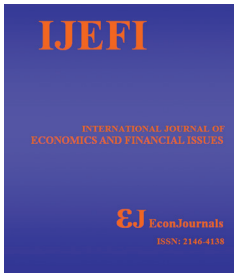

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The Mediating Role of R&D Intensity in the Effect of Corporate Sustainability on Financial Performance#

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ABSTRACT

There has been a significant rise in the frequency of natural disasters such as fires, droughts, floods and tornadoes; furthermore, it has been clearly seen that epidemic preparedness throughout the world, especially in regard to the COVID-19 pandemic, can be improved by providing social supports, particularly to underdeveloped countries. Due to these developments, there is an ever greater tendency to undertake sustainability activities. Moreover, it is well known that firms make significant research and development (R&D) efforts for these activities. Hence, the current study aims to determine the mediator role of R&D activities in the impact of corporate sustainability practices on financial performance. For this purpose, panel data analysis was applied to corporate sustainability and financial data from 23 firms trading in Borsa Istanbul between 2014 and 2020. The analysis results show that corporate sustainability applications affect financial performance negatively and that this effect implicitly turns positive with the intervention of R&D efforts.

Keywords: Corporate Sustainability, Corporate Social Responsibility, Research and Development Intensity, Financial Performance, Mediating Role
JEL Classifications: C58

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1. INTRODUCTION

There has been a rapid increase in scientific and other studies of sustainability and, more specifically, of corporate sustainability (CS), especially in recent years. Recent studies of this topic have generally focused on the predictors and consequences of CS (Aguinis and Glavas, 2012), which they suggest is a "grey area" due to the complex consequences of the direct impact of CS on financial performance (FP) (Sameer, 2021). Research conducted on this issue has stated that there has been a shift in the CS-FP relationship in regard to the mechanism of how CS is converted into FP (Ye et al., 2021). Hence, the use of mediator variables to reveal the mechanisms of action in studies conducted on CS and environmental issues has become ever more important in recent years (López-Gamero et al., 2009; Aguinis and Glavas, 2012). However, even if there is a transformation in the examination of mediator mechanisms in the effect of CS on FP, it is persistently emphasised that studies in this area are insufficient (Margolis and Walsh, 2003; Grewatsch and Kleindienst, 2017). Another important point to which attention is drawn by current studies investigating both the direct impact of CS and/or environmental activities on FP and mediation mechanisms (Habib, 2024) is that many studies in the field have focused on firms in developed countries, such as the USA and European countries (Zeng et al.,

2010; Hasan et al., 2021). Therefore, the number of studies of firms operating in developing countries is quite limited (Alshehhi et al., 2018).

Considering the differences, including in perspectives, in CS applications and organisational structure, pressures from civil society and financial markets and criteria for the adoption of CS, mechanically applying the findings obtained from developed countries to developing countries is not seen as good practice (Robertson, 2009; Su et al., 2020; Manrique and Martí-Ballester, 2017; Kalia and Aggarwal, 2023). The present study aimed to investigate the mediating role of R&D intensity in the effect of CS on FP through panel data analysis. For this purpose, the FP data covering the CS activities of 23 firms operating in Turkey in the periods 2014-2019 and 2015-2020 were examined. Grewatsch and Kleindienst (2017) suggested that studies examining the mediating role of intangible resources and abilities are in their infancy and that studies taking this approach could make great contributions to our knowledge of the CS-FP relationship. For this reason, R&D intensity in the mediation mechanism of the effect of CS on FP has been discussed. Researching firms in Turkey will help to fill the gap in this area, as this study will add to the limited number of studies conducted in developing countries.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Empirical studies of the relationship between CS and FP started with Maskowitz (1972). In recent years, studies of this issue have increased rapidly. Examination of the studies carried out to date reveals that mixed results have been obtained, and, despite the differences in the results, they are generally supported by theories, hypotheses or perspectives in the field of finance and management. Friedman (1970), the founder of shareholder theory, which argues that CS negatively affects FP, stated that firms have only one social responsibility, which he defined as the use and design of firm resources and activities in a way that benefits their shareholders and therefore the firm. Freeman (1984), who argued the opposite of this theory, put forward stakeholder theory, suggesting that firms are not only responsible for their shareholders, but also need to balance the interests of stakeholders that may affect or be influenced by the achievement of their goals. By the 2000s, McWilliams and Siegel (2000) proposed Supply-Demand Hypothesis on achieving a neutral effect of CS on FP. Accordingly, the supply of social performance of each firm depends on the corporate social responsibility (CSR) performance demand experienced by that firm. Therefore, firms will be equally profitable in the case of equilibrium, but the amount of CSR activity produced will be different (Platonova et al., 2018; Chen et al., 2023; Rahi et al., 2024). In light of this detail and mixed results the following hypothesis was developed:

H_{1a}: CS has an impact on FP.

