The Role of Corporate Social Responsibility in Affecting Operational Efficiency: Evidence from China

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Compliance with Ethical Standards

All authors declare that there's no conflict of interest.

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Abstract

This study delves into the relationship between corporate social responsibility (CSR) and operational efficiency. By examining a sample of publicly traded Chinese firms, we find that firms with higher CSR performance are associated with higher operational efficiency. This relationship remains robust after we employ an instrumental variable approach using local CSR intensity as a proxy. Additionally, our cross-sectional analyses suggest that the association between CSR performance and operational efficiency becomes stronger for firms with better financial conditions, fewer uncertainties related to litigation, information, and suppliers, and more intense industry competition. Our findings are consistent with alternative model specifications. Overall, our study provides evidence to highlight the positive role of CSR engagement regarding operational efficiency, which is meaningful for firms seeking operational efficiency improvement.

Keywords: *corporate social responsibility; operational efficiency; financial condition; uncertainty; industry competition*

1. Introduction

With the ongoing degradation of the ecological environment and the rise in corporate scandals, there's a growing awareness of the importance of sustainable development. Consequently, individuals are pressing companies to fulfill their corporate social responsibilities (CSRs). Many companies are responding to stakeholders' ethical expectations by undertaking CSR initiatives, but the results vary. While some evidence suggests that CSR involvement positively impacts a company's progress by enhancing firm value, fostering customer loyalty, boosting employee morale, and reducing the risk of financial downturns (Bardos et al., 2020, Kim et al., 2014, Branco and Rodrigues, 2006, Lee et al., 2012). Nevertheless, dissenting opinions are present. Some managers question whether CSR involvement truly affects a firm and even warn against the notion of a "CSR bubble." Academic research also indicates that CSR engagement can have adverse effects under certain conditions. For instance, López et al. (2007) demonstrate that CSR adoption among European firms correlates negatively with performance. Similarly, Li et al. (2021) find a positive relationship between CSR engagement and a firm's idiosyncratic risk beyond a specific threshold.

Furthermore, research perspectives on the impact of CSR engagement are often limited. Many studies concentrate on financial performance metrics such as returns on assets (ROA), Tobin's Q, idiosyncratic risk, and stock price crash risk (e.g., Wang et al. (2015), Kim et al. (2014), Mishra and Modi (2013)). Recently, there has been a growing body of literature examining the link between CSR engagement and specific stakeholder responses (e.g., Shen and Benson (2014), Luo and Bhattacharya (2006)). However, there is a lack of understanding regarding the role of CSR engagement in a firm's operations management. This area of exploration is crucial as it can either enhance the efficiency of production and business operations or divert firms from their core business objectives and strategies. Our study aims to contribute comprehensive evidence on how

operational efficiency is influenced by CSR engagement and the underlying variations in this relationship. Such evidence can offer a deeper understanding of CSR engagement and provide valuable guidance for modern firms seeking to improve operational efficiency.

To delve into the discussed topic, we establish the rationale behind the relationship between CSR and operational efficiency. Operational efficiency gauges a firm's effectiveness in converting various operational inputs into output. CSR engagement can impact operational efficiency through key participants in this process, including employees, managers, and consumers.

For employees, CSR engagement has the potential to enhance productivity. Specifically, it can bolster employees' organizational identification, thereby improving task performance (Shen and Benson, 2014). Moreover, previous research suggests that CSR engagement can effectively diminish employee turnover costs and absenteeism by offering more meaningful job opportunities (Carnahan et al., 2016, Branco and Rodrigues, 2006). Consequently, CSR practices can efficiently mitigate additional recruitment and training costs resulting from absenteeism, free riding, and turnover.

In the case of managers, CSR engagement can cut costs by enhancing the quality of information used for operational decisions. Studies indicate that inaccurate information can lead to suboptimal management decisions (e.g., overforecasting and underforecasting), leading to increased costs (e.g., inventory costs (Cheng et al., 2018)). By attracting stakeholder attention to information quality, CSR engagement reduces the likelihood of information manipulation by the firm (Wang et al., 2018). Thus, CSR engagement can diminish operational costs stemming from misinformation.

Regarding consumers, CSR engagement can stimulate market demand by attracting ethical consumers and bolstering brand identification and consumer satisfaction (He and Li, 2011, Park et al., 2017). Consequently, heightened CSR engagement translates into increased operational output (i.e., operational income). Drawing from the aforementioned studies, we posit that CSR

engagement positively influences a firm's operational efficiency.

To investigate the correlation between CSR engagement and operational efficiency, we analyze a sample of Chinese listed firms spanning from 2010 to 2019. Drawing from previous studies (e.g., Li et al. (2010), Lam et al. (2016), Li et al. (2022)), we gauge operational efficiency using stochastic frontier estimation, which assesses a firm's effectiveness in converting operational inputs into output. Additionally, we utilize a comprehensive CSR score from Hexun as a proxy for CSR engagement, aligning with the approach taken by Li et al. (2021). Our regression findings indicate that firms with greater CSR engagement tend to exhibit higher operational efficiency. To address potential omitted variable concerns, we employ the two-stage least squares (2SLS) method, leveraging an instrumental variable (IV) to capture exogenous variations in CSR engagement. Following the methodology of Jiraporn et al. (2014), we use the average CSR score of geographically proximate firms as our instrument. Our analysis reveals a consistently positive impact of instrumented CSR engagement on operational efficiency, lending robust support to our main findings.

Moreover, we delve into cross-sectional analysis to deepen our comprehension of the relationship between CSR engagement and operational efficiency. Initially, we explore whether a firm's financial health influences this relationship. Previous research suggests that the positive impact of CSR engagement is more pronounced for firms in better financial conditions (e.g., Koh et al. (2014)). This is because poorly performing firms often struggle to offer attractive compensation and benefits to stakeholders. Consequently, stakeholders such as employees and consumers may exhibit less enthusiastic responses to CSR engagement initiatives (Wang and Qian, 2011). Inspired by previous literature (e.g., Ou and Penman (1989), Piotroski (2000a), Bates et al. (2009), Fama and French (2015)), we develop four metrics to assess a firm's profitability, cash reserves, financial liquidity, and overall financial health. Our empirical findings align with our

hypothesis, indicating that the relationship between CSR engagement and operational efficiency weakens for firms with poorer financial conditions.

Additionally, we investigate whether uncertainties surrounding a firm influence the impact of CSR engagement on operational efficiency. Intuitively, managing uncertainties consumes a firm's resources, such as litigation costs and expenses associated with recovering from supply chain disruptions. In such scenarios, a firm facing greater uncertainties is expected to allocate more resources to ensure profitability. Otherwise, the costs induced by uncertainties may elevate the risk of bankruptcy for the firm. To validate our hypothesis, we initially employ litigation and arbitration events to gauge a firm's litigation uncertainty. Subsequently, drawing from Li and Zaiats (2017), we use the dispersion of analyst earnings forecasts as a proxy for information uncertainty. Finally, following the approach of Peng et al. (2020) a , we calculate the standard deviation of suppliers over the past three years to measure supplier uncertainty. Consistent with our conjecture, our analysis reveals that the relationship between CSR engagement and operational efficiency is less pronounced for firms facing greater litigation, information, and supplier uncertainties.

Furthermore, we investigate the influence of pressure from industry competition. Intense competition within an industry can have dual effects: it can motivate "lazy" managers and employees to work harder (Aghion et al., 2013), while also enhancing the value of unique product attributes in a crowded marketplace (Bardos et al., 2020). CSR attributes can contribute to a product's uniqueness, attracting demand from ethical consumers. Thus, we hypothesize that pressure from industry competition strengthens the impact of CSR engagement on operational efficiency. Empirical evidence supports our conjecture, indicating a more pronounced relationship between CSR engagement and operational efficiency for firms operating in highly competitive industries.

Finally, we undertake further analyses to validate the robustness of our primary findings. The

first concern revolves around the potential bias induced by omitted regional factors. Geographical proximity fosters information flow among firms, which has been shown to positively influence both CSR engagement and operational efficiency (Husted et al., 2016, Lam et al., 2016). Therefore, there's a possibility that our baseline results are driven by regional information flow. To address this concern, we exclude firms located in first-tier cities, which typically benefit from advanced information and technologies. Additionally, we incorporate city fixed effects to control for unobserved city-level factors, such as regional policies that might simultaneously influence CSR investment and corporate operations. Our analysis demonstrates that the empirical results remain robust, indicating that our findings are not biased due to omitted regional factors. The second concern pertains to unobserved firm-level characteristics, such as managerial ability and corporate culture. To alleviate this concern, we include firm fixed effects and find that the results remain consistent. Thus, it is less likely that the impact of CSR engagement on operational efficiency is biased due to unobserved firm-level factors. The third concern revolves around the possibility that our findings are driven by Merger & Acquisition (M&A) activities. Firms can potentially enhance moral capital and operational efficiency through M&As, which could bias our results. To address this concern, we exclude firm-year observations involved in M&A activities. Upon analyzing the subsample, we find that the relationship between CSR engagement and operational efficiency remains robustly positive.

