0.254	−0.171	—	−0.112	0.193	−0.140	0.878	−0.118
$\Delta CSR(t-1)$	0.007	−0.014	−0.034	0.053	0.248	0.296	−0.112	—	0.194	0.231	−0.090	0.879
$NETCSR(t)$	−0.069	−0.116	0.036	0.030	0.913	0.846	0.193	0.194	—	0.928	0.262	0.245
$NETCSR(t-1)$	−0.052	−0.108	0.057	0.027	0.839	0.915	−0.140	0.231	0.928	—	−0.117	0.297
$\Delta NETCSR(t)$	−0.053	−0.030	0.023	0.009	0.259	−0.113	0.878	−0.090	0.262	−0.117	—	−0.127
$\Delta NETCSR(t-1)$	−0.044	−0.040	−0.032	0.034	0.245	0.295	−0.118	0.879	0.245	0.297	−0.127	—

Note: This table presents the correlation matrix of implied volatility and the two KLD CSR variables employed in this study. The variable *iv* is the annual mean implied volatility calculated for each firm-month. *CSR* and *NETCSR* are the aggregate and net CSR variable, respectively, which are constructed based on the KLD database. We follow Cai et al. (2012) to define the variables.

TABLE 5 Fama–MacBeth regressions: KLD CSR variables

***Dependent*: iv_t**	**(1)**	**(2)**
Intercept	0.138	0.128
	(4.12)	(5.30)
CSR	0.001	
	(0.04)	
NETCSR		−0.001
		(−2.59)
Firm size	−0.006	−0.005
	(−2.53)	(−1.97)
Leverage	0.001	0.001
	(1.87)	(1.86)
Market-to-book ratio	−0.002	−0.002
	(−1.70)	(−1.45)
Realized vol	0.008	0.008
	(12.17)	(12.44)
ROA	−0.001	−0.001
	(−8.26)	(−7.86)
Annual stock return	−0.000	−0.000
	(−1.71)	(−1.81)
Adj. R^2	0.612	0.615
N	11,202	11,202

Note: This table reports the results of the Fama and MacBeth (1973) regressions of implied volatility on KLD CSR variables and the other control variables. The dependent variable *iv* is the monthly mean implied volatility for each month *t* in the sample period. The variables *so*, *csr*, *firm size*, *leverage*, *market-to-book ratio*, and *vol* are the aggregate CSR, net CSR index, firm size, leverage ratio, market-to-book ratio, and realized volatility, respectively. We follow Cai et al. (2012) to define the CSR variables. The *t*-statistics are calculated based on Newey and West's (1987) adjusted standard errors with 6-month lags, whose length is determined by Newey and West's (1994) automatic lag selection. The *t*-statistics are in parentheses. The predictive results are described in the Appendix.

CSR as a risk-mitigation tool, and we find examples in emerging markets. On their CSR website, Shinhan Financial Group, one of the largest banking groups in South Korea, states that their "investment for future" is "for the reputational risk management of the company."

These examples show that the source of CSR-as-insurance could be a social contract, so quantifying CSR's risk-management benefit requires understanding its implicit contractual nature. However, how CSR is defined can change results. In addition, ASSET4 and KLD measures of CSR are essentially qualitative, but quantifying the effect of such measures could be logically problematic. However, we believe such issues reveal both strengths and weaknesses of our approach in the concurrent Fama–French regressions, as this asset-pricing approach allows us to extract quantitative information from qualitative measures. Strategic resources and

capabilities are qualitative, but despite their importance in strategy, few studies establish how to quantify them. If resources and capabilities determine firm performance, they should also affect asset pricing concurrently. Asset-pricing models suggest a way to quantify qualitative strategic resources, and our approach illustrates how to advance the literature toward quantifying strategy concepts using simple finance techniques.