As seen in CS, a critical literature review demonstrates that there is no commonly-accepted consensus for the impact of environmental dimension on FP. Although the proposed hypotheses and theories for the different results regarding the environmental dimension of CS are valid (Salzmann et al., 2005), they are based on the positive effect of environmental activities on FP, cost leadership and differentiation advantage (Porter, 1998; Molina-Azorín et al., 2009; Chen et al., 2016; Saeed et al., 2025). Recent research (Christmann, 2000; Delmas et al., 2011) proposes that proactive firms can have lower production costs by reducing pollution than those of their reactionary counterparts.

However, the idea that green products are more valuable than traditional products in customer perceptions provides the advantage of differentiation and enables the firm to take a better position than its competitors (Chen et al., 2016). In contrast, according to Wagner et al. (2001), the negative effect is based on "traditional" microeconomic theory. It is assumed in this theory that pollution reduction and environmental performance improvements decrease marginal benefits and increase marginal costs. Researchers who defend the negative effect believe that these assumptions occur when the productivity of environmental regulations decreases, financial resources are wasted and firms are forced to build new factories and make investments abroad (Bhat, 1998). Therefore, due to the availability of mixed results similar to CS, the second hypothesis developed within the scope of the present study is as follows:

H_{1b}: The environmental dimension of CS has an impact on FP.

In previous studies which used R&D activities to measure innovation (Gallego□Álvarez et al., 2011; Hull and Rothenberg, 2008; Kim and Kim, 2018), the relationship between CS and innovation has generally been explained through a resource□based view (RBV) (Bahta et al., 2021). RBV argues that a firm that outperforms its competitors develops distinctive resources that are rare, valuable, inimitable and not easily substitutable (Barney, 1991). RBV states that CS activities can help the firm's strategy and contribute to innovation, which will create value by providing different resources and capabilities to those of other firms (Ye et al., 2021). In parallel with this view, Shefer and Frenkel (2005) stated that firms should invest in R&D to innovate. Past studies (Acs and Audretsch, 1988; Parisi et al., 2006; Seenaiah and Rath, 2018) have claimed that R&D activities have a positive impact on all innovations performed, including product innovation (Baumann and Kritikos, 2016). In addition, McWilliams and Siegel (2000) suggested that R&D and CS are positively related, as many aspects of CS create product innovation, process innovation or both. In light of this information, the third hypothesis created within the scope of the study is:

H_{2a}: CS has a positive impact on R&D activities.

For the relationship between the environmental dimension of CS and R&D activities (and hence innovation), Hart (1995) stated that RBV failed to define the sources of competitive advantage due to the growing size of ecological problems and therefore proposed a resource-based view which included the natural environment. This approach was based on three environmental strategies: reduction and pollution prevention, product management (priority to less waste production in product design and development)

and sustainable development (a long-term vision for the use of environmentally sensitive products and technology). The three environmental strategies mentioned suggest that, since they are based on the firm's resources and capabilities, which are costly to imitate, such an orientation never jeopardises the competitive advantage but can strengthen and differentiate the firm's position.

When innovation is considered the best way of simultaneously reacting to rapidly changing external environment conditions (Yildiz and Aykanat, 2021), firms frequently use it to create new markets for "green" products as a response to a global change toward valuing energy-saving and low-pollutant products. Therefore, pressures related to environmental issues directly affect R&D management, in particular, due to the need to refocus on products, processes and technology as a way to achieve greater environmental sensitivity for firms (Roome, 1994). Studies examining this effect have concluded that it is generally positive (Russo and Fouts, 1997; Eiadat et al., 2008; Lee et al., 2015). Based on these considerations, the following hypothesis was developed:

H_{2b}: The environmental dimension of CS has a positive impact on R&D activities.

Tubbs (2007) and Hutauruk (2024) critically reviewed previous studies that address the profitability of R&D operations and their contribution to productivity and concluded that firms with intensive R&D operations have higher profitability and, thus, increased firm performance. Ehie and Olibe (2010) explained these positive contributions by suggesting that R&D investments created value for the firm and provided a competitive advantage. Studies conducted of firms that apply CS and specifically take environmental sensitivity into account reached similar conclusions. For example, Lin (2017) stated that if firms are involved in CS, R&D investments positively affect their performance. Ganda (2018) found that green R&D investments positively affected green performance, while Lin (2021), in his environmental measurement model, found that R&D activities positively affected FP. The following hypothesis was developed considering the explanations and results regarding the impact of R&D activities on FP:

H_3: R&D activities have a positive impact on FP.