This study contributes to the existing literature in several key ways. Firstly, it enriches the literature on the impact of CSR engagement, particularly focusing on its positive aspects. Previous research has extensively documented the beneficial effects of CSR engagement, including enhancements in product market perception, firm value, social externalities, employee and customer perceptions, and reductions in stock price crash risk (Bardos et al., 2020, Chen et al., 2018, Kim et al., 2014, Lee et al., 2013). Our study complements this body of literature by

examining CSR engagement from the perspective of operations management. By demonstrating that CSR engagement can indeed enhance a firm's operational efficiency, our findings offer valuable insights for managers grappling with concerns regarding the "CSR bubble." Moreover, our study aligns with the resource-based view, suggesting that CSRs can cultivate unique resource advantages, thereby augmenting a firm's competitive edge.

Secondly, our study contributes to the literature on operational efficiency. The enhancement of a firm's operational efficiency has been a topic of formal discussion for many years. Within existing literature, one strand focuses on the influence of managerial decisions on operational efficiency. For instance, Lam et al. (2016) demonstrate that a firm's social media initiatives can bolster its operational efficiency, while Cheng et al. (2018) reveal that material weaknesses in internal control mechanisms can diminish it. Li et al. (2022) highlight how the appointment of Chief Risk Officers can positively impact a firm's operational efficiency. Our study extends this line of inquiry by examining the role of CSR engagement, which has garnered increasing attention in recent years. We find evidence suggesting that CSR engagement can serve as a valuable tool for managers seeking to enhance operational efficiency. Additionally, our findings reveal that the strength of the positive relationship between CSR engagement and operational efficiency may vary depending on certain corporate characteristics, such as financial conditions, corporate uncertainties, and industry competition. This nuanced understanding adds depth to the literature on operational efficiency and sheds light on the multifaceted nature of CSR engagement's impact on firm performance.

2. Hypothesis development

This section formulates testable hypotheses regarding the relationship between a firm’s CSR performance and its operational efficiency. CSR engagement can influence various stakeholders during operations, including employees, managers, and consumers. Based on the impact on these

stakeholders, we posit that CSR engagement can promote operational efficiency for the following reasons:

For employees, CSR engagement can foster stronger attachment among employees to the firm, leading to improved employee performance and reduced turnover rates. Firms with a positive CSR reputation are more likely to attract employees, and CSR initiatives directed at employees can enhance task performance and extra-role helping behavior through increased organizational identification (Shen and Benson, 2014, Turban and Greening, 1997). Moreover, when firms align their ethical values with employees' perceptions, employees experience greater satisfaction and organizational commitment, thereby reducing turnover rates (Sims and Keon, 1997). Consequently, CSR engagement can mitigate costs associated with employee absenteeism and turnover. Furthermore, previous research suggests that employee attitudes influence service quality, customer satisfaction, and profitability (Ton and Huckman, 2008, Yee et al., 2008). CSR engagement may also enhance operational efficiency by improving operational income.

For managers, CSR engagement positively impacts the quality of information used for managerial decisions, thereby reducing costs associated with misreports. Operational decisions made by managers rely on accurate report information. Inaccurate reports can lead to suboptimal operational decisions, such as underpredicting or overpredicting, resulting in insufficient or excessive stock of raw materials. This, in turn, leads to increased costs for rushed overtime material preparation or excess inventory storage (Feng et al., 2009). Cheng et al. (2018) provide evidence supporting this, demonstrating that low-quality information stemming from material weaknesses in internal control diminishes a firm's operational efficiency, while remediation of these weaknesses improves operational efficiency. Previous literature indicates that CSR engagement can enhance information quality. Ethical positions can help identify misconduct during operations (Rodgers et al., 2015). Consequently, firms with mandatory CSR disclosure tend to engage in

weaker earnings management and exhibit higher information quality (Wang et al., 2018). Therefore, CSR engagement may enhance a firm's operational efficiency by reducing costs associated with misreports.

For consumers (market), CSR engagement increases consumer loyalty and market demand, thereby boosting operating income. For instance, Marin et al. (2009) demonstrate that CSR initiatives contribute to customer loyalty through positive evaluation and identification. Similarly, Park et al. (2017) document a positive relationship between CSR engagement and customer loyalty driven by satisfaction and induced trust. Ultimately, socially responsible practices respond to the demands of ethical consumers, which translate into actual demand and improved operating income (Kuokkanen and Sun, 2020, Wong et al., 2018). For instance, Nyame-Asiamah and Ghulam (2020) illustrate that CSR activities can increase a firm's sales. Drawing from this literature, we propose our first hypothesis:

H1: CSR engagement is positively related to a firm's operational efficiency.

Prior evidence suggests that the value derived from CSR activities is influenced by firms' financial conditions. Specifically, firms experiencing financial distress have a reduced capacity to offer desirable dividends for shareholders, job security for employees, and high-quality products and services for customers (Suchman, 1995). Engaging in CSR activities may conflict with the core objectives of operations, as it involves allocating resources away from core business activities. Consequently, stakeholders are more likely to expect firms facing financial distress to prioritize allocating their limited resources towards improving profitability through core business operations rather than engaging in CSR activities. In other words, stakeholders have lower expectations and attach less value to poorly performing firms in terms of their moral investment (Wang and Qian, 2011). Consistent with this perspective, Koh et al. (2014) demonstrate that the positive impact of

corporate social performance on firm value diminishes for firms experiencing financial distress. Building on this literature, our third hypothesis is proposed as follows:

H2: The positive relationship between CSR engagement and operational efficiency is less pronounced for firms with worse financial conditions.

Moreover, uncertainties surrounding firms may also influence the impact of CSR engagement on operational efficiency. Firstly, firms must allocate resources to cover costs induced by uncertainty. For instance, firms involved in lawsuits must bear significant litigation expenses, leading to decreased resource availability (i.e., pecuniary costs). Additionally, litigation events can incur nonpecuniary costs, such as wasted managerial time and attention on nonproductive activities, and reductions in reputation and incentives (Hassan et al., 2021). Therefore, stakeholders express greater concerns about firms with higher levels of uncertainty, potentially exhibiting fewer positive responses to their moral engagement.

Secondly, uncertainties can significantly hinder a firm's development, resulting in reduced corporate performance and increased risks (Hendricks and Singhal, 2005b, Hendricks and Singhal, 2005a). Specifically, Hendricks and Singhal (2005a) indicate that supply-chain disruptions lead to a 107% reduction in operating income, a 114% reduction in return on sales, and a 92% reduction in return on assets. Barron et al. (2009) demonstrate that firms with a high dispersion in analyst earnings forecasts (i.e., external investors' perceptions of a firm's prospects) are more likely to experience higher idiosyncratic risk.

The evidence presented suggests that firms facing uncertainties must prioritize resource allocation to recover from them in the short term. Failure to do so could jeopardize a firm's ability to meet basic demands, increasing the risk of bankruptcy due to sustained poor performance. Consequently, when firms face heightened uncertainties, they are more susceptible to operational

disruptions. As a result, the effect of CSR engagement on operational efficiency weakens. In summary, we propose our third hypothesis as follows:

H3: The positive relationship between CSR engagement and operational efficiency is less pronounced for firms with higher uncertainties.

As CSR engagement can enhance operational efficiency through increased market demand, we anticipate that the positive relationship between CSR engagement and operational efficiency is more pronounced for firms facing more intense market competition.

Firstly, market competition exerts pressure on "lazy" managers and employees to work harder instead of resting on their laurels (Aghion et al., 2013). Thus, if CSR engagement can improve operational efficiency through internal stakeholders (e.g., employees and managers), this positive effect should be more pronounced when the pressure from market competition is higher.

Secondly, intense market competition typically signifies high substitutability among products within the current market. In such circumstances, enhancing the uniqueness of a firm's products becomes more valuable. Conversely, a firm offering homogeneous commodities in a fiercely competitive market faces volatile market demand, quickly rendering existing inventories obsolete (Han et al., 2017). Evidence suggests that CSR attributes can capture consumers' attention and preferences, adding value to firms' products (Surroca et al., 2010, Kihlstrom and Riordan, 1984). Therefore, compared to other markets, a firm's CSR engagement in a market with more intense competition is more likely to enhance the firm's output given its inputs.

In summary, our fourth hypothesis is proposed as follows:

H4: The positive relationship between CSR engagement and operational efficiency is more pronounced for firms with more intense industry competition.

