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Working Paper 16-096

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Abstract

This study examines the relationship between firm innovation and CSR. Stakeholders' concern over transaction-specific investments exacerbates when firms engage heavily in innovation activities. To secure stakeholders' support, firms adopt CSR effectively as an *ex ante* signal of sustainability and goodwill. As CSR is endogenous to a firm's innovation activities, we rely on an instrumental variable (IV) approach to test our hypothesis. Using a sample of 3,315 U.S. publicly-listed firms from 2001 through 2011, we find that more innovative firms also engage more in CSR activities. This effect is stronger for firms of higher risk and/or operating in a less munificent environment. Additionally, firms with higher innovation reap greater financial benefits from their CSR activities.

Keywords: Corporate social responsibility, Firm innovation, Transaction-specific investments, Firm risk, Environmental munificence

INTRODUCTION

Strategic management research has been giving increasing thoughts to the role of corporate social responsibility (CSR) in a firm's long-term competitive advantage (e.g. Berman *et al.*, 1999; Choi and Wang, 2009; Du, Bhattacharya, and Sen, 2011; Flammer, 2014; Waddock and Graves, 1997; Wang and Qian, 2011). CSR reflects the extent to which a firm actively engages in social initiatives in response to a diverse set of stakeholder interests (Carroll, 1979; Mattingly and Berman, 2006; McWilliams and Siegel, 2001; Wood, 1991). Given the broad influence of CSR in a firm's strategy and performance, it is important to understand what factors drive a firm's engagement in CSR (Brammer and Millington, 2008). Research has shown that firms use CSR to enhance their reputation and social image (Godfrey, 2005) so as to effectively differentiate themselves from other firms (McWilliams and Siegel, 2001). However, the potential connection between CSR and other business strategy has not been thoroughly investigated. To better understand this link, we examine whether a firm's innovation may affect its engagement in CSR.

Innovation has been considered as a key factor determining a firm's ability to sustain its competitive advantages nowadays (Brown and Eisenhardt, 1995; Miller, Fern, and Cardinal, 2007; Wadhwa and Kotha, 2006). A firm's capability to innovate helps the firm better respond to the fast and abrupt environmental changes (Daft, 1982; Eisenhardt and Brown, 1998; Grossman and Helpman, 1994; Schumpeter, 1942). Although abundant attention has been paid to the antecedents of firm innovation (Makri, Lane, and Gomez-Mejia, 2006; Miller and Toulouse, 1986; Yadav, Prabhu, and Chandy, 2007; Young, Charns, and Shortell, 2001), limited efforts have been devoted to examining whether or not innovation may influence a firm's other strategic choice. Indeed innovation can be a help as well as a hamper for the firm. We propose that the

same characteristics of innovation that often enable firms to have competitive advantage in markets (Miller et al., 2007) may also lead to a severe problem of information asymmetry among firms and stakeholders.

Innovation is inherently highly risky (Drucker, 1985) and requires a lot of firm-specific investments (Helfat, 1994). Stakeholders that closely deal with firms of high innovation also need to invest in transaction-specific assets whose return is very uncertain. In addition, firms' innovation activities are highly complex in nature, and stakeholders may have very little control of the process. Information asymmetry between firms and stakeholders exacerbates when firms engage more in innovation activities. In this regard, stakeholders may develop a strong concern over any transaction-specific investment with the focal firm. Therefore, *ex ante* contracting with a highly innovative firm, potential stakeholders such as employees and suppliers will consider whether transaction-specific investments including human capital, skills/technology, equipment and facilities can generate enough returns for them. Due to their transaction-specific investments, it is simply too costly for stakeholders to terminate a contract once established with the firm (Hart and Moore, 1988). If a firm is not sustainable, any transaction-specific investment will be wasted in a long run, theoretically, in which case the stakeholders would rather *not* engage with the firm in the first place. Therefore, stakeholders face a severe information asymmetry problem when they are dealing with a highly innovative firm. This concern may not be serious for stakeholders of firms not engaging in innovation because they would not be asked to make transaction-specific investments in the first place.

We argue that potential stakeholders' concern over transaction-specific investments in innovative firms will motivate firms to engage more in CSR. CSR can reduce information asymmetry between the firm and its stakeholders by serving as a credible signal of firm

sustainability *ex ante* contracting. Stakeholders' concern over transaction-specific investments can be relieved as CSR can signal the firm's sustainability.

With a sample of 3,315 U.S. publicly-listed firms during the period from 2001 to 2011, we provide evidence that firms featuring greater innovation record a higher level of CSR. Our results are robust to controlling for the potential endogeneity issue and to alternative measures of innovation and CSR. We also find that the relationship becomes stronger when the internal or external environment causes information asymmetry to worsen, such as when the firm's risk level is higher or when the firm is operating in a less munificent market. We further show that CSR brings more financial benefits to firms exhibiting greater innovation.

This study makes significant contributions to the existing literature. First, the existing research on the drivers of CSR has mostly paid attention to leadership (Briscoe, Chin, and Hambrick, 2014; Chin, Hambrick, and Trevino, 2013; Marquis and Lee, 2013; Tang et al., 2015), firm internal resources (Johnson and Greening, 1999; McWilliams and Siegel, 2000; Waddock and Graves, 1997), and external environment factors (Flammer, 2014; Marquis, Davis and Glynn, 2013; Tilcsik and Marquis, 2013). Little is known about whether and if yes, how firm innovation would affect CSR. We complement the existing literature by showing that a firm's innovation may significantly determine its CSR participation. Therefore this study establishes a direct link between CSR research and the literature on firm innovation.

