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Environmental Policy: Effect on Oil and Gas Sector

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Keywords: energy, environmental policy, financial performance, oil and gas, financial risks.

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I. INTRODUCTION

Energy topics, among which energy's economic roles, energy security and environmental issues, have been regularly voiced in scholarly dialogues and discussions. In this regard, energy security and environmental issues are often seen mutually exclusive unless a future breakthrough in technology realizes the fourth energy transition. Obtaining a compromise between the two goals is often challenging, as the prerequisites for a green transition are yet to be readily available, while the mounting concerns over energy insecurity are constantly rising over the past few years. Recently, research attention seems to be directed at curtailing environmental deterioration (see [Cui et al., 2021; Luo et al., 2021; Ma, Zhang & Yin, 2021; Schabek, 2020; Wang, Li & Zhang, 2021; Wang et al., 2021]), illustrating a bias towards green issues. This has led us to question whether energy security is by far neglected, which contributes to swell the probability of energy shortage in industrial manufacturing and eventually distort the normal functioning of the economy.

Both historical and modern evidence is available to interpret the roles of energy in maintaining economic health. Specifically, in the time series analysis model in Stern D.'s study (1993, 2000), energy is included as an imperative factor explaining the growth of GDP, in addition to capital and labor. As of the past, many industrial booms, which have breathed life into the human standard of living, were the implication of an "energy-fed" innovation, for example "coal-fired steam power", "oil-fired internal-combustion engines" or "electricity" [The Economist, 2008]. Many researchers and scholars have placed energy innovation as the center of the arguments interpreting the driving force behind the historic Industrial Revolution in Great Britain [Allen, 2009; Pomeranz, 2012; Stern & Kander, 2010; Wrigley, 1988; Wrigley, 2010]. In the present climate, the production of almost all the necessities for maintaining a fulfilling life, ranging from petroleum, cars, food, buildings, machinery and equipment involves the use of energy. By this token, energy activates a mechanism to affect consumers' welfare by the costs and quality of goods and services, the power and status of the national economy, as well as the availability of job opportunities [The National Academies, 2022].

As a contrast to energy's strategic roles, the world is shouldering the escalating burden of energy insecurity due to a persistent energy crisis since 2021, which have constantly shown no signs of alleviating its severity in some years to come. Statistical records illustrate unprecedented variations in gas, oil and coal prices, with an increase of +290%, +50% and +47%, respectively [Matos & Gili, 2022]. The robust recovery of the global economy following the years of COVID's recession has constantly stimulated demand for energy [Berahab, 2022; Gilbert & Bazilian, 2022; Matos & Gili, 2022]. Soaring demand in parallel with supply disruptions due to the catastrophic impact of the pandemic has amplified the state of imbalance between supply and demand [Berahab, 2022; Gilbert & Bazilian, 2022]. Besides, socio-economic aspects, including geopolitics, hostile competition on the same LNG supply market between Europe and Asia also participated in the sudden upwards of energy prices [Berahab, 2022; Gilbert & Bazilian, 2022; Matos & Gili, 2022].

In this context, the fourth energy transition seems to be a promising solution to the opportunity cost of energy security and environmental issues. However, historical evidence suggests that the transition from one energy source to another often takes a long period of time [Ritchie, Roser & Rosado, n.d.]. Meanwhile, the prolonged energy crisis has built up an intensifying pressure on the speed of the transition path. To observe a clear progress in energy transition from fossil fuels to renewable resources will require addressing some major challenges, including geopolitical concerns, financial constraints, and especially technological innovation [Nevshehir, 2021]. Due to the challenges related to the immutable laws of physics and chemistry, technological innovation in energy transition calls for the pursuit of novelty rather than improvements to existing technology [Nevshehir, 2021]. In other words, the green transition should be accompanied by the construction of new power plants based on environmentally friendly technology, and this involves being nominated as a national policy objective [Sachs et al., 2019]. Research by Kordana S. et al. (2019) defines the "intermittent" and "uncontrollable" nature as the major technical obstacles to the integration of RES into power systems. As an additional point, Nevshehir N. (2021) states that low energy conversion rates and the RES's reliance on fossil fuels can drive the green energy industry against sustainability; and emphasizes the importance of weighing the challenges and opportunities until the introduction of a disruptive technology.