3. Data, variable construction, and description

3.1 Operational efficiency

Following previous studies (e.g., Li et al. (2010), Li et al. (2022)), we measure operational efficiency using stochastic frontier estimation, which assesses a firm's efficiency in converting various operational inputs into operational output. Mathematically, we construct a stochastic function as shown in the following equation:

$$y_{i,j,t} = \beta_0 + \beta_1 emp_{i,j,t} + \beta_2 cgs_{i,j,t} + \beta_3 cap_{i,j,t} + \beta_4 emp^2_{i,j,t} + \beta_5 cgs^2_{i,j,t} + \beta_6 cap^2_{i,} \\ cgs_{i,j,t} + \beta_8 emp_{i,j,t} cap_{i,j,t} + \beta_9 cgs_{i,j,t} cap_{i,j,t} + v_{i,j,t} - u_{i,j,t} \quad (1)$$

where i, j, and t, are firm, industry[1], and year indexes, respectively; $y_{i,j,t}$ is the natural log of operating income; $emp_{i,j,t}$ represents the natural log of the number of employees; $cgs_{i,j,t}$ denotes the natural log of cost of goods sold; and $cap_{i,j,t}$ is the natural log of capital expenditure. Inspired by Li et al. (2022), we also include the possible interactions among the three operational inputs to better capture the complex relationships between operational inputs and output. $v_{i,j,t}$ is the stochastic random error that follows $N(0,\sigma_v^2)$; whereas $u_{i,j,t}$ captures a firm's technical inefficiency compared with the most efficient firm (i.e., the frontier) and follows $N^+(0,\sigma_u^2)$, that is, $u_{i,j,t}$ follows the so-called half normal distribution.

Based on the above assumptions, we use the maximum likelihood estimating method to estimate the parameters ($\vec{\beta}$, σ_v^2, σ_u^2). With the parameters in hand, we then estimate the total residual term $\varepsilon_{i,j,t}$, which equals $v_{i,j,t} - u_{i,j,t}$. Next, we let $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\lambda = \sigma_u/\sigma_v$, and estimate $u_{i,j,t}$ as the conditional expectation of $u_{i,j,t}$ given $\varepsilon_{i,j,t}$ as follows[2]:

[1] Industries are defined using the CSRC classification method.

[2] The estimating method is first documented by JONDROW, J., KNOX LOVELL, C. A., MATEROV, I. S. & SCHMIDT, P. 1982. On the estimation of technical inefficiency in the stochastic frontier production function model. *Journal of Econometrics,* 19**,** 233-238. and is widely used to estimate the firm-specific efficiency in later literature.

$$\hat{u}_{i,j,t} = E[u_{i,j,t}|\varepsilon_{i,j,t}] = \sigma_* \left[\frac{\varphi(b_{i,j,t})}{1 - \Phi(b_{i,j,t})} - b_{i,j,t} \right] \quad (2)$$

where $\sigma_*^2 = \sigma_v^2 \sigma_u^2 / \sigma^2$, $b_{i,j,t} = \varepsilon_{i,j,t} \lambda / \sigma$, $\varphi(\cdot)$ represents the standard normal density function, and $\Phi(\cdot)$ is the standard normal cumulative distribution function. As our stochastic function takes the translog form with $u_{i,j,t} \geq 0$, we then calculate the operational efficiency as follows:

$$OpEfficiency_{i,j,t} = e^{-\hat{u}_{i,j,t}} \quad (3)$$

Hence, $OpEfficiency_{i,j,t}$ is a direct indication of a firm's operational efficiency, and ranges from 0 to 1 with $OpEfficiency_{i,j,t} = 1$ representing a firm without operational inefficiency.

3.2 Corporate social responsibility

The annual CSR data for all A-share firms listed on the Shenzhen Stock Exchange and Shanghai Stock Exchange are gathered from Hexun, a third-party CSR rating agency. Hexun has been conducting professional evaluations of CSR for each listed firm annually since 2010, utilizing information from annual reports, CSR reports, and other public sources. Hexun's CSR score comprises five main aspects: shareholder responsibility, employee responsibility, supplier and consumer responsibility, environmental responsibility, and social responsibility, each consisting of secondary and tertiary items[3]. The CSR scores provided by Hexun are widely regarded as comprehensive and reasonable indices for CSR engagement and are commonly utilized in existing studies (e.g., Zhao and Xiao (2019), Shou et al. (2020), Wen et al. (2021), Li et al. (2021)). Therefore, we collect the total CSR score for each listed firm annually from Hexun and employ it as our measure of CSR engagement (*CSR_score*).

[3] See more information on http://stock.hexun.com/2013/gsshzr/index.html (in Chinese).

3.3 Controls related to firm characteristics

To examine the effect of CSR on operational efficiency, we adopt control variables drawn from previous literature that may influence our estimations. We utilize firm-specific financial data obtained from the China Stock Market & Accounting Research (CSMAR) database. The control variables include: *LogAsset* measures the firm size and equals the logarithm of total assets. *ROA* is the return on assets and equals earnings divided by total assets. *Leverage* captures the long-term solvency, which equals total debts divided by the total assets. *LogAge* controls for the effect of firms' life cycle dynamics on CSR, which is represented by the logarithm of the number of years since the listing date. *MarketToBook* reflects a firm's growth opportunities, which is calculated as the market value of equity divided by the book value. *Cash_ratio* equals cash holding divided by total assets. *RD_ratio* is the ratio of R&D expenses to total assets. Additionally, we employ several variables to control for the effect of corporate governance. *InstituHoldRatio* measures the institutional holding ratio and equals the number of institutional holding shares divided by the number of shares outstanding. *CEO_duality* is a dummy variable that equals one if a firm's CEO is also the president or chair of the board and 0 otherwise. *SOE* is a dummy variable representing the ownership type, with a value of one for state-owned firms and 0 otherwise. Industry-level control variables are not included as we introduce industry-year fixed effects in our regression specifications to capture all time-variant variations across industries. Detailed information on variable construction is available in Appendix A.

3.4 Descriptive statistics

We present our sample selection process in Panel A of Table 1. Initially, we gather 29,398 firm-year observations encompassing 3,874 unique firms listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange in China from 2010 to 2019. We begin by removing 6,445 firm-

year records with missing values in operational efficiency. Subsequently, we exclude firm-year records with missing values in CSR scores or other control variables. This refinement results in a final sample of 22,780 firm-year observations representing 3,606 unique listed firms.

Panel B provides a breakdown of the sample distribution by year from 2010 to 2019. The composition of the sample has remained relatively balanced over the years. With the evolution of China's stock market, the proportion of firms each year has gradually increased from 7.01% to 12.98%.

In Panel C, we depict the sample distribution across industries. We categorize all firms based on the CSRC 2012 industry classification code (ICC) and observe that the majority of observations (62.68%) are concentrated in the manufacturing industry (ICC: C). Only 0.21% of observations pertain to the education industry (ICC: P).

Insert Table 1 here

Table 2 presents the summary statistics of variables utilized in the empirical regressions, encompassing the number of observations, mean, standard deviation, minimum, maximum, and percentiles. To mitigate the influence of extreme values, we winsorize all non-binary variables at 1% in both tails. The average value of our CSR engagement measure (*CSR_score*) is 0.257, with a standard deviation of 0.153. Our CSR engagement measure aligns with Li et al. (2021), as their study reports a mean and standard deviation of 0.262 and 0.186, respectively.

The highest value of operational efficiency (*OpEfficiency*) is 0.801, while the lowest is 0.042, indicating significant variability in operational efficiency. Regarding the control variables, the mean values of logged firm size, ROA, leverage, logged firm age, market-to-book ratio, cash ratio, and R&D ratio are approximately 8.290, 0.048, 0.407, 2.055, 2.428, 0.179, and 0.002, respectively.

Concerning corporate governance for listed firms, on average, institutional holdings represent about 44.5% of shares, approximately 4.5% of CEOs concurrently serve as the president or chair of the board, and around 35% of firms are state-owned.

Insert Table 2 here

Table 3 presents the Pearson correlation matrix between variables in the lower triangle and the Spearman correlation matrix between variables in the upper triangle. Correlations significant at least at the 5% level are denoted with *. The correlations largely align with our expectations, whether utilizing Pearson or Spearman correlation.

Insert Table 3 here

Specifically, operational efficiency (*OpEfficiency*) exhibits a significantly positive correlation with the measure of CSR engagement (*CSR_score*), offering initial support for our hypothesis H1. Furthermore, operational efficiency demonstrates positive associations with ROA, firm size, and firm age, indicating that more profitable, larger, and older firms tend to have higher operational efficiency. Additionally, firms with stronger solvency display higher operational efficiency, as evidenced by the negative correlation between operational efficiency and leverage, and the positive correlation between operational efficiency and cash hold ratio.