Second, we contribute to the stakeholder management research by offering refreshing evidence on the signalling role of CSR in better managing firm–stakeholder relationships. Previous research has highlighted CSR's instrumental role in gaining support from stakeholders (Freeman, 1984), or as an insurance against potential threats (Godfrey, Merrill, and Hansen, 2009; Koh et al., 2013), or in signalling a firm's product quality (Fisman, Heal, and Nair, 2008;

Servaes and Tamayo, 2013). Scant attention has been paid to such a question as whether CSR can help reduce information asymmetry among innovative firms and stakeholders. Our study suggests that CSR can be a signal received and interpreted by stakeholders before contracting, which can help relieve stakeholders' concerns over transaction-specific investments in the firm.

Lastly, we also add important knowledge to the firm innovation literature by exploring the potential costs imposed on stakeholders by a firm's innovation activities. Innovation can afford competitive advantage to the firm (Eisenhardt and Brown, 1998; Wadhwa and Kotha, 2006), yet it can also make stakeholders who make transaction-specific investments to bear costs. Our results suggest that firms that give a strategic priority to innovation can employ CSR as an effective means to reduce information asymmetry among themselves and stakeholders, thus easing the latter's concerns. In a sense, the linkage between firm innovation and CSR suggests that CSR is unlikely an independent strategy, but instead can interact with other strategic actions to form a cohesive whole. In addition, our findings also help reconcile the mixed finding on the relationship between CSR and firm financial performance (for a review, see Margolis and Walsh, 2003; Orlitzky et al., 2003). It seems that those firms with a higher level of innovation can reap more financial benefits from their CSR engagements.

THEORY AND HYPOTHESES

Firm Innovation and CSR

According to the knowledge-based view (Grant, 1996; Kogut and Zander, 1992), differences in innovative capabilities determine differences in firm performance. Innovation in the form of a unique and superior combination of firm resources may bring considerable benefits to the focal firm (Schumpeter, 1934). However, the same characteristics of innovation that help firms obtain competitive advantages in markets (Wadhwa and Kotha, 2006) may also exacerbate information

asymmetry among firms and their stakeholders. This is largely due to the fact that stakeholders who closely deal with a firm of greater innovation have to make more transaction-specific investments.

Helfat (1994) has insightfully pointed out that innovation requires firm-specific investments. First, innovation involves a significant portion of tacit knowledge, which cannot be communicated precisely using words, numbers, or pictures, and which therefore is difficult to codify. Over time, these communication codes and coordination processes will evolve into "dynamic routines" (Dosi et al., 1992), which largely contribute to the firm-specificity of innovation. Second, innovation involves learning, which is cumulative and path-dependent (Cohen and Levinthal, 1990; Dosi et al., 1992). As a result, the direction of innovation depends on the nature of the accumulated knowledge base, reinforcing the firm-specificity of innovation (Helfat, 1994). Therefore, firm innovation demands a lot of firm-specific assets.

Stakeholders that closely deal with a firm of great innovation may have to cope with investing in complementary firm-specific assets, which imply a lot of transaction-specific investments. Transaction-specific investments involve investments in human, physical, and technical capital that cannot be redeployed without losing productive value (Williamson, 1975, 1981). Because transaction-specific investments limited economic value in alternative settings, stakeholders whose investments have a substantial transaction-specific component are constrained in their transactions with the focal firm (Williamson, 1981). Moreover, writing and enforcing contracts associated with transaction-specific investments is generally difficult (Hart, 1995). As a result, stakeholders' investment in transaction-specific assets demanded by innovation likely leaves them vulnerable to opportunistic behavior by the firm of great innovation (Klein, Crawford, and Alchian, 1978; Williamson, 1981). For example, in 1970, Intel

planned to invest in developing the first semiconductor DRAM (dynamic random access memory), the 1 kilobit '1103', which was no doubt a significant piece of innovation. However, Intel's engineers were seriously concerned about the potential negative consequences of developing knowledge and skills specific to DRAM technology. 'There was a lot of resistance to semiconductor technology on the part of the core memory engineers. The engineers didn't embrace the 1103 until they realized that it wouldn't make their skills irrelevant' (Cogan and Burgelman, 1989: 2-3). Similarly, the suppliers and distributors need to invest in specialized equipment and facilities that may be less useful for other products; customers will find it difficult to accept an alternative product once they have purchased a highly innovative product. The Intel example shows while innovation can generate competitive advantage for firms, it is also likely to give rise to stakeholders' reluctance to invest in the necessary transaction-specific assets because such investment can put them in a potentially vulnerable position. Once stakeholders make transaction-specific investments, it is difficult for them to use such investments for other purposes. Therefore, stakeholder must be convinced the firm with whom they are contracting is sustainable and of goodwill. Without sufficient trust in a firm's sustainability and goodwill, stakeholders will be reluctant to commit to such transaction-specific investments and so will be their support to focal firm.

Firms of great innovation can relieve their stakeholders' concerns and obtain their support by signalling their sustainability and goodwill. According to the signalling theory, effective signals must meet two interrelated criteria: first, they must be observable; second, they must be sufficiently costly so that only the truly sustainable firms can afford to give them (Spence, 1974; Stiglitz, 1985; Bergh and Gibbons, 2011).