What has exacerbated the already vulnerable problem of energy security is the fact that fossil-fuel-based companies, which dominate the global energy supply, are incurring grave financial risks. Presence of instability in the fossil-based energy sector has been showing signs since before 2020, as a result of the rise of the renewable energy sector and regulatory burden [NWC, n.d.]. Furthermore, investment pressure is cited as one of the main hurdles targeting fossil fuel companies [NWC, n.d.]. For example, programs like the Climate Action 100+ Initiative, which has so far aroused the interest of more than 700 investors, representing $68 trillion of assets under management, are joining forces to place financial constraints on countries generating most of the global greenhouse gas emissions [Climate Action 100+, 2022; NWC, n.d.]. Additionally, Oliver Wyman argues that a heavy carbon emission tax can expose many oil and gas companies to a higher risk of default by more than 2-3 times [Nauman & Temple-West, 2020]. Besides, many banks have initiated their first steps to safeguard themselves from the risks accompanying loan provisions to oil and gas companies. A number of central banks are inclined to include climate change risks to a stringent test. For instance, the UK central bank plans to devise a strategy of modeling companies' exposure to the Paris Agreement goals [Nauman & Temple-West, 2020]. In another case, a British multinational universal bank Barclays has been bearing the pressure of terminating fundings to some fossil fuel companies. In the favor of climate regulations, energy companies are constantly voicing their concerns over the threat of being cut off from loans and bond markets [Nauman & Temple-West, 2020].

On this account, this study seeks to gauge the effect of environmental policies on the financial health of fossil energy companies and suggest the features of environmental policies in a modern oil and gas sector. It, however, by no means argues against the sustainable goals but aims to find a compromise to satisfy the conflicting interests between ensuring energy security and maintaining environmental health. As the problem of energy security becomes more acute, the introduction of stringent environmental policies targeting oil and gas companies only can add more fuels to the severity of energy imbalance and harm the already vulnerable global economy during the historic COVID's recession. While the fourth energy transition is inevitable, it must be tailored to the socio-economic, political and security contexts, and this is how the research has a role to play.

II. LITERATURE REVIEW

2.1. Measuring Firms' Financial Performance

Corporate finance is a dominating research question in the economic field and has awakened the interest of many scholars in the financial world. Measuring the financial performance of a company, accordingly, has convincing grounds to be based on. Most studies perceive ROA, or ROE as a well-reasoned tool to study the financial status of a firm. The study of Battisti E. et al. (2020), which aims to interpret the impact of knowledge management practices on the financial results of global startups, employs a DEA model, with revenue and ROA being included as output variables [Battisti, 2022]. Likewise, some papers examining energy firms describe ROA and ROE as a decent approach to report the financial functioning of the firms. Schabek T. (2020) selects both indicators ROE and ROA to demonstrate the financial health of sustainable power producers in emerging markets and believes that those are "the most natural and popular measures" when reporting financial strength of a firm. Quite similarly, Cui Y. et al. (2021) argue that ROE is an ideal indicator to learn the financial disclosure of a firm, while Wang X. et al. (2021) uses ROA, current ratio (CR) and total asset turnover (TAT) to depict a company's solvency, operating capacity and profitability.

By comparison, ROA and ROE both aim to assess companies' efficiency in allocating financial resources. Factoring in the two variables' pros and cons, some studies argue that ROA performs better compared to ROE in reporting profit potentials, as it rules out the inclusion of any purposeful and unstable attempt in profit enhancement [Hage et al., 2013; Zhang et al., 2014]. Adding to the point, the difference between ROE and ROA regarding the effect of leverage and debt explicitly supports the use of ROA. Accordingly, a company's high ROE may indicate an attribution of profits to its capital structure rather than to its financial management capacity. In line with the formula, ROE poorly represents how efficiently a company employs its assets by borrowing and issuing bonds [Mcclure, 2021]. While debt can allow a firm to fulfill its short-term goals, an excessive amount of debt may lead the company to more exposure to instability in the long term. A company with poor management of debt means having a risky capital structure, threatening its future viability [Hage et al., 2013]. In this study, the companies of research interest are all in one specific industry – oil and gas sector, which causes no inconvenience regarding imbalanced ROA distribution across different industries as suggested by Birken E. (2021) and Gallo A. (2016). For all the illustrated points, this study opts for the use of ROA as a variable that illustrates a company's financial image. ROA of oil and gas companies in the research sample is calculated by the following formula:

