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ORIGINAL PAPER

Too little of a good thing? Curvilinear effects of corporate social responsibility on corporate financial performance

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Abstract
The purpose of this study is to contribute to the existing body of research on the impact of Corporate Social Responsibility (CSR) on Firm Performance (FP). The study employs a longitudinal panel data sample of 132 automotive companies, using a dynamic Generalized Method of Moments model. The analysis examines the relationship between CSR ratings and yearly financial performance, taking into account various control variables. The results of the analysis suggest that there is a non-linear, U-shaped relationship between CSR and FP. The direction of this relationship (positive or negative) is dependent on the level of CSR engagement. This means that CSR activities do not immediately yield benefits, but instead provide advantages once a certain level of CSR has been reached. The study also finds that the impact of CSR on FP is positively moderated by technological innovation. This indicates that firms with higher levels of investment in technology benefit more from CSR activities in terms of their financial performance.

Keywords Corporate social responsibility · Corporate financial performance · Dynamic model · System GMM · Curvilinear

JEL Classification M21 · B23

1 Introduction

Corporate social responsibility (CSR) is a global business trend that asserts that engaging in socially responsible activities has a positive impact on stakeholders, protects against negative publicity, and shapes customer perceptions (Einwiller et al. 2019) while also indirectly increasing firm value (Bardos et al. 2020). In recent years, CSR has received significant attention from researchers due to its widespread impact on the marketplace (Shah and Khan 2019). Many studies have analyzed the

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relationship between CSR and firm performance (FP) (Asay et al. 2018; Hasan et al. 2018; Liu et al. 2021). However, only a limited number of studies have focused on the effect of corporate philanthropy, a component of CSR, on firm performance (Marquis and Qian 2014; Wang and Qian 2011; Wang et al. 2008).

CSR, as an integral component of business practices, involvescompanies taking voluntary actions to contribute to the well-being of society and the environment (Marquis and Lee 2013). Research suggests that implementing CSR initiatives not only enhances a firm's reputation and financial performance but also creates a positive image for all stakeholders involved (Pan et al. 2018). These actions establish connections with government officials and politicians (Jia and Zhang 2014), resulting in potential business investment opportunities (Jia et al. 2019), increased visibility (Chan and Feng 2019), and improved socio-political legitimacy. Consequently, this elicits positive responses from stakeholders, reduces tax burdens, and enhances access to government subsidies (Wang and Qian 2011).

The automotive industry is a major player in the global economy, providing jobs, driving innovation, and enabling mobility. However, it also faces challenges related to its impact on the environment and society, leading to a greater emphasis on CSR (Russo-Spena et al. 2018a, b). CSR is a company's commitment to operate in a responsible and sustainable manner, taking into account the impact of its activities on the environment, employees, and the wider community (Málovics and Kraus, 2008).

In the automotive sector, the primary focus is reducing greenhouse gas emissions. Many companies have invested in research and development of electric and hybrid vehicles, while others have made commitments to reduce emissions from their manufacturing processes (Lin et al. 2014; Erickson 2017). For example, Toyota has set a goal of reducing its carbon footprint by 90% by 2050 (Ozawa et al. 2018), while Volkswagen has committed to investing billions in electric vehicles (Zeng et al. 2019). In addition to reducing emissions, companies in the automotive sector are also working to promote diversity and inclusion within the workplace. The industry has traditionally been dominated by men, and many companies are now working to address this imbalance. For example, General Motors has set a target of achieving gender balance in its global workforce by 2020 (Manuel et al., 2019) while Ford has launched a diversity and inclusion strategy to create a more inclusive culture within the company (Lynch 2017). Companies in the automotive sector are also looking to support local communities through various initiatives. For example, BMW has launched a program that provides training and support to small businesses in developing countries, while Ford has launched a sustainable mobility program to provide funding and expertise to improve mobility in underserved communities (Coe et al. 2017).

Based on the argument above, CSR is a vital aspect in the automotive industry, as it not only shapes the reputation of companies, but also plays a critical role in fostering sustainable growth and benefiting communities and the environment. Thus, it is imperative to conduct more in-depth research to fully comprehend the impact of CSR in the automotive industry and to enhance its positive effects for all stakeholders.

CSR initiatives can enhance firm performance by improving brand image and reputation, attracting and retaining customers, employees, and investors, and creating cost savings and efficiencies (Epure 2022). Moreover, consumers are becoming increasingly concerned with the social and environmental impact of their purchases and are willing to pay more for products and services that align with their values. By incorporating CSR initiatives into their business strategies, automotive companies can differentiate themselves from their competitors and appeal to these values-driven consumers. However, the relationship CSR and corporate financial performance remains unresolved in the literature (Kotzian 2022) with some studies finding a positive relationship (Giang and Dung 2022; Hsu et al. 2022; Pham and Tran 2020; Servaes and Tamayo 2013; Simpson and Kohers 2002), some a negative relationship (Groening and Kanuri 2013; Kruger, 2015; Mutuc et al., 2021; Le and Kweh, 2022) and others finding no relationship (Griffin and Mahon, 1997; McWilliams and Siegel 2000).

The existing literature tends to assume a linear relationship between CSR and FP, but there is a growing interest in non-linear relationships (López-Penabad et al. 2022). The CSR and FP is considered to be a non-linear relationship because the impact of CSR initiatives on a company's financial performance can vary depending on various factors, such as the company's size, industry, and target audience. For example, the impact of CSR initiatives on financial performance may not be immediate. It may take time for the benefits of CSR initiatives to materialize and be reflected in the company's financial performance. Different industries may have varying levels of impact from CSR initiatives. For example, companies in the consumer goods sector may have a higher impact from CSR initiatives because consumers are more sensitive to the social and environmental impact of their purchases. This varied array of perspectives presents a prime opportunity to examine the connection between CSR endeavors and FP and determine if CSR has had an impact on FP.

Technological innovation (TI) refers to the creation and implementation of new and improved technology products, processes, or systems (Porter and Kramer 2006). It can encompass a wide range of technological developments, including the invention of new devices, the improvement of existing products, the application of technology in new ways, and the integration of various technologies to create entirely new systems (Balon et al*.*, 2016; Luthra et al*.*, 2011). TI is crucial to the automotive sector for several reasons (Lin et al. 2018). Technological advancements in the automotive sector have allowed for the creation of more fuel-efficient vehicles, reducing the carbon footprint and mitigating the effects of climate change (Muslemani et al. 2018). The automotive industry is highly competitive, and TI can give companies a competitive edge (Coccia 2017). By introducing new and innovative products and services, companies can differentiate themselves from their competitors and attract customers. Technological innovation can also drive growth for the automotive sector (Lin et al. 2019a, b, c). For example, the development of new products and services can create new markets and revenue streams. Additionally, investing in research and development can lead to the creation of new technologies that can be commercialized and generate significant returns.

TI can play a crucial role in enhancing CSR in the automotive sector (Marin et al. 2017). Advanced technologies, such as connected vehicles and autonomous driving, can improve road safety and reduce the environmental impact of vehicles.

Companies can also use technology to better track and monitor their supply chain operations, ensuring that their suppliers adhere to high ethical and environmental standards (Fraga-Lamas et al*.,* 2019). Additionally, the use of automation and robotics in the manufacturing process can reduce waste and increase efficiency, leading to a more sustainable and socially responsible production process (Ashima et al. 2021). TI can also help companies to better engage with their stakeholders and communicate their CSR initiatives, by leveraging digital platforms and communication tools (Ashima et al. 2021). Overall, TI can play a significant role in enhancing CSR in the automotive sector and promoting sustainability and responsible business practices. This paper aims to shed light on the conflicting findings regarding the effectiveness of CSR on FP by exploring the role of TI as an important factor. The literature provides a rationale for this type of investigation.

This study explores the relationship between CSR and FP, offering three key insights. Firstly, it examines both linear and non-linear aspects of the relationship. Secondly, it uses dynamic panel data and GMM estimations to address endogeneity and simultaneity biases. Thirdly, it investigates the moderating effect of TI on the relationship between CSR and FP. By doing so, this study provides a more comprehensive understanding of the CSR-FP relationship, and sheds light on the impact of TI on the relationship.

This study offers three important insights into the CSR-FP relationship. First, inspired by the studies of Barneet et al. (2012), Wang et al. (2016) and Trumpp and Guenthe (2017), this study investigates both the linear and non-linear nature of the CSR-FP link. Second, this study addresses the issues of endogeneity and simultaneity biases by employing the dynamic panel data estimation, System GMM (generalised method-of-moments) estimations. Moreover, this study employs Brambor et al.'s (2006) interaction strategy to calculate the standard error to estimate the marginal effect of CSR on FP contingent on firms, thereby answering the call of.