6 | IMPLICATIONS FOR THE PRIOR LITERATURE

6.1 | Sample selection issues

The literature tends to highlight the mitigating effect of CSR on negative events. For example, the literature focuses on whether the harm to a "CSR-doing-firm" is low when a "firm accident" occurs. However, this approach does not prove that CSR has an insurance benefit, especially if the firm is rational. For example, reduced cash flow due to an insurance expense can decreases pending on safety, increasing minor accidents. In that case, CSR increases the probability of at least minor accidents. On average, however, the realized loss per accident is higher for non-CSR firms than for CSR firms because the former experience only major accidents, while the latter experience both major and minor accidents. Nevertheless, from a risk-management perspective, the former are more desirable than the latter, which strategically transfer their risk-management costs to insurance firms. In equilibrium, rational firms that use CSR-as-insurance save risk-related costs by continuing to do so, while rational firms that avoid CSR-as-insurance save the costs by continuing not to do so. This intuition is in line with empirical findings related to strategic CSR (Hawn & Kang, 2018; Siegel & Vitaliano, 2007).

In addition, firms may want to engage in CSR when they expect moderately negative events to occur. CSR may be able to address moderately negative or trivial events, but not serious ones. For example, suppose greenwashing can be effective in distracting stakeholders from noticing minor ecological offenses, but not significant disasters. In that case, firms that experience minor events are more likely to engage in CSR activities than are those that experience significant disasters. The data will contain sets of {frequent minor negative events, frequent greenwashing CSR activities}, ..., {infrequent disasters, infrequent CSR activities} that can create a spurious mitigating pattern—that is, a negative relationship between CSR and the seriousness of negative events. This leads to a wrong interpretation of the spurious relationship—that "CSR is associated with the decreased negative impact of CSR."

As another example, BP is notorious for environmentally damaging actions. However, before the *Deepwater Horizon* accident in 2010, BP was in DJSI FTSE4Good and a leader in Tomorrow's Value Rating (TVR). TVR evaluates firms' sustainability performances in terms of strategy, engagement, governance, innovation, and value chain. BP also adopted international reporting guidelines from the Global Reporting Initiative. Despite its environmental issues, BP's Beyond Petroleum campaign had been praised and awarded, and its revenue had increased. Nevertheless, CSR failed to mitigate negative reactions to the 2010 *Deepwater Horizon* oil spill, so its previous CSR efforts were regarded as cases of greenwashing (Delmas & Burbano, 2011). In general, if firms use CSR to distract stakeholders from small accidents, statisticians will observe a spurious negative relationship between CSR and small negative accidents. To solve these problems, we examine an ex ante measure of firm risk, such as option-implied volatility, that can signal a firm's true risk, which is the focus of the current study.

6.2 | Hidden assumptions about market efficiency

The next issue is the hidden assumption of market efficiency. If a financial market is efficient, future changes in firm value and current CSP should be unrelated because the current firm value already incorporates the CSR's value implications.[5] In other words, the change in firm value after controlling for opportunity costs should remain flat as it relates to CSR—that is, it should have an insignificant coefficient in a regression—because firm value updates CSR's impact concurrently. Consequently, if the market is efficient, the relationship between CSR and the asset price should appear only as a concurrent correlation, not as a predictive relationship. The CSR literature is ambiguous on this point: If a study argues that CSR increases future firm value (i.e., long-term value creation; e.g., Minor & Morgan, 2011), it should explain why the market does not instantly update relevant information and what kind of market inefficiency is assumed in connecting current CSR and future performance. This study demonstrates how to overcome this challenge.[6]

7 | CONCLUSION

CSR-as-insurance protects brands and firms' reputations (KPMG, 2017). We identify the value of CSR-as-insurance using implied volatility. Insurance is a put option, which is a one-to-one function of implied volatility. Hence, we identify insurance values (option values) by analyzing how implied volatilities vary as CSR changes, which in turn reveals the value of CSR-as-insurance.