Recent research has found that the positive impact of CS on FP depends on the mediating or moderating effects of the level of intangible resources of a firm (innovation, human capital, reputation, corporate culture, etc.) (Blanco et al., 2013). Previous studies examining the mediating role of innovation in the CS-FP relationship found that CS leads to innovation, and this contributes positively to the financial outputs of the firm (Martinez-Conesa et al., 2017; Chouaibi et al., 2020; Bahta et al., 2021). As R&D activities are one of the predecessors of innovation, these studies strengthen the claim that R&D activities may have a mediating role in the CS-FP relationship. These findings could be supported by those of McWilliams and Siegel (2000) and Van Beurden and Gössling (2008), who claimed that R&D activities had a mediating role, as well as those of Hull and Rothenberg (2008), Blanco et al. (2013) and Han et al. (2025) who measured innovation through R&D activities. In addition, Schnippering (2020) conducted a literature review and stated that it is useful to include R&D in the established models in the CS-FP relationship. In line with this, the following hypothesis was developed within the scope of the study:

H_{4a}: R&D activities have a mediating role in the impact of CS on FP.

Li et al. (2020) stated that considering innovation as a tool when examining the relationship between corporate environmental responsibility and FP would contribute to making this relationship clear and gaining more accurate results. From this point of view, studies examining the mediating role of innovation in the impact of environmental practices on FP have stated that such practices improve FP by increasing innovation (Zhang and Ma, 2021). Since R&D and innovation are likely to be positively related to firm value (Xu et al., 2020), any impact of environmental efforts on R&D has an indirect impact on firm value (Lioui and Sharma, 2012). Li and Ramanathan (2018) examined this indirect effect and stated that technical innovation (R&D intensity) in light-polluting sectors of the environment had a partial mediating role in the impact of environmental performance on FP. As a result, considering that the results suggest both that environmental practice positively affects innovation (including green innovation) and that innovation increases FP, the following hypothesis was developed:

H_{4b}: R&D activities have a mediating role in the impact of the environmental dimension of CS on FP.

3. METHODOLOGY AND DATA

3.1. Sampling

The sustainability index (XUSRD) has been calculated by Borsa Istanbul in Turkey since 2017 to evaluate Turkish firms' sustainability-led operations. The official sustainability reports of firms are evaluated in the calculation of the index. CS reports in Turkey provide information about the activities of the previous year. For this reason, the data of the CS scores *t-1* and the financial performance indicators for the *t* period were used in the study. Within the scope of the study, it was found that 60 firms were included in the XUSRD index at least once between 2014 and 2019. Since 19 of these 60 firms operate in the financial institution sector, the calculation of financial ratios is quite different. Of the remaining 41 firms, 14 with three or more missing CS reports could not be included in the sample group. Finally, the CS reports of the remaining 27 firms were examined, and 23 firms that created a content index according to the reporting guidelines published by the Global Reporting Initiative (GRI) formed the final sample group.

3.2. Measurements

3.2.1. Dependent variable: Financial performance

The measurement of FP is usually based on accounting-based (ROA, ROE, etc.) or market-based (Tobin Q, market value, market value/book value, etc.) measurements. Past studies found that accounting-based measurements are generally useful in measuring the firm's past performance, while market-based measurements could be considered an indicator of expected performance in the future (Hoskisson et al., 1994; Peloza, 2009). However,

because accounting-based measurements could be manipulated by administrators (Cordeiro and Sarkis, 1997) and market-based measures are more sensitive to changes in CS than accounting-based measurements (Galant and Cadez, 2017; Hasan et al., 2021), market-based measurements were preferred in the study. The Tobin Q is the most frequently used of such measurements in the current literature, along with different market-based measurements. In the measurement of the Tobin Q, the calculation method used was in the form of ([Total Liabilities + Market Value]/Total Assets), which has often been used in past studies to examine the relationship between CS and FP (Chen and Lee, 2017; Awaysheh et al., 2020; Su et al., 2020; Lee and Isa, 2024; Le et al., 2025). The market value used to measure the value of the Tobin Q was obtained by multiplying the number of circulating shares of the firm by the unit stock price (Yusoff et al., 2013; Laskar, 2018).

3.2.2. Independent variable: Corporate sustainability

Following earlier studies (Nekhili et al., 2017; Kim and Kim, 2018; Laskar, 2018), a binary coding (i.e. 1 = if each item is disclosed by the firm; 0 = if each item is not disclosed by the firm) was used to measure CS using content analysis methodology by searching sustainability and operation reports, websites, etc. To avoid any subjectivity in such a coding, firm declarations of the GRI content index were considered. The GRI has published two guidelines, GRI-G4 in 2013 and GRI-Standards in 2016. The majority of the firms using the GRI reporting guide in CS reporting in Turkey followed the GRI-G4 reporting guide. Therefore, in order to create a standard in the reports, the criteria for GRI-G4 and GRI-Standards were matched using the officially published "mapping" (Global Reporting Initiative, 2016). Thus, the 91 criteria in the GRI-G4 guideline were reduced to 82 criteria and a common ground was established for further examination.