Hsu et al. (2022) that employing new, confirmed methodologies to particular industries will provide more fascinating outcomes that indicate a non-linear CSR-FP correlation. Third, recent evidence suggests that TI is a significant driver of firm performance (Hull and Rothenberg 2008; Hsu et al. 2022; McWilliam and Siege 2000). However, a much-debated question is whether TI can enhance the relationship between CSR and FP. We address this issue by adopting McWilliam and Siege (2000) way of categorisation of TI in investigating the moderating effect of TI on the relationship between CSR and FP.

This article has been structured into five sections where the first part of this article highlighted the gaps and significance of this study. The next section offers insights into works which have been conducted in the domains of CSR and FP while the third segment describes the data source and methodological approach used in this study. The last two sections discuss the data analysis and results while the remaining segment presents the concluding remarks.

2 Conceptual model and hypotheses

After Milton Friedman's well-known denial of the concept of CSR in 1970, there has been a significant shift in the discussion surrounding good corporate citizenship. According to Friedman (1970: 1), "*a business's social responsibility is solely to* *maximize profits*." This idea implies that managers should not use shareholder funds for anything other than maximizing returns for shareholders. The agency theory suggests that managers may overinvest in CSR in order to improve their personal image, leading to lower profits (Barnea and Rubin 2010).

However, this line of thought has not been definitively supported by theory or empirical evidence. There are many compelling arguments that a strong CSR performance can lead to greater profits and higher shareholder value (see Deng et al. 2013; Wang et al. 2016). Additionally, strategic investments in CSR can also have a positive impact on a company's competitive position (Porter and Kramer 2002).

2.1 It pays to be good

According to various authors such as Kim et al. (2018), Lee and Jung (2016), McGuire et al. (1988), and Ullman (1985), the positive association between FP and CSR is based on the "good management theory". This theory suggests that in order for a company to reap the benefits of CSR, both good management and executive support are necessary. The benefits of CSR can include cost savings, improved future cash flows, enhanced sales performance, lower cost of capital, and favorable procurement conditions (Ozdemir et al. 2022). These benefits are believed to be achieved when companies are perceived as socially responsible by stakeholders, such as employees, suppliers, shareholders, customers, and the community. This can improve the company's reputation and help secure critical resources controlled by stakeholders. The stakeholder theory also supports this positive relationship between FP and CSR by suggesting that a company's ability to meet stakeholders' expectations can be improved through a strong environmental strategy and CSR efforts, leading to a superior reputation and higher profit.

The resource dependence viewpoint posits that CSR can serve as a means for firms to reduce the risks associated with resource acquisition. A good reputation for CSR can improve a company's public image, making key stakeholders, including employees, suppliers, shareholders, customers, and the community, more willing to cooperate and offer resources. For example, employees may have greater commitment to a company with a good reputation for human resource, job seekers may view the company as attractive, and customers may respond to CSR by choosing the company's products more frequently or paying a premium. Investors, especially institutional investors, may be more likely to invest in firms implementing CSR, as demonstrated by the demand for mutual funds specializing in companies that meet certain social standards. Societies may also offer favorable terms for local infrastructure or tax breaks for socially responsible firms. Thus, CSR helps firms secure and retain critical resources that are controlled by stakeholders.

The stakeholder theory argues that CSR has a positive impact on FP by going beyond the minimum level of compliance with CSR requirements and addressing environmental and social issues (Abid 2022). This can improve the firm's ability to meet stakeholder expectations, as demonstrated through an active environmental strategy. A positive reputation that results from such efforts can lead to higher profits and establish a positive relationship between FP and CSR (Abid 2022) Both the resource dependence and stakeholder theories support each other as incorporating stakeholder perspectives into the business strategy and decision-making can be seen as a competency in itself, while resource dependence theory can be considered an intangible asset.

2.2 The costs of being good

The trade-off hypothesis proposed by Friedman (1970) argues that the FP of a company is negatively impacted by its engagement in social and environmental activities. According to this view, social and environmental activities result in a shift of resources away from the company's core business, which creates disadvantages compared to competitors who are less socially or environmentally responsible. The hypothesis suggests that the economic benefits of such activities are lower compared to their costs, including increased production or service costs and higher prices for products resulting from environmentally friendly production processes. This argument is supported by studies that have shown that investments in socially responsible practices can be perceived as cost-creating and have a direct negative impact on a company's FP (Xiang et al. 2021).

However, it's important to note that the direct costs associated with CSR are not the only aspect that affects the FP of a company. The long-term benefits of CSR such as enhanced reputation, improved relationships with stakeholders, and increased customer loyalty can result in increased revenue and market share (Dixon-Fowler et al. 2013). Research has also shown that firms that engage in CSR are more likely to attract and retain employees, leading to decreased turnover and recruitment costs (De Roeck and Farooq 2018). In addition, companies with a strong reputation for CSR are often more resilient in the face of economic challenges and are better equipped to navigate potential risks (Brammer and Millington 2008). Therefore, while the direct costs associated with CSR may impact the short-term financial performance of a company, the long-term benefits of engaging in socially responsible activities are likely to outweigh these costs.

Additionally, stakeholder perception of a firm's excessive slack resources could also lead to a negative impact on its reputation (Seifert et al. 2004). This negative perception could also result in lower levels of support from stakeholders, including customers, employees and suppliers (Jensen 2002). Furthermore, it might also discourage potential investors from investing in the firm, which could affect its ability to raise capital and secure critical resources (Seifert et al. 2004).

Moreover, if a firm's CSR efforts are perceived as insincere or not genuine, it could backfire and have a negative impact on the firm's reputation (Seifert et al. 2004). Hence, it is crucial for a firm to be transparent and communicate effectively about its CSR initiatives, in order to gain stakeholder support and maintain its positive reputation.

2.3 Curvilinear relationship between CSR and FP

Recently, there has been a renewed interest in the actual relationship between FP and CSR. According to Maqbool and Bakr (2019), the association is more complex than previously assumed. A recent analysis of the costs and benefits of CSR has revealed a U-shaped relationship between FP and CSR.

The direct cost of CSR, represented by curve A in Fig. 1, increases as the sum of CSR investments increases, due to economies of scale and learning effects in managing CSR activities. These direct costs include recurrent labor costs such as overtime payments and wage hikes, increased management time for CSR steering meetings, social assurance measures, employee support such as meal allowances and medical expenses, training, facilities upgrade and maintenance, and monitoring and reporting (McWilliams and Siegel 2001). At low levels of CSR investment, these costs, including agency costs, are minimal. However, as CSR investments increase, these costs also increase. If the amount of CSR investments exceeds the tolerance level of key stakeholders, concerns about the possibility of misusing corporate resources by managers may arise (Wang et al. 2008).

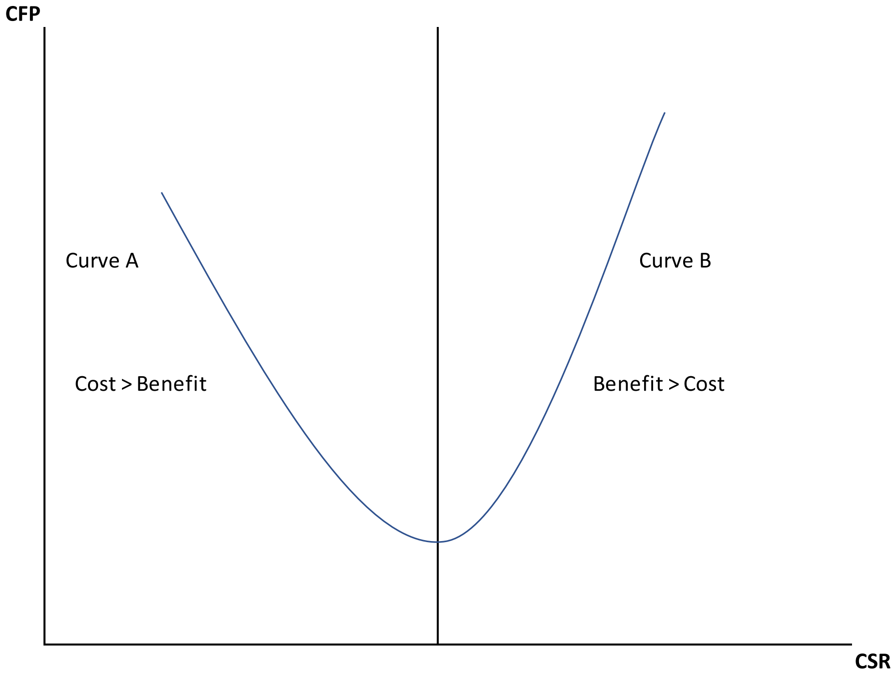
It is believed that the benefits associated with CSR will increase, mainly due to positive responses from stakeholders and the impact of organizational learning in managing CSR activities. However, it is also expected that the increase in benefits (represented by the slope of the curve for the cost-of-funds-to-firm total benefits) will eventually plateau for several reasons. Firstly, even if stakeholders are supportive of CSR initiatives, there are limits to the amount and type of resources that these socially conscious stakeholders can provide to the firm. As a result, the firm cannot fully reap the benefits of CSR. Secondly, even if unlimited resources are assumed to be available from stakeholders, maintaining a steady flow of benefits is unlikely. Excessive investments in CSR by the firm may result in transferring some of the expenditure burdens to stakeholders, such as lower wages, higher product/service prices, or lower returns on investments (McWilliams and Siegel 2001). This, in turn, leads to a decline in the marginal benefit of CSR (as shown in Curve B in Fig. 1). However, there is a gradual increase in the total benefits of CSR with a corresponding increase in CSR engagements until an optimal point is reached.