We find that implied volatility is negatively correlated with current and lagged CSR. The size of the correlations is economically significant, so CSR is related to risk-management benefits, and the financial markets price the benefits. Furthermore, CSR's insurance benefit is larger for firms with high leverage, growth opportunities, or uncertainty, and lower for sound firms with high market value, accounting performance, and financial performance.[7] These results are consistent with CSR-as-insurance; if CSR is insurance against future uncertainty, it should be less useful for firms that are already strong than for those that are not.

We provide a positive answer to the question of whether CSR creates additional value for shareholders. CSR creates financial value, which is of direct interest to investors, by reducing risk and lowering stock price volatility. Our results also suggest that the two risk-management tools, CSR and derivatives, are related, so strategic management research on CSR can help derivatives pricing and corporate risk management.

This study has two primary limitations. We use implied volatility as the dependent variable and apply Fama-MacBeth regressions to incorporate both time-series and cross-sectional information. To focus on identifying the equilibrium or asset pricing implied in concurrent relationships, we avoid using an event study or regression discontinuity design. Future studies can

[5]The corporate social performance versus corporate financial performance (CSP-CFP) relationship is an important topic. Conducting CSR to manage a firm's risks (i.e., insurance) can weaken the CSP-CFP relationship and even render it negative (e.g., Godfrey, 2005). In insurance contracts, the value of the insurance premium is less than the expected value of the insurance payment. If no accident occurs, insurance is a pure expense, but because of the risk premium, insurance typically has a negative net present value projection for the insured. If we extend this logic, a negative CSP-CFP relationship is natural and expected.

[6]The predictive regression in the Appendix discusses this point in detail.

[7]The results are described in the appendices.

examine CSR's average treatment effects on implied volatilities using a quasi-experimental design, to which our research can be easily extended. This is another methodological contribution of our research design. Option-implied volatilities are continuous, readily available, and real-time indexes, so they can be straightforwardly combined with difference-in-differences, regression discontinuity design, and event studies. We hope future research will exploit these advantages of option-implied volatility.

In addition, while we analyze the second moment of stock returns (i.e., implied volatility), future studies could examine higher moments or even entire implied distributions. Such analyses will produce highly sophisticated insights into CSR's risk-management benefit. Looking at international differences could also be useful; we compare U.S. to non-U.S. firms in the Supporting information, but future studies could exploit international institutional heterogeneities in detail.

ACKNOWLEDGEMENTS

We thank the Korean Society of Strategic Management for their helpful comments as well as the 2019 best paper award. We also thank the Korea Academy of Business Ethics for their valuable comments, and appreciate Maeil Business Newspaper for the 2017 MK award for new scholars' article. Two anonymous reviewers and the associate editor, Aaron Chatterji, significantly enhanced this paper. Wiley's English Language Editing Services offered excellent services. All errors are ours. This work was supported by Hankuk University of Foreign Studies Research Fund of 2020.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

How to cite this article: Kim S, Lee G, Kang H-G. Risk management and corporate social responsibility. *Strat Mgmt J*. 2021;42:202–230. https://doi.org/10.1002/smj.3224

APPENDIX A: PREDICTIVE AND INTERACTION TERMS

This section shows that CSR predicts future implied volatility and suggests possible causality as well as the robustness of the concurrent relationship. In addition, this section confirms that all results remain robust even after controlling for interaction terms. The interaction terms produce interesting implications.

Table A1 reports the regression results. The predictive relationships between CSR and implied volatility are statistically significant. Figure A1 reports the one-month lagged predictive relationship between the mean implied volatility in month $t + 1$ and each CSR variable percentile in month t. The linear prediction of implied volatility is plotted as a solid line with the shaded 95% confidence interval. The figure shows the strong negative relationship between the CSR variables and implied volatility, which is consistent with the regression results.

Table A2 reports the Fama–MacBeth predictive regression results. The coefficients are the mean of the coefficients from the monthly cross-sectional regressions. The *t*-statistics are calculated based on Newey and West's (1987) adjusted standard errors with 6-month lags, whose length is determined by the automatic lag selection of Newey and West (1994). The table reveals the predictive negative relationships between implied volatility and the CSR variables, even after controlling for other factors and considering the lagged independent variables. The results are *highly significant* such that they remain robust to various alternative specifications.