After the coding of the CS reports of all firms between the years 2014 and 2019 was completed, the firms in the sample group were grouped according to whether they were in the manufacturing sector or not. Then, criterion weighting was determined separately for firms in- and outside the manufacturing sector using the entropy method (Wang et al., 2015; Aktaş and Demirel, 2021; Stojanović et al., 2021). Following the determination of the weights, the following method was used to calculate the final scores for CS and environment dimensions separately:

$$DS_{it} = \frac{\sum_{j=1}^{N_j} x_{ij} w_{ij}}{N_j} \quad (1)$$

In Equation (1), i: refers to firm, t: refers to years, j: refers to criteria here, DS_{it} refers to the points of i firm in t year (respectively, economic, environmental and social), N_j: refers to the number of criteria in j dimension, x_{ij}: refers to the value of j criteria in i firm, and w_j: refers to the weight of j criteria. In the calculation of the final scores, separate criterion weights were used in- and outside the manufacturing sector. After the scores belonging to the three dimensions of CS (economic, environmental and social) were calculated, the total CS score (CSS) was obtained with the addition of these scores.

However, due to incomplete reports, seven observations could not be accessed, and it was seen that 23 observations in the period 2014-2019 of the 131 firms in the sample were complete. Although there are few studies in the current literature, it is possible to find studies in which the linear interpolation method was used to complete incomplete observations in CSSs (Hilary and Hui, 2009; Jha and Cox, 2015; Wu et al., 2016). Therefore, five of the seven observations were completed by linear interpolation, and two were completed by linear extrapolation method. Finally, 138 observations were obtained at the end of the preparation phase of the paper.

3.2.3. Mediator variable: R&D intensity

R&D intensity, which has a very important role in creating sustainable competitive advantage and growth in total revenue, is calculated by the ratio of R&D expenditures to the net sales of the firm, which is widely used in the literature (McWilliams and Siegel, 2000; Servaes and Tamayo, 2013; Kang et al., 2016; Zhou et al., 2020; Han et al., 2025).

3.2.4. Control variables

Past studies highlighted the importance of inclusion of control variables in the model to make sure that any relationship between CS, stakeholder management and FP is not the result of any other misleading variables (Hillman and Keim, 2001; Husted and Allen, 2007). Therefore, the most frequently used control variables in the current literature are discussed in the study. When prior studies are examined, it is noted that the most commonly used control variable is firm size (Konar and Cohen, 2001; Callan and Thomas, 2009; Chen and Wu, 2020; Duque-Grisales et al., 2020). Although there are varying calculation methods for measuring firm size, the logarithm of total assets, which is the most commonly used calculation method, was used in this paper (Servaes and Tamayo, 2013; Kim and Kim, 2018; Nuber et al., 2020; Saeed et al., 2025).

The leverage ratio, which is considered a risk indicator for shareholders, was calculated in the form of (Total Debt/Total Assets) (Garcia-Blandon et al., 2020) and was chosen as another control variable (Wagner, 2005; Schreck, 2011; Russo and Mariani, 2013; Yu and Zhao, 2015). Finally, the sector, which is claimed to have caused differentiation in the results regarding the relationship between innovation and CS (Gallego□Álvarez et al., 2011), was taken as the control variable in the model in which R&D intensity was taken as the dependent variable (Hull and Rothenberg, 2008; Tsai and Wang, 2008; Ye et al., 2021). The sector variable was taken as "1" if the firm is in the manufacturing sector, and "0" if it is not (Callan and Thomas, 2009; Kuzey and Uyar, 2017; Nuber et al., 2020).

3.3. Analysis

The traditional approach proposed by Baron and Kenny (1986) was used to analyse mediating in this study considering the developed hypotheses. In this approach, the independent variable is expected to have a direct effect on the dependent variable; the independent

variable is expected to have an effect on the mediator variable; and the mediator variable is expected to have a significant effect on the dependent variable. If these prerequisites are met, the effect of the independent variable and the mediator variable on the dependent variable is considered. Thus, the indirect effect of the independent variable on the dependent variable (with the effect of the intermediary variable) is revealed. In light of these explanations, the schematic representation of the steps followed to test the hypotheses developed in this study, in which the mediating role of R&D intensity in the effect of CS on FP is explained, is as follows in Figure 1.

CSS, which is presented in the research model, refers to the corporate sustainability score, and EDS refers to the environmental dimension score. The panel regression method was used in the analysis of the models in which FP was taken as the dependent variable. In Model 2A and Model 2B, in which R&D intensity was taken as the dependent variable, there are "0s" in the observation values because some firms in the sample group did not spend on R&D. For this reason, the panel Tobit regression method was applied in the models in which R&D intensity was taken as the dependent variable, as in similar studies, in order not to cause any bias of "0" value in the dependent variable (Tyagi et al., 2018; Seenaiah and Rath, 2018). The mathematical models designed for the study are as follows:

$$Tobin\ Q_{it} = \beta_0 + \beta_1\ CSS_{it-1} + \beta_2\ Firm\ size_{it-1} + \beta_3\ Leverage_{it-1}$$ Model 1A