We propose that CSR can meet these two criteria and function effectively as a credible signal. First, firms with a good CSR record are able to establish a good social image in the eyes of stakeholders through accumulating moral capital (Godfrey, 2005). A good social image can in turn help identify emerging problems, prevent fraud, preserve corporate reputation, and minimize any penalty when transgression occurs (Francis and Armstrong, 2003). Accumulating moral capital through CSR engagement can attract more positive attention from all kinds of stakeholders (Godfrey *et al.*, 2009). Therefore, CSR as a signal is highly observable to stakeholders. Second, CSR can effectively separate firms having different levels of sustainability. CSR is costly and requires a lot of firm resources (Freeman, 1984) and it may be a while before it would generate any financial benefits for the firm (Berman *et al.*, 1999; Hillman and Keim, 2001). Indeed some existing findings suggest that CSR may actually hurt a firm's short-term market value (e.g., Di Giuli and Kostovetsky, 2014). Therefore CSR could be a very costly and unrewarding investment for unsustainable firms. By contrast, a sustainable firm would find CSR less costly because the benefits from CSR in the long run should outweigh the short-term cost. So CSR as a signal can effectively separate sustainable firms from unsustainable ones.

Once the firm has initiated a transaction with a stakeholder, CSR can help further reduce stakeholders' concern over transaction-specific investments as expropriating this stakeholder would damage the firm's social image. As it takes time to build up a good social image through engagement in CSR and any CSR engagement can be very costly, it would make little business sense for firms to ruin a good social image by acting irresponsibly toward their stakeholders.

In sum, innovation exposes stakeholders to potential risks arising from information asymmetry among themselves and firms of high innovation. Stakeholders want to make sure that the firms they are doing business with are sustainable and responsible. In order to relieve

stakeholders' concerns over their transaction-specific investments, firms of high innovation are motivated to signal their sustainability and take their responsibility seriously through actively engaging in CSR. This reasoning leads to our Hypothesis 1.

Hypothesis 1: Firm innovation has a positive effect on CSR.

Moderating effects of firm risk and market munificence

Identifying the boundary condition of the aforementioned relationship would lend greater credence to the proposed information asymmetry mechanism. As explained earlier, firms of high innovation engage in CSR activities to ease the information asymmetry among firms and the stakeholders. Therefore those internal and external factors that influence the information asymmetry should moderate the main effect. An innovative firm's incentives to participate in CSR activities should be stronger if information asymmetry among firms and stakeholders exacerbates. We conjecture that stakeholders have more concerns when they are investing in firms with higher financial risk and firms operating in a less munificent industry (hence greater environmental risk).

Firm financial risk

We measure firm financial risk by a firm's financial leverage, which reflects its ratio of debt to total equity. Since a greater debt ratio implies lower borrowing ability, firms with high financial leverage are more likely to default or go bankrupt (Bromiley, 1991). Naturally stakeholders will have more concerns over the sustainability of such firms. In addition, higher leverage can induce greater moral hazard problems such as risk shifting (e.g., managers may take on low-value but risky projects because of limited liability) (Jensen and Meckling, 1976) and debt overhanging (e.g., managers may stop making an effort because of liquidation threat) (Myers, 1977). Thus the risk is greater for stakeholders who invest in firms with higher financial leverage because of

exacerbated information asymmetry. In such a situation, the benefits of CSR as a way to reduce information asymmetry for firms of high innovation are stronger as is their motivation to engage in CSR. Therefore we predict that:

> *Hypothesis 2: The positive effect of firm innovation on CSR is stronger for firms having a higher financial leverage.*

Market munificence

Market munificence measures a firm's task environment's capacity to support sustained growth (Dess and Beard, 1984). A munificent market provides more opportunities to firms (Hambrick and Finkelstein, 1987). Information asymmetry among firms and stakeholders becomes more severe in a less munificent market. For instance, in an adverse market, it is very difficult for stakeholders to predict a firm's sustainability and to build accurate and verifiable performance measures for the firm. Meanwhile, because of the adversity in the operating environment, the firm may have more leeway to expropriate the stakeholders. Thus stakeholders have reason to worry even more about the potential risks of their transaction-specific investments. In such a situation, CSR can benefit firms of high innovation by reducing information asymmetry. In contrast, when the market is munificent, stakeholders' concern will be significantly reduced. Thus these firms have weaker motivation to engage in CSR when market munificence is higher. Therefore we predict that:

> *Hypothesis 3: The positive effect of firm innovation on CSR is weaker when market munificence is higher.*

METHOD

Sample

We obtain CSR information from Kinder, Lydenberg, Domini & Co., Inc. (KLD) for the period from 2001 to 2011. KLD data are considered to be among the best data available to construct a

comprehensive measure of CSR (e.g., Choi and Wang, 2009; Hillman and Keim, 2001; Waddock and Graves, 1997). We merge the KLD data with *Compustat* data to extract more financial information of the sampled firms. We include only firms with industry classification information (SIC code). We exclude firms in the financial industry (SIC codes: 6000-6999) and the regulated utilities industry (SIC codes: 4900-4999) because their products/services are not comparable to those provided by firms in other industries. We further exclude penny firms (share price less than 1 dollar). We make sure to include only firms that have valid data for all key variables and control variables. Our final sample contains 18,912 firm-year observations involving 3,315 unique firms.

Measures

Corporate social responsibility (CSR)

There are 13 categories of CSR activities in the KLD database. Following Servaes and Tamayo (2013), we remove the corporate governance dimension from our CSR measure because corporate governance is mainly concerned with how shareholders discipline or reward their managers. We also exclude categories related to a specific product and industry as we are trying to examine how product strategy affects CSR and firms cannot easily alter their industry or products given their product strategy. Therefore, our CSR measure at year *t* is based on five dimensions from the KLD data: community, diversity, employee relations, environment, and human rights (Servaes and Tamayo, 2013).