4. Main results

4.1 Baseline model

To test hypothesis H1, which predicts a positive association between a firm's CSR engagement and operational efficiency, we employ the following regression model:

$$OpEfficiency_{i,t+1} = \alpha_1 + \beta_1 \times CSR\_score_{i,t} + \lambda_n \times \overrightarrow{Controls_{n,i,t}} + \gamma_j + \eta_t + \varepsilon_{i,t} \quad (4)$$

where $OpEfficiency_{i,t+1}$ is firm *i*'s efficiency in transforming operational inputs into output based on stochastic frontier estimation in year *t+1*; $CSR\_score_{i,t}$ is the CSR scores of firm *i* in year *t*

obtained from Hexun; $\overrightarrow{Controls_{n,i,t}}$ denotes a series of control variables described in Section 3.3. The observations are at the firm-year level, and all independent variables are measured in year *t*. In our initial specification, γ_j represents the industry fixed effect, while η_t represents the year fixed effect. In the second specification, we also include industry-year fixed effects to account for time-variant industrial fixed effects. All standard errors are clustered at the firm level. In the equation provided, our focus lies on coefficient β_1, which represents the impact of *CSR_score* on the firm's operational efficiency. This coefficient is of particular interest as it captures the effect of CSR on operational efficiency.

Insert Table 4 here

Table 4 presents the results obtained from employing the OLS regression model based on Eq. (4). In Column (1), where only industry fixed effects and year fixed effects are included, the coefficient on *CSR_score* is negative and statistically significant at the 1% level (0.349 with t = 26.36). This negative association aligns with H1, indicating that a firm's CSR engagement is indeed influential and can contribute to enhancing its operational efficiency. The coefficient's magnitude implies that a one-standard-deviation increase in CSR engagement leads to approximately a 5.34 percentage point increase in operational efficiency, or about 29.34% of the standard deviation of operational efficiency for the overall sample.

Moving to Column (2), where control variables mentioned in Section 3.3 are added, although the coefficient on *CSR_score* decreases to 0.118, it remains statistically significant at the 1% level with a t-statistic of 10.02. This result suggests that a one-standard-deviation change in CSR is associated with a 9.92% change in the standard deviation of operational efficiency.

Subsequently, Columns (3)-(4) introduce industry-year fixed effects to further control for time-variant industry-level effects, such as industry competition, reform, or regulations. The

coefficients on *CSR_score* remain consistent with those in Columns (1)-(2) in terms of magnitude and significance. Overall, the findings consistently support H1.

Regarding the control variables, it's noteworthy that firms with larger sizes and longer operational histories tend to exhibit higher operational efficiency. This could be attributed to the fact that larger and more established firms often possess mature operational systems, thus leading to enhanced efficiency. Additionally, the significant positive coefficient on ROA suggests that firms with greater profitability tend to demonstrate higher operational efficiency.

Furthermore, the negative coefficients on Leverage and positive coefficients on *Cash_ratio* indicate that firms with stronger financial solvency tend to achieve higher operational efficiency. Additionally, the significant positive coefficient on the institutional holding ratio (*InstituHoldRatio*) implies that firms with better corporate governance structures tend to exhibit greater operational efficiency.

Lastly, the lower operational efficiency observed in state-owned firms may be attributed to reduced managerial flexibility inherent in such organizations.

4.2 Endogeneity issues: instrument variable approach

In this study, the positive correlation between CSR and operational efficiency could potentially face endogeneity concerns stemming from omitted variables. One plausible scenario is the influence of unobserved factors, such as corporate culture, which may simultaneously impact both CSR engagement and operational efficiency. In this context, corporate culture serves as a latent driver shaping the link between CSR and operational efficiency.

To address this potential issue, we employ the 2SLS-IV method, leveraging instrumental variables to introduce exogenous variations in CSR. This approach allows us to investigate the relationship between instrumented CSR and operational efficiency.

$$CSR\_score_{i,t} = \alpha_1 + \vartheta_1 \times CSR\_local\_intensity_{i,t} + \lambda_n \times \overrightarrow{Controls_{n,i,t}} + \gamma_j + \eta_t + \varepsilon_{i,t} \quad (5)$$

$$OpEfficiency_{i,t+1} = \alpha_1 + \beta_1 \times \widehat{CSR\_score}_{i,t} + \lambda_n \times \overrightarrow{Controls_{n,i,t}} + \gamma_j + \eta_t + \varepsilon_{i,t} \quad (6)$$

where $CSR\_local\_intensity_{i,t}$ is the local CSR intensity of firm *i* in year *t*, $CSR\_score_{i,t}$ is the CSR score of firm *i* in year *t*; $OpEfficiency_{i,t+1}$ represents the firm *i*'s efficiency in year *t+1*; $\widehat{CSR\_score}_{i,t}$ is the fitted value of $CSR\_score_{i,t}$ based on the first-stage regression.

We follow Jiraporn et al. (2014) to construct a measure of CSR local intensity, which we utilize as an instrumental variable. Initially, we gather geographical location data from the CSMAR database, encompassing the stock code, year, and headquarters coordinates (longitude and latitude) of each listed firm. This dataset enables us to compute the local CSR intensity for each listed firm, taking into account weighted distances.

To calculate the local CSR intensity, we determine the distances between the focal listed firm and all other firms. We assign weights using the formula $Weight_{i,k,t} = \frac{1}{(1 + d_{i,k,t})}$, where $d_{i,k,t}$ signifies the distance between focal firm *i* and other firm *k* in year *t*. The rationale behind the weight variable ($Weight_{i,k,t}$) is that firms in closer proximity contribute more to the CSR spillover pool around the focal firm *i*. Subsequently, we integrate geographical location data with CSR information using the stock code identifier. The CSR local intensity is formulated as follows:

$$CSR\_local\_intensity_{i,t} = \sum_{k=1}^{K} \left(\frac{Weight_{i,k,t}}{\sum_{k=1}^{K} Weight_{i,k,t}} \times CSR\_score_{k,t} \right) \quad (7)$$

where $CSR\_score_{k,t}$ represents the CSR score of firm *k* (excluding firm *i* itself) in year *t*. A valid IV must satisfy both the relevant and exclusion conditions (Stock and Yogo, 2005). Concerning the relevance condition, local CSR intensity is a significant determinant of the focal firm's CSR engagement (Jiraporn et al., 2014, Husted et al., 2016). Regarding the exclusion condition,

CSR_local_intensity is derived from the CSR engagement of nearby firms, excluding the focal firm. As a result, the operational efficiency of the focal firm is unlikely to be influenced by the CSR activities of other firms. Therefore, we conjecture that the IV *CSR_local_intensity* can meet both the relevant and exclusion conditions.

Results of the IV regression's first stage are reported in Panel A of Table 5. Across all four specifications in Columns (1)-(4), there is a significant relationship between *CSR_local_intensity* and *CSR_score* at the 1% level. This finding aligns with our expectation that higher local CSR intensity correlates with increased CSR engagement.

We also conducted under-identification and weak instrument tests, allowing for clustered errors, under the null hypothesis that the instrument *CSR_local_intensity* is uncorrelated with *CSR_score*. Across Columns (1) to (4), the F-values for the Kleibergen-Paap rk LM statistic range from 79.12 to 118.38, surpassing the critical threshold of 16.38 for the 5% significance level as recommended by Stock and Yogo (2005) (i.e., K2=1; see Table 5.2, p101). This indicates that the first-stage equation is identified, and our instrument satisfies the relevance condition without succumbing to estimation bias from the weak instrument issue.

Panel B presents the second-stage regression results. Across all specifications, the relationship between instrumented CSR score and operational efficiency is positive and statistically significant, at least at the 5% level. For instance, in Column (4), where all control variables and industry-year fixed effects are included, the coefficient on $\widehat{CSR\_score}_{i,t}$ is 0.200 with a t-statistic of 1.96. Overall, the findings in Table 5 offer robust evidence that a firm's CSR engagement can causally impact its operational efficiency after mitigating endogenous concerns.

Insert Table 5 here

5. Cross-sectional analyses

5.1 Financial condition

To investigate whether the association between CSR engagement and operational efficiency varies with the firm's financial health, we first consider profitability as a dimension. We measure profitability using *OperatingProfit*, following the methodology of Fama and French (2015) *OperatingProfit* is calculated as (sales - cost of goods sold – SG&A expense – interest expense) divided by lagged book equity from the previous year. To facilitate interpretation, we standardize *OperatingProfit* by subtracting the sample mean and dividing by the in-sample standard deviation. We present the results of the cross-sectional analysis with all fixed effects and control variables included in Column (1) of Table 6. The coefficient on *CSR_score* is positive and statistically significant at the 1% level, consistent with our main findings. Regarding the interaction term, the coefficient on *CSR_score*OperatingProfit* is 0.096, significant at the 1% level. This implies that a one-standard-deviation increase in operating profits from the sample mean approximately doubles the effect of CSR engagement on operational efficiency.