$$ROA = \frac{Net\ Income}{Total\ Assets}$$

2.2. Measuring Environmental Policy Stringency

Considerable effort has been invested to construct a measurement of environmental policy stringency in a number of studies (see [Cole & Elliott, 2003; Damania, 2001; Dasgupta, 2010; Eliste & Fredriksson, 2002; Grether & Mathys, 2012; Harris, Konya & Matyas, 2002; Hilton & Levinson, 1998; Sauter, 2014; Xing & Kolstad, 2002]); however, there is yet a broadly accepted indicator [Sauter, 2014]. The principal drawback of previous attempts is that they are rarely constructed on a strong theoretical basis but are mainly driven by data availability [Knill, Schulze & Tosun, 2012]. Inevitably, these indicators show lack of effectiveness in gauging the stringency of state regulations on environmental issues, which have been touched on in the research of Sauter C. (2014). Firstly, a survey or self-reporting approach (see [Dasgupta, 2010; Eliste & Fredriksson, 2002]) falls short of objectivity and thus is often biased [Sauter, 2014]. Secondly, the monetary approach (as suggested by Magnani E. (2000), Pearce D. & Palmer C. (2001)) is far too specific when including only one regulatory instrument and excluding the implementation of other policies. Another problem that should be addressed is the effect of imbalanced distribution of cross-country efficiency. High public expenditure on environmental issues does not necessarily interpret a country's stringency in terms of environmental policies [Sauter, 2014]. Thirdly, policy-specific approach (see [Nakada, 2006; Smarzynska & Wei, 2001]), likewise, is rather too particular to describe the characteristics of national environmental policy as a whole [Sauter, 2014]. Finally, the group of performance indicators (see [Cole & Elliott, 2003; Damania, 2001; Grether & Mathys, 2012; Harris, Konya & Matyas, 2002; Hilton & Levinson, 1998; Xing & Kolstad, 2002]) tries to quantify the problem that environmental policies attempt to solve; hence shows little relevance to policy stringency [Sauter, 2014].

Besides, some approaches have advanced one step further as constructed on a sound methodological basis (see [Botta & Koźluk, 2014; Sauter, 2014]). Sauter C. (2014) argues that a good index should be based on a description of the phenomenon it tries to measure, hence allowing us to identify its sub-components. Considering the definitions proposed by Sauter C. (2014) and Botta E. & Koźluk T. (2014), the composite index approach of OECD is an ideal choice in the framework of this study. To specify, Sauter C. (2014) determines pollutant policies as the focus of his research, or in a narrower term - anthropogenic CO_2 emissions. Meanwhile, Botta E. & Koźluk T. (2014) give a more comprehensive definition to environmental policy: "a higher, explicit or implicit, cost of polluting or environmentally harmful behavior" [Botta & Koźluk, 2014]. Furthermore, their research offers two types of environmental policy stringency: EPS index for the energy sector and economy-wide EPS. This study, hence, uses the EPS index for the energy sector as the independent variable because it takes into account the environmental policies targeted at the energy sector.

According to Botta E. & Koźluk T. (2014), the structure of the EPS index for the energy sector has two components: market-based and non-market-based instruments, which are equally weighted. Market-based policies include government regulations by means of taxes, trading schemes, and feed-in tariffs (FITs), with the weight of each type being 33%. Besides, non-market policies are divided into standards (emission limit values) and R&D subsidies for the renewable energy sector; both have the weight of 50%. The score for each regulatory component is determined by a cross-country comparison, based on which the value of EPS is calculated. The value of EPS may vary from 0 to 6, with 6 indicating the highest level of stringency [Botta & Koźluk, 2014].

2.3. The Determinants of Financial Performance of Firms

In addition to the independent and dependent variables, the research model also includes some control variables, including corporate financial indicators and macroeconomic factors. The choice regarding control variables is based on the results of former studies on relevant topics. Existing literature on the determinants of financial performance of firms is the major source of information to construct the research model. Description of the research model is presented in Table 1.