As each of the five dimensions involves a number of strengths and concerns, the total number of concerns is subtracted from the total number of strengths to arrive at a net score for each dimension. One methodological challenge is that in the KLD ratings, the evaluation criteria vary across the five dimensions and over the years. For instance, for the community dimension, a

firm's strengths are evaluated on seven aspects, while the concerns are assessed on four aspects. We follow Servaes and Tamayo (2013) and address this challenge as follows: for each firm year, we scale the strengths (concerns) by the maximum possible number of strengths (concerns) applicable in each category-year.[1] This procedure gives us an index of strengths (concerns) between 0 and 1 for each firm-year. We then take the difference between the strength index and the concern index to obtain our net *CSR* measure.[2]

Firm innovation

In the main analyses, we use R&D expenditure as the measure of firms' investment in innovation activities. Because innovation usually involves a long process, we follow the methodology of the Bureau of Economic Analysis (BEA) (Sliker, 2007) to construct a stock measure of R&D investment by capitalizing firms' R&D expenses. In particular, BEA constructs R&D capital using the perpetual inventory method.

$$R\&D\ Stock_{i,t} = (1-\delta_0)R\&D\ Stock_{i,t-1} + \frac{R\&D_{i,t}}{cpi_t} \quad (1)$$

where cpi_t is the consumer price index and *R&D* is the R&D expenses for the year. To implement the law of motion in equation (1), we choose the initial R&D stock according to

$$R\&D\ Stock_0 = \frac{R\&D_1}{g+\delta_0} \quad (2)$$

We follow BEA to use a depreciation rate (δ_0) of 15% and a growth rate (g) of 10%. Our results are robust to different choices of δ_0 and g though.

Although R&D stock successfully captures the input of firms' innovation activities, it may ignore the efficiency in the innovation process. In the robustness tests, we construct measures of

[1] See footnote 6 in Servaes and Tamayo (2013) for an example.
[2] Our results are not affected if we use the raw number of strengths and concerns from KLD to construct the CSR measure.

firms' innovation activities by focusing on innovation outputs, i.e. the number of patents granted to the firm or the number of citations received by the firm. Our conclusions are not affected.

Moderating variables

Firm financial leverage is measured by the firm's ratio of total debt to total assets. The higher the leverage, the more likely is the firm to default or go bankrupt. *Market munificence* is measured by the industry mean of the Tobin's Q (*Q*). *Q* is the market value of equity plus the book value of liabilities divided by total assets and is a popular measure of firms' growth opportunities (see Stein 2003 for an example). A higher value indicates more growth opportunities available in the industry in which the firm operates.

Control variables

We control for firm characteristics such as performance, age, and size, because these factors can affect a firm's engagement in social activities (Adams and Hardwick, 1998; Waddock and Graves, 1997). Firms with better financial performance are more likely to invest in social activities because they have more resources at their disposal. We include ROA (return on assets) the measure of firm financial performance and Q (Tobin's Q) as the measure of firm's growth oppotunities. Firm age is measured by the natural logarithm of one plus the number of years since the firm appeared in the *Compustat* database for the first time. Firm size is measured by the natural logarithm of the firm's total assets. We also control for analyst coverage (LnCoverage) to capture the firm's public exposure and the amount of attention it has received (Shen, Tang, and Chen, 2014). Analyst coverage is measured as the number of analysts who have issued at least one earnings forecast for the firm in year *t*-1. Finally, we control for industry (SIC two-digit) and year fixed effects. We calculate the robust standard errors clustered by firm. The variable

definitions are summarized in Appendix A. All continuous variables are winsorized at 1% and 99% to reduce the influence of outliers (Servaes and Tamayo, 2013).

Endogeneity and the instrumental variable (IV) approach

Endogeneity may be an issue with our research design. First, a firm's CSR policy and firms' innovation activities can be jointly determined. Although we have controlled for the observable firm characteristics, the unobservable determinants can result in an omitted variables problem. Second, firms engaging in social activities may choose to engage in more innovation activities. This will lead to a reverse causality problem.

A typical way to address the endogeneity concerns is to use an instrumental variable (IV) approach (Kennedy, 2006; Wooldridge, 2002). The IV approach requires instruments that are related to a firm's innovation but independent of its CSR activities. In this study, we use the education level of the state where the firm's headquarter is located as a valid instrument variable for firms innovation activities. Innovation requires more sophisticated knowledge on the part of producers, distributers and consumers respectively (Porter, 1980; Li and Calantone, 1998; Carlile, 2002). Those having a better education would possess more sophisticated knowledge, but it may or may not increase their tendency to engage in socially responsible activities. The education level of a state is defined as the share of its population having a bachelor's degree or above. The education data obtained are from the U.S. Census Bureau, which conducts a survey every five years. To mitigate the possibility that the development of the state economy increases the share of the population who are educated, we rank all 51 states by their education level in 1970 and use this rank as our instrument variable. Our conclusions are not affected if we rank the states by their education level in 2000 which is the year right before our sample starts. A firm's education rank is the education rank of the state where the firm's headquarter is located.

RESULTS

Table 1 presents the descriptive statistics and correlations for the studied variables. The pairwise correlations among the independent variables are not particularly high. The highest correlation is found between firm Q and market munificence (0.55), which is not surprising because firm-level growth opportunities are correlated with industry-level growth opportunities. Further investigation does not reveal any serious multicollinearity problem: the variance inflation factor of the variables is acceptable with a maximum of 2.37 and a mean of 1.65 (Cohen *et al.*, 2003).