The concurrent countervailing forces described above result in a U-shaped curvilinear relationship between FP and CSR (as depicted in Fig. 1). Within certain limits, CSR can help the firm secure critical resources from different stakeholders and provide insurance-like protection, minimizing the risk of losing these resources (Curve B). While high levels of CSR contributions may have a positive effect, this effect will eventually level off as stakeholder support becomes limited and agency and direct costs increase (Curve A).

Hypothesis 1: There is a curvilinear relationship between CSR and FP.

2.4 The moderation effect of technological innovation

The concept of TI has been introduced to characterize how organizations can create a path to implement positive changes that drive organizational growth (Gaynor 2002; Martinez-Conesa et al. 2017). Firms that employ TI can benefit from sustainability and competitiveness in a global economy. According to the resource-based view (RBV), firms can outperform their competitors by developing valuable, rare,



Negative Effect	Positive Effect
1. Trade-off hypotheisi 2. Managerial opportunism hyphothesis	1. Resource-based view theory 2. Stakeholder theory 3. Good management hypothesis
This is the position of neoclassical economists who believe that socially dependable conduct will result into several financial advantages while the different costs will lessen the benefits and the wealth of the shareholder (Waddock & Graves, 1997). Organisations only have one social duty, which is to earn a profit while building benefits. CSR expansion pointlessly increases their expenses and lowers their profit (Friedman, 1970)	CSR is positively correlated with good stakeholder management because improved relationships with stakeholders can be achieved by engaging in socially responsible behaviour (Hillman and Keim 2001). For example, satisfying stakeholders' expectations with transparent CSR activities may improve employees' motivation and result in improved productivity and reduced costs (Turban and Greening 1996; Lankoski 2008). In addition, consumers will prefer or even pay more for 'green' products or products offered by socially responsible firms, which may result in increased revenues (Elfenbein and McManus 2010).

Fig. 1 Too little of a good thing hypothesis. *Source*: Author (2019)

non-substitutable, and difficult-to-imitate resources through TI (Barney 1991, 2001; Ferreira et al. 2016).

TI can be a source of competitive advantage, which is crucial for survival and profitability (Martinez-Conesa et al. 2017). Strategically-oriented socially responsible actions (as determined by high CSR) can be considered as a form of investment for promoting process and product innovations (Severo et al. 2017). For instance, firms can improve their level of CSR by offering products with labels showcasing socially responsible production methods or the use of organic or non-polluting ingredients. Effective resource utilization and production cost reduction can also be achieved through a firm's production policy that addresses environmental concerns like energy and water conservation, and waste management (Christmann 2000).

TI is a key source of competitive advantage for firms (McWilliams and Siegel 2000). Numerous studies have demonstrated the positive relationship between TI and firm performance. However, the interaction between CSR and FP has been found to be moderated by TI (Cegarra-Navarro, 2016; Hull and Rothenberg 2008). A review study by Van Beurden and Gossling (2008) supports the impact of TI investment on the CSR-FP relationship, indicating that firms investing in TI are more likely to experience positive outcomes regarding the relationship between CSR activities and FP. On the other hand, Hull and Rothenberg (2008) found that in high-innovation environments, the relationship between CSR and FP is diminished, as less innovative firms tend to benefit relatively more from CSR initiatives compared to more innovative firms. Moreover, there are several additional arguments to consider. Technologically innovative firms often face heightened expectations from stakeholders regarding their CSR efforts (Berrone et al., 2013; Atasu et al., 2017). Furthermore, innovation can drive the evolution of CSR practices within industries (Lozano et al., 2016; Borghini et al., 2020). TI combined with CSR initiatives can differentiate firms in competitive markets (Porter and Kramer, 2011) and lead to cost reduction through innovative solutions (Handfield et al., 2013). These arguments highlight the multidimensional relationship between TI, CSR, and FP, emphasizing the need for firms to leverage their innovative capabilities to enhance CSR outcomes, meet stakeholder expectations, gain competitive advantages, and drive long-term financial success.

Numerous studies have contributed to our understanding of the relationship between CSR, TI, and FP, highlighting the positive moderating effect of innovation on the CSR-FP relationship. Lioui and Sharma (2012) conducted a study that revealed a significant and positive impact of the interaction between CSR and TI on firm value, indicating that firms that effectively integrate CSR and TI experience enhanced financial outcomes. Aguinis and Glavas (2012) further supported this finding by demonstrating that higher investments in innovation lead to greater financial rewards, thereby reinforcing the importance of innovation in driving firm performance.

In an environment characterized by strong innovation, Wang and Choi (2013) observed a more pronounced relationship between CSR and FP. Their research indicated that when firms operate in an innovative setting, CSR initiatives have a more substantial impact on FP. This suggests that innovative firms have the potential to harness the benefits of CSR and translate them into superior financial outcomes.

On the other hand, Wagner (2010) conducted an investigation into the interaction between innovation and the CSR-FP relationship and found that the intensity of innovation neither strengthens nor weakens the link. The study highlighted that the presence of innovation does not necessarily amplify or diminish the impact of CSR on FP. This conclusion aligns with the findings of Lee et al. (2016), who also found no significant moderating effect of innovation on the CSR-FP relationship.

Taken together, these studies emphasize the complex nature of the relationship between CSR, TI, and FP. While several studies demonstrate the positive moderating effect of innovation on the CSR-FP relationship, it is important to consider the context and specific dynamics at play. The interplay between CSR, innovation, and financial performance warrants further exploration to gain a more comprehensive understanding of how these factors interact and influence firm outcomes.

TI reflects a firm's effectiveness in generating new ideas and developing products/services (Kao, 1995; Lumpkin and Dess, 1996). Firms with superior TI experience strong customer loyalty, competitive advantage, brand recognition, and a price premium for their services/products (Givon, Mahajan and Muller, 1995). Innovation often leads to the creation of valuable, rare products that the producing firm can appropriate (Hart,1997; Nidumolu, Padgett and Galan, 2010; Prahalad and Rangaswami, 2009). For example, innovative technologies and processes can aid in the redesign of manufacturing processes, reducing pollution and waste, increasing energy efficiency, and incorporating eco-friendly features into product/service offerings."

TI can offer benefits to a firm, but it is not necessarily a prerequisite for enhancing the performance of CSR practices. However, TI can play a moderating role in the relationship between CSR practices and related performance (Martinez-Conesa et al. 2017). The introduction of new technologies and processes has the potential to foster trust and support among members of an organization. By enabling individuals to comprehend and adapt to new social and economic conditions, innovative practices can facilitate organizational members in navigating and responding to emerging challenges.

Furthermore, TI can assist organizational members in effectively negotiating their objectives and goals, thereby striking a balance between conflicting demands from different stakeholder groups (Bocquet et al*.*, 2013). This ability to reconcile and address diverse stakeholder expectations is crucial for sustainable performance and long-term success. Through innovative approaches, organizations can engage with stakeholders, gain their trust, and align their interests with CSR objectives, leading to improved performance outcomes (Mattera and Baena 2015).

By leveraging TI in conjunction with CSR practices, firms can enhance their performance by actively involving various stakeholders. The integration of innovative technologies and processes with CSR initiatives can create new opportunities for collaboration, communication, and co-creation with stakeholders, resulting in mutual benefits and positive performance outcomes. It is important to note that while TI can facilitate the implementation and effectiveness of CSR practices, the success of CSR does not solely rely on technological advancements. Other factors, such as organizational culture, leadership commitment, and stakeholder engagement, also significantly influence the outcomes of CSR initiatives.