Table 1: Research Model

Variable	Determined by	Measured by	Role	References
Financial performance	ROA	Net profits divided by total assets	Dependent variable	[Battisti, 2022; Qi et al., 2022; Schabek, 2020; Wang, Li & Zhang, 2021; Zhang et al., 2014]
Environmental policy stringency	EPS	Composite index approach developed by OECD	Independent variable	[Botta & Koźluk, 2014]
Firm-level indicators				
Firm size	SIZE	Natural logarithm of total assets	Control variable	[Ang, 2022; Erdogan & Yamaltdinova, 2019; Luo et al., 2021; Ma, Zhang & Yin, 2021; Schabek, 2020; Siddique et al., 2021; Sun et al., 2020; Wang, Li & Zhang, 2021]
Growth rate of total revenues	GROW	Growth rate of total revenues in a given year	Control variable	[Ang, 2022; Ma, Zhang & Yin, 2021; Schabek, 2020; Sun et al., 2020]
Capital investment	CAIN	Natural logarithm of capital expenditures divided by total revenue	Control variable	[Schabek, 2020; Siddique et al., 2021]
Capital structure	LIQU	Current assets divided by current liabilities	Control variable	[Alkaraan et al., 2022; Lim, Wang & Zeng, 2018; Ma, Zhang & Yin, 2021; Sun et al., 2020; Wang, Li & Zhang, 2021]
Firm age	AGE	Natural logarithm of years gap between year of establishment and current year	Control variable	[Cui et al., 2021; Lim, Wang & Zeng, 2018; Liu, Fang & Xie, 2021; Siddique et al., 2021; Wang, Cho & Lin, 2019; Wang, Li & Zhang, 2021; Wang & Zou, 2018]
Country-level indicators				
Economic development	GDPC	GDP per capita	Control variable	[Sun et al., 2020]
Financial development	FIND	Ratio of financial system deposits to GDP	Control variable	[Sun et al., 2020]

Source: research results

Overall, the research model consists of 1 independent variable (EPS) and 7 control variables (SIZE, GROW, CAIN, LIQU, AGE, GDPC and FIND). Most studies suggest a positive causal relationship between revenue growth and the companies' financial results. Revenue growth demonstrates increased demand for energy, efficiency of revenue management and reinforced competitiveness [Schabek, 2020; Sun et al., 2020]. Capital investment is also expected to amplify financial performance, as it enables to unlock production potential of the companies [Schabek, 2020]. In addition, macroeconomic factors should presumably have a positive impact on the financial performance of firms. Macroeconomic variables (GDPC and FIND) portray the overall economic and financial state of a country. Stability of the macroeconomic environment fosters a healthy business climate for firms' development, thus contributing to the corporate financial growth.

Nonetheless, current literature also shows contradictions in some respects. Firstly, according to Schabek T. (2020), firm size is expected to positively affect financial performance of a company owing to economy of scale. However, evidence from some other studies argues against his suggestion, addressing major drawbacks of large-scale firms, such as challenges in internal management [Sun et al., 2020]. Capital structure is another factor subjected to heated debate. On the one hand, Schabek T. (2020) supports the idea that taking risks improves expected returns, which will correspondingly result in higher ROA. On the other hand, he contends that taking more debts will equivalently expose the company to higher risks, which will eventually lead to a probable bankruptcy. By comparing current assets with current liabilities, capital structure allows to learn a company's capacity of covering its liabilities.

So far, little efforts have been made to assess the impact of environmental policy on the financial functioning of oil and gas companies, as data unavailability challenges the feasibility of research [Sauter, 2014], which leaves a gap in existing literature. As environmental policy "increases the costs of environmentally harmful behavior" [Botta & Koźluk, 2014], it is supposed to affect the financial performance of oil and gas firms in a negative way. Hence, following hypothesis is proposed:

H_1: Increased stringency of environmental policy produces a negative impact on the financial performance of oil and gas companies.

The remaining parts of this study aim to test the hypothesis, as well as resolve the contradicting suggestions in previous literature.

III. DATA AND METHODOLOGY

3.1. Data Source & Data Processing

To begin with, the methodology, data sampling and the choice of research period of this study are subjected to the effect of data availability. Correspondingly, the study inevitably has borne some certain shortcomings, which will further be addressed in the conclusion. In this analysis, "data processing" will be performed to treat the drawbacks and limit the potential defects. In terms of methodology, the study employs a quantitative approach for a panel dataset of 21 countries over a three-year period (2018-2020).