For our second dimension, we examine the firm's cash ratio (*Cash_ratio*). Following Bates et al. (2009), we define the cash ratio as the firm's cash holding divided by total assets in the previous year. This proxy assesses the adequacy of cash reserves for project execution. In Column (2) of Table 6, we report the results. The coefficient on the interaction term *CSR_score*Cash_ratio* is positive and statistically significant at the 1% level. Specifically, the coefficient on *CSR_score*Cash_ratio* is 0.027, approximately 23.7% (=0.027/0.114) of the coefficient on *CSR_score*. This indicates that a one-standard-deviation decrease in the cash holding ratio from the sample mean reduces the relationship between CSR engagement and operational efficiency by approximately 23.7%.

For our third dimension, we consider the firm's financial liquidity, measured as the firm's current assets divided by current liabilities in the previous year (*Current_ratio*) following (Ou and Penman, 1989). In Column (3) of Table 6, we present the results. The coefficient on the interaction term *CSR_score*Current_ratio* is 0.042, with a t-statistic of 4.05. This finding suggests that the relationship between CSR engagement and operational efficiency weakens by 35.6% (=0.042/0.118) for firms with a current ratio one standard deviation below the sample mean compared to firms with a current ratio equal to the sample mean.

Insert Table 6 here

Fourth, we adopt the approach proposed by Piotroski (2000b) to construct a fundamental health score, which is the sum of 9 indicator variables. Each indicator variable equals one if it satisfies specific conditions: (1) ROA is positive; (2) CFO (cash flow from operating divided by lagged total assets) is positive; (3) ROA > $ROA_{(t-1)}$; (4) CFO > $CFO_{(t-1)}$; (5) Leverage < $Leverage_{(t-1)}$; (6) *CurrentRatio* > $CurrentRatio_{(t-1)}$; (7) the firm did not issue equity in the last year; (8) *GrossMarginRatio* > $GrossMarginRatio_{(t-1)}$, where *GrossMarginRatio* equals (sales – cost of goods sold) / sales; (9) *AssetTurnoverRatio* > $AssetTurnoverRatio_{(t-1)}$, where *AssetTurnoverRatio* equals sales divided by lagged total assets. In Column (4) of Table 6, we present the results. The coefficient on the interaction term, *CSR_score*FundamentalScore*, is positive and statistically significant at the 1% level. Specifically, the coefficient is 0.044, approximately 42.3% (=0.044/0.104) of the coefficient on *CSR_score*. This result suggests that a one-standard-deviation decrease in fundamental health from the sample mean will decrease the relationship between CSR engagement and operational efficiency by approximately 42.3%. Overall, the results in Table 6 provide support for our hypothesis that the impact of CSR engagement on operational efficiency is less pronounced for firms with financial condition concerns.

5.2 Uncertainty

n this subsection, we delve into the influence of uncertainties faced by firms on the relationship between CSR engagement and operational efficiency. Essentially, uncertainties deplete a firm's resources, diverting attention and capital away from CSR initiatives towards resolving issues such as lawsuits or penalties. As these uncertainties elevate the risk of bankruptcy, stakeholders prioritize firms focusing on core business operations rather than ethical endeavors (Koh et al., 2014). Motivated by this line of research, we hypothesize that the impact of CSR engagement on operational efficiency diminishes for firms grappling with heightened uncertainties. Our examination unfolds across three dimensions: litigation uncertainty, information uncertainty, and supply-chain uncertainty.

Firstly, we examine the impact of litigation uncertainty. We gauge this uncertainty using the natural logarithm of one plus the number of litigation and arbitration events in the year (*Log_LA_num*). A higher *Log_LA_num* signifies that the firm is more likely to allocate significant attention and capital to manage these issues and potentially face substantial penalties. The findings are presented in Column (1) of Table 7. We observe a positive and statistically significant association between *CSR_score* and *OpEfficiency* at the 1% level, aligning with our primary results. Regarding the interaction term, the coefficient on *CSR_score*Log_LA_num* is negative and statistically significant at the 1% level. This suggests that a one-standard-deviation increase in litigation uncertainty from the sample mean corresponds to a 51.9% reduction in the relationship between CSR engagement and operational efficiency.

Next, we employ analyst forecast dispersion to gauge the divergence of external investors' opinions regarding a firm's development (*AnalystDispersion*). High analyst forecast dispersion signals greater information uncertainty and variability in investors' perceptions of a firm's growth trajectory. Inspired by Li and Zaiats (2017), *AnalystDispersion* is estimated as follows:

$$AnalystDispersion_{i,t} = \sqrt{\frac{\sum_{n=1}^{N}(EPS_{i,t,n} - \overline{EPS}_{i,t})^2}{N-1}} \Big/ \overline{EPS}_{i,t} \quad (8)$$

where $EPS_{i,t,n}$ is the *n*th analyst report's forecasted earnings per share (EPS) covering firm *i* in year *t* and $\overline{EPS}_{i,t}$ is the average forecasted EPS among firm *i*'s all *N* forecasted reports in year *t*.

The result is shown in Column (2) of Table 7. We find the coefficient on *CSR_score*AnalystDispersion* equals -0.031 with *t*-statistics equal to -3.36. The coefficient is statistically significant at the 1% level and approximately 45.6% (=-0.031/0.068) of the coefficient on *CSR_score*. It indicates that a one-standard-deviation increase in analyst forecast dispersion from the sample mean will lead to an approximately 45.6% decrease in the relationship between CSR engagement and operational efficiency.

The third metric is supplier instability, a proxy for uncertainty in supply-chain disruption. Following Peng et al. (2020), we first use the "Herfindal-style" index to calculate supplier concentration (*SC*) as follows:

$$SC_{i,t} = \sum_{m=1}^{5} Purchase\_ratio_{i,m,t}^2 \quad (9)$$

where $Purchase\_ratio_{i,m,t}$ is the purchase ratio of firm *i* from the mth largest supplier in year *t*. We then calculate the standard deviation of SC_{i,t_2}, SC_{i,t_1}, and $SC_{i,t}$ to measure the volatility of suppliers, the measure of supplier instability is given by:

$$SupplierInstability_{i,t} = \sqrt{(SC_{i,t\_2} - \overline{SC})^2 + (SC_{i,t\_1} - \overline{SC})^2 + (SC_{i,t} - \overline{SC})^2} \Big/ \overline{SC} \quad (10)$$

where $\overline{SC}$ is the average of SC_{i,t_2}, SC_{i,t_1}, and $SC_{i,t}$.

We present the findings in Column (3) of Table 7. Utilizing *CSR_score* and *SupplierInstability*, we construct the interaction term and observe its coefficient to be negative and statistically

significant at the 5% level. Specifically, the coefficient on *CSR_score*SupplierInstability* is -0.032, approximately 26.2% (=-0.032/0.122) of the coefficient on *CSR_score*. This outcome indicates that a one-standard-deviation increase in supplier instability from the sample mean will reduce the impact of CSR engagement on operational efficiency by roughly 26.2%. Overall, the results in Table 7 offer supporting evidence for H3, suggesting that uncertainties weaken the relationship between CSR engagement and operational efficiency.

Insert Table 7 here

5.3 Industry competition

We explore the impact of industry competition as our final perspective. We hypothesize that market competition enhances the link between CSR engagement and operational efficiency for several reasons. Firstly, in a competitive market, CSR attributes become more valuable as they can differentiate products and attract additional consumer demand. Secondly, market pressures may drive greater efficiency among internal stakeholders, thereby strengthening the relationship between CSR engagement and operational efficiency. To test this hypothesis, we adopt the approach of Cosset et al. (2016) and use one minus the Herfindahl-Hirschman Index (HHI) of each firm's sales fraction (market share fraction) in the same industry as proxies for industry competition[4].

The results in Table 8 confirm our hypothesis that industry competition strengthens the link between CSR engagement and operational efficiency. In Column (1), using a firm's sales fraction to measure industry competition (*IndustryCompetiSale*), we find a positive and statistically significant coefficient on the interaction term *CSR_score*IndustryCompetiSale* at the 1% level. Specifically, a one-standard-deviation increase in *IndustryCompetiSale* from the sample mean

[4] Proxies for industry competition in regressions can be absorbed by industry-year fixed effects.

corresponds to a 23.9% increase in the relationship between CSR engagement and operational efficiency. Similarly, in Column (2), when using a firm's market share fraction to measure industry competition (*IndustryCompetiSize*), we observe a positive and statistically significant coefficient on the interaction term *CSR_score*IndustryCompetiSize* at the 1% level. This result indicates that a one-standard-deviation increase in *IndustryCompetiSize* is associated with a 16.8% increase in the impact of CSR engagement on operational efficiency. These findings provide support for our hypothesis (H4) that industry competition amplifies the relationship between CSR engagement and operational efficiency.