-----Insert Table 1 about here-----

We also perform univariate test to examine how *CSR* varies across firms with different innovative activities. The mean *CSR* score for firms in bottom tercile of *R&D Stock* is -0.23 and the mean *CSR* score for firms in top tercile of *R&D Stock* is -0.11 suggesting a 0.12 difference in *CSR* score across these two groups. The p-value of this difference is less than 0.001. In addition, the effect size (*Cohen's d*) of this difference is 0.23 with a 95% confidence interval of (0.20, 0.26).

Do firms engaging in more innovation embrace CSR more actively?

Our Hypothesis 1 suggests that firms engaging in more innovation activities have a higher level of CSR. In this section, we use the following empirical model to test this hypothesis:

$$CSR_{i,t} = \alpha + \beta * R\&D\ Stock_{i,t-1} + \gamma * Controls + \varepsilon_{i,t} \quad (3)$$

where *CSR*, *R&D Stock* and control variables are as defined in the previous section. Standard errors are controlled for and clustered at the firm level.

The results are presented in Table 2. In Model (1), we include industry and year fixed effects. In addition, it is necessary to control for unobserved firm heterogeneity which may affect both firms' innovation and *CSR*. As we use a stock measure of R&D input which tends to be

stable over years, it may not be appropriate to add firm fixed effects in the models. We address this issue in two ways. In Model (2), we control for firm's lagged *CSR* to study whether or not firms' innovation has a significant impact on the dynamics of *CSR* performance. In addition, we control for firm random effects in Model (3). The coefficient of *R&D Stock* is positive and with very low p-values in all three regressions (*p-value* <0.001 in all three regressions). The coefficient of *R&D Stock* in Model (2) is smaller because of controlling for the lagged CSR performance. Using the coefficient in Model (1), we calculate the average effect of *R&D Stock* on *CSR*. A change of one standard deviation in *R&D Stock* will lead to a change of 0.049 in *CSR*, which is more than 8.5% of the standard deviation of *CSR* itself.[3] We thus conclude that the effect of a firm's innovation is not only statistically significant, but also economically important. These results render strong support to Hypothesis 1.

-----Insert Table 2 about here-----

Our IV results are presented in Table 3. Column (1) of Table 3 reports the first-stage results. Education ranks in 1970 are highly correlated with *Firm Innovation* in the expected direction. The Cragg-Donald (1993) F tests (F-stats is 223.812) reject the null hypothesis of a weak instrument. The second-stage results are reported in Column (2) of Table 3. We include both industry and year fixed effects in the model. The coefficients obtained via the IV approach are larger than those reported in Table 2 (corresponding to the same specifications) which is not surprising because the two-stage estimator is inefficient but consistent (Wooldridge, 2006). Overall, our results are unlikely affected by endogeneity problems.

-----Insert Table 3 about here-----

Moderating effects

[3] 0.188*0.258/0.569=8.52%

The results from testing Hypotheses 2 and 3 are reported in Table 4. We include industry and year fixed effects from Models (1) to (3). In Models (1) and (2) we include interactions one by one. In Model (3), we include both interactions and our results are unaffected. Both the interaction between *R&D Stock* and *Firm Risk* and that between *R&D Stock* and *Market Munificence* are positive and with low p-values ($p < 0.001$ and $p = 0.009$, respectively), suggesting that the relationship between firms' innovation and CSR is strengthened when firm financial leverage is high or market munificence is low. Therefore Hypotheses 2 and 3 are supported.

-----Insert Table 4 about here-----

Robustness tests with alternative measures of firm innovation

When constructing our key measure of firm innovation *R&D Stock*, we replace missing R&D expenses with zero. However, Koh and Reeb (2015) find that some firms with missing R&D still file patents. Their evidence suggests that replacing missing R&D with zero may not be appropriate for all cases. To address this concern, we use three alternative ways to deal with the missing R&D problem. In the Model (1) of Table 5, we construct *R&D Stock KR* by excluding all firms which do not report R&D expense but file patents. In the Model (2) of Table 5, we construct *R&D Stock non-missing* by excluding all firms with missing R&D. Lastly, in Model (3) of Table 5, we use the decile rank of *R&D Stock* (*R&D Stock Rank*) instead of *R&D Stock* itself as the measure of firm innovation to mitigate the potential measurement errors. As indicated by the results in Table 5, our results are robust with all these alternative measures.

R&D Stock captures the firms' cumulative inputs in innovation activities. However, it ignores the outcomes of firms' innovation activities. To assure the robustness of our results, we also construct two measures based on the output of firms' innovation activities: *LnNum_Patent*

and *LnNum_Cites*. *LnNum_Patent* is the natural log of number of patents that the firm has filed and eventually granted in year t-1. *LnNum_Cites* is the natural log of number of citations that the firm has received from the patents in year t-1. The number of patents which represents the total outputs of innovation activities, and the number of citations which represents both the quantity and the quality of the outputs of innovation activities are commonly accepted measures of the innovation outputs of firms (e.g., He and Tian 2013). The data are extracted from U.S. Patent and Trademark Office (PTO) and cover the period from 2001 to 2009. Kogan et al. (2015) provide a detail explanation of the data construction.[4] The results based on these two output-based innovation measures are reported in column (4) and (5) in Table 5. Again, our results are robust to these alternative measures.