The selected countries for analysis are mainly OECD members; non-member countries include Brazil, China, India, Indonesia, Russia, South Africa. As those are the dominant players in the energy market, local firms take an active participation in the global energy sector. Statistical data for the six-point assessment of environmental policy stringency of 27 OECD members and 6 non-member countries in the period 1990-2015 are available and can be extracted from OECD iLibrary [OECD Statistics, n.d.]. The data for country-level control variables, including economic development and financial development are extracted from the database of the World Bank Group and the Global Economy [TheGlobalEconomy, 2022; World Bank Data, n.d.].

For a firm-level study on a specific industry, it is apparent that one of the possibly finest approaches for the choice of firms is using Standard Industrial Classification code (SIC code) to pick a list of companies in the industry of interest. Unfortunately, the author's accessibility to a compiled dataset of corporate financial reports (e.g. COMPUSTAT , Bloomberg Professional) is limited. As an alternative, companies are sorted out from the list of top largest oil and gas companies by market capitalization, according to a survey of 6,029 companies in the fossil energy sector reported by Global Ranking [Companies Market Cap, n.d.]. Data for corporate financial reports, including annual income statement and annual balance sheet, are compiled using the companies/market query of Dow Jones Factiva. The companies with the absence of any needed financial indicator in the examined period (2018-2020) are removed from the sample to ensure the transparency and reliability of the modeling method. Eventually, the number of oil and gas companies selected for sample analysis is 72. Drawing a sample of companies from the list of major players in the oil and gas industry by market capitalization is also because they are the leaders in ensuring global energy security. Regarding regional distribution of oil and gas companies, the U.S oil and gas firms constitute about 50% of the total number of companies selected. Other companies are located in different parts of the world, including Asia-Pacific, Europe and Africa, but with much less frequency.

In the earlier part, we accept that most aspects of the study rest on the matter of data inaccessibility. We have also discussed that the figures for national environmental policy stringency, quantified by the composite index methodology developed by OECD are available for the period 1990-2015. However, financial performance data compiled using the company profile analysis tool of Dow Jones Factiva are available in a different period (2018-2020), resulting in an inconsistency in terms of possible research period between the dependent and independent variables. This entails the adjustment of one of the two variables in line with the other regarding research period. In this regard, the choice for the period 1990-2015 appears to offer much of a comparative advantage. Firstly, a wider range of years may involve a compiled dataset with considerably larger observations, contributing to raise the research's reliability. Secondly, the impact of the global economic shock factor, caused by the COVID-19 pandemic, is not to be included. However, the data on the financial performance of fossil fuel firms in the corresponding period go beyond the author's accessibility, unless subject to a manual process of aggregating financial statements of each company for each year. Due to the time limit of the study, the option illustrates infeasibility. Alternatively, the period 2018-2020 is preferably selected as the research period. To treat the data for environmental policy stringency, the author employs the FORECAST function in Microsoft Excel to project the approximate values for this variable in the period 2018-2020. The FORECAST function in Microsoft Excel predicts future values for an indicator using a linear regression, meaning along a line of best fit based on historical data [Microsoft Support, n.d.]. In this case, we assume that the set of EPS between 1990 and 2015 for each country is a single time series, and is a function correlated with time (or variable *t*) by a linear function. Given such assumptions, the FORECAST function in Microsoft Excel is reasonably implemented to project the future values of EPS from 2018-2020. Forecast results of the corresponding EPS in the period 2018-2020 are presented in Table 2.

Table 2: Results of forecast model for EPS in Microsoft Excel

Country	2018	2019	2020
Australia	3.70	3.84	3.97
Austria	3.79	3.88	3.97
Brazil	0.41	0.41	0.41
China	1.87	1.93	2.00

Finland	4.18	4.30	4.43
France	4.31	4.46	4.60
Greece	2.66	2.72	2.78
Hungary	3.83	3.96	4.10
India	1.43	1.48	1.52
Indonesia	1.07	1.11	1.14
Italy	3.37	3.46	3.55
Japan	3.07	3.15	3.23
Korea, Republic Of	3.95	4.09	4.23
Norway	3.51	3.61	3.72
Poland	3.33	3.44	3.55
Portugal	3.15	3.24	3.33
Russian Federation	0.87	0.89	0.91
South Africa	1.04	1.07	1.09
Spain	3.71	3.81	3.91
Sweden	4.15	4.28	4.40
United States	3.15	3.24	3.34