What can explain the predictive relationship? Why does CSR predict future implied volatility? Its causal mechanism is based on the investor underreaction argument. Our logic is as follows. Take strategic CSR for example. It is difficult to capture the value implications of strategic CSR because it reflects firms' capabilities and resources. A firm cannot undertake strategic CSR successfully without applying its core capabilities and resources (Russo & Fouts, 1997). Resources and capabilities are, by definition, ambiguous, socially complex, and intangible (Barney, 1991; Dierickx & Cool, 1989). Their values depend on the extent of differences in expectations. Therefore, the information content of strategic CSR on resources and capabilities is unlikely to be clear at the beginning. Subsequently, such different expectations lead to a reaction by only a proportion of market participants (some may even take the opposite reaction) after CSR occurs. This generates investor underreaction to CSR, which represents the time lag in resolving different opinions on the strategic implications of CSR. Due to this investor underreaction, implied volatility responds to CSR with lags. Hence, *the higher the level of a firm's CSR performance is*, *the lower the future implied volatility will be*.

This logic for the underreaction of financial markets to CSR resembles the accruals anomaly (Sloan, 1996) or the tax-expense momentum (Thomas & Zhang, 2011), which are influential

TABLE A1 Predictive regression of implied volatility on CSR

***Dependent*: iv_{t+1}**	**Predictive coefficients**
$csr(i,t)$[a]	−0.025
	(−4.65)
$iv(i,t)$	0.723
	(68.90)
Adj. R^2	0.741
N	1,925
Firm-fixed effects	Yes

Note: This table reports the results of the predictive regressions of implied volatility on the CSR variables, where $iv(i,t)$ is the annual mean implied volatility of firm i in year t, $so(i,t)$ is the social score of firm i in year t, and $csr(i,t)$ is the CSR index that ignores the missing values in scores of firm i in year t. The *t*-statistics are in parentheses. We control for firm-fixed effects.

[a]The coefficients and t-values of $so(i,t)$ are −0.020 (−5.13).

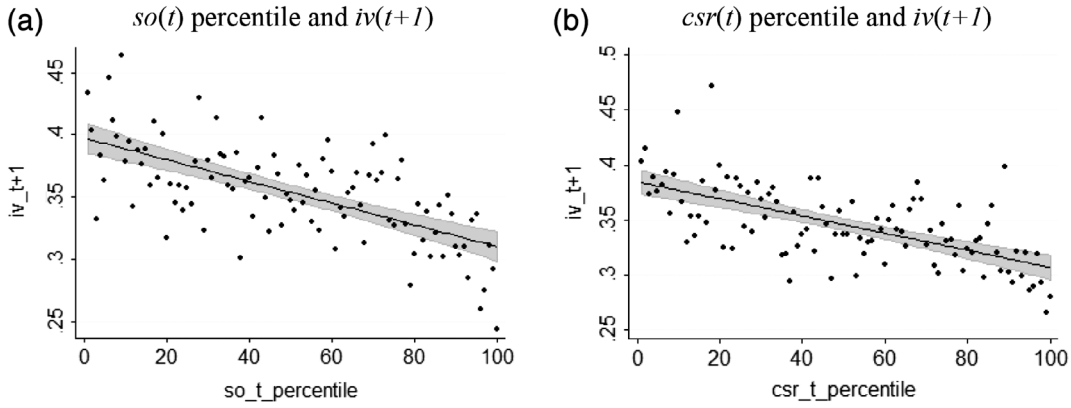

FIGURE A1 Predictive relationship between CSR and implied volatility. This figure illustrates the relationship between the CSR variables and implied volatility using two-way scatterplots of the mean implied volatility for each CSR variable percentile. The figure reports the one-month predictive relationship by plotting the mean implied volatility in month $t + 1$ for each CSR variable percentile in month t. In each figure, the linear prediction of implied volatility is plotted as a solid line with the shaded 95% confidence interval. (a) $so(t)$ percentile and $iv(t + 1)$. (b) $csr(t)$ percentile and $iv(t + 1)$