While TI is generally regarded as beneficial for firms, there can be instances where it has a negative moderation effect on the relationship between CSR and FP. Increased investment in both TI and CSR may lead to a situation where performance outcomes are compromised.

One possible argument is that excessive investment in technological innovation may divert resources and attention away from other areas, including CSR initiatives. Firms heavily focused on TI may allocate a significant portion of their financial resources, time, and effort to research, development, and implementation of innovative technologies. This intense focus on TI can result in a neglect of social and environmental responsibilities, leading to a weakened CSR-FP relationship. For instance, firms may prioritize short-term financial gains driven by innovative products or services, potentially undermining their overall financial performance. Over time, this narrow focus on TI without a corresponding emphasis on CSR may result in reputational damage, legal issues, or public backlash, negatively impacting FP (Barnett and Salomon 2012).

Moreover, in some cases, the pursuit of technological innovation may involve high costs and risks. Companies investing heavily in TI may face substantial financial burdens, including research and development expenses, acquiring advanced technology, or adapting to rapidly changing market demands. Such financial strains can limit the available funds for CSR activities. As a result, the company's ability to effectively engage in socially responsible practices may be compromised, leading to a weakened CSR-FP relationship. The inadequate allocation of resources to CSR can result in missed opportunities to address social and environmental concerns, which may negatively impact financial performance (Margolis and Walsh 2003).

Additionally, a narrow focus on TI may lead to a lack of alignment between CSR efforts and stakeholder expectations. Stakeholders, including customers, employees, investors, and communities, increasingly expect firms to demonstrate responsible business practices and contribute positively to society. If stakeholders perceive the firm as prioritizing innovation at the expense of addressing social and environmental concerns, it can erode stakeholder trust and loyalty. Negative stakeholder perceptions and disengagement can lead to decreased customer loyalty, difficulty in attracting and retaining talent, and reduced investor confidence. Ultimately, these factors can have adverse effects on financial performance, as the firm may face reputational risks, decreased market share, and increased costs associated with stakeholder dissatisfaction (Orlitzky et al. 2003).

The relationship between CSR and FP exhibits a U-shaped pattern when moderated by TI. The integration of TI and CSR practices can lead to performance improvements by enabling organizations to effectively adapt to changing contexts, meet stakeholder expectations, and foster collaboration.

Research suggests that TI enhances the positive impacts and outcomes of CSR efforts, even though it is not a prerequisite for successful CSR practices. When organizations strategically integrate TI with CSR initiatives, they gain the ability to navigate dynamic environments and address emerging challenges effectively. By leveraging innovative technologies and processes, firms can align their CSR activities with stakeholder expectations, thus positively influencing financial performance.

The U-shaped relationship between CSR and FP, moderated by TI, indicates that an optimal level of TI integration is essential for maximizing the benefits of CSR on financial outcomes. Too little or too much integration of TI may lead to suboptimal results. Organizations that strike the right balance between TI and CSR are more likely to experience enhanced financial performance, as they effectively leverage innovation to address societal and environmental concerns while meeting stakeholder demands.

In summary, the U-shaped relationship between CSR and FP, with the moderation effect of TI, highlights the importance of strategically integrating these factors. By finding the optimal level of TI integration and aligning it with CSR practices, organizations can harness the potential for performance improvements, navigate changing landscapes, and effectively respond to stakeholder expectations.

Based on the above-mentioned discussion, the second hypothesis put forward is:

Hypothesis (H2) TI moderates the U-shaped CSR–FP relationship in such a manner that the same level of CSR corresponds to a higher level of financial performance when the firm's innovation is higher.

3 Methods

3.1 Data and sample

The sample for this study consisted of 384 companies mentioned in the 2017 CSRHub list of the world's automotive companies. These companies were selected based on four criteria: being in the automotive sector, being listed in the CSRHub ranking between 2011 and 2017, being publicly listed from 2011 to 2017, and being mentioned in the Thomson Reuters database for audited financial statements between 2011 to 2017. The sample was monitored for two years to determine the dimensional dynamics of the database through the lagged values of the dependent variable. Observations with Cook's Distance larger than 4/n and influential cases with distance values greater than 1 were removed to enhance the study assumptions. The final sample consisted of 924 observations from 132 firms yearly from 2011 to 2017. The data for the study was obtained from the CSRHub database for the determination of PCSR and from Thomson Reuters DataStream for the financial information.

3.2 Dependent variables

The dependent parameters in the study represent FP and CSR are quantified using three standard measures: market-based, accounting-based, and perceptual measures. To incorporate more independent FP quantifiers, the study used both the market-based and accounting-based measures. The three accounting-based measures for FP include: Return on Assets (ROA), calculated as EBIT (Earnings Before Interest and Tax) divided by total assets, Return on Equity (ROE), calculated as net income divided by total equity, and Return on Capital Investment (ROIC), calculated as earnings before tax, interest, and depreciation, excluding any loss or gain from dead investments. The market-based quantifier used in the study is Tobin's Q ratio, which represents the total debt including market equity value and total assets. Tobin's Q is included as a complement to the other measures of FP (Pekovic and Vogt 2021).

3.3 Measurements of corporate social responsibility

The researchers in this study used the CSR rating of the firms from the CSRHub database. CSRHub collects information from over 100 sources and assigns scores to the companies based on four environmental indicators: community, employee, performance, and governance. The CSRHub database includes more than 17,267 firms from 135 industries located in 133 countries and uses data from nine different sources of SRI (Socially Responsible Investment) and ESG (Environment, Social, Governance) assessment firms. The data is also obtained from over 265 NGOs (non-governmental organizations) to maintain consistency in its CSR ratings. The CSRHub database is considered beneficial as it combines more than 118 million elements of data on CSR performance from 525 data sources. The overall performance of the company's CSR activities is rated on a scale from 0 to 100, where a higher rating indicates a better CSR performance.

3.4 Moderator

The R&D intensity was used as a proxy for TI and was calculated as the ratio of R&D spending to total sales, obtained from DataStream. The positive relationship between CSR and R&D is based on the idea that investments in R&D lead to innovations that are valued by stakeholders and that various facets of CSR (such as environmental or product quality) can encompass either a product or a process innovation. The interaction term of CSR*TI is used to denote the moderation effect in the analysis.

3.5 Control variables

In this study, the authors control for the impact of firm size, industry, capital structure, free cash flow, and advertising intensity on the relationship between CSR and FP. Firm size was measured by the natural logarithm of total assets in US dollars. Capital structure was represented by the debt-to-equity ratio. Advertising intensity was measured as the total advertisement spending scaled by total firm sales. Free cash flow on sales was quantified as net cash flow relative to sales. These control parameters are commonly used in research to account for factors that could impact the relationship between CSR and FP.

3.6 The dynamic model

According to our theoretical framework, we have specified a model to examine the determinants of FP. Before doing so, we thoroughly examined the correlation between the two concepts, taking into consideration a linear and straightforward relationship rather than a quadratic one. To account for the delayed effect of CSR on FP, we have also included one-year lagged CSR variables in our model. The following models represent our findings.

$$CFP_{it} = \beta_0 + \sum_{i=0}^{n} \beta_1 CFP_{it-1} + \sum_{i=0}^{n} \beta_2 CSR_{it-1} + \sum_{i=0}^{n} \beta_3 CSR^2_{it-1} + \sum_{i=0}^{n} \beta_4 CONTROL_{it} + \varepsilon_{it} \tag{1}$$

where εit represents the observation-specific error term, FP_{it} denotes the dependent variable of firm performance, CSR_{it-1} and $CSR^2{}_{it-1}$ are the independent variables of corporate social responsibility, and CONTROL represents a set of control parameters believed to be important for FP.

However, this model may encounter several econometric challenges. Firstly, there may be an association between the error term and both CSR_{it-1} and FP_{it}, leading to the need for lagged variables in the equation. Secondly, the parameters of CSR_{it-1} may be endogenous, meaning there is a causal relationship between FP_{it} and CSR_{it-1} that goes in both directions. As a result, these regressors may also be associated with the error term.

