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EXAMINING THE RELATION BETWEEN MARKET VALUE AND CO_2 EMISSION: STUDY OF INDIAN FIRMS

Keywords: market value, CO_2 emission, India, sustainability, emerging.

J E L Classification: Q51, Q56.

Abstract: In the present era, sustainable business practices have become an important metric for measuring the organisational effectiveness. Shareholders have added sustainability as an important dimension of firms' performance and consider it as value relevant for determining the market value of any company. Given the premises, present study examines the impact of CO_2 emission on the market value of the firm (measured by market-to-book value ratio and Tobin's Q ratio) in the context of a developing country. Current study is based on panel data of 230 firm-year observations collected from the annual report of Carbon Disclosure Project (CDP) and annual report of sample companies. Using panel least square regression analysis, the findings indicate significant adverse impact of CO_2 emission on the firm value. In other words, sharehold-

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ers assign negative value to higher discharge of carbon dioxide and reflect the same by lowering the market value of shares. Further, the results are checked for robustness using generalised method of moments (GMM) and the conclusions are found coinciding. Present findings have important implications for regulatory authorities, policy makers, and practicing managers.

Introduction

Though industrialisation has brought several progressive changes in the evolution of human life, one of the most antagonistic effects is the environmental degradation which forced us to think about the success of the current state of world economy. Ecological concerns such as global warming, monsoon irregularities, and natural calamities such as floods and famines are the outcomes of raising emission of carbon and other toxic materials by the industrial and manufacturing undertakings. However, the global community have started responding to this and the United Nations Framework Convention on Climate Change (UNFCCC), has initiated to address this issue. In 2005, the Kyoto protocol has been imposed to confine the amount of CO_2 discharge to the allowable range for the advanced nations. CO_2 discharge is one of the critical determinants of degradation of environment quality and investors and shareholder considered the same as an important issue affecting firm value (Busch & Hoffmann, 2011; Lewandowski, 2017). Cumulative awareness and concern about polluting environment has pressurised companies to reduce their GHG emission (Jeswani, Wehrmeyer & Mulugetta, 2008; Raval, Saxena & Thanki, 2021) and evaluate as well as report opportunities and/or threats arising from climate-change faced by the companies (Matsumura, Prakash & Vera-Muñoz, 2014). This gave rise to a long-standing debate among the organisations as well as researchers about the association between emission level and the firm performance. Till now, several studies have been conducted on different facets of society, governance and environment along with their possible influence on the financial performance (Kleimeier & Viehs, 2016). Primarily, these research inquiries have focused on developed economies (Nishitani & Kokubu, 2012; Ramiah, Martin & Moosa, 2013) which have an established legal and institutional framework for disclosing environmental and emission data. However, this area is underexplored with respect to the emerging countries like India (Aifuwa, 2020).

In the given context, present study attempts to provide comprehensive examination of the association between market value of firm and the level of car-

bon discharge. Shareholders use the disclosed financial and non-financial data of the company to value its market performance and these disclosures can lower the asymmetry of information between investors and managers. Further, it eases the forecasting of stock returns and reduces the risk and uncertainty (Poshakwale & Courtis, 2005). Present study uses market-to-book value (MBV) and Tobin's Q (TQ) ratio to measure the market value of the firm whereas CO_2 emission data has been considered as explanatory factor. Besides, firm-specific control variables are also adopted for comprehensive results. The outcomes of research indicate negative and significant impact of carbon emission on both measures of market value of the selected companies. Further, these results are important as they prove that participants of capital market consider pollution disclosure as vital information even in developing countries like India which are not obliged to reduce CO_2 discharge.

The current investigation adds value to the extant research in three major ways. First, the present study examines the issue in the Indian context which is considered to be one of the fastest growing economies and also holds the fourth position in the global CO_2 emission (Kumar & Firoz, 2018). Further, developed and emerging countries have significant structural differences and therefore, the research outcome of the developed countries needs further probing before applying to developing nations. Secondly, the study is based on longitudinal data of seven years (2013–2019) considering the phase-II of Kyoto protocol instead of cross-sectional data which provides more robust and reliable results. Third, the robustness of results has been further examined by using generalised method of moments (GMM) for reliability and validity.

