Energy Consumption Structure and ESG Performance of Listed Companies: An Empirical Study Based on Chinese A-Share Listed Companies

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Abstract. This paper empirically examines the impact of regional energy consumption structure on corporate ESG ratings using data on Chinese A-share listed companies and the energy consumption structure of provinces and municipalities from 2011-2019. It is found that corporate ESG scores decline in regions where coal consumption accounts for a larger share of total energy consumption. In further research, the paper finds energy consumption structure is significant negative effects on the environmental and social dimensions and no significant effects on the governance dimension. From the perspective of regional heterogeneity, the impact of coal consumption share on corporate ESG performance is negatively significant in eastern China, but not in central and western. In terms of corporate heterogeneity, the share of consumption of state-owned corporates has a negatively significant impact on corporate ESG performance, while non-state-owned corporates do not have a significant impact.

Keywords: Energy consumption structure; Corporate ESG score; Corporate sustainability

1 Introduction

Energy is the driving force of national economic development. But the unreasonable energy consumption structure can bring about the deterioration of the natural environment and hinder sustainable economic development. The current research on the relationship between energy consumption, economic growth and environmental pollution suggests that there is a dynamic causal relationship between these three factors. Zhang et al. (2009) [8] concluded that there is a one-way Granger causality from energy consumption to carbon emissions by developing a multivariate model of economic growth, energy utilization, carbon emissions, capital and urban population in China. Pao and Tsai (2010) [6] studied the dynamic causality between energy consumption, output and

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environmental pollution for the BRIC countries as a whole. Zhao et.al (2016) [9] using provincial level data in China to explore the equilibrium relationship between real GDP, electricity consumption, total fixed asset investment and employment. Stern (2004) [7] highlighted the role of improved energy consumption structure on environmental sustainability.

China has clearly put forward the goal of "peak carbon and carbon neutral". Which has put forward higher requirements for the sustainable development of corporates. Investors are also incorporating the environmental and social performance of corporates into their investment decision functions, and the Corporate ESG Index is a concrete manifestation of this emerging investment philosophy. Which is a combination of three aspects of corporate performance: environmental, social and governance.

In the current state of corporate ESG research, corporate ESG performance has become an important measure of economic performance. Cheng et al. (2014) [1] and Ghoul et al. (2017) [3] find that companies that perform well in a combination of environmental, social and governance aspects have access to financial resources at a lower cost and are able to grow significantly. Using industry characteristics as an entry point, Garcia et al. (2017) [2] find industries that are vulnerable to environmental or social criticism are likely to make efforts to improve their ESG performance. Using the price fluctuation data of the capital markets during the COVID-19 period. Huang et al. (2022) [5] explored the impact of natural disasters on corporate ESG disclosure and found that companies in close proximity to natural disasters were more likely to increase their ESG disclosure after the disaster.

The innovation of this paper is mainly reflected in two aspects: Firstly, the current research on energy consumption structure is still focused on the evolution of energy consumption structure and its impact on regional macroeconomic performance, but lack of in-depth research on the impact of energy consumption structure on regional micro-corporates. Our paper makes use of the ESG performance of listed companies to supplement this issue at the micro level. Secondly, the research on corporate ESG is still in its infancy in both domestic and international academic circles, and most of the existing studies have explored the causes of corporate ESG performance in terms of the internal environment of corporates, while our paper explores its impact on the ESG performance of local corporates according to the external economic environment in which the corporates are located.

The rest part is organized as follows: Part II presents the econometric model setting and variable selection. Part III presents the baseline regression results. Part IV presents the robustness tests. Part V presents further analysis, and Part VI presents the conclusions and policy recommendations.

2 Construction and Geometrical Dimensions of Specimens

2.1 Description of specimens

This paper uses data of Chinese A-share listed companies from 2011-2019 as the research sample, in which corporate ESG data is obtained from Bloomberg Financial Terminal, and the rest of the data is obtained from the Wind database, CSMAR

database, China Energy Statistical Yearbook and the statistical yearbooks of Chinese provinces. The sample data were initially screened and processed: companies in the financial sector, companies in the ST category, companies with missing ESG scores and companies with missing key financial management data were excluded. The energy consumption structure data in this paper is selected at the provincial level. Given the source and availability of data, Tibet, Hong Kong, Macao and Taiwan are not included in the sample.