Furthermore, time-invariant characteristics specific to the firm may impact the explanatory variables, leading to the inclusion of fixed effects represented by μ_i in the error term. Lastly, the panel data used in this study has a limited time dimension ($T=7$) and a larger number of firms ($N=132$), making it necessary to use the linear GMM dynamic panel determination method as suggested by Arellano–Bond (1991), Arellano–Bover (1995) and Blundell–Bond (1998). Thus, the final model can be represented as follows:

$$\begin{aligned} \Delta FP_{it} = \beta_0 &+ \sum_{i=0}^{n} \beta_1 \Delta FP_{it-1} + \sum_{i=0}^{n} \beta_2 \Delta CSR_{it-1} + \sum_{i=0}^{n} \beta_3 \Delta CSR^2_{it-1} \\ &+ \sum_{i=0}^{n} \beta_4 \Delta CONTROL_{it} + \Delta\varepsilon_{it} \end{aligned} \tag{2}$$

The Eq. (2) transforms the independent variables by taking the first difference, effectively eliminating the property-specific, time-invariant effects. To be able to incorporate both lagged CSR_{it-1} and lagged $CSR^2{}_{it-1}$ as instruments in the level equations, the authors use a system GMM, under the assumption that $E(\Delta CSR_{it-1}\ \varepsilon_{it})=0$. Additionally, the weak exogeneity assumption for CSR_{it-1} requires $E(\Delta\ CSR_{it-s}\ \Delta\varepsilon_{it})=0$ for $t=3, \ldots, T$ and $s \geq 2$ (Arellano and Bover 1995).

3.7 Moderation effect

The subsequent equation was applied to examine the hypotheses for the moderation effect:

$$FP_{it} = \beta_0 + \sum_{i=0}^{n} \beta_1 FP_{it-1} + \sum_{i=0}^{n} \beta_2 CSR_{it-1} + \sum_{i=0}^{n} \beta_3 TI_{it-1} + \sum_{i=0}^{n} \beta_5 (CSR * TI)_{it-1} + \sum_{i=0}^{n} \beta_6 CSR^2_{it-1} + \sum_{i=0}^{n} \beta_7 (CSR^2 * TI)_{it-1} + \sum_{i=0}^{n} \beta_8 CONTROL_{it} + \varepsilon_{it} \quad (3)$$

where FP_t and FP_{t-1} represent FP and its lagged amount. $CONTROL_{it}$ represents a set of other control parameters that are supposed to have a bearing on FP. CSR is a continuous parameter that represents the extent of giving for every firm-year observation. TI_{it} is the extent of technological innovation. β_0 to β_8 represent the parameters to be determined, and ε_{it} is an error term.

3.8 Marginal effect

It is important to note that, as stated by Brambor et al. (2006), deducing the coefficients on β2, β3, and β6 in Eq. (3) is incorrect when there is an interaction term present in the model. These coefficients only reflect the impact of TI on growth and FP when there is no presence of CSR and its squares, respectively. Hence, it is not appropriate to claim that a significant and positive coefficient of β2, β3, and β6 implies an increase in FP due to an increase in TI or CSR.

Instead, the role of TI as a moderator can influence the impact of increased CSR activities on FP, therefore β5 can be slightly positive or negative, depending on the effect of TI on FP. To determine the overall impact of increased CSR activities on FP, Brambor et al. (2006) suggest computing the partial derivative of economic growth, as follows: For Eq. (1), we can calculate the marginal effect using the following equation:

$$\frac{\delta FP_{it}}{\delta CSR_{it-1}} = \beta_2 + 2\beta_3 CSR_{it-1} \quad (4)$$

For Eq. (3), we calculate the marginal effect by using the equation below:

$$\frac{\delta FP_{it}}{\delta CSR_{it-1}} = \beta_2 + \beta_5 TI_{it-1} + 2\beta_6 CSR_{it-1} + 2\beta_7 CSR_{it-1} * TI_{it-1} \quad (5)$$

Equation (5) states that changes in FP due to changes in CSR depend on CSR itself and TI. With the presence of TI, when TI = 1, Eq. (5) can be simplified as follows:

$$\frac{\delta FP_{it}}{\delta CSR_{it-1}} = \beta_2 + \beta_5 + 2\beta_6 CSR_{it-1} + 2\beta_7 CSR_{it-1} \quad (6)$$

If the interaction term $(CSR*TI)_{it-1}$ is significantly and positively associated with FP, but only CSR_{t-1} is significantly negative, it suggests that CSR_{t-1} has a positive impact on FP only when the level of TI has reached a minimum threshold. To determine the total impact of increasing CSR on FP due to TI, we can calculate the partial derivative of FP with respect to the CSR parameter in Eq. (5). On the other hand, if the interaction term $(CSR^2*TI)_{it-1}$ is significantly and negatively linked to CSR_t and only CSR is significantly positive, it suggests that CSR has a negative impact on FP only when the level of TI has reached a maximum threshold.

4 Results and discussion

4.1 Descriptive statistics

The information of the parameters is given in Table 1. The CSR score ranged from 31 to 72, with an average of 53.2 and higher CSR score indicating better CSR performance. Four measures of FP were used including three accounting-based measures (ROE, ROA, and ROIC) and one market-based measure (Tobin's Q). The average ROA was 0.1365 per year, with a minimum and maximum of 1.00 and −0.3296 per year, respectively. The average ROE was 0.6231 per year, with a range from −2.92 to 26.48 per year. The average ROIC was 0.291 per year, with a minimum and maximum of 7.55 and − 0.68 per year. Tobin's Q values ranged from − 7.82 to 3.37. To test for multicollinearity, VIF (variance inflation factors) were calculated, and a VIF value higher than 10 indicates severe multicollinearity. However, the VIF values in our data do not exceed 1.42, and the mean VIF value is 1.25, indicating that multicollinearity should not be an issue (Tables 2, 3, 4, 5).

4.2 Estimation of the model

The study investigated the relationship between CSR and FP using a sample from the period of 2011 to 2017. The baseline model, based on a two-step GMM

Table 1 Descriptive summary

Varaible	Description	Obs	Mean	SD	Min	Max
FP (firm performance)	ROA (return on asset)	924	0.1364	0.1223	− 0.3296	1.0000
	ROE (return on equity)	924	0.6231	1.8722	− 2.9200	6.4783
	ROIC (return on invested capital)	924	0.2910	0.6200	− 0.6810	7.5481
	Tobin's Q	924	0.7603	0.9439	− 7.8209	3.3730
Independent	CSR (Corporate social responsibility)	924	53	7	31	72
Control	Leverage	924	2.3329	8.4029	− 16.7000	21.5000
	Free cash flow	924	0.0841	0.6634	− 1.5309	8.4951
	ln total assets	924	3.7364	0.7809	2.1139	5.7045
	TI (Technological innvation)	924	0.0495	0.0672	0.0128	1.0245
	Advertisment intensity	924	0.1412	0.0830	0.0194	0.5446

Log total assets is measured by US dollars, while others have no units

Table 2 Correlation matrix

	ROA	ROE	ROIC	Tobin's Q	CSR	LEV	FCF	SIZE	TI	AD
ROA	1									
ROE	0.0685	1								
ROIC	0.0838	0.4573	1							
Tobin's Q	−0.763	0.1198	0.0481	1						
CSR	0.0585	−0.0536	−0.0005	−0.066	1					
LEV	0.0585	0.8712	0.0584	0.1416	−0.0518	1				
FCF	0.0768	−0.0003	0.0145	−0.0118	−0.0004	−0.0237	1			
SIZE	−0.0968	−0.055	−0.0405	−0.048	0.4204	−0.0053	0.088	1		
TI	−0.2223	−0.0791	−0.1087	0.0744	−0.0828	0.031	−0.1265	−0.1849	1	
AD	−0.1376	−0.1227	−0.1519	0.0412	−0.0384	−0.331	−0.0759	−0.2984	0.4723	1

ROA Return on assets, *ROE* Return on equity, *ROIC* Return on capital invest, *FCF* Free cash flow, *Lev* Leverage, *AD* Advertising intensity, *TI* Technological innovation and *Size* ln total assets, *CSR* Corporate social responsibility

Table 3 CSR–FP relationship in linear models (baseline model)

Variables	Model (1) ROA	Model (2) ROE	Model (3) ROIC	Model (4) Tobin's Q
ROA_{t-1}	0.416***			
	(0.339)			
ROE_{t-1}		0.351***		
		(0.048)		
$ROIC_{t-1}$			0.744***	
			(0.0187)	
Tobin's Q_{t-1}				0.545***
				(0.0250)
Leverage	−0.000451	−0.205***	−0.000454	0.00179
	(0.00714)	(0.00816)	(0.00736)	(0.00284)
Free cash flow	0.280***	0.608**	0.222	0.0411*
	(0.00228)	(0.262)	(0.138)	(0.0249)
ln total assets	0.779***	0.187**	0.223***	0.202**
	(0.00102)	(0.077)	(0.0422)	(0.0875)
Advertisment intensity	0.016***	1.277	3.268***	0.785**
	(0.021)	(3.667)	(0.352)	(0.278)
Constant	0.766***	16.33	4.845*	0.855**
	(0.219)	(20.48)	(2.751)	(0.384)
Country	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Observations	792	792	792	792
Number of firms	132	132	132	132
No of instruments	20	20	20	20
AR(1)	−0.78(0.057)	−1.55 (0.213)	−2.63(0.165)	−3.85(0.005)
AR(2)	2.48(0.316)	0.74(0.543)	0.01(0.990)	−0.59(0.553)
Wald test z1	30.87(0.000) (df = 5)	347.87(0.000) (df = 5)	8.51(0.000) (df = 5)	48.46(0.000) (df = 5)
Wald test z2	78.99(0.000) (df = 2)	208.99(0.000) (df = 2)	16.99(0.000) (df = 2)	25.66(0.000) (df = 2)
Hansen test	21.31(0.451)	11.80(0.107)	33.65(0.742)	27.57(0.442)
Hansen different test	8.01(0.108)	14.108(0.051)	24.48(0.045)	8.29(0.141)