Insert Table 8 here

6. Further analyses

6.1 Geographic clustering

The geographic clustering of firms, particularly in first-tier cities, raises concerns about potential bias in the relationship between CSR and operational efficiency. With knowledge spillover effects documented within such clusters (Ellison et al., 2010), both CSR engagement and operational efficiency may be influenced by this geographic concentration. Given that many Chinese firms are situated in first-tier cities like Beijing, Shanghai, Guangzhou, and Shenzhen, comprising 27.1% of our sample, there's a possibility of bias in our findings.

To address this concern, we initially exclude firms headquartered in first-tier cities and re-estimate our regression model. Panel A of Table 9 presents these results, indicating that even after removing these firms, the positive relationship between CSR engagement and operational efficiency remains significant. For instance, in Column (4), the coefficient of *CSR_score* is 0.121 with a t-statistic of 8.68, implying a 10.2% increase in the standard deviation of operational efficiency for every one-standard-deviation increase in *CSR_score*.

Furthermore, to further mitigate potential biases, we introduce city fixed effects in Panel B of Table 9. Remarkably, our positive CSR-efficiency relationship persists across all columns, reaffirming the robustness of our findings and alleviating concerns regarding the geographic clustering effect of first-tier cities.

6.2 Unobservable firm characteristics

To address concerns about unobservable firm-specific characteristics influencing the correlation between CSR engagement and operational efficiency, we introduce firm fixed effects, as suggested by Lins et al. (2017). This helps control for time-invariant unobservable firm traits that could confound our analysis. The results, presented in Panel C of Table 9, reaffirm the robustness of our findings.

Across all four columns, the coefficients on *CSR_score* remain positive and statistically significant, indicating a persistent positive relationship between CSR engagement and operational efficiency. Notably, in Column (4), where controls, industry-year fixed effects, and firm fixed effects are included, the coefficient of *CSR_score* is 0.046 with a t-statistic of 5.02. This suggests that our results withstand the inclusion of firm fixed effects, further enhancing the credibility of our findings.

Insert Table 9 here

6.3 M&As

To address concerns about the potential influence of M&A activities on the positive relationship between CSR engagement and operational efficiency, we conducted additional analyses. M&A activities could introduce bias into our baseline regressions due to their positive association with both CSR engagement and operational efficiency (Bena and Li, 2014, Halkos and Tzeremes, 2013).

In our sample, 14.7% (3,347 out of 22,780) of firm-year observations involve M&A activities. To mitigate this concern, we excluded firm-year observations associated with M&A announcements and re-estimated Eq. (4). The results, presented in Panel D of Table 9, show that the coefficients on CSR engagement remain positive and statistically significant at the 1% level across all columns.

For instance, in Column (4), the coefficient of *CSR_score* is 0.125 with a t-statistic of 10.11, indicating that M&A activities do not significantly affect our baseline estimations. This finding suggests that the observed positive relationship between CSR engagement and operational efficiency persists even after excluding observations involving M&A activities.

7. Conclusion

7.1 Research findings

This study delves into the relationship between a firm's CSR engagement and its operational efficiency. Our empirical findings indicate that firms with higher levels of CSR engagement tend to exhibit greater operational efficiency. Even when employing local CSR intensity as an instrument to address potential endogeneity, we still observe a positive association between instrumented CSR engagement and operational efficiency.

Further analyses shed light on various dimensions of this relationship. We find that the impact of CSR engagement on operational efficiency is amplified for firms with stronger financial standings and fewer uncertainties, such as those related to litigation, information, and supplier dynamics. Moreover, firms operating in more competitive industries appear to benefit more from CSR engagement in terms of operational efficiency.

Our study also encompasses several robustness checks. These include excluding firms headquartered in first-tier cities, incorporating city-fixed effects to control for regional factors, incorporating firm fixed effects to address omitted firm-level characteristics, and excluding

observations involving M&A activities. Across these alternative specifications, the positive relationship between CSR engagement and operational efficiency remains robust.

In summary, our findings underscore CSR engagement as a valuable avenue for enhancing a firm's operational efficiency.

7.2 Theoretical implications

This study contributes to the existing literature in several meaningful ways. Firstly, it adds to the growing body of evidence supporting the positive impact of CSR engagement. In the face of pressing climate concerns and the imperative for sustainable development, firms worldwide are compelled to embrace social responsibility. This study addresses a critical question for managers: the consequences of CSR engagement for their firms. Drawing on stakeholder theory and legitimacy theory, which posit that CSR activities can enhance stakeholder support and legitimacy, respectively, we find empirical support for the notion that CSR engagement positively influences a firm's operational performance. This finding not only aligns with previous research demonstrating the value and reputation benefits of CSR engagement but also introduces a novel perspective by highlighting its positive impact on operational efficiency.

Secondly, our study enriches the understanding of factors contributing to operational efficiency improvement. Operational efficiency determinants have garnered significant attention in recent literature. Our findings complement this body of work by demonstrating that CSR engagement can be a potent means to enhance operational efficiency. By embracing CSR initiatives, firms can improve their operational performance, aligning with broader organizational objectives. Moreover, our study underscores the nuanced nature of this relationship, revealing how factors such as financial distress, uncertainties, and industry competition can moderate the positive effect of CSR engagement on operational efficiency. This highlights the importance of considering contextual factors in understanding the implications of CSR initiatives for firm performance.

7.3 Managerial implications

Our study yields two key managerial implications. Firstly, we underscore the importance of CSR engagement as a strategic tool for operations management. Managers are encouraged to integrate CSR initiatives into their operational strategies, recognizing the potential benefits for enhancing efficiency. However, it's crucial for managers to recognize that the impact of CSR initiatives may vary depending on the firm's specific characteristics. Therefore, when formulating CSR strategies, managers should carefully consider factors such as the firm's financial standing, exposure to uncertainties (e.g., litigation, information, and supply chain uncertainties), and the competitive dynamics of the industry. Tailoring CSR efforts to align with these contextual factors can maximize their effectiveness in driving operational efficiency improvements.

Secondly, our findings advocate for policymakers to incentivize and support CSR initiatives. Recognizing the dual benefits of CSR engagement—both in terms of generating positive externalities such as pollution reduction and energy conservation, as well as enhancing operational efficiency—regulators can play a proactive role in fostering CSR adoption. Policymakers may consider implementing measures such as CSR tax incentives to encourage firms to invest in socially responsible practices. By incentivizing CSR engagement, policymakers can not only promote sustainable business practices but also contribute to overall improvements in operational efficiency across firms, thereby fostering economic growth and societal well-being.

7.4 Limitations and future research

This study acknowledges several limitations that offer avenues for future research. Firstly, our analysis examines the impact of aggregated CSR engagement on operational efficiency without delving into the specific categories of CSR activities. Prior research suggests that different types of CSR initiatives may yield varying effects, with activities such as employee-related CSR potentially exerting a significant influence on innovation outcomes, contingent upon employee

involvement (Liu et al., 2020, Hawn and Ioannou, 2016). Therefore, future studies could benefit from subdividing CSR activities and investigating their differential impacts on operational efficiency.

Secondly, our analysis is based on data from Chinese listed firms, which may limit the generalizability of our findings to other contexts. Future research could conduct more comprehensive cross-country analyses across both developed and developing economies to ascertain whether the relationship between CSR engagement and operational efficiency holds true across diverse institutional and market settings. Additionally, exploring the dynamics of CSR and operational efficiency within the context of privately-owned firms could provide valuable insights, given the unique operational challenges and considerations faced by such enterprises, such as credit constraints (Poncet et al., 2010).

Thirdly, our study exclusively focuses on the operational efficiency implications of CSR engagement. Future research could broaden the scope by examining how CSR activities impact various facets of operations management beyond efficiency metrics. For instance, exploring the influence of CSR on supply chain resilience, quality management practices, or risk mitigation strategies could offer a more comprehensive understanding of the interplay between CSR and operational dynamics.

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Appendix A. Variable Definitions.