Research methodology and the course of research process

Present research is aimed to examine the relation between and the effect of CO_2 emission on market value of the Indian companies. Like other emerging economies, environmental reporting including carbon emission is not compulsory in India and therefore the sample companies are selected from the annual report of Carbon Disclosure Project (CDP) annual reports. Financial and other data has been collected for a reference period of 7 years (2013–2019) considering the second phase of the Kyoto protocol. The study uses Tobin's Q and MBV ratio to measure the market value whereas log of CO_2 emission as independent vari-

able. Using multiple and GMM regression analysis, the study concluded significant negative effect of emission on firm value.

Review of literature and hypothesis formulation

Environmental Disclosure Theories

Environmental disclosures provide vital information for signalling corporate performance and attracting funds as well as to improve goodwill (Verrecchia, 1983). Corporate environmental disclosures are largely governed by two theories named as 'voluntary disclosure' (Luo & Tang, 2014) and 'legitimacy theory' (Gray, Kouhy & Lavers, 1995). Voluntary disclosure theory depicts that firms with lower level of CO_2 emission will be motivated to disclose the same as it enhances their goodwill and the competitive advantage over other companies (Clarkson, Overell & Chapple, 2011). On the contrary, companies with high carbon emission inclined to avoid disclosing such information and continue themselves as average performers (Giannarakis, Konteos, Sariannidis & Chaitidis, 2017). Legitimacy theory is built upon the concept of 'corporate citizenship', wherein companies disclose non-financial information to legitimise their activities (Brammer & Pavelin, 2006). According to this approach, companies with high levels of CO_2 discharge are anticipated to reveal more information to provoke the increased risk of legality and eventually change the opinion of stake-holders by educating and informing them about the changes in their performance and these companies attempts to highlight other accomplishments related to the social cause.

Review of empirical studies and development of hypothesis

Past studies focusing on CO_2 and firm performance have been differentiated on two major themes, i.e. 'win-lose' and 'win-win' (Boiral, Henri & Talbot, 2012). According to the win-lose argument, the national obligation to diminish CO_2 emission enforces taxes, penalties and legal actions against high emitting companies. In other words, endeavours to cut carbon discharge results into unproductive utilisation of resources which adversely affect the relative position of firm compared to competitors (Delmas, Nairn-Birch & Lim, 2015; Wang, Li & Gao, 2014). In disagreement to this, promoters of alternative argument advo-

cate that an attempt to lower CO_2 discharge brings indirect profit opportunity in form of encouraging innovations that increases revenue or reduces cost (Porter & van der Linde, 1995). According to this approach, financial performance of the organisation can be improved by reducing CO_2 emission (Dowell, Hart & Yeung, 2000; Boiral et al., 2012; Raval et al., 2021). Past studies from Al-Tuwaijri, Christensen and Hughes II (2004), Wang et al. (2014), and Kumar and Firoz (2019) have studied the effect of CO_2 emission on market value of firm. However, the findings are found to be contradictory. Further, as pointed by Margolis, Elfenbein and Walsh (2008) and Garcia-Castro, Arino and Canela (2010), findings of past research are subject to the measures used for indicating the variables. According to Lee, Park and Klassen (2013), shareholders respond negatively to CO_2 emission and their findings concluded that high emitting firms will have lower market value. Similar findings are reported by Saka and Oshika (2014) in their research on more than 1000 Japanese firms and concluded adverse relation between market price of share and level of CO_2 emission. Considering a sample of S&P 500 companies, Matsumura et al. (2014) have indicated that increase in CO_2 emission will lead to reduction in price of ordinary shares. Similarly, findings of King and Lenox (2001), Al-Tuwaijri et al. (2004), Ramiah et al., (2013) have also supported negative relation between firms' level of carbon emission and market value. Delmas et al. (2015) have analysed the impact of CO_2 emission on financial peroformance using cross-sectional data of 1095 US firms. They have divided economic performance as short-term (indicated by ROA) and long-term (indicated by Tobin's Q ratio) and suggested negative effect of reduction in carbon emission on ROA and positive effect of the same on Q ratio. Investment for reducing carbon emission may not yield returns in short-run but capital market participants realise the importance of the same and hence act favourably towards the strategies implemented to reduce GHG and carbon emission in environment (Delmas et al., 2015). It is important here to note that extant literature has also found that negative effect of CO_2 can be reduced if the firms discloses the data publicly. As against major past studies, Wang et al. (2014), using tobin's Q ratio, have found direct relation between the level of CO_2 emission and firm value in the Australian context.