$$Tobin\ Q_{it} = \beta_0 + \beta_1\ EDS_{it-1} + \beta_2\ Firm\ size_{it-1} + \beta_3\ Leverage_{it-1}$$ Model 1B

$$R\&D\ Intensity_{it} = \beta_0 + \beta_1\ CSS_{it} + \beta_2\ Firm\ size_{it-1} + \beta_3\ Sector_{it}$$ Model 2A

$$R\&D\ Intensity_{it} = \beta_0 + \beta_1\ EDS_{it} + \beta_2\ Firm\ size_{it-1} + \beta_3\ Sector_{it}$$ Model 2B

$$Tobin\ Q_{it} = \beta_0 + \beta_1\ R\&D\ Intensity_{it-1} + \beta_2\ Firm\ size_{it-1} + \beta_3\ Leverage_{it-1}$$ Model 3

$$Tobin\ Q_{it} = \beta_0 + \beta_1\ CSS_{it-1} + \beta_2\ R\&D\ Intensity_{it-1} + \beta_3\ Firm\ size_{it-1} + \beta_4\ Leverage_{it-1}$$ Model 4A

$$Tobin\ Q_{it} = \beta_0 + \beta_1\ EDS_{it-1} + \beta_2\ R\&D\ Intensity_{it-1} + \beta_3\ Firm\ size_{it-1} + \beta_4\ Leverage_{it-1}$$ Model 4B

The study used the *t-1* values of the CS, the values of the t period of the FP, which refers to the current period. By adopting this retrospective approach (Lin et al., 2019), the information from the previous period was made effective for CS explanations. Therefore, the CS data between 2014 and 2019 and the FP values between 2015 and 2020 were taken as the basis. However, the information used in calculating both the R&D intensity of FP and the control variables was taken from the official balance sheets of the firms. Whilst the unit dimension (firms) *N* greater than *T* (years) shows a micro/small panel feature (Baltagi, 2013; Gujarati, 2014), similar studies (Cordeiro and Sarkis, 1997; Ganda, 2018; Wasara and Ganda, 2019; Partalidou et al., 2020) in the existing literature use panel regression with micro/small panel data.

4. EMPIRICAL FINDINGS

When the descriptive statistics in Table 1 are examined, it is seen that the minimum value of the EDS and R&D intensity variables was 0. The reason for this is that no firm presented any criteria related to the environmental dimension in at least one of the reports published for EDS between 2014 and 2019. In the R&D intensity, the minimum value was calculated as 0 because some of the firms did not spend on R&D.

In order for the analyses to provide more reliable results, the scattering graphs of the independent variables CSS and EDS variables with the dependent variable Tobin Q were examined. The unnecessary inclusion of polynomial values in a model

Figure 1: Research model

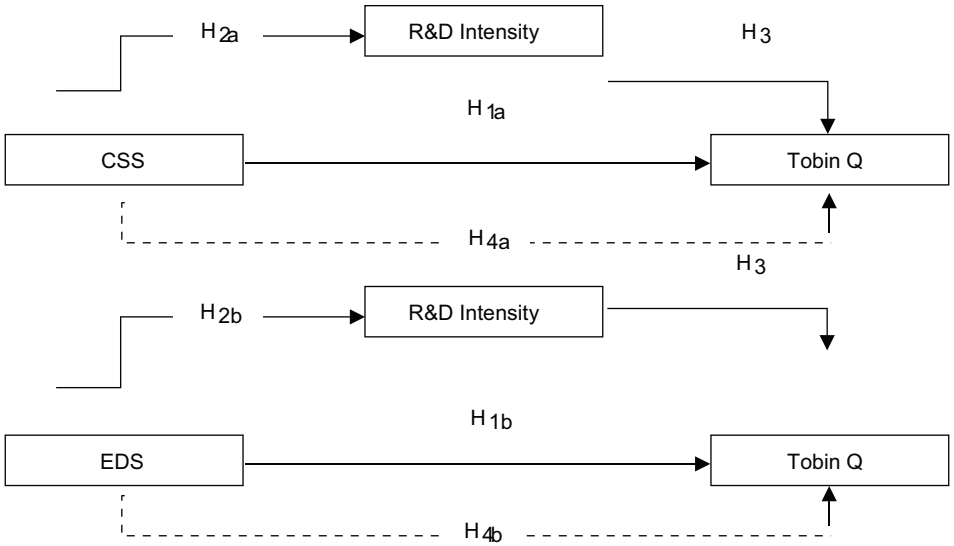

Table 1: Descriptive statistics

Variable	Observations	Mean	Std. Dev.	Min.	Max.
Tobin Q	138	1.274538	0.4014783	0.73004	2.65818
CSS	138	0.0180506	0.0069421	0.0008132	0.0367603
EDS	138	0.0061343	0.0021414	0.0000000	0.0121174
R&D intensity	138	0.0035345	0.0060649	0.0000000	0.03007
Firm size	138	22.76848	0.9962708	20.93478	25.71282
Leverage	138	0.6198128	0.1747123	0.17735	0.97767

CSS: Corporate sustainability score (total), EDS: Environmental dimension score

that should be created linear or preference for linear methods if the most appropriate curve is not linear can cause obtained results to be misleading (Montgomery et al., 2012). Therefore, scatter plots were studied, and it was decided that linear models should be used. Then, in order to investigate the multicollinearity problem, variance inflation factor (VIF) values were calculated, and VIF values <5 were calculated for both the mean and each independent variable. Therefore, it was found that there was no multicollinearity problem.