2.2 Model setting and selection of variables

This paper constructs the following econometric model to examine the relationship between regional energy consumption structure and corporate ESG scores, using data from all A-share listed companies from 2011-2019. The benchmark estimation model used in this paper is as follows.

$$y_{i,t} = \beta_0 + \beta_1 energy_{i,t} + \beta_2 X_{i,t}^{c} + \sigma_j + t + \varepsilon_{i,t} \quad (1)$$

Where i represents the sample of listed companies examined and y denotes the corporate ESG score which use the Bloomberg ESG score. Considering the reality that coal consumption has long accounted for a large absolute proportion of China's energy consumption, we use the proportion of coal consumption to total energy consumption to measure the energy consumption structure of each province. As the units of energy consumption data are not uniform across statistical yearbooks, we converted the units of energy consumption data to standard coal before conducting the data analysis. σ_j are industry fixed effects and t are year dummy variables. X denotes firm-level control variables, which were selected in this paper drawing on Harjoto.et.al (2020) [4] and other factors that may affect firm ESG performance: firm age, firm size, return on net assets, asset-liability ratio, nature of firm ownership, board size, proportion of female directors on the board, proportion of independent directors on the board and separation rate of two offices. The variables are defined in Table 1.

Table 1. Definitions and descriptions of key variables

Variable type	Variable name	Variable symbols	Variable Description
Explained variable	Corporate ESG Score	ESG	Bloomberg ESG Score
Explanatory variable	Energy consumption structure	energy	Total coal consumption/total energy consumption
Control variable	Age of business	age	2022 - Year of business establishment
	Size of business	size	Total assets
	Return on net assets	roe	Net profit/total owner's equity
	Gearing ratio	lev	Total liabilities/total assets
	Nature of ownership	state	1 = state-owned, 2 = private, 3 = foreign, 4 = other
	Board size	board	Number of board members
	Percentage of women on the board	woman	Number of women on the board / Number of board members

	Percentage of independent directors on the board	indep	Number of Independent Directors / Number of Board of Directors
	Separation rate	dual	Separation rate

3 Analysis of Baseline Regression Results

3.1 Descriptive statistics

Descriptive statistics of the selected variables are presented in Table 2. The maximum value of the ESG score of the sample companies was 64.115 and the minimum value was 1.240, with a standard deviation of 6.779, which shows the ESG score varies significantly between the sample companies.

Table 2. Variable definitions and descriptive statistics

Variable	N	Mean	Sd.	Min	P50	Max
ESG	8555	20.402	6.779	1.240	19.834	64.115
energy	8555	0.305	0.157	0.012	0.301	0.686
roe	8555	0.081	1.617	-66.535	0.082	90.705
age	8555	24.324	5.054	8	24	43
board	8555	9.045	1.882	0	9	18
state	8555	1.507	0.609	1	1	4
size	8555	348.499	1264.998	0.104	91.952	27331.9
lev	8555	0.479	0.257	-0.194	0.485	10.495
woman	8555	0.127	0.123	0	0.111	0.714
indep	8555	0.375	0.057	0.181	0.363	0.8
dual	8555	5.398	8.268	-7.64	0	56.109

3.2 Baseline regression results

The correlation between corporate ESG score and energy consumption structure is regression according to formula (1), and the results are presented in Table 3. Column (1) is the univariate regression result, which shows that there is a significant negative effect of energy consumption structure on ESG score; column (2)-(3) controls for industry fixed effects and column (3) futher controls for year fixed effects, the coefficient of energy consumption structure is still significantly negative at the 1% level; column (4) adds a series of internal control variables, the coefficient of energy consumption structure is still significantly negative at the 1% level. The results of the baseline regression indicate that the structure of energy consumption has a strong explanatory power on the ESG scores of companies.