Source: sample analysis

3.2. The Empirical Model

The obtained data after "data processing" will be analyzed using a variety of econometric models for a panel dataset: Pooled Ordinary Least Squares (Pooled OLS), Fixed-Effects Model (FEM), Random-Effects Model (REM). The rationale for the choice of the most appropriate model is the absence of defects, specifically serial autocorrelation and heteroskedasticity. The comparison of models is facilitated by employing a set of econometric tests (White test, Wooldridge test, Hausman test and modified Wald test). If none of the models appears to be defect-free, the Generalized Least Squares (GLS) model will be implemented to treat the defects in the existing models and is expected to quantify a more accurate estimate. Factoring in all the points mentioned, the best-fitted model will be selected to translate the magnitude of the effect of environmental policy stringency on the financial performance of oil and gas firms. The analytical framework is handled using STATA 17.0, a powerful and user-friendly instrument in dealing with econometric models.

All things considered, the function explaining the impact of the government's environmental policy instruments on the financial disclosure of oil and gas companies during the period 2018-2020 is expressed as follow:

$$ROA_{it} = \alpha_0 + \alpha_{jt} EPS_{jt} + \sum_{it=1}^{n} \beta_{it}\varphi_{it} + \sum_{jt=1}^{k} \beta_{jt}\varphi_{jt} + \varepsilon_{it} + \varepsilon_{jt}$$

Where:

ROA_{it}: Returns on assets of company *i* in year *t*;

EPS_{jt}: Environmental policy stringency of country *j* in year *t*;

φ_{it}: Column vector of firm-level variables for firm *i* in year *t*;

φ_{jt}: Column vector of country-level variables for country *j* in year *t*;

α_{jt}, β_{it}, β_{jt}: regression coefficients for EPS of country *j* in year *t*, firm-level variables of firm *i* in year *t*, country-level variables of country *j* in year *t*, respectively;

α_0: intercept;

ε_{it}, ε_{jt}: stochastic error terms of the firm *i* in the year *t* and of the country *j* in year *t*, respectively;

The inclusion of variables in the model is in accordance with the determinants of financial performance of oil and gas firms, as discussed in Literature Review.

IV. RESULTS

4.1. Descriptive Statistics

Table 3: Illustrates a statistical description of all variables in the research model. The figures for statistical indicators (mean, standard deviation, minimum and maximum values), derived from STATA.17, are all presented. Hence, a brief overview on the sample firms' financial characteristics and status of the national macroeconomic development is revealed.

Table 3: Descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max
ROA	216	.0717589	.1215171	.000904	1.481774
EPS	216	2.789413	1.060305	.410083	4.600321
SIZE	216	9.233017	2.869745	1.164829	13.00132
GROW	216	-.8030386	.4360811	-.9992752	4.088889
CAIN	216	-1.877375	1.042194	-5.281641	2.075864
LIQU	216	1.326832	.7883415	.1436719	4.375285
AGE	216	3.718515	.8325743	1.791759	5.209486
GDPC	216	10.20054	1.11618	7.564087	11.31774
FIND	216	.8825157	.4150424	.3449367	2.545475

Source: results analysis

First of all, the companies selected as input data for the sample have a level of ROA ranging from 0.09% to 148%, demonstrating a sound success in terms of financial functioning in general. The mean value of ROA is 7.7%, which outperforms the corresponding figure for the energy sector as a whole (5.09%, as suggested by Factiva, Factset Research Systems Inc.).

In addition, other firm-specific indicators (size, liquidity), also represent an optimistic result of corporate financial health, as the mean values are relatively high (9.23 and 1.33, respectively). The figures suggest that principally, the selected oil and gas companies are relatively large in terms of acquired assets and have a rigid capital structure, with total assets exceeding total liabilities by about 33%. The results are rather comprehensible, as the list of 72 oil and gas companies is sorted out from a record of top 200 ranking companies by market capitalization in the fossil energy sector. The table also demonstrates that those companies are inclined to a shrinking trend of revenues, which can be learnt through a negative average revenue growth (-0.80%).

In terms of the EPS index, the value range [0.41; 4.60] implies a high level of disparity among 21 countries in terms of the stringency of the government's environmental policy instruments. Generally, the level of environmental regulation stringency is rather modest with a mean value of only 2.79 points, as compared to the maximum value of 6 points.