In contrast to macro panels, micro panels contain a unit root and structural break only in exceptional cases because the time dimension is small (Baltagi, 2013). For this reason, the model selection stage, which is another stage, was started without applying unit root tests. The Breusch-Pagan (1980) test, Hausman (1978) test and robust Hausman test were applied in parallel with the characteristics of the panel data in the model selection phase, respectively. As a result of the tests carried out, it was concluded that the random unit effects model was effective in all models in which the panel regression method was used. It was seen that the normality assumption tested by the D'Agostino, Belanger and D'Agostino (1990) test was confirmed to have prevented bias in the prediction results.

Finally, heteroscedasticity, autocorrelation, cross-section dependence and slope heterogeneity were tested. Heteroscedasticity was tested with the Levene-Brown-Forsythe (1974) test, autocorrelation was tested with the modified Bhargava, Franz, Narendranathan and Durbin-Watson (1982) test and Baltagi-Wu LBI (1999) test, cross-section dependence was tested with the Pesaran CD (2004) test and slope heterogeneity was tested with Pesaran and Yamagata (2008) test. At the end of the tests, it was concluded that no model confirmed any assumptions. Therefore, Table 2 presents coefficient estimations using Driscoll and Kraay's estimator in line with De Pascale et al. (2020)'s approach.

According to Table 2, it could be said that all models are significant. In the interpretation of the findings, Model 1A-Model 4A and Model 1B-Model 4B were considered together. The combined evaluation of the results of direct and indirect effects allows for clearer interpretations of the type of mediation effect (partial or full mediation), taking into account the probability values of the coefficients. When coefficients and probability values were simultaneously evaluated, coefficients and probability values for direct and indirect effects of CSS on Tobin Q in the current period were calculated as (c = −0.0953 and P = 0.001; c = −0.0901 and P = 0.004), respectively. Similarly, the coefficients and probability values of the direct and indirect effect of the previous year's EDS on the Tobin Q in the current period were calculated as (c: −0.2114 and P = 0.015; c: −0.1974 and P = 0.021). While the coefficients belonging to both CSS and EDS are about 0 in absolute terms, it was seen that the p values approached 0.1, which is the limit value, with the inclusion of the R&D intensity in the model. In light of these results, it was concluded that the CS and environmental statements in the previous period negatively affected the Tobin Q of the current period but that the intensity of R&D had a partial mediating role in this effect. In other words, these results indicate that CS and environmental explanations had a direct negative effect on Tobin Q but indirectly contributed positively to the intensity of R&D.

The obtained findings are in agreement with similar studies. When previous studies are examined, some show that CS has a negative effect on FP (Wright and Ferris, 1997; Wagner, 2010; Gras-Gil et al., 2016). Similarly, it is possible to find studies showing that the environmental dimension of CS has a negative effect (Cordeiro and Sarkis, 1997; King and Lenox, 2001; Daszynska-Zygadlo et al., 2016) on FP. Similar to the direct effects, the results obtained in the part in which mediation mechanisms are discussed are in accordance with previous studies. Some studies in the literature prove that R&D activities (innovation in some studies) have a partial mediation effect (Martinez-Conesa et al., 2017; Bahta et al., 2021) or full mediation effect (Surroca et al., 2010; Blanco et al., 2013; Maletič et al., 2015), regardless of its sign on the effect of CS on FP.

When Model 3 is considered, it is seen that the R&D intensity increases the Tobin Q value in the current period, which is in parallel with the findings of past studies (Ehie and Olibe, 2010; Lin, 2017; Ganda, 2018; Duque-Grisales et al., 2020). When the results of Tobit regression analysis for Model 2A and Model 2B, in which the effect of CSS and EDS on R&D intensity is measured, are considered, both CSS and EDS statements in the same period had a positive effect on the intensity of R&D intensity, as has been found in past studies (Jansen et al., 2006; Zhou et al., 2020; Eiadat et al., 2008; Lee et al., 2015).