puzzles in the accounting and finance literature. Accruals denote non-cash components in earnings and are less persistent than cash flows. In behavioral explanations, investors overreact to accruals and underreact to the cash flow component; therefore, accruals predict lower returns in the future. Investors underreact to the cash flow component because they do not infer cash flow well from the accrual component. Similarly, investors underreact to tax surprises because tax accounting is complex and murky. Thus, tax surprises predict positive future returns and earnings. Interestingly, such anomalies persist for over a year in many cases.

The abovementioned accounting and finance literature suggest why CSR predicts negative future implied volatility. Resources and capabilities are socially complex and causally ambiguous. These strategic variables are more difficult to grasp than accruals and tax accounting are. It is even more challenging to assess whether a CSR activity is a logical extension of resources than to assess accruals or tax. Hence, financial markets underreact to CSR and thus, implied volatilities underreact to CSR, which eventually generates a negative predictive relationship between past CSR and future implied volatility.

Hence, we summarize the logic of the predictive relationship as follows. If investors underreact to complex accounting variables such as accruals and tax, then they should underreact to CSR further because the value implication of CSR is more complex than those of the aforementioned accounting variables. Underreaction to accounting variables generates a predictive relationship between the variables and future stock price. Therefore, the underreaction to strategy variables (CSR) should generate a stronger predictive relationship than accruals and tax do. The complexity of understanding the strategic implications of CSR is discussed in Fombrun, Gardberg, and Barnett (2000), Godfrey et al. (2009), and Surroca, Tribó, and Waddock (2010) who argue that the public lacks the expertise, time, and resources to understand the complex information implied in CSR. Then logically, it should take time for financial markets to fully update value-relevant information in CSR.

Table A3 reports the Fama–MacBeth regression results for the interaction terms between the CSR and control variables. The negative relationship between implied volatility and the

TABLE A2 Fama–MacBeth predictive regressions

***Dependent*: iv_{t+1}**	**Predictive coefficients**
Intercept	0.177
	(10.05)
csr[a]	−0.028
	(−1.68)
Firm size	−0.006
	(−2.13)
Leverage	0.000
	(1.95)
Market-to-book ratio	−0.002
	(−3.71)
Realized vol	0.008
	(11.75)
ROA	−0.001
	(−4.88)
Annual stock return	−0.000
	(−1.97)
Adj. R^2	0.563
N	28,484

Note: This table reports the results of the Fama and MacBeth (1973) regressions of implied volatility on CSR and the other control variables. The dependent variable *iv* is the monthly mean implied volatility for each month *t* in the sample period from 2002 to 2008. The variables *so*, *csr*, *firm size*, *leverage*, *market-to-book ratio*, and *vol* are the social scores, CSR index, firm size, leverage ratio, market-to-book ratio, and realized volatility, respectively. The CSR index ignores the missing values in scores. The independent variables are measured in $t - 1$ for the lagged regressions. The *t*-statistics are calculated based on Newey and West's (1987) adjusted standard errors with 6-month lags, the length of which is determined by Newey and West's (1994) automatic lag selection. The *t*-statistics are in parentheses.

[a]The coefficients and *t*-values of $so(i,t)$ −0.027 (−2.32).

CSR variables is still present, even with the interaction terms. The only exception occurs in the interaction between the CSR variables and realized volatility. Significant negative coefficients exist for the interaction term between CSR and realized volatility, while positive coefficients occur for realized volatility. Intuitively, today's realized volatility increases current and future implied volatility, which in turn reflects the expectation about future realized volatility. CSR negatively moderates this relationship, as shown by the interaction term. In fact, CSR weakens the impact of today's uncertainty on future uncertainty so much that CSR compensates for future uncertainty by increasing it via a direct route.