The variables are *CSR* CSR score, *ROA* return on assets, *ROE* return on equity, *ROIC* return on invest capital, *p*-values in parentheses: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

Sample period: 2011–2017. Syntax xtabond2 twostep small robust. *p*-values are reported in brackets. Hansen J-test presents the *p*-values for the null hypothesis that instruments are valid. Diff-in-Hansen test presents the *p*-values for the validity of the additional moment restrictions that are necessary for system GMM. The *p*-values presents for AR(1) and AR(2) are for first and second order autocorrelated disturbances in the first differences equations. Constant not presented. Wald test statistics gives significant values of $\chi 2$, rejecting the null hypothesis that estimated coefficients are jointly and significantly different from zero, meaning that model is having predictive power. z1 and z2 refer to Wald test in general

Table 4 CSR–FP relationship in linear models

Variables	Model (1) ROA	Model (2) ROE	Model (3) ROIC	Model (4) Tobin's Q
ROA_{t-1}	0.451***			
	(0.0223)			
ROE_{t-1}		0.291***		
		(0.011)		
$ROIC_{t-1}$			0.834***	
			(0.0397)	
Tobin's Q_{t-1}				0.655***
				(0.0260)
CSR_{t-1}	0.001452	0.2241	−0.203	−0.01254
	(0.0318)	(0.492)	(0.931)	(0.1568)
Leverage	−0.333***	−0.195***	−0.0344**	0.0289***
	(0.00468)	(0.00926)	(0.00226)	(0.00134)
Free cash flow	0.540***	0.888**	0.102	0.0501*
	(0.00348)	(0.262)	(0.118)	(0.0339)
ln total assets	0.769***	0.187**	0.313***	0.332**
	(0.00102)	(0.065)	(0.0212)	(0.1025)
Advertisement intensity	0.284***	1.289	3.468***	0.685**
	(0.021)	(3.547)	(0.152)	(0.078)
Constant	0.436*	−14.33	5.085*	−0.855**
	(0.239)	(18.43)	(2.651)	(0.394)
Country	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Observations	792	792	792	792
Number of firms	132	132	132	132
No of instruments	20	20	20	20
AR(1)	−2.81(0.158)	−1.27(0.313)	−3.20(0.185)	−2.85(0.051)
AR(2)	−1.00(0.316)	0.61(0.543	0.01(0.990)	−0.59(0.553)
Wald test z1	30.87(0.000) (df=6)	347.87(0.000) (df=6)	8.51(0.000) (df=6)	48.46(0.000) (df=6)
Wald test z2	78.99(0.000) (df=2)	208.99(0.000) (df=2)	16.99(0.000) (df=2)	25.66(0.000) (df=2)
Hansen test	24.31(0.261)	9.80(0.207)	28.75(0.712)	21.87(0.062)
Hansen different test	8.02(0.123)	9.10(0.92)	12.39(0.085)	7.29(0.152)

The variables are *CSR* CSR score, *ROA* return on assets, *ROE* return on equity, *ROIC* return on invest capital, *p*-values in parentheses: $*p<0.1$; $**p<0.05$; $***p<0.01$

Sample period: 2011–2017. Syntax xtabond2 twostep small robust. *p*-values are reported in brackets. Hansen J -test presents the *p*-values for the null hypothesis that instruments are valid. Diff-in-Hansen test presents the *p*-values for the validity of the additional moment restrictions that are necessary for system GMM. The *p*-values presents for AR(1) and AR(2) are for first and secondorder autocorrelated disturbances in the first differences equations. Constant not presented. Wald test statistics gives significant values of $\chi 2$, rejecting the null hypothesis that estimated coefficients are jointly and significantly different from zero, meaning that model is having predictive power. z1 and z2 refer to Wald test in general

Table 5 CSR–FP relationship in quadratic models

Variables	Model (1)	Model (2)	Model (3)	Model (4)
	ROA	ROE	ROIC	Tobin's Q
ROA_{t-1}	0586***			
	(0.0004)			
ROE_{t-1}		0.1820***		
		(0.0000)		
$ROIC_{t-1}$			0.458***	
			(0.0000)	
Tobin's Q_{t-1}				0.118***
				(0.0000)
CSR_{t-1}	−0.458**	−0.319***	−0.219***	−0.874***
	(0.0017)	(0.0096)	(0.0018)	(0.0063)
$CSR_{t-1}{}^{2}$	0.415***	0.555***	0.343***	0234***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Leverage	−0.135***	−0.211***	−0.432***	−0.213***
	(0.0000)	(0.0000)	(0.0022)	(0.0000)
Free cash flow	0.111***	2.010***	−0.9634***	−0.205***
	(0.0006)	(0.369)	(0.0245)	(0.0117)
ln total assets	0.234***	0.086***	0.0216***	0.0925***
	(0.0000)	(0.0004)	(0.0000)	(0.0006)
Advertising intenstiy	−0.993***	−2.883***	−1.444***	0.372***
	(0.0056)	(0.182)	(0.201)	(0.1015)
Constant	11.308***	12.106***	22.308***	10.184***
	(0.0610)	(0.317)	(0.448)	(0.119)
Country	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes

Table 5 (continued)

Variables	Model (1)	Model (2)	Model (3)	Model (4)
	ROA	ROE	ROIC	Tobin's Q
Observations	468	468	468	468
No of firms	132	132	132	132
No of instruments	45	45	45	45
AR(1)	−4.11(0.442)	−1.33(0.185)	−1.20(0.229)	−6.01(0.113)
AR(2)	12.22(0.425)	−11.13(0.555)	−31.03(0.225)	−2.89(0.471)
Hansen test	22.81(0.189)	33.74(0.576)	24.48(0.167)	13.92(0.368)
Wald test z1	33.87(0.000) (df = 8)	37.87(0.000) (df = 8)	18.52(0.000) (df = 8)	46.41(0.000) (df = 8)
Wald test z2	75.99(0.000) (df = 2)	28.99(0.000) (df = 2)	16.29(0.000) (df = 2)	24.66(0.000) (df = 2)
Hansen different test	9.96(0.191)	4.47(0.724)	14.44(0.044)	5.40(0.612)
CSR investment threshold	34.11	42,56	45,67	47.99
Marginal effect				
Mean	0.0435***	0.036603***	0.08549***	0.61345***
Min	−0.03605***	−0.0440324***	−0.05215***	−0.543159***
Max	0.0661***	0.069536***	0.8029**	0.950735***

The variables are *CSR* CSR score, *ROA* return on assets, *ROE* return on equity, *ROIC* return on invest capital, *p*-values in parentheses: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Sample period: 2011–2017. Syntax xtabond2 twostep small robust. *p*-values are reported in brackets. Hansen J -test presents the *p*-values for the null hypothesis that instruments are valid. Diff-in-Hansen test presents the *p*-values for the validity of the additional moment restrictions that are necessary for system GMM. The *p*-values presents for AR(1) and AR(2) are for first and second order autocorrelated disturbances in the first differences equations. Constant not presented. Wald test statistics gives significant values of $\chi 2$, rejecting the null hypothesis that estimated coefficients are jointly and significantly different from zero, meaning that model is having predictive power. z1 and z2 refer to Wald test in general. z1 and z2 refer to Wald test in general estimator, was re-estimated using the CSR score as the target variable. The results of the linear regression models (1 to 4) showed a positive but insignificant relationship between CSR and the four FP indicators (ROE, ROA, ROIC, and Tobin's Q). However, the lagged FP coefficient was significant and positive, confirming the dynamic specifications of the model and the existence of past performance impacting current performance.