As pointed earlier, limited studies have explored the relation between CO2 emission and market value of the firm. Ganda and Milondzo (2018), using data of South African companies, have found negative effect of CO_2 emission on firm performance. Kumar and Firoz (2019) have studied effect of certified emission reduction announcements on abnormal stock returns using event study meth-

odology. They have reported that capital markets do not respond to such announcements significantly and concluded weak effect of emission reduction on stock returns. Therefore, research findings of developing nations are partly congruent with developed ones but still require further empirical evidence to generalise the same. The above discussion signifies the importance of carbon emission and its effect on firm value. Though several studies have attempted to draw meaningful insights, the findings are contradictory and inadequate and hence present study attempts to contribute in this growing pool of knowledge. Based on past empirical results, the study hypothesised that:

Hypothesis 1: CO_2 emission will have negative impact on firms' market value.

Research methodology

Operationalisation of Variables

Table 1 summarises the variables considered for study categorised as independent, dependent, and control. The table also describes the concept, formula, and source of including variable. According to Margono and Gantino (2021), the market value depends on the firm-specific variables such as firm size, leverage and sales growth which are used as control variables along with carbon emission.

Table 1. Description of Variables

Variables	Computation	Source
Dependent Variable		
Tobin's Q ratio (TQ)	$\frac{\text{Market value of equity + Pref. Stock + Debt}}{\text{Total Assets}}$	King & Lenox (2001); Delmas et al. (2015)
Market-to-Book Value (MBV)	$\frac{\text{Market Value of Share}}{Book\ Value\ of\ Share}$	Delmas et al. (2015)
Explanatory Variables		
Carbon Emission (CEM)	Log (Carbon Emission)	Wang et al. (2014); Delmas et al. (2015)
Control Variables		
Growth (GR)	$\frac{S_t - S_{t-1}}{S_{t-1}}$	Al-Tuwaijri et al. (2004)

Table 1. Description...

Variables	Computation	Source
Size (SZ)	Log (Total Assets)	Li et al. (2014); Matsumura et al. (2014)
Leverage (LV)	$\frac{\text{Debt}}{\text{Total Assets}}$	Giannarakis et al. (2017); Griffin, Lont, & Sun (2017)
Capital Intensity (CI)	$\frac{\text{Capital Expenditure}}{\text{Sales}}$	Chithambo & Tauringana (2014); Ganda & Milondzo (2018)

S o u r c e : summarised from the review of literature and CMIE database.

Sample Selection and Collection of Data

Initially, companies that responded to the CDP questionnaire and reported CO_2 emission data are considered for sample selection. As CO_2 reporting is not mandatory in India, the sample companies are not constant for the study period and hence the obtained data set is an unbalanced panel data. Further, companies that belonged to financial service sector are removed as their regulatory and operational framework differ from non-finance companies (Kumar & Firoz, 2018). In addition, companies with insufficient financial data have been further excluded to arrive at final sample. Table 2 presents the year-wise number of sample firms.