Besides, the overall health of national macroeconomics, depicted by the financial and economic developments, shows promising results in the investigated countries. Specifically, 21 countries in the research sample have an average percentage of financial system deposits to GDP equal to 88%, indicating that typically, firms' exposure to financial support from national financial institutions is relatively high.

4.2. Correlation Analysis

Table 4: Illustrates the correlations of the independent and control variables. The extent to which those variables correlate with one another can be interpreted using Pearson-correlation coefficients and their corresponding significance values.

Table 4: Correlation analysis

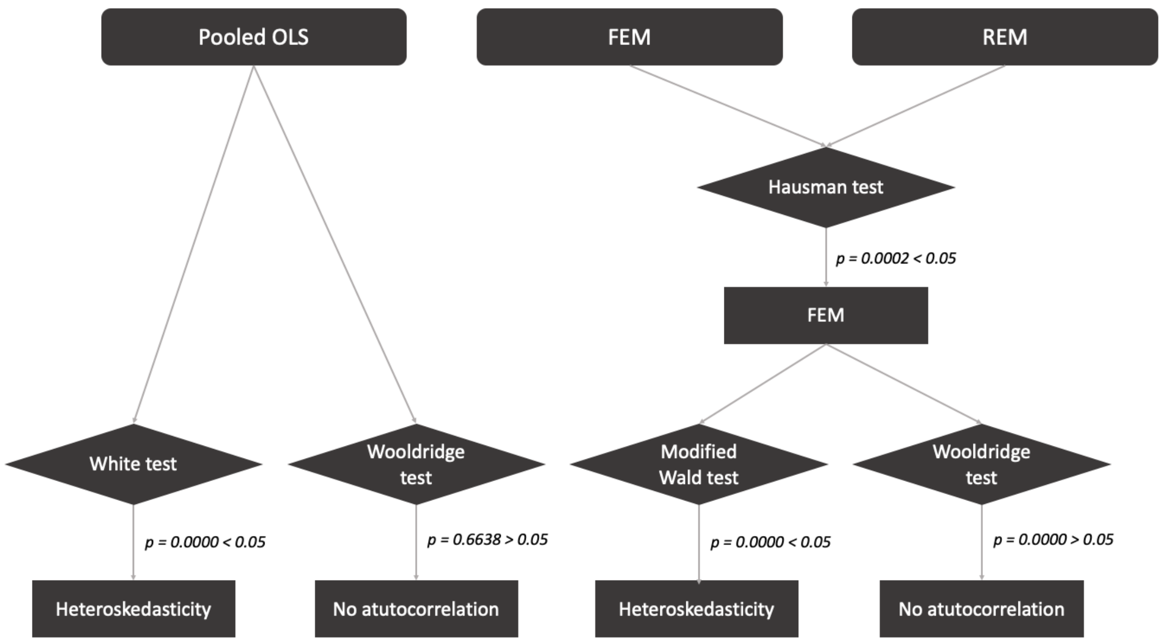
	EPS	SIZE	GROW	CAIN	LIQU	AGE	GDPC	FIND
EPS	1.0000							
SIZE	-0.0336	1.0000						
	0.6229							
GROW	0.0276	-0.0878	1.0000					
	0.6864	0.1988						
CAIN	0.0480	0.0652	0.3078	1.0000				
	0.4827	0.3405	0.0000					
LIQU	-0.0937	-0.1265	0.2861	-0.1364	1.0000			
	0.1699	0.0635	0.0000	0.0452				
AGE	0.1302	0.2667	-0.1575	-0.1690	0.0454	1.0000		
	0.0561	0.0001	0.0205	0.0129	0.5073			
GDPC	0.7773	0.1869	0.0839	0.2239	-0.0325	0.1577	1.0000	
	0.0000	0.0059	0.2192	0.0009	0.6346	0.0204		
FIND	0.4011	-0.4183	-0.0176	-0.1682	-0.0705	0.0220	0.3523	1.0000
	0.0000	0.0000	0.7969	0.0133	0.3025	0.7478	0.0000	