----Insert Table 5 about here----

Revisiting the CSR-corporate financial performance relationship

As a supplementary analysis, we explore the relationship between CSR and subsequent corporate financial performance. The existing research on the association between CSR and corporate financial performance presents mixed findings (e.g., Orlitzky et al., 2003; Wright and Ferris, 1997; Flammer, 2014). We suspect this inconsistency may be due to the failure to take into account certain firm-level characteristics (such as firm innovation) as the boundary conditions in previous research. Indeed, CSR may help some firms more than others (cf. Servaes and Tamayo, 2013). Therefore, in Table 6, we examine the relationship between CSR and corporate financial performance when firm innovation serves as a moderator. In Models (1), the dependent variable is *ROA* in year t and in Model (2), the dependent variable is the three-year average *ROA* from years *t* through *t+2* while all independent variables are measured at year t-1.

[4] The patent data are available at https://iu.app.box.com/patents.

Our main interest is the interaction terms between *R&D Stock* and CSR (i.e., *CSR* × *R&D Stock*). The interaction effect on firm future performance is positive and with low p-values for both one year ahead *ROA* and 3-year average future ROA (*p-values* are less than 0.001 and 0.069, respectively). This finding suggests that for firms of high innovation, CSR can contribute more to corporate financial performance.

----Insert Table 6 about here----

DISCUSSION

Conclusions and implications

Studying CSR has important strategic implications for firms, as "investments made in enhancing social responsibility are best focused on building primary stakeholder relationships that are not easily replicated by competitors" (Ramchander, Schwebach, and Staking, 2012: 312). As such, researchers have been eager to identify the drivers of CSR. While some research has attended to the firm-level factors influencing the role of corporate executives in CSR (e.g., Kang, 2013), the question of how other business strategies such as innovation affects a firm's CSR engagement remains under-explored to the best of our knowledge. This study directly links the two streams of research on firm innovation and CSR.

By explicitly testing the relationship between firm innovation and CSR, our study contributes to the strategic CSR literature in particular and the strategic management research in general in several ways. First, we look inside the firm from a new angle and examine whether or not firm innovation affects its CSR engagement. Our evidence on the association between firm innovation and CSR demonstrates that CSR is unlikely an independent strategy, but instead interacts with other business initiatives to form a cohesive whole.

Second, we provide evidence on the signalling role of CSR in reducing information asymmetry between firms and stakeholders. Stakeholders have serious concerns over transaction-specific investments when they deal with firms of high innovation. Our study suggests that CSR can work as a signal to reduce information asymmetry, especially for firms of high innovation.

Third, this study reveals the boundary condition of the relationship between firm innovation and CSR by studying the moderating role played by internal and external risks. Our findings suggest that the relationship strengthens with increasing firm risk and market uncertainty. Our study thus enriches the understanding of what drives a firm's CSR engagement and may inspire future research to broaden this scope by investigating other potential moderating factors at the individual manager, firm, and contextual levels.

In addition, by acknowledging that firm innovation generates a competitive advantage for firms but at the same time creates an unexpected level of risk for stakeholders, our study offers evidence that firms of high innovation can use CSR as an effective tool to offset the costs of certain business strategies and increase the chances of reaping the financial benefits. Indeed our supplementary analysis renders support to a contingent perspective of the CSR-corporate financial performance relationship: for firms of high innovation, CSR can help them more in terms of financial performance. This resonates with the recent call for more investigations on the boundary conditions of the influence of CSR on firms (e.g., Barnett and Salomon, 2012; Ioannou and Serafeim, 2015).

Limitations and future research

Our study can be improved in the following ways. First, although we have implicitly used stakeholder theory to explain the mechanism linking firm innovation and CSR, we have not

directly measured the resources or support provided by particular stakeholder groups. The contributions would have been even sharper if we were able to directly measure stakeholders' resources or support and how stakeholders actually perceive firms of different levels of innovation via surveys for examples. Future research should consider this possibility and try to confirm the theoretical propositions in this study.

Second, this study takes a strategic CSR view and highlights the instrumental role of CSR in reducing information asymmetry between firms and stakeholders. But a firm may engage in CSR for other social reasons. For example, the cultural setting or the regulatory environment may oblige a firm to commit to CSR. Therefore, future research could well benefit from integrating an instrumental view with a social or ethical view of CSR motivation.

On a final note, our findings apply to public firms but do not necessarily can be extended to private firms, because usually private firms face a different set of constraints and objectives and may also deal with a different group of stakeholders. In addition, firms with different ownership structures and embedded in different institutional contexts may prefer different innovation strategies. So it would be meaningful to extend our predictions to other social and cultural contexts. Margolis and Walsh (2003: 278) encouraged CSR research to "stress the importance of developing models that incorporate omitted variables, testing mediating mechanisms and contextual conditions". Therefore, we urge future research to validate our conclusions for firms with different ownership structures and embedded in different social contexts (cf. Wiersema and Bird, 1996). We believe that such explorations would provide insights into Jensen's (2002) "enlightened" stakeholder theory, which postulates that an appropriate objective function of a firm should consider all types of stakeholders of the firm.