Table 3. Baseline regression results

Variables	(1) ESG	(2) ESG	(3) ESG	(4) ESG
energy	-5.557***	-8.224***	-5.629***	-5.766***
	(1.803)	(1.646)	(1.724)	(1.466)

Control variables	NO	NO	NO	YES
Industry fixed ef-	NO	YES	YES	YES
fects	NO	NO	YES	YES
Year fixed effects	8555	8555	8555	8966
Observations	0.017	0.129	0.167	0.309
R2				

Note: Values in brackets are standard errors of clustering at the provincial level; ***, ** and * represent 1%, 5% and 10% significance levels.

4 Robustness Tests

4.1 Substitution of measures of explanatory variables

We replaced the explanatory variables with a robustness check by using the ratio of the total consumption of coal, oil and natural gas to the total energy consumption of each province as a measure of energy consumption structure, denoted by Nenergy. The regression results in the first column of Table 4 show that the coefficient of energy consumption structure is still significantly negative, which is consistent with the results of the baseline regression.

4.2 Substitution of measures of explained variables

We replace the measures of the explanatory variables for robustness testing by using the ESG rating data of SynTao Green Finance as a proxy variable for corporate ESG, and the time frame here is 2015-2019 due to the availability of data. The index is constructed from three first-level indicators (environmental, social and governance), 13 second-level indicators and multiple three-level indicators, which can comprehensively reflect the ESG performance of listed corporates. The rating of SynTao Green Finance consists of ten levels: A+, A, A-, B+, B, B-, C+, C, C- and D. Each of the ten levels is assigned a value of 1-10 from lowest to highest. Table 4 shows the coefficient on energy consumption structure is significantly negative, in line with the results of the benchmark regression.

Table 4. Robustness test regression results

Variables	**(1)** **ESG**	**(2)** **Business Road to Green ESG**
Nenergy	-4.755***	
	(0.964)	
energy		-0.831**
		(0.386)
Control variables	YES	YES
Industry fixed effects	YES	YES
Year fixed effects	YES	YES
Observations	7989	2079
R2	0.287	0.137

Note: Values in brackets are standard errors of clustering at the provincial level; ***, ** and * represent 1%, 5% and 10% significance levels.

5 Further Analysis

5.1 Sub-impact of energy consumption structure on ESG

Corporate ESG indicators consist of three dimensions: environmental, social and governance. Therefore, to further investigate the impact of energy consumption structure on ESG performance, we regress each of the three sub-indicators on energy consumption structure. The corporate ESG sub-indicators are used from Bloomberg Financial Terminals and the sample interval is 2011-2019.

Referring to Harjoto et al. (2020), the following econometric model was constructed.

$$y_{i,t}(E,S,G) = \beta_0 + \beta_1 energy_{i,t} + \beta_2 X_{i,t}^{c} + \sigma_j + t + \varepsilon_{i,t} \quad (2)$$

The explained variables are the corporate environment sub-score, corporate social sub-score and corporate governance sub-score, and the control variables are the same as in the baseline regression model. The results of the itemised regressions are shown in Table 5.

The first column of Table 5 shows the regression results of the ESG composite score on the energy consumption structure, while columns 2-4 show the regression results of the environmental, social and governance on the energy consumption structure respectively. The coefficient on environmental and social governance is significantly negative. The possible reason is that the firms face greater challenges on the environmental and social dimensions. The non-significant coefficient in the fourth column suggests that the structure of energy consumption does not have an impact on the governance dimension of firms, suggesting that corporate governance is still more influenced by factors internal to the firm.

Table 5. Regression results by item

Variables	(1) ESG	(2) E	(3) S	(4) G
energy	-5.766***	-5.075***	-9.099***	-3.184
	(1.466)	(1.710)	(2.064)	(2.857)
Control variables	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES
Province - annual fixed	YES	YES	YES	YES
effects	8555	6745	7776	7989
Observations	0.309	0.253	0.204	0.223
R2				

Note: Values in brackets are standard errors of clustering at the provincial level; ***, ** and * represent 1%, 5% and 10% significance levels.