Table 2. Sample selection

Year	Companies that disclosed CO2 data	Finance companies	Companies with incomplete data	Sample Firms
2013	35	5	3	27
2014	39	4	4	31
2015	42	5	4	33
2016	44	6	5	33
2017	46	8	6	32
2018	48	8	6	34
2019	55	9	6	40

S o u r c e : author's calculations.

Annual reports of CDP have been considered as a source of collecting data of CO_2 emission. It is an international not-for-profit institution that collects and summarises the data on carbon and other related toxic emission according to country as well as corporates. Past studies from Wang et al. (2014), Giannarakis et al. (2017) have also considered CDP as a trustworthy source for such data. Further, PROWESS database has been utilised for collecting data of firm value as well as other control variables as pointed in above section.

Effect of CO_2 emission on firm value

Present study is based on unbalanced panel data of CDP India firms that have disclosed CO_2 data through responding CDP questionnaire. Hence, two multiple regression model by taking firm value, i.e. Tobin's Q ratio and MBV as dependent variable and emission of CO_2 as independent have been formulated. Referring the extant literature, the relation between CO_2 and firm value is expected to be negative (Smale, Hartley, Hepburn, Ward & Grubb, 2006; Ramiah et al., 2013; Lee et al., 2013; Delmas et al., 2015) and therefore sign of β_1 will be negative.

$$\text{Tobin's } Q_t = \alpha + \beta_1 \times CO_2 \text{ Emission}_t + \beta_2 \times \text{Growth}_t + \beta_3 \times \text{Size}_t + \beta_4 \times \text{Leverage}_t + \beta_5 \times \text{Capital Intensity}_t + \beta_6 \times \text{Firm Effect} + \beta_7 \times \text{Year Effect} + \varepsilon_t \quad (1)$$

$$MBV_t = \alpha + \beta_1 \times CO_2 \text{ Emission}_t + \beta_2 \times \text{Growth}_t + \beta_3 \times \text{Size}_t + \beta_4 \times \text{Leverage}_t + \beta_5 \times \text{Capital Intensity}_t + \beta_6 \times \text{Firm Effect} + \beta_7 \times \text{Year Effect} + \varepsilon_t \quad (2)$$

Where:

α = Intercept

β_1 to β_5 = Regression co-efficient

ε = Error Term

t = Number of Year (2013 to 2019)

Further, as the study is based on multiple regression model, there is a possible issue of multicollinearity and autocorrelation which has been tested using Variance Inflation Factor (VIF) and Durbin-Watson (DW) statistics respectively. Besides, corporate finance research may expose to endogeneity issue arising from omitted variables and simultaneity of occurrence. Presently, market value of the firm may affect the level of carbon emission leading to the problem of reverse causality, i.e. simultaneity. Further, firm value is a function of several company specific as well as macro variables and hence there can be possibility of omitted variable bias. To address the same, the regression model indicated above has been recomputed using generalised methods of moments (GMM) estimation.

Data Analysis And Results

Descriptive Statistics

Table 3 portrays the summary of descriptive statistics of the selected companies. First part of table represents the output for MBV and Tobin's Q ratio. Average (median) values of Tobin's Q ratio and MBV are 2.4114 (2.0318) and 3.9180 (3.1600) respectively indicating that the selected firms are performing well with respect their market value. However, minimum and maximum values of both measures demonstrate high-degree of variation among the sample companies. Further, average CO_2 emission for the selected period is more than eight lakh matric tone with a standard deviation of 12.70 lakh matric tone (MT). Higher value of standard deviation as compared to average represents enormous level of variations among the selected companies so far as CO_2 discharge is concerned. The sample firms have reported a mean (standard deviation) revenue growth rate of 10.67 (17.18) percent showing moderate but inconsistent growth. Average value of debt-asset ratio for the sample is 0.3783 that shows higher dependence on owners' fund instead of debt. Lastly, based on the summary of data, it can be concluded that the sample firms can be characterised as low levered, moderately growing, and medium size companies.