The study also looked into the relationship between CSR and FP in quadratic systems and discovered that a U-shaped relationship existed between CSR and each of the FP indicators (López-Penabad et al. 2022), suggesting that the benefits of CSR activities only accrue after a certain threshold level has been reached. The threshold values for the four FP indicators were 42.46 for ROE, 34.11 for ROA, 45.67 for ROIC, and 47.99 for Tobin's Q. This supports the hypothesis that a non-linear relationship exists between CSR and FP and the conclusion that less CSR spending is not always better and may even hinder profitability.

The marginal effects at the minimum, mean, and maximum levels were significant, with a positive impact on FP at maximum CSR levels and a negative impact at minimum CSR levels. This indicates that a higher CSR level plays a more significant role in supporting FP and requires a significant investment in resources to positively impact the firm's supply chain. The results support the idea that a U-shaped relationship exists between CSR and FP and that a higher score of CSR, positively associated with spending, leads to a positive correlation between CSR and FP only with a significant investment and achievement in CSR.

4.3 Moderation effect of technological innovation

Tables 6, 7, and 8 present the baseline, linear, and quadratic-by-linear correlations between CSR and TI and their impact on FP. The results of the linear interaction (Table 7) showed that the interaction between CSR scores and TI $(CSR*TI)_{t-1}$ did not have a significant effect on the FP measures of Return on Equity (ROE), Return on Assets (ROA), Return on Invested Capital (ROIC), or Tobin's Q. However, when a quadratic-by-linear correlation was included (Table 8), the results showed that TI had a significant moderating effect on the relationship between CSR and FP.

The findings indicated a U-shaped correlation between CSR and FP, with a negative $(CSR*TI)_{t-1}$ *and then a positive* $(CSR^2*TI)_{t-1}$ interaction effect, which suggests that a high level of TI enhances the CSR-FP relationship while a low level of TI results in a negative relationship. The results support Hypothesis 2, which states that TI can regulate the relationship between CSR and FP.

The subsequent step was to calculate the marginal effect, and the results showed that the turning points for the four FP measures were lower with the inclusion of TI interaction. The marginal effects showed that both TI and CSR were positive and statistically significant at the maximum and mean levels but negative at the minimum level. Among the four FP measures, Tobin's Q had the highest marginal effect at the average level and the maximum unfavorable effect on progress at the minimum level.

Table 6 CSR–FP relationship in linear models

Variables	Model (1) ROA	Model (2) ROE	Model (3) ROIC	Model (4) Tobin's Q
ROA_{t-1}	0.441***			
	(0.0000)			
ROE_{t-1}		0.871***		
		(0.0000)		
$ROIC_{t-1}$			0.654***	
			(0.0007)	
Tobin's Q_{t-1}				0.235***
				(0.0000)
CSR_{t-1}	0.00812	0.0023	−0.333	0.454
	(0.43318)	(0.222)	(0.741)	(0.389)
Leverage	−0.1388***	0.195***	−0.521***	0.389***
	(0.0268)	(0.0026)	(0.0066)	(0.0010)
Free cash flow	0.190***	−0.678**	0.112***	0.401***
	(0.0012)	(0.482)	(0.0101)	(0.0239)
ln total assets	0.8469***	0.337***	0.413***	0.412***
	(0.0002)	(0.0015)	(0.0112)	(0.0125)
TI_{t-1}	0.519***	6.080***	1.442***	0.160
	(0.0254)	(0.199)	(0.148)	(0.157)
Advertisement intensity	0.384***	0.345	1.168***	0.878**
	(0.0111)	(3.547)	(0.052)	(0.0008)
Constant	11.536***	−16.33	1.945	−10.955***
	(0.339)	(15.48)	(2.851)	(0.284)
Country	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Observations	792	792	792	792
Number of firms	132	132	132	132
No of instruments	20	20	20	20
AR(1)	12.02(0.347)	−11.14(0.313)	−9.39(0.445)	−6.25(0.091)
AR(2)	−1.45 (0.556)	1.61(0.443	0.87(0.240)	−0.69(0.113)
Wald test z1	26.87(0.000) (df=7)	37.17(0.000) (df=7)	18.51(0.000) (df=7)	38.46(0.000) (df=7)
Wald test z2	34.99(0.000) (df=2)	28.97(0.000) (df=2)	17.99(0.000) (df=2)	5.66(0.000) (df=2)
Hansen test	9.31(0.291)	23.80(0.667)	32.75(0.802)	21.17(0.152)
Hansen different test	10.02(0.228)	11.10(0.172)	16.39(0.155)	18.23(0.131)

The variables are *CSR* CSR score, *ROA* return on assets, *ROE* return on equity, *ROIC* return on invest capital, *TI* technological innovation, repressed by total R&D. *p*-values in parentheses: $*p<0.1$; $**p<0.05$; $***p<0.01$. Sample period: 2011–2017. Syntax xtabond2 twostep small robust. *p*-values are reported in brackets. Hansen J -test presents the *p*-values for the null hypothesis that instruments are valid. Diff-in-Hansen test presents the *p*-values for the validity of the additional moment restrictions that are necessary for system GMM. The *p*-values presents for AR(1) and AR(2) are for first and second order autocorrelated disturbances in the first differences equations. Constant not presented. Wald test statistics gives significant values of $\chi 2$, rejecting the null hypothesis that estimated coefficients are jointly and significantly different from zero, meaning that model is having predictive power. z1 and z2 refer to Wald test in general

Table 7 CSR–FP relationship in linear models

Varables	Model (1) ROA	Model (2) ROE	Model (3) ROIC	Model (4) Tobin's Q
ROA_{t-1}	0.0284**			
	(0.0283)			
ROE_{t-1}		0.217***		
		(0.0000)		
$ROIC_{t-1}$			0.337***	
			(0.0000)	
Tobin's Q				0.213***
				(0.0000)
CSR_{t-1}	−0.0208	0.776	−0.223	−0.01098
	(0.0204)	(1.136)	(0.504)	(0.0450)
$(CSR*TI)_{t-1}$	0.0300	−30.35	7.769	0.1691
	(0.415)	(32.51)	(6.709)	(0.912)
TI_{t-1}	2.333***	0.7719***	0.891	0.456***
	(0.0113)	(0.0001)	(0.0000)	(0.0021)
Leverage	0.216***	0.341***	0.443***	0.114***
	(0.0118)	(0.0011)	(0.00441)	(0.00407)
Free cash flow	0.0668**	−0.415***	0.484****	−0.3118***
	(0.0307)	(0.010)	(0.0014)	(0.0004)
ln total assets	−0.810***	0.512***	0.579***	0.786***
	(0.0380)	(0.0013)	(0.0017)	(0.0098)
Advertisement intensity	−0.898*	−3.447**	−2.712	−0.829***
	(0.599)	(1.122)	(5.771)	(0.0116)
Constant	7.999***	6.459***	12.13***	11.655***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Country	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Observations	792	792	792	792
No of firms	132	132	132	132
No of instruments	20	20	20	20
AR(1)	6.08(0.333)	0.64(0.249)	2.70(0.330)	4.30(0.321)
AR(2)	6.09(0.477)	2.12(0.885)	7.13(0.451)	6.49(0727)
Wald test z1	33.87(0.000) (df = 8)	57.87(0.000) (df = 8)	24.51(0.000) (df = 8)	55.46(0.000) (df = 8)
Wald test z2	44.99(0.000) (df = 2)	68.99(0.000) (df = 2)	17.99(0.000) (df = 2)	66.66(0.000) (df = 2)
Hansen test	14.99(0.344)	8.73(0.449)	48.76(0.371)	21.78(0.673)
Diffrent in hansent test	7.73(0.320)	9.31(0.585)	36.82(0.329)	12.37(0.572)

The variables are *CSR* CSR score, *ROA* return on assets, *ROE* return on equity, *ROIC* return on invest capital, *TI* technological innovation, repressed by total R&D

P-values in parentheses: *$p<0.1$; **$p<0.05$; ***$p<0.01$. Sample period: 2011–2017. Syntax xtabond2 twostep small robust. *p*-values are reported in brackets. Hansen J -test presents the *p*-values for the null hypothesis that instruments are valid. Diff-in-Hansen test presents the *p*-values for the validity of the additional moment restrictions that are necessary for system GMM. The *p*-values presents for AR(1) and

Table 7 (continued)

AR(2) are for first and second order autocorrelated disturbances in the first differences equations. Constant not presented. Wald test statistics gives significant values of $\chi 2$, rejecting the null hypothesis that estimated coefficients are jointly and significantly different from zero, meaning that model is having predictive power. z1 and z2 refer to Wald test in general

The results indicate that the relationship between CSR and FP has a U-shaped correlation when there is TI, confirming Hypothesis 2. Before reaching the turning point, low CSR activities do not positively impact FP. However, external factors like government policies, employee complaints, and community discussions may force companies to increase their social activities, leading to increased benefits and further inspiration to do more. The marginal effects showed that CSR benefits firm value more than accounting measures, as Tobin's Q had a higher marginal effect than ROE, ROA, and ROIC.