This finding reveals one important mechanism on how an insurance benefit of CSR arises. The more turbulent today's situation becomes, the more the market fears future uncertainty.

CSR allays (negatively moderates) this market concern. The insurance benefit of CSR thus becomes salient when financial markets face uncertainty. To rephrase, the negative relationship between CSR and implied volatility appears partly because CSR in turbulent times becomes a particularly valuable insurance contract.[8] We believe this result an important implication in the era of high technological, geo-political, and social uncertainty.

The other results of Table A3 are also noteworthy. The positive moderators are firm size, financial performance (ROA), and previous annual stock returns. The negative moderators are leverage, the market-to-book ratio, and realized volatility. Such moderating relationships are highly intuitive and confirm the validity of our analysis.

First, firms already in a good situation do not enjoy as much insurance benefit from CSR as those in a bad situation. The former includes large firms and those with high accounting and financial performance, which reduce the market's expectation about future risk. Going back to the car insurance example, bad drivers clearly benefit more from insurance than good drivers do because upside potential is irrelevant in insurance contracts. The best case of insurance is when no accident occurs (i.e., insurance becomes useless) because insurance is only for downside protection. Hence, our results confirm that CSR is indeed an insurance mechanism against future risk.

Second, firms in risky situations can reduce future risk to a large extent by undertaking CSR. The financial markets have concerns about firms with high leverage or high volatility, as these factors increase the default probability. High CSR decreases future risk, which in turn reduces the likelihood of a future accident (e.g., it lowers default probability). Hence, our results again prove that CSR is an insurance mechanism.

Third, firms with growth options (i.e., a high market-to-book ratio) enjoy larger insurance benefits than those without. Growth options are intangible and sensitive to market expectations. By undertaking CSR, firms can cement this growth option, which in turn decreases future uncertainty about firms, as well as the market's concern (i.e., implied volatility). This result is important because it shows the "terms" of the insurance contract implied in CSR. CSR-as-insurance protects the growth options of firms. Hence, it is a valuable contract for technology firms. As technology firms have large growth options, they benefit markedly from CSR insurance. Intuitively, CSR should be important for firms with contentious technologies such as artificial intelligence, biotechnology, and big data, among others, which are the focus of "technology wars" between major economic powers.

Table A4 reports the regression results replicating Table A2. The table reveals the predictive negative relationships between implied volatility and *NETCSR*, even after controlling for other factors. The results are consistent with the concurrent regression results in the main texts.

[8]This result is in turn in line with those in the Supporting information (Tables S3 and S4) about the salience of negative shocks.

TABLE A3 Predictability of the CSR variables for implied volatility: interaction effect