Variables	Description
OpEfficiency	The firm's efficiency in transforming operational inputs into operational output based on stochastic frontier estimation.
CSR_score	The CSR scores of each listed firm each year are obtained from Hexun.
LogAsset	The natural logarithm of total assets.
ROA	Return on assets, which equals earnings divided by total assets.
Leverage	Total debts divided by the total assets.
LogAge	The natural logarithm of the number of years since the listing year.
MarketToBook	The market-to-book ratio, which equals the market value of a firm's equity divided by the book value.
Cash_ratio	Cash holding divided by total assets.
RD_ratio	R&D expenses divided by total assets.
InstituHoldRatio	The institutional holding ratio, which equals the number of institutional holding shares divided by the number of shares outstanding.
CEO_duality	A dummy variable that equals one if a firm's CEO is also the president or chair of the board and 0 otherwise.
SOE	A dummy variable that equals one if the firm is a state-owned enterprise and zero otherwise.
CSR_local_intensity	The distance-weighted average CSR of nearby firms of a focal firm.
OperateProfitability	(sales - cost of goods sold - SG&A expense - interest expense) / lagged book equity.
Current_ratio	Current assets divided by current liabilities
FundamentalScore	The sum of 9 dummy variables to form a fundamental health score.

Log_LA_num	The natural logarithm of one plus the number of litigation & arbitration events in the year.
AnalystDispersion	The standard deviation of analysts' forecasted EPS covering the firm in the year divided by the average of the forecasted EPS.
SupplierInstability	The supplier instability measure, which equals the volatility of supplier concentration scaled by the average supplier concentration in the past three years.
IndustryCompetiSale	One minus HHI of each firm's sales fraction in the same industry.
IndustryCompetiSize	One minus HHI of each firm's market share fraction in the same industry.

Table 1. Sample selection and distribution.

Panel A: Sample selection method		
	Number of firm-year	Number of unique
Firms listed on the SSE and SZSE in China during 2010-2019	29,398	3,874
Excluding observations with missing operational efficiency	-6,445	-205
Excluding observations with missing CSR scores	-125	-59
Excluding observations with missing control variables	-48	-4
Final sample	22,780	3,606

Panel B: Distribution of sample by fiscal year					
Year	Number of firm-	Fraction of	Year	Number of firm-	Fraction of
2010	1,597	7.01%	2015	2,275	9.99%
2011	1,796	7.88%	2016	2,524	11.08%
2012	1,907	8.37%	2017	2,924	12.84%
2013	1,938	8.51%	2018	2,916	12.80%
2014	1,946	8.54%	2019	2,957	12.98%
Total	22,780	100.00%			

Panel C: Distribution of sample by industry					
CSRC	Number of firm-	Fraction of	CSRC	Number of firm-	Fraction of
A	226	0.99%	J	131	0.58%
B	564	2.48%	K	939	4.12%
C	14,279	62.68%	L	335	1.47%
D	819	3.60%	M	203	0.89%
E	628	2.76%	N	363	1.59%
F	1,125	4.94%	P	48	0.21%
G	734	3.22%	Q	82	0.36%
H	59	0.26%	R	343	1.51%
I	1,794	7.88%	S	108	0.47%
Total	22,780	100.00%			

This table reports sample selection and distribution in this paper. Panel A reports the sample selection method. Panel B and Panel C present sample distribution by year and industry, respectively. Industry classification in Panel C is based on CSRC 2012 industry classification code. A: Agriculture, B: Mining, C: Manufacturing, D: Electronic and gas, E: Construction, F: Wholesale and retail, G: Transportation, H: Accommodation and catering, I: Information and technology, J: financial service, K: Real estate, L: Leasing and business services, M: Scientific research and technical services, N: Public facilities management, P: Education, Q: Health and social work, R: Culture, sports and entertainment, S: Comprehensive.

Table 2. Summary statistics of variables.

	N	Mean	SD	Min	P25	P50	P75	Max
$OpEfficiency_{t+1}$	22,780	0.462	0.182	0.042	0.336	0.485	0.598	0.801
CSR_score_t	22,780	0.257	0.153	-0.022	0.179	0.228	0.279	0.750
$LogAsset_t$	22,780	8.290	1.299	6.006	7.341	8.104	9.019	12.331
ROA_t	22,780	0.048	0.049	-0.156	0.022	0.044	0.072	0.195
$Leverage_t$	22,780	0.407	0.206	0.047	0.239	0.396	0.562	0.868
$LogAge_t$	22,780	2.055	0.849	0.154	1.407	2.188	2.808	3.277
$MarketToBook_t$	22,780	2.428	2.169	0.306	1.084	1.785	2.947	13.254
$Cash\_ratio_t$	22,780	0.179	0.143	0.011	0.078	0.135	0.235	0.683
RD_ratio_t	22,780	0.002	0.006	0.000	0.000	0.000	0.000	0.037
$InsitituHoldRatio_t$	22,780	0.445	0.252	0.003	0.226	0.470	0.652	0.908
$CEO\_duality_t$	22,780	0.045	0.207	0.000	0.000	0.000	0.000	1.000
SOE_t	22,780	0.350	0.477	0.000	0.000	0.000	1.000	1.000

This table reports summary statistics of variables in this paper. For each variable, "N" represents the number of observations, "Mean" represents the equal-weighted mean value, "SD" represents its standard deviation, "Median" represents the median value, and "PX" represents the Xth percentile of its distribution.

Table 3. Correlations and descriptive statistics.

	Variables	1	2	3	4	5	6	7	8	9	10	11	12
1	$OpEfficiency_{t+1}$	1.00	0.40*	0.21*	0.48*	-0.13*	0.01	0.01	0.11*	-0.01	0.13*	0.01	-0.03*
2	CSR_score_t	0.25*	1.00	0.23*	0.52*	-0.06*	-0.01*	-0.07*	0.18*	0.00	0.22*	0.04*	0.09*
3	$LogAsset_t$	0.20*	0.27*	1.00	-0.14*	0.55*	0.48*	-0.24*	-0.30*	0.06*	0.42*	0.08*	0.38*
4	ROA_t	0.43*	0.36*	-0.08*	1.00	-0.44*	-0.28*	0.07*	0.32*	-0.02*	0.04*	0.00	-0.17*
5	$Leverage_t$	-0.13*	0.03*	0.55*	-0.38*	1.00	0.42*	0.01	-0.41*	-0.02*	0.23*	0.04*	0.32*
6	$LogAge_t$	-0.01	0.05*	0.44*	-0.23*	0.42*	1.00	0.19*	-0.26*	0.05*	0.23*	0.03*	0.47*
7	$MarketToBook_t$	-0.01	-0.08*	-0.26*	0.04*	0.05*	0.20*	1.00	0.01*	0.10*	-0.06*	0.00	-0.02*
8	$Cash\_ratio_t$	0.12*	0.07*	-0.30*	0.27*	-0.43*	-0.33*	0.00	1.00	0.05*	-0.04*	0.01	-0.09*
9	RD_ratio_t	0.00	-0.01	-0.03*	0.02*	-0.08*	0.00	0.09*	0.05*	1.00	-0.04*	0.07*	0.00
10	$InsitituHoldRatio_t$	0.12*	0.22*	0.44*	0.07*	0.24*	0.24*	-0.01	-0.06*	-0.07*	1.00	0.00	0.42*
11	$CEO\_duality_t$	0.01	0.04*	0.08*	0.01	0.04*	0.03*	0.01	0.00	0.05*	0.00	1.00	-0.04*
12	SOE_t	-0.04*	0.16*	0.40*	-0.12*	0.32*	0.46*	-0.02*	-0.11*	-0.03*	0.43*	-0.04*	1.00

This table presents the correlation matrix of our variables. The lower triangle is for Pearson correlation, and the upper triangle is for Spearman correlation. We use * to denote the correlations significant at least at the 5% level.

Table 4. The effect of CSR on operational efficiency.

Dependent variable =	$OpEfficiency_{t+1}$			
	(1)	(2)	(3)	(4)
CSR_score_t	0.349***	0.118***	0.350***	0.112***
	(26.36)	(10.02)	(26.15)	(9.52)
$LogAsset_t$		0.038***		0.039***
		(16.37)		(16.71)
ROA_t		1.014***		1.028***
		(23.42)		(24.39)
$Leverage_t$		-0.154***		-0.156***
		(-11.99)		(-12.18)
$LogAge_t$		0.006***		0.006***
		(6.97)		(6.99)
$MarketToBook_t$		-0.001		-0.001
		(-0.24)		(-0.26)
$Cash\_ratio_t$		0.086***		0.094***
		(7.04)		(7.61)
RD_ratio_t		-0.355		-0.342
		(-1.19)		(-1.16)
$InsitituHoldRatio_t$		0.019**		0.020***
		(2.46)		(2.60)
$CEO\_duality_t$		-0.023***		-0.020***
		(-2.96)		(-2.64)
SOE_t		-0.031***		-0.032***
		(-6.24)		(-6.33)
Year fixed effects	Yes	Yes		
Industry fixed effects	Yes	Yes		
Industry-year fixed effects			Yes	Yes
Number of obs.	22,780	22,780	22,778	22,778
Adjusted R^2	0.177	0.332	0.184	0.344

This table presents the OLS regression results related to the impact of CSR on operational efficiency. The dependent variable (*OpEfficiency*) is a firm's efficiency in transforming operational inputs into operational output based on stochastic frontier estimation. The independent variable (*CSR_score*) is the CSR scores of each listed firm each year obtained from Hexun. Control variables are available in Appendix A. We include year fixed effects and industry fixed effects to capture annual unobservable factors and time-constant industry common factors faced by all firms in Columns (1) and (2). In Columns (3) and (4), we further include industry-year fixed effects to capture time-variate industry factors. *T*-statistics are reported in parentheses below the regression coefficients with standard errors clustered at the firm level. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided), respectively.