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Appendix A: Definitions of variables used in this paper

Table A. Variable definitions

Variable	Definition
CSR	The total number of strengths across the five dimensions of community, diversity, employee relations, environment, and product minus the total number of concerns across the same five dimensions.
Education Rank 1970	The rank of the education level of the state in 1970 where the firm's headquarter locates now. The education level is defined as the percentage of residents with bachelor degree or above of the total population in the state. The higher the rank, the higher the education level of the state in 1970.
Firm Age	The natural logarithm of one plus the number of years from the year in which the firm appeared in CRSP for the first time to year t-1.
Firm Risk	Firm risk is measured by firm's book leverage which is defined as book value of debt divided by the sum of equity and book value of debt in year t-1.
Firm Size	The natural logarithm of firm's total assets in year t-1.
GPM	The gross profit margin ratio defined as firm's sales minus cost of goods sold (COGS), scaled by sales.
HIndex	Herfindahl index based on 2-digit-SIC industry defined as sum of the square of market share of all firms in the same industry.
LnCoverage	The natural logarithm of one plus the number of analysts covering the firm in year t-1.
Market Munificence	Industry mean of the market-to-book ratio in year t-1. Industry is defined based on 2-digit SIC code.
LnNum_Patent	The natural logarithm of one plus the number of patents filed and approved by the firm in year t-1.
LnNum_Cites	The natural logarithm of one plus the number of citations received by the patents filed by the firm in year t-1.
Q	The market-to-book ratio defined as the market value of equity plus the book value of liabilities divided by total assets at the end of year t-1.
R&D Stock	Capitalized R&D expenditure in year t-1.
R&D Stock KR	It takes the value of R&D Stock if R&D Stock is positive. It is treated as missing if the firm is with zero R&D Stock but has filed patents during year t-5 to t-1.
R&D Stock non-missing	It takes the value of R&D Stock if R&D Stock is positive. It is treated as missing if the firm is with zero R&D Stock.
ROA	Return on assets in year t-1, which is defined by income before extraordinary items scaled by total assets.

Table 1. Descriptive statistics and correlations

Variable	Mean	Median	STD.	1	2	3	4	5	6	7	8
1. R&D Stock	0.132	0.000	0.258								
2. Q	1.904	1.478	1.189	0.341							
3. ROA	0.038	0.039	0.085	-0.239	0.282						
4. Firm Size	7.426	7.322	1.663	-0.311	-0.320	0.033					
5. LnCoverage	1.981	2.079	0.811	0.074	0.228	0.137	0.421				
6. Firm Age	2.977	2.944	0.691	-0.112	-0.181	0.102	0.386	0.030			
7. Firm Risk	0.327	0.313	0.263	-0.318	-0.382	-0.183	0.473	-0.034	0.140		
8. Market Munificence	1.816	1.655	0.684	0.413	0.555	0.076	-0.333	0.113	-0.182	-0.344	
9. CSR	-0.198	-0.250	0.569	0.061	0.071	0.075	0.249	0.201	0.123	0.021	0.052

N=18,192; See Appendix for variable definitions.

We report raw values of our moderating variables in the table. Pairwise correlation coefficients are reported.

Table 2. Regression analysis of R&D Stock on a firm's CSR

We use the following model:

$$CSR_{i,t} = \alpha + \beta * R\&D\ Stock_{i,t-1} + \gamma * Controls + \varepsilon_{i,t}$$

	CSR		
	(1)	(2)	(3)
R&D Stock	0.188	0.046	0.185
	(0.045)	(0.012)	(0.024)
Q	0.026	0.006	-0.008
	(0.007)	(0.002)	(0.004)
ROA	0.336	0.136	0.265
	(0.077)	(0.029)	(0.047)
Firm Size	0.104	0.037	0.079
	(0.011)	(0.003)	(0.005)
LnCoverage	0.036	0.012	0.026
	(0.013)	(0.004)	(0.007)
Firm Age	0.047	0.007	0.010
	(0.014)	(0.004)	(0.010)
Firm Risk	-0.081	-0.030	-0.037
	(0.041)	(0.011)	(0.022)
Market Munificence	0.065	0.018	0.030
	(0.016)	(0.005)	(0.008)
Prior CSR		0.849	
		(0.007)	
Intercept	Yes	Yes	Yes
Firm random effects	No	No	Yes
Industry fixed effects	Yes	Yes	No
Year fixed effects	Yes	Yes	Yes
Adjusted R^2	0.180	0.721	0.134
Observations	18,192	18,192	18,192

Heteroskedasticity robust standard errors are clustered by firm and are reported in parentheses. See Appendix for variable definitions.

Table 3. IV Regression analysis of R&D Stock on a firm's CSR

We use the following model in the first stage:

$$R\&D\ Stock_{i,t-1} = \beta_0 + \beta_1 * IV + \beta_2 * Controls + v_{i,t-1}$$

and the following model in the second stage:

$$CSR_{i,t} = \gamma_0 + \gamma_1 * R\&D\ \widehat{Stock}_{i,t-1} + \gamma_2 * Controls + \varepsilon_{i,t}$$

$R\&D\ \widehat{Stock}_{i,t-1}$ is the predicted value of *R&D Stock* from the first stage model.

	R&D Stock	*CSR*
	(1)	(2)
Education Rank 1970	0.002	
	(0.000)	
$R\&D\ \widehat{Stock}_{i,t-1}$		1.592
		(0.452)
Q	0.039	-0.030
	(0.004)	(0.020)
ROA	-0.873	1.592
	(0.049)	(0.413)
Firm Size	-0.019	0.131
	(0.003)	(0.014)
LnCoverage	0.025	-0.002
	(0.004)	(0.018)
Firm Age	0.018	0.027
	(0.005)	(0.016)
Firm Risk	-0.103	0.075
	(0.014)	(0.066)
Market Munificence	0.050	-0.008
	(0.007)	(0.029)
Intercept	Yes	Yes
Industry fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Cragg-Donald F-Statistics	223.812	
Adjusted R^2	0.502	0.176
Observations	18,192	18,192

Heteroskedasticity robust standard errors are clustered by firm and are reported in parentheses. See Appendix for variable definitions.