According to the results of the control variables presented in the models, firm size had a negative effect on Tobin Q, as found by past studies (Konar and Cohen, 2001; Servaes and Tamayo, 2013). It could be expected that firm size will negatively affect FP because small firms can take actions that will provide a competitive advantage over their larger competitors, and synergy is more intense in small firms (Neilsen, 1974; Chen and Hambrick, 1995; Dixon-Fowler et al., 2013). In those studies which concluded that leverage, as a control variable, had a positive impact on FP when managers in highly leveraged firms were prevented from financing unprofitable investment opportunities, the proxy costs

Table 2: Results of direct and indirect effects

	Dependent variable: Tobin Q					Dependent variable: R&D intensity	
	Model 1A	Model 4A	Model 1B	Model 4B	Model 3	Model 2A	Model 2B
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
Constant	5.4965 (0.000)	4.3817 (0.000)	4.955 (0.000)	3.927 (0.000)	3.579 (0.000)	0.0321 (0.000)	0.0336 (0.000)
CSS	−0.0953 (0.001)	−0.0901 (0.004)				0.0775 (0.043)	
EDS			−0.2114 (0.015)	−0.1974 (0.021)			0.2369 (0.064)
R&D intensity		21.7959 (0.000)		21.8963 (0.000)	0.2233 (0.000)		
Firm size	−0.1843 (0.000)	−0.138 (0.000)	−0.1626 (0.000)	−0.1203 (0.000)	−0.1097 (0.000)	−0.0014 (0.001)	−0.0015 (0.000)
Leverage	0.235 (0.072)	0.1929 (0.161)	0.2456 (0.040)	0.2086 (0.093)	0.1868 (0.141)		
Sector						0.0026 (0.029)	0.0026 (0.002)
Sig.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0057	0.0000
R^2	0.0813	0.2923	0.0769	0.3102	0.3215		

CSS: Corporate sustainability score (total), EDS: Environmental dimension score
The values in parentheses indicate the P-values.

were found to have decreased and the value of the firm increased (Aivazian et al., 2005; Donker et al., 2008; Garcia-Castro et al., 2010; Martínez-Ferrero and Frias-Aceituno, 2015).

4.1. Test for Mediating Effect

At this stage, whether the indirect effects were significant or not was tested with the Sobel test. The results obtained are presented in Table 3.

Table 3: Sobel tests

CSS→R&D intensity→Tobin Q			
Test	Test statistics	Standard error	P-value
Sobel test	1.97605654	0.87612739	0.04814837
Aroian test	1.96488958	0.88110664	0.04942702
Goodman test	1.98741609	0.87111967	0.04687631
EDS→R&D intensity→Tobin Q			
Test	Test statistics	Standard error	P-value
Sobel test	1.81655044	2.91198498	0.06928598
Aroian test	1.80620764	2.92865974	0.07088591
Goodman test	1.82707298	2.89521419	0.0676888

All P-values were significant at the level of 10% according to the Sobel, Aroian and Goodman tests. Therefore, it was concluded that the mediating role of R&D intensity in the effect of CSS and EDS on FP is confirmed. It could be stated that these findings are consistent with the findings of Surroca et al. (2010), who examined the mediating role of innovation in the effect of CS on FP and concluded that the mediating effect of the innovation variable is significant. Moreover, the mediation result obtained is in line with the statement of Coelho et al. (2023) that R&D has an indirect role.

4.2. Policy Implications and Recommendations

Firms engaged in both CS and environmental activities can incur relatively high amounts of costs in the short term as a result of large administrative and/or operational investments (Mittal et al., 2008; Horváthová, 2012; Partalidou et al., 2020). On the one hand, there appears to be a significant imbalance between costs and benefits when the long-term realised benefits of such firms are simultaneously considered (Lee, 2020; Le et al., 2025). On the other hand, shareholders usually perceive CS expenditures as misuse or misappropriation of firm resources (Margolis and Walsh, 2003; Friedman, 2007) within the context of shareholder theory.

A survey conducted on Middle and East European countries proposed that, although the majority of consumers and investors attach importance to social and environmental issues in such regions, price and quality of goods are the foremost indicators of their purchasing decisions (Gugler and Shi, 2009). As a developing country, the same holds for Turkey due to the fact that the level of economic development is still at the development stage. Therefore, the fundamental reason for such behaviour is that investors are primarily concerned with how to increase their income sources and protect themselves from poverty. Along these lines, Turkish firms are recommended to constantly inform both existing and potential investors about the long-term benefits of CS applications. Video-sharing websites and social media accounts of Turkish firms can, in particular, become efficient technological tools to share the required information. Those channels and accounts should involve consistent information to all investors about middle- and long-term gains of firms despite the short-term costs of CS applications through relevant animations, brief informational content, short film screenings, etc. Hence, the emphasis of investors can be shifted to a more accurate position in line with the objectives of firms.

By placing CS at the centre of firms' strategic decisions, several benefits can potentially be gained, such as complying with international regulations on environmental protection, contributing to the elimination of global concerns on natural resource use or playing a more active role in solving social issues. Therefore, R&D activities play a crucial role in acquiring and developing sustainability-oriented innovation capability, which is considered a significant approach to gain such benefits (Little, 2005). As a real-life implementation of improving R&D activities, Turkish Airlines has successfully made significant contributions to both carbon emissions and fuel savings by the use of biofuels and the replacement of steel brakes with carbon brakes in aircrafts. As seen in this example, sustainability issues should be handled according to the characteristics of the sector and the firm, and appropriate projects should be carried out.