Table 5. The effect of CSR on operational efficiency: instrumental variable approach.

	(1)	(2)	(3)	(4)
Panel A: First stage of 2SLS		Dependent variable = CSR_score_t		
$CSR\_local\_intensity_t$	0.996***	0.716***	1.000***	0.717***
	(10.88)	(8.97)	(10.86)	(8.89)
Number of obs.	22,780	22,780	22,778	22,778
Adjusted R^2	0.144	0.340	0.146	0.344
Weak instrument test (*F*)	118.38	80.50	117.86	79.12
Panel B: Second stage of 2SLS		Dependent variable = $OpEfficiency_{t+1}$		
$\widehat{CSR\_score}_t$	0.467***	0.217**	0.459***	0.200**
	(5.33)	(2.13)	(5.20)	(1.96)
Number of obs.	22,780	22,780	22,778	22,778
Panels A-B:				
Controls		Yes		Yes
Year fixed effects	Yes	Yes		
Industry fixed effects	Yes	Yes		
Industry-year fixed effects			Yes	Yes

This table presents 2SLS regression results related to the impact of CSR on operational efficiency. In the first stage, we use an instrumental variable to extract exogenous variations of *CSR_score*, where *CSR_local_intensity* is the instrumental variable for *CSR_score* and is defined as the distance-weighted average CSR of nearby firms of a focal firm. $\widehat{CSR\_score}$ is the fitted value of *CSR_score* based on the first-stage regression. Panel A reports the first-stage results, while Panel B reports the results of the second stage. The Weak instrument test (*F*) is the Kleibergen-Paaprk weak identification test, where the null hypothesis is that the instrument does not correlate with *CSR_score*. Other specifications are the same as Table 4.

Table 6. The effect of CSR on operational efficiency across financial conditions.

Dependent variable =	$OpEfficiency_{t+1}$			
	(1)	(2)	(3)	(4)
CSR_score_t	0.047***	0.114***	0.118***	0.104***
	(4.42)	(9.67)	(9.97)	(8.88)
CSR_score_t*$OperatingProfit_t$	0.096***			
	(7.44)			
$OperatingProfit_t$	0.086***			
	(25.92)			
CSR_score_t*$Cash\_ratio_t$		0.027***		
		(2.78)		
$Cash\_ratio_t$		0.013***		
		(7.13)		
CSR_score_t*$Current\_ratio_t$			0.042***	
			(4.05)	
$Current\_ratio_t$			0.004**	
			(2.34)	
CSR_score_t*$FundamentalScore_t$				0.044***
				(6.34)
$FundamentalScore_t$				0.007***
				(5.15)
Controls	Yes	Yes	Yes	Yes
Industry-year fixed effects	Yes	Yes	Yes	Yes
Number of obs.	22,778	22,778	22,778	22,778
Adjusted R^2	0.419	0.344	0.345	0.346

This table presents the OLS estimations related to the impact of CSR on operational efficiency across firms' financial conditions. We measure financial conditions from four dimensions. In Column (1), the proxy is *OperatingProfit*, which equals (sales - cost of goods sold - SG&A expense - interest expense) / lagged book equity. In Column (2), the proxy is *Cash_ratio*, which equals the cash holding divided by total assets. In Columns (3), the proxy is *Current_ratio*, which equals current assets divided by current liabilities. In Column (4), *FundamentalScore* is the sum of 9 dummy variables to form a fundamental health score. All four proxies are normalized by subtracting the in-sample means and dividing the differences by in-sample standard deviations, respectively. Other specifications are the same as Table 4.

Table 7. The effect of CSR on operational efficiency across uncertainty.

Dependent variable =	$OpEfficiency_{t+1}$		
	(1)	(2)	(3)
CSR_score_t	0.104***	0.068***	0.122***
	(8.78)	(5.82)	(5.85)
CSR_score_t*$Log\_LA\_num_t$	-0.054***		
	(-4.86)		
$Log\_LA\_num_t$	-0.001		
	(-0.76)		
CSR_score_t*$AnalystDispersion_t$		-0.031***	
		(-3.36)	
$AnalystDispersion_t$		-0.008***	
		(-5.36)	
CSR_score_t*$SupplierInstability_t$			-0.032**
			(-2.14)
$SupplierInstability_t$			0.001
			(0.65)
Controls	Yes	Yes	Yes
Industry-year fixed effects	Yes	Yes	Yes
Number of obs.	22,778	15,926	7,926
Adjusted R^2	0.345	0.387	0.323

This table presents the OLS regression results related to the impact of wages on operational efficiency regarding firms' uncertainties. We measure firms' uncertainties from three dimensions. In Columns (1), *Log_LA_num* equals the natural logarithm of one plus the number of litigation & arbitration events in the year. In Column (2), *AnalystDispersion* is the standard deviation of analysts' forecasted EPS covering the firm in the year divided by the average of the forecasted EPS. In Column (3), *SupplierInstability* is the supplier instability measure, which equals the volatility of supplier concentration scaled by the average supplier concentration in the past three years. All three measures are normalized by subtracting the in-sample means and dividing the differences by in-sample standard deviations, respectively. Other specifications are the same as Table 4.

Table 8. The effect of CSR on operational efficiency across industry competition.

Dependent variable =	$OpEfficiency_{t+1}$	
	(1)	(2)
CSR_score_t	0.113***	0.113***
	(9.59)	(9.59)
CSR_score_t*$IndustryCompetiSale_t$	0.027***	
	(3.03)	
CSR_score_t*$IndustryCompetiSize_t$		0.019**
		(2.26)
Controls	Yes	Yes
Industry-year fixed effects	Yes	Yes
Number of obs.	22,778	22,778
Adjusted R^2	0.344	0.344

This table presents the OLS regression results of estimating the impact of CSR engagement on operational efficiency across the firm's industry competition. In Column (2), we measure industry competition as *IndustryCompetiSale*, which equals one minus HHI of each firm's sales fraction in the same industry. In Column (2), we measure industry competition as *IndustryCompetiSize*, which equals one minus HHI of each firm's market share fraction in the same industry. The two measures are normalized by subtracting the in-sample means and dividing the differences by in-sample standard deviations, respectively. Other specifications are the same as Table 4.

Table 9. Alternative model specifications.

Dependent variable =	$OpEfficiency_{t+1}$			
	(1)	(2)	(3)	(4)
Panel A: Removing firms in first-tier cities				
CSR_score_t	0.365***	0.125***	0.374***	0.121***
	(23.34)	(9.12)	(23.07)	(8.68)
Number of obs.	16,617	16,617	16,612	16,612
Adjusted R^2	0.178	0.332	0.183	0.343
Panel B: Controlling city fixed effects				
CSR_score_t	0.336***	0.121***	0.336***	0.114***
	(26.23)	(10.32)	(26.06)	(9.78)
Number of obs.	22,766	22,766	22,764	22,764
Adjusted R^2	0.226	0.358	0.233	0.370
City fixed effects	Yes	Yes	Yes	Yes
Panel C: Controlling firm fixed effects				
CSR_score_t	0.123***	0.052***	0.119***	0.046***
	(12.83)	(5.55)	(12.40)	(5.02)
Number of obs.	22,591	22,591	22,589	22,589
Adjusted R^2	0.590	0.610	0.600	0.622
Firm fixed effects	Yes	Yes	Yes	Yes
Panel D: Removing firms with M&As				
CSR_score_t	0.363***	0.127***	0.371***	0.125***
	(26.62)	(10.41)	(26.28)	(10.11)
Number of obs.	19,433	19,433	19,431	19,431
Adjusted R^2	0.198	0.352	0.205	0.364
Panels A-D:				
Controls		Yes		Yes
Year fixed effects	Yes	Yes		
Industry fixed effects	Yes	Yes		
Industry-year fixed effects			Yes	Yes

This table reports the robust tests for alternative model specifications of baseline regressions. In Panel A, we remove firms located in the first-tier cities, including Beijing, Shanghai, Guangzhou, and Shenzhen. In Panel B, we include additional city fixed effects to capture the unobservable regional factors. In Panel C, firm fixed effects are introduced to capture unobservable firm characteristics. In Panel D, we run regressions after excluding firm-year observations with M&A announcements. Other specifications are the same as Table 4.