Panel A. Concurrent relation												
	Interacting so with…						***Interacting csr* with…**					
	Firm size	**Leverage**	***m/b* ratio**	**Realized vol**	**ROA**	**Ann. ret.**	**Firm size**	**Leverage**	***m/b* ratio**	**Real. vol.**	**ROA**	**Ann. ret.**
Intercept	0.210	0.166	0.164	0.143	0.168	0.168	0.040	0.136	0.132	0.232	0.129	0.128
	(16.14)	(16.65)	(17.68)	(14.11)	(18.28)	(17.92)	(2.80)	(9.78)	(9.04)	(16.51)	(9.26)	(8.98)
so	−0.106	−0.023	−0.018	0.032	−0.028	−0.027						
	(−11.43)	(−4.00)	(−3.33)	(3.51)	(−5.06)	(−4.97)						
csr							−0.039	−0.008	−0.010	0.021	−0.011	−0.011
							(−10.44)	(−3.89)	(−4.83)	(6.51)	(−5.91)	(−5.70)
Firm size	−0.010	−0.006	−0.006	−0.006	−0.006	−0.006	0.003	−0.007	−0.007	−0.007	−0.007	−0.007
	(−5.91)	(−4.18)	(−4.25)	(−4.13)	(−4.47)	(−4.33)	(2.33)	(−5.88)	(−5.91)	(−5.69)	(−6.05)	(−5.94)
Leverage	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(4.13)	(3.41)	(3.84)	(3.74)	(3.97)	(3.93)	(4.06)	(1.31)	(3.76)	(3.54)	(3.80)	(3.83)
Market-to-book ratio	−0.002	−0.002	−0.001	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002
	(−7.40)	(−6.69)	(−2.75)	(−7.11)	(−6.96)	(−6.89)	(−7.02)	(−6.43)	(−4.05)	(−6.69)	(−6.72)	(−6.72)
Realized volatility	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.005	0.009	0.009
	(27.15)	(27.30)	(27.37)	(30.12)	(27.42)	(27.56)	(27.00)	(27.02)	(27.05)	(11.32)	(27.07)	(27.22)
ROA	−0.001	−0.001	−0.001	−0.001	−0.002	−0.001	−0.001	−0.001	−0.001	−0.001	0.001	−0.001
	(−8.95)	(−8.87)	(−8.56)	(−8.88)	(−8.42)	(−8.82)	(−8.73)	(−8.85)	(−8.66)	(−9.29)	(1.81)	(−9.02)
Annual stock return	0.000	0.000	0.000	0.000	0.000	−0.001	0.000	0.000	0.000	0.000	0.000	0.001
	(−4.32)	(−4.33)	(−4.40)	(−4.34)	(−4.35)	(−5.01)	(−4.30)	(−4.31)	(−4.33)	(−4.21)	(−4.32)	(3.13)
Interaction term	0.009	0.000	−0.002	−0.002	0.001	0.000	0.003	0.000	0.000	−0.001	0.000	0.000
	(8.21)	(−0.82)	(−5.58)	(−8.73)	(4.75)	(3.82)	(7.27)	(−1.33)	(−0.92)	(−10.15)	(4.29)	(4.30)

TABLE A3 (Continued)

	Interacting so with…						*Interacting csr* with…					
Panel A. Concurrent relation												
	Firm size	**Leverage**	***m/b* ratio**	**Realized vol**	**ROA**	**Ann. ret.**	**Firm size**	**Leverage**	***m/b* ratio**	**Real. vol.**	**ROA**	**Ann. ret.**
Adj. R^2	0.567	0.566	0.566	0.568	0.567	0.568	0.567	0.567	0.566	0.567	0.567	0.570
N	30,671	30,671	30,671	30,671	30,671	30,671	30,671	30,671	30,671	30,671	30,671	30,671
Panel B. Lagged relation												
Intercept	0.212	0.169	0.170	0.150	0.174	0.174	0.053	0.147	0.135	0.237	0.133	0.133
	(15.55)	(16.22)	(17.68)	(14.53)	(18.27)	(17.93)	(3.53)	(10.55)	(9.19)	(17.36)	(9.50)	(9.21)
so	−0.099	−0.018	−0.019	0.029	−0.028	−0.027						
	(−10.23)	(−3.48)	(−3.57)	(3.34)	(−5.40)	(−5.29)						
csr							−0.036	−0.006	−0.010	0.021	−0.011	−0.011
							(−9.08)	(−3.23)	(−5.26)	(7.01)	(−6.44)	(−6.11)
Firm size	−0.010	−0.006	−0.006	−0.006	−0.006	−0.006	0.002	−0.007	−0.007	−0.007	−0.007	−0.007
	(−5.48)	(−4.16)	(−4.26)	(−4.16)	(−4.52)	(−4.38)	(1.45)	(−5.84)	(−5.88)	(−5.64)	(−6.03)	(−5.93)
Leverage	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(4.07)	(3.66)	(3.82)	(3.72)	(3.93)	(3.91)	(4.00)	(0.53)	(3.74)	(3.52)	(3.79)	(3.81)
Market-to-book ratio	−0.002	−0.002	−0.001	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002
	(−7.53)	(−6.93)	(−3.33)	(−7.25)	(−7.04)	(−7.05)	(−7.14)	(−6.61)	(−3.91)	(−6.84)	(−6.84)	(−6.86)
Realized vol	0.008	0.008	0.008	0.009	0.008	0.008	0.008	0.008	0.008	0.005	0.008	0.008
	(25.75)	(25.89)	(26.02)	(28.90)	(26.02)	(26.13)	(25.61)	(25.60)	(25.68)	(10.98)	(25.67)	(25.75)
ROA	−0.001	−0.001	−0.001	−0.001	−0.002	−0.001	−0.001	−0.001	−0.001	−0.001	0.001	−0.001
	(−7.89)	(−7.74)	(−7.41)	(−7.78)	(−7.50)	(−7.75)	(−7.63)	(−7.74)	(−7.48)	(−8.13)	(2.76)	(−7.87)
Annual stock return	0.000	0.000	0.000	0.000	0.000	−0.001	0.000	0.000	0.000	0.000	0.000	0.001
	(−4.23)	(−4.24)	(−4.31)	(−4.24)	(−4.25)	(−4.95)	(−4.20)	(−4.23)	(−4.25)	(−4.14)	(−4.22)	(3.74)