R&D activities pave the way for firms to engage in unique and different activities from their competitors on the basis of RBV. Therefore, one can argue that firms concentrating on R&D activities can attract attention from investors and increase their

market value as well. In Turkey, certain incentive and grant programs are provided by the government to support the R&D activities of firms in the country. For instance, the Social Security Institution and the Ministry of Industry and Technology in Turkey collaborate to prepare future support programs to provide discounts to firms in the premiums paid to the government with an increase of personnel employed for R&D activities. Similarly, project-based grant programs are implemented by the Scientific and Technological Research Council of Turkey, which refunds costs for firms importing R&D and innovation-based equipment and machinery. In addition, the Presidential Investment Office provides corporate and customs tax exemption for firms' R&D expenditure. Hence, firms are recommended to develop future R&D projects by closely following such governmental incentives and grants.

CS applications can be considered to have a particular feature that resembles a "starting point" necessary for the realisation of innovation. At that starting point, the direction of both research and development activities can be determined by assessing social and/or environmental priorities. Thus, a clearer path can be accomplished in innovation development. As a result, it may be possible to monitor improvements in the financial performance of firms. Today, firms can engage in joint R&D activities and, accordingly, can enable innovation by collaboration with national and international scientific organisations, universities and start-ups on the development of new technologies. For instance, the WeWalk Smart Walking Stick project, a joint project run by a firm operating in the manufacturing sector in Turkey and the YGA (Young Guru Academy), can be considered the starting point of the main goal of eliminating inequalities in line with sustainable development goals. In order to increase the freedom of movement of visually impaired individuals and make their lives easier, R&D studies such as the industrial design, software, hardware and prototype preparation of a smart walking stick were carried out by the corresponding firm and volunteer engineers from the YGA. As a result of the R&D studies, the serial production of the product and its transportation to the end user were also provided by this firm. Thus, an important contribution was made to visually impaired individuals' life quality, enabling them to continue their lives in the same way as other individuals in the society, and, at the same time, a crucial reference was provided for the corresponding firm in terms of investors and potential customers. In that sense, firms' continuous support of notable ideas and projects on environmental and social issues contributes remarkably to CS applications being the starting point of R&D activities.

Allocating a budget to R&D activities for firms is undoubtedly considered as an additional cost item. At this point, additional support from governments for firms which are effective in R&D activities can be regarded as a useful approach alongside recent support including financial assistance, tax exemptions, incentives and subsidies. Accordingly, particular incentives and grant programs are recommended for CS-based projects by the Ministry of Industry and Technology and the Scientific and Technological Research Council of Turkey. On the other hand, financial assistance from banking and other financial institutions cannot be neglected in terms of supporting the R&D costs of firms. The banking sector should pay more attention to firms' need for financial support to undertake sustainability-focused transformations. The budget constraints of firms will be positively affected since the banking sector gives priority to both CS applications and CS-related R&D activities of firms in terms of meeting their cash demand with low interest rates.

5. CONCLUSION

The present paper examines first, the direct effects of CS and environmental activities on the FP of Turkish firms; second, the impacts of CS and environmental activities on R&D activities and the impact of R&D activities on FP; and finally, the mediating role of R&D activities in the impact of CS and environmental activities on FP. The empirical results reveal that CS and environmental activities have a direct negative impact on FP, while they have a positive impact on R&D activities. Similarly, R&D activities were found to have a positive impact on FP. Finally, there exists a statistically significant mediating role of R&D activities for the impact of CS and environmental activities on FP.

The most important limitation of this study is the relatively small sample size due to the limited number of firms operating in XUSRD. As far as is known, no previous study has addressed moderating mechanisms for the impact of CS on FP in Turkey. From that aspect, the empirical evidence of the present study provides valuable information for policy and decision makers. In the future, long-term impacts can also be sought by increasing the time dimension and number of firms involved in XUSRD. In this study, firms are classified as being in- or outside the manufacturing sectors on CS operations; thus, sensitive measures are gained by evaluating the importance levels of the CS criteria separately. In future studies, sectoral classification can be considered from a broader perspective along with the increasing number of firms in XUSRD.

Since Turkey is on the rise in technological innovations in many fields, especially defence and automotives, the mediating role of R&D intensity has been discussed within the scope of the study. In that context, this paper contributes by placing the current situation on the roadmap in Turkey. In addition, future studies can be extended under the framework of complex relations among CS, innovation and value creation by specifically considering social innovation or non-technological innovation types (i.e., marketing, job models, etc.) as recommended by Martinez-Conesa et al. (2017). Performing serial mediation analyses in which the interaction between R&D and innovation is simultaneously considered can also be beneficial to gain a better understanding of the mediation mechanisms in the impact of CS on FP.

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