5 Conclusion

Our research aimed to understand the relationship between FP and CSR for companies in the automotive sector. We found evidence of a U-shaped relationship between FP and CSR, which has not been fully explored in previous studies that mostly relied on linear models. Our findings highlight the importance of considering the moderating impact of TI in the FP-CSR relationship. Our research supports multiple theories such as the trade-off hypothesis, the managerial opportunism hypothesis, the resource dependence theory, the good management hypothesis, and the stakeholder theory, which all contribute to the "too little of a good thing" impact of CSR on FP. The relationship between FP and CSR is positive for firms with high CSR but becomes negative for firms with low CSR. To shift from a negative to a positive relationship, companies could adopt a proactive approach to environmental and social issues, as recommended by King and Lenox (2002) and Clarkson et al. (2011). In conclusion, our results suggest that "it pays to be good" once a minimum level of CSR is achieved.

5.1 Theoretical implications

Our research makes three important contributions to the existing literature. Firstly, we provide evidence of a non-linear, U-shaped relationship between CSR and FP in the automotive sector. Our findings offer empirical support for the "Too-Little-of-a-Good-Thing" (TLGT) effect, which suggests that the relationship between CSR and FP is both positive and negative, depending on the level of CSR. Firms with low CSR are likely to have a negative impact on FP, while those with higher levels of CSR are more likely to benefit from their CSR activities. This finding is in line with the TLGT framework, which incorporates several theories, including the trade-off hypothesis, the managerial opportunism hypothesis, the win–win hypothesis, the resource-based view, and the stakeholder theory.

Table 8 CSR–FP relationship quadratic models

Variables	Model (1)	Model (2)	Model (3)	Model (4)
	ROA	ROE	ROIC	Tobin's Q
ROA_{t-1}	0.232***			
	(0.0119)			
ROE_{t-1}		0.323***		
		(0.00050)		
$ROIC_{t-1}$			0.835***	
			(0.00263)	
Tobin's Q_{t-1}				0.882***
				(0.0020)
CSR_{t-1}	0.00231**	0.0338***	0.04179**	0.00415***
	(0.0328)	(0.0001)	(0.0030)	(0.0002)
CSR_{t-1}^{2}	0.0087***	0.0305***	0.00401***	0.00712***
	(0.0025)	(0.0022)	(0.0008)	(0.0031)
TI_{t-1}	3.420***	45.45***	30.67***	25.11***
	(0.907)	(13.20)	(10.487)	(12.291)
$(CSR*TI)_{t-1}$	−0.177***	−1.954***	−1.028***	−0.811***
	(0.0156)	(0.388)	(0.389)	(0.431)
$(CSR^{2}*TI)_{t-1}$	0.233***	0.0187***	0.0011***	0.0156***
	(0.0000)	(0.0012)	(0.0000)	(0.0001)
Leverage	−0.0011***	−0.810***	−0.427*	−0.0246
	(0.0001)	(0.0000)	(0.0000)	(0.0022)
Free cash flow	0.0527***	0.222**	−0.0449	−0.445***
	(0.005)	(0.0154)	(0.0416)	(0.0038)
ln total assets	0.360***	0.4302***	0.692***	0.5542***
	(0.00102)	(0.0007)	(0.0041)	(0.0073)
Advertisment intensity	−0.113***	−2.116***	−1.227***	0.448***
	(0.0002)	(0.0004)	(0.0610)	(0.1012)

Table 8 (continued)

Variables	Model (1)	Model (2)	Model (3)	Model (4)
	ROA	ROE	ROIC	Tobin's Q
Constant	0.168***	0.789***	0.0123	0.551***
	(0.002)	(0.074)	(0.549)	(0.001)
Country	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Observations	468	468	468	468
No of firms	91	91	91	91
No of instruments	65	65	65	65
AR(1)	−5.42(0.501)	−2.26(0.195)	−4.21(0.117)	−2.99(0.403)
AR(2)	−0.34(0.798)	−0.45(0.126)	−3.33(0.563)	−0.18(0.558)
Wald test z1	38.40(0.000) (df = 9)	38.87(0.000) (df = 9)	33.51(0.000) (df = 9)	55.46(0.000) (df = 9)
Wald test z2	78.99(0.000) (df = 2)	48.99(0.000) (df = 2)	45.99(0.000) (df = 2)	78.66(0.000) (df = 2)
Hansen test	12.08(0.347)	22.51(0.165)	16.78(0.330)	9.95(0.644)
Hansen different test	9.30(0.162)	257.98(0.684)	14.14(0.342)	10.73(0.211)
CSR investment threshold	12.4545	22.5449	25.3201	30.2308
Marginal effect				
Mean	0.0755**	0.04813***	0.04919***	0.9045**
Min	−0.2155***	−0.130324**	−0.13215***	−0.2659***
Max	0.7101***	0.6646***	0.4308***	0.5235***

The variables are *CSR* CSR score, *ROA* return on assets, *ROE* return on equity, *ROIC* return on invest capital, *TI* technological innovation, repressed by total R&D. *p*-values in parentheses: *$p<0.1$; **$p<0.05$; ***$p<0.01$. Sample period: 2011–2017. Syntax xtabond2 twostep small robust. *p*-values are reported in brackets. Hansen J -test presents the *p*-values for the null hypothesis that instruments are valid. Diff-in-Hansen test presents the *p*-values for the validity of the additional moment restrictions that are necessary for system GMM. The p-values presents for AR(1) and AR(2) are for first and second order autocorrelated disturbances in the first differences equations. Constant not presented. Wald test statistics gives significant values of $\chi 2$, rejecting the null hypothesis that estimated coefficients are jointly and significantly different from zero, meaning that model is having predictive power. z1 and z2 refer to Wald test in general

Secondly, our study sheds light on the relationship between CSR and FP in the automotive industry, highlighting the significance of social and environmental considerations and their impact on FP. Our results, based on both accounting and market-based performance measures, provide robust evidence for a curvilinear relationship between CSR and FP in the automotive sector.

Thirdly, we show that TI has a significant moderating effect on the relationship between CSR and FP. Our results suggest that a firm's level of TI plays a crucial role in determining the extent to which it can benefit from CSR. This finding is consistent with the contingency theory, which states that the effectiveness of a management practice depends on the context. Our results indicate that highly innovative firms can reap greater benefits from CSR due to their stronger ties with stakeholders and the greater signal impact of a positive image and reputation in dynamic industries. Additionally, our findings highlight that CSR helps firms manage environmental uncertainty, which has not been emphasized in previous studies. Overall, our analysis provides a more comprehensive understanding of the relationship between CSR and FP and uses Brambor et al.'s (2006) interaction technique to calculate the standard error and assess the moderating effect of TI on this relationship.

5.2 Practical implications

This study provides important suggestions for corporate managers in the automobile industry. The results indicate that moderate levels of CSR activities result in the best FP. Managers should understand that CSR activities can positively impact their bottom line, but should also assess stakeholders' responses when making important CSR decisions. Excessive investments in CSR can increase costs without generating corresponding benefits. Managers should understand that CSR is an important part of doing business and has the potential to improve the financial performance of the company. When making decisions regarding CSR, managers should be cautious of stakeholders' feedback and provide convincing justifications for their investments. Companies should consider their technological innovations when formulating their CSR strategy and channel their efforts towards relevant CSR initiatives. This will enable the firm to better manage finances and meet stakeholders' expectations. Both CSR and R&D can provide a competitive edge for the company, but firms should also focus on initiatives that show their responsibility to society. This creates opportunities for sustainable relationships with stakeholders.

5.3 Limitations and suggestions for future studies

The limitations of this report should be addressed in future studies. Firstly, the CSRHub scores used in the report may not accurately reflect the actual level of a company's CSR activities, as they only provide a general indication of a company's efforts. Secondly, this report was unable to determine which specific type of CSR activity had the greatest impact on FP, as the study used a monolithic approach to categorize different types of CSR activities. Thirdly, the sample used in this report only consisted of companies with a high market capitalization, limiting the generalizability of the results to the entire automotive sector. To address these limitations, future studies should use a more comprehensive and accurate measure of CSR activities, consider the specific effects of different types of CSR activities, and include a wider range of companies from various regions and industries. Additionally, empirical studies should be conducted using better research techniques and larger, more diverse datasets to increase the accuracy and generalizability of the results.

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