5.2 Regional heterogeneity

Due to the uneven regional economic development in China and the differences in economic and environmental constraints faced by the eastern, central and western regions, we divided the provinces into eastern, central and western regions. According to the

regression results in Table 6, it can be seen that the higher the share of coal consumption in the east has a greater negative impact on corporate ESG, which to a certain extent indicates that the eastern region faces higher environmental and social requirements. As the eastern region is economically developed, stakeholders have higher environmental, social and governance requirements for local corporates, while the central and western regions are still in a period of economic development, where the improvement of economic efficiency is still put in the forefront of corporate development.

Table 6. Regression results for heterogeneity

Variables	(1) East ESG	(2) Medium ESG	(3) West ESG	(4) State-owned corporates	(5) Non-state corporates
energy	-5.377***	-3.062	-5.221	-6.632***	-2.958
	(1.964)	(7.896)	(6.468)	(1.242)	(2.504)
Control variables	YES	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Province - annual	YES	YES	YES	NO	NO
fixed effects	5523	1519	947	4456	3823
Observations	0.362	0.305	0.422	0.339	0.222
R2					

Note: Values in brackets are standard errors of clustering at the provincial level; ***, ** and * represent 1%, 5% and 10% significance levels.

5.3 Corporate heterogeneity

The difference in corporate ownership brings about multiple impacts. Compared to private corporates, on the one hand, SOEs enjoy special political and economic resources, thus the energy consumption structure has a greater impact on their ESG ratings; on the other hand, SOEs may actively invest in environmental protection due to political pressure and social responsibility pressure thus improving their ESG performance. We therefore examine the difference of ESG scores caused by agricultural consumption structure between SOEs and non-SOEs by dividing the sample into SOEs and non-SOEs. The regression results in the column (4)-(5) of Table 6 show that the coefficient on energy consumption structure is significantly negative, possibly due to the difficulties of SOEs to escape from the impact of unsustainable energy consumption structure on their overall performance due to organisational inertia and resource advantages. Non-SOEs are influenced by market competition and are concerned about their investment value, and ESG ratings may directly affect their ability to raise capital, so investors' attention to corporate ESG will motivate non-SOEs to improve their ESG scores.

6 Conclusion

This paper uses data on Chinese A-share listed companies from 2011-2019 and data on energy consumption structure by province to conduct an empirical study and finds the higher the proportion of coal consumption in a company's region, the worse the ESG

performance of the company will be, and this finding still holds after replacing the measure of energy consumption structure and replacing the ESG measure of the company. After regressing the three dimensions of environment, society and governance on the regional energy consumption structure of corporates, it is found that the energy consumption structure measured by the share of coal consumption has a very significant negative effect on the environmental and social performance of corporates. Based on the reality of uneven economic development in China, we found that the proportion of coal consumption in eastern regions has a significant negative impact on enterprise ESG, while the central and western regions have no significant impact. In the regression analysis of the sample corporates into SOEs and non-SOEs, it is found that there is a significant negative effect of the share of coal consumption of SOEs on their ESG scores, while no significant relationship is found in the sample of non-SOEs.

Combining the above analysis, we put forward the following three suggestions: First, promote the transformation of the energy consumption structure and increase the proportion of clean energy consumption. Second, further improve the ESG rating to provide investors with a reliable basis for value investment, guide the direction of sustainable development for corporates and prepare for better achievement of the goal of "peak carbon and carbon neutral". As the development of China's ESG rating market is still immature, the definition of ESG sub-indicators by various institutions is blurred, so the government needs to play a service and top-level design role in the construction of the ESG system. In addition, listed companies should make corporate sustainable development their development goal, adapt to new investment concepts and enhance their ability to resist risks. Third, promote the energy technology revolution and drive industrial upgrading. Based on China's national conditions, follow the new trend of the international energy technology revolution, take green and low-carbon as the direction, promote technological innovation, industrial innovation and business model innovation.

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