Table 3. Descriptive Statistics

	Obs.	Minimum	Maximum	Mean	Median	Std. Dev.
TQ	230	0.1130	9.8608	2.4114	2.0318	1.9882
MBV	230	0.3400	17.0000	3.9180	3.1600	2.9685
CO_2 Emission (in MT)	230	2,517.00	56,093,007.00	8,001,650.00	186,860.00	12,704,512.00
Log (CO_2 Emission)	230	1.5315	7.7489	5.2221	4.7994	1.6238
Sales Growth	230	-0.5470	1.7180	0.1067	0.1044	0.1718
Size	230	0.6105	6.5660	4.4790	4.5982	0.8887
Leverage	230	0.0286	0.8587	0.3783	0.3823	0.2198
Capital Intensity	230	0.0000	4.5391	0.1314	0.0596	0.5372

S o u r c e : author's calculations.

Correlation Analysis

The coefficient of correlation depicts how strongly the dependent and independent variables are related in a linear form. Correlation is an essential condition to be satisfied prior to the implementation of regression model. Output of Pearson correlation has been summarised in table 4. In congruence with King and Lenox (2001), the results indicate a significant negative correlation between CO_2 emission and both measures of market value i.e., Tobin's Q and MBV ratio. With respect to the control variables, firm-size and leverage has been found to be negatively and significantly correlated with market value measures which indicates that shareholders respond adversely to higher debt level. Sales growth was found to have positive correlation with firm value but it lacks statistical significance. Though majority of independent variables are not significantly correlated, the study adopts variance inflation factor (VIF) for examining the multicollinearity issue. The highest values of VIF for both regression models (TQ and MBV) are 2.862 and 1.762 respectively. These values are lower than the acceptable value of 10 (Wang et al. 2014; Gujarati, 2003) and therefore, it can be concluded that the regression output will not be affected by multicollinearity.

Table 4. Correlation Matrix

	TQ	MBV	CO_2	SG	Size	LEV	CI
TQ	1.0000						
MBV	0.8717**	1.0000					
CO_2	-0.2052*	-0.2410**	1.0000				
SG	0.0068	0.1178	-0.2205*	1.0000			
Size	-0.3037*	-0.1750**	-0.0967	0.1501	1.0000		
LEV	-0.4290**	-0.1295*	0.3089	-0.1069	-0.1093*	1.0000	
CI	-0.0753*	-0.0617	-0.0572	-0.0300	0.0279	0.0498	1.0000

S o u r c e : author's calculations.

Results of Regression Analysis

Present study examines the relation between CO_2 discharge and firm value. Table 5 provides the summary output of regression analysis considering TQ and MBV as dependent variables respectively. In line with the conclusion of 'win-win' approach, the results indicate significant negative (p – value < 1%) impact of CO_2 emission on both measures of firm value. In other words, firms that endeavour to reduce CO_2 levels will be rewarded by increased market value. Past studies from Nishitani and Kokubu (2012), Saka and Oshika (2014), and Delmas et al. (2015) have confirmed the negative effect of CO_2 discharge on firm value. Besides, investors value the sustainable environment practices of firms such as carbon manegement of emitting firms and respond positively for such initiatives (Delmas, Etzion & Nairn-Birch, 2013). Negative impact of emission can be explained as government, for reducing carbon emissions, imposes penalties and other taxes on polluting firms and enforces them for making unproductive investments resulting into erosion of their profitability (Ganda & Milondzo, 2018; Wang et al., 2014). Besides CO_2 emission, firm size and leverage are found to have significant negative effect on firm value, whereas sales growth and capital intensity are not found to be insignificant.