TABLE A3 (Continued)

Panel B. Lagged relation												
Interaction term	0.008	0.000	−0.002	−0.002	0.002	0.000	0.003	0.000	0.000	−0.001	0.001	0.000
	(6.75)	(−1.93)	(−5.20)	(−8.46)	(4.74)	(4.46)	(5.97)	(−2.15)	(−0.28)	(−10.52)	(4.73)	(4.63)
Adj. R^2	0.564	0.562	0.562	0.564	0.563	0.565	0.563	0.563	0.562	0.566	0.563	0.567
N	28,661	28,661	28,661	28,661	28,661	28,661	28,661	28,661	28,661	28,661	28,661	28,661

Note: This table reports the results of the Fama–MacBeth regressions of implied volatility on the CSR variables and the other control variables while considering the interaction effects between CSR and the other control variables. Variables include *so*, the social score; *csr*, the CSR index that ignores the missing values in scores; and *m*/*b* ratio, the market-to-book ratio. We show the results related to the social score for robustness check.

TABLE A4 Fama–MacBeth predictive regressions: KLD CSR variables

***Dependent*: iv_{t+1}**	**(1)**	**(2)**
Intercept	0.151	0.138
	(4.64)	(5.43)
CSR	−0.004	
	(−0.14)	
NETCSR		−0.001
		(−2.67)
Firm size	−0.007	−0.006
	(−2.74)	(−2.13)
Leverage	0.001	0.001
	(1.87)	(1.87)
Market-to-book ratio	−0.003	−0.002
	(−1.80)	(−1.55)
Realized vol	0.008	0.008
	(11.56)	(11.82)
ROA	−0.001	−0.001
	(−6.54)	(−6.27)
Annual stock return	−0.000	−0.000
	(−1.67)	(−1.78)
Adj. R^2	0.614	0.563
N	10,570	10,570

Note: This table reports the results of the Fama and MacBeth (1973) regressions of implied volatility on KLD CSR variables and the other control variables. The dependent variable *iv* is the monthly mean implied volatility for each month *t* in the sample period. The variables *so*, *csr*, *firm size*, *leverage*, *market-to-book ratio*, and *vol* are the aggregate CSR, net CSR index, firm size, leverage ratio, market-to-book ratio, and realized volatility, respectively. We follow Cai et al. (2012) to define the CSR variables. The independent variables are measured in month $t - 1$ for these predictive lagged regressions. The *t*-statistics are calculated based on Newey and West's (1987) adjusted standard errors with 6-month lags, the length of which is determined by Newey and West's (1994) automatic lag selection. The *t*-statistics are in parentheses.