Table 4. Regression analysis of the moderating effects

We use the following model:

$$CSR_{i,t} = \theta_0 + \theta_1 * R\&D\ Stock_{i,t-1} + \theta_2 * Moderating\ variable * R\&D\ Stock_{i,t-1} + \theta_3 * Controls + \varepsilon_{i,t}$$

	CSR		
	(1)	(2)	(3)
R&D Stock	0.120	0.414	0.363
	(0.046)	(0.110)	(0.110)
Q	0.026	0.027	0.027
	(0.007)	(0.007)	(0.007)
ROA	0.335	0.299	0.295
	(0.077)	(0.076)	(0.075)
Firm Size	0.106	0.104	0.106
	(0.011)	(0.011)	(0.011)
LnCoverage	0.034	0.036	0.034
	(0.013)	(0.013)	(0.013)
Firm Age	0.044	0.047	0.044
	(0.014)	(0.014)	(0.014)
Firm Risk	-0.144	-0.078	-0.142
	(0.044)	(0.041)	(0.044)
Market Munificence	0.062	0.080	0.078
	(0.016)	(0.016)	(0.016)
*R&D Stock * Firm Risk*	0.488		0.501
	(0.137)		(0.136)
*R&D Stock * Market Munificence*		-0.094	-0.102
		(0.039)	(0.039)
Intercept	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Adjusted R^2	0.182	0.181	0.183
Observations	18,192	18,192	18,192

Heteroskedasticity robust standard errors are clustered by firm and are reported in parentheses. See Appendix for variable definitions.

Table 5. Robustness check: using alternative measures of innovation activities

Panel A. Alternative product specificity measures

	(1)	(2)	(3)	(4)	(5)
R&D Stock KR	0.193				
	(0.045)				
R&D Stock non-missing		0.208			
		(0.048)			
R&D Stock Rank			0.019		
			(0.005)		
LnNum_Patent				0.061	
				(0.011)	
LnNum_Cites					0.036
					(0.007)
MTB	0.026	0.029	0.029	0.020	0.021
	(0.007)	(0.009)	(0.007)	(0.008)	(0.008)
ROA	0.345	0.416	0.238	0.296	0.284
	(0.078)	(0.093)	(0.068)	(0.085)	(0.085)
Firm Size	0.108	0.148	0.102	0.045	0.052
	(0.011)	(0.018)	(0.011)	(0.011)	(0.011)
LnCoverage	0.033	0.022	0.037	0.020	0.021
	(0.013)	(0.021)	(0.013)	(0.014)	(0.014)
Firm Age	0.045	0.053	0.045	0.043	0.046
	(0.014)	(0.023)	(0.014)	(0.015)	(0.015)
Firm Risk	-0.070	-0.102	-0.086	-0.057	-0.069
	(0.042)	(0.067)	(0.041)	(0.046)	(0.046)
Market Munificence	0.066	0.095	0.066	0.062	0.063
	(0.017)	(0.025)	(0.016)	(0.017)	(0.017)
Intercept	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.181	0.237	0.179	0.179	0.174
Observations	16,884	8,191	18,192	11,893	11,893

Panel B. Alternative CSR measures

	CSR_Strength	*CSR_Concern*	Raw CSR
	(1)	(2)	(3)
R&D Stock	1.011	0.169	0.826
	(0.185)	(0.042)	(0.092)
MTB	0.148	0.035	-0.011
	(0.030)	(0.008)	(0.016)
ROA	1.364	0.437	1.083
	(0.307)	(0.097)	(0.173)
Firm Size	0.611	0.165	0.419
	(0.045)	(0.009)	(0.020)
LnCoverage	0.124	0.043	0.152
	(0.052)	(0.013)	(0.027)
Firm Age	0.158	0.016	0.008
	(0.055)	(0.013)	(0.039)
Firm Risk	-0.520	-0.130	-0.219
	(0.164)	(0.038)	(0.083)
Market Munificence	0.288	0.058	0.138
	(0.064)	(0.017)	(0.030)
Prior CSR		0.901	
		(0.006)	
Intercept	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Adjusted R^2	0.393	0.200	0.250
Observations	18,192	18,192	18,192

Heteroskedasticity robust standard errors are clustered by firm and are reported in parentheses. See Appendix for variable definitions.

Table 6. The implication of future performance

We use the following model:

$$\overline{ROA}_{i,t+k} = \rho_0 + \rho_1 * CSR_{i,t} + \rho_2 * CSR * R\&D\ Stock_{i,t} + \rho_3 * R\&D\ Stock_{i,t} + \rho_4 * Controls + \varepsilon_{i,t+k}$$

	ROA_{t+1}	Average Future $ROA_{t+1,t+3}$
	(1)	(2)
CSR	-0.001	0.001
	(0.001)	(0.001)
CSR R&D Stock*	0.022	0.014
	(0.006)	(0.008)
R&D Stock	-0.048	-0.036
	(0.005)	(0.006)
MTB	0.014	0.015
	(0.001)	(0.001)
ROA	0.571	0.398
	(0.017)	(0.016)
Firm Size	-0.000	0.000
	(0.001)	(0.001)
LnCoverage	0.004	0.001
	(0.001)	(0.001)
Firm Age	0.009	0.011
	(0.001)	(0.001)
Firm Risk	0.008	0.005
	(0.003)	(0.004)
Market Munificence	-0.006	-0.006
	(0.001)	(0.002)
Intercept	Yes	Yes
Industry fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Adjusted R^2	0.437	0.422
Observations	18,192	13,870

Heteroskedasticity robust standard errors are clustered by firm and are reported in parentheses. See Appendix for variable definitions.