Table 5. Regression Output using panel estimation

Variables	Expected Relation	Tobin's Q	MBV
Constant	-----	5.8127** (0.8182)	9.5268** (1.2128)
CO_2 Emission	Negative	-0.0170* (0.08348)	-0.4083** (0.1237)
Sales Growth	Positive	0.5056 (0.7587)	1.5813 (1.1246)
Size	-----	-0.7056*** (0.1441)	-0.7227** (0.2136)
Leverage	Negative	-0.4643* (0.6059)	-0.9620* (0.8981)
Cap. Intensity	Negative	-0.2135 (0.2143)	-0.3125 (0.3177)
Firm Effect		Yes	Yes
Year Effect		Yes	Yes
F – Value (Sign. Level)		5.1119 (0.0002)	5.8520 (0.0000)
R^2 / Adj. R^2		0.5325 / 0.4938	0.3526 / 0.3354
Notes: Significant Level *: 5%, **: 1%, ***: 10%			

S o u r c e : author's calculations.

Result of GMM estimation – Robustness Analysis

As mentioned earlier, the endogeneity problem, in corporate finance research, mainly arises due to simultaneity between independent and dependent variable and variables that are omitted. In the present context, the issue of endogeneity may affect the conclusion as market value of the firm can influence the dependent variables of the model such as CO_2 emission. Stating differently, companies with higher market value may not be willing to reduce carbon emission as it may affect their competitive position and later on, financial performance. To control this issue, GMM estimation has been used to re-compute the model and to assess the robustness of output (Wintoki, Linck & Netter, 2012; Mubeen, Han, Abbas & Hussain, 2020). Table 6 summarises the GMM output as well as Wald $\chi 2$ test for checking model significance, the serial correlation test i.e., Arellano-Bond test AR (1) and AR (2), and lastly the Sargan test for overidentifying restrictions. The results of GMM output are in alignment with the first method that ensures robustness of results and the conclusion derived from both the methods are parallel.

Table 6. Regression Output using GMM estimation

Variables	Expected Relation	Tobin's Q	MBV
Constant	-----	8.0705 (0.04112)*	3.1051 (1.4079)*
CO_2 Emission	Negative	-0.0217 (0.0326)**	-0.3983 (0.1087)**
Sales Growth	Positive	0.3462 (0.0220)	1.4291 (0.7039)
Size	----	0.2364 (0.0096)**	0.2265 (0.3287)***
Leverage	Negative	-0.3659 (0.0259)**	-0.1634 (0.8971)**
Cap. Intensity	Negative	-0.2351 (0.0062)	-0.2956 (0.1979)
Firm Effect		Yes	Yes
Year Effect		Yes	Yes
Wald – χ^2		202.3896**	204.6423**
Sargan Test (p-value)		0.4356	0.4943
AR (1) p – value	0.0923		0.0732
AR (2) p – value		0.2956	0.2678
Notes: Significant Level *: 5%, **: 1%, ***: 10%			

S o u r c e : author's calculations.

CONCLUSION AND IMPLICATIONS

Sustainable development goals, as prescribed by the United Nations, are highly concerned with the environmental impact of business operations, especially emission of CO_2. In the given context, present research examines the relation between CO_2 emission and market value of the firm. Using unbalanced panel data of Indian firms for a period of seven years (2013–2019), the study analyses the effect of carbon emission on Tobin's Q ratio and market to book value ratio. Multiple regression along with GMM estimation has been adopted for data analysis. The results indicate strong negative impact of carbon emission on both measures of market value for selected companies. In other words, higher level of emission of CO_2 will result into lowering the market value of company. It can be explained as shareholders perceive carbon emission as adverse signal and reflect the same by negative effect on market price of shares.

Besides, leverage and asset size are also found to be significant determinants of firm value.

Present research findings have important implications for practitioners. First, managers can adopt 'green' business practices that assist in reducing carbon discharge. Further, by adopting environment-friendly practices, firm value may be augmented as investors attach positive signal to such announcements (Kumar & Firoz, 2019; Smale et al., 2006). Second, as shareholder consider emission as important information, firms should disclose their CO_2 data publicly so that they can win the trust of investors. Though current research attempts to provide comprehensive view on carbon emission and financial performance, few limitations are encountered. First, as emission disclosure norms are not mandatory in India, present research is based on CDP India firms. Secondly, similar research can be conducted using cross-country data to study the difference in the developed and emerging nations.

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