Source: results analysis

Results in the table show that 13 pairs of variables are found to be statistically correlated, with a confidence level of 95%. They are (CAIN ~ GROW), (LIQU ~ GROW, CAIN), (AGE ~ SIZE, GROW, CAIN), (GDPC ~ EPS, SIZE, CAIN, AGE) and (FIN ~ EPS, SIZE, CAIN, GDPC). Overall, the country-level control variables observe a correlation with most of the remaining indicators, with the number of correlated pairs being 4 for each variable. Moreover, it can also be interpreted that national macroeconomic indicators are the contributing factor to the stringency of environmental policies, depicted by a relatively high correlation coefficient (0.78 and 0.40, respectively). Apart from GDPC and FIND, EPS does not have correlation with any other variable, indicating that the choice of independent variable is sensible. The remaining pairs of variables show only a modest level of interaction, with the correlation coefficients all less than 0.4, implying that the independent variables moderately correlate with each other and thus are acceptable to use in analysis. Considering the above preliminary assessment, the chosen variables have only a modest level of correlation, indicating that the model is suitable for use and with least likelihood of multicollinearity.

4.3. Regression analysis

The role of this section is twofold. Firstly, it aims to determine the most appropriate model for the selected panel data sample. Secondly, it seeks to gauge the effect of the government's environmental regulation on the financial performance of oil and gas companies. Figure 1 below depicts the results of econometric tests in an attempt to select the best model.



Source: author

Figure 1: Econometric test results for 3 models

As illustrated, neither of these models is an appropriate choice, as heteroskedasticity exists in both cases. On this point, the GLS model with adjustment for heteroskedasticity will then be implemented to address the matter of heteroskedasticity in the previously mentioned models. The result of the GLS model reveals an absence of first-order autocorrelation and heteroskedasticity, showing advantages compared to Pooled OLS, FEM and REM. In addition, the significance value of F test is equal to 0.0000 < 0.05, indicating that generally, the model is statistically significant. Table 5 below describes a comparative analysis of Pooled OLS, FEM, REM and GLS models and reveals the figures for standardized beta value of each model.

Table 5: Comparison of Pooled OLS, FEM, REM and GLS

	(1) Pool OLS	(2) FEM	(3) REM	(4) GLS
EPS	-0.0165 [-1.58]	-0.0294 [-0.16]	-0.0168 [-1.49]	-0.00712*** [-2.89]
SIZE	-0.00315 [-1.06]	-0.206*** [-3.97]	-0.00324 [-1.01]	-0.00290*** [-3.35]
GROW	0.198*** [11.85]	0.185*** [8.68]	0.200*** [11.85]	0.207*** [22.05]
CAIN	-0.0362*** [-4.87]	-0.0612*** [-4.13]	-0.0383*** [-4.91]	-0.0225*** [-8.76]
LIQU	-0.0208** [-2.26]	-0.0286 [-1.44]	-0.0214** [-2.20]	-0.00407 [-1.57]
AGE	0.00497 [0.59]	0.280 [1.15]	0.00479 [0.53]	0.00316* [1.83]
GDPC	0.0230** [2.08]	0.145 [0.84]	0.0236** [1.99]	0.00774*** [2.60]
FIND	-0.0414** [-1.99]	0.0390 [0.24]	-0.0414* [-1.85]	-0.0282*** [-5.17]
_cons	0.0492 [0.58]	-0.428 [-0.21]	0.0432 [0.47]	0.178*** [6.03]
N R-sq	216 0.424	216 0.510	216	216

Source: results analysis

As heteroskedasticity has been treated using the GLS method, most variables in the proposed research model are statistically significant, with the only exception being liquidity. Hence, the number of factors explaining the dynamics of financial performance of oil and gas companies has increased significantly compared to the previous models. In addition, evidence from all the three previous models suggests that environmental policy stringency does not affect how well a business is performing financially, which argues against the proposed hypothesis. The GLS model, on the contrary, demonstrates a clear causal relationship between state regulation on environment-related issues and the financial performance of oil and gas firms. Details about standardized beta and the corresponding significance value of each variable by GLS method are presented in Table 6.

Table 6: GLS model estimation of standardized beta value and its significance

ROA	Coefficient	Std. err.	z	P>z	[95% conf.	interval]
EPS	-.0071206	.0024618	-2.89	0.004	-.0119455	-.0022956
SIZE	-.0028954	.0008646	-3.35	0.001	-.0045899	-.0012008
GROW	.2074184	.0094071	22.05	0.000	.1889809	.2258559
CAIN	-.0225032	.0025701	-8.76	0.000	-.0275405	-.0174659
LIQU	-.0040665	.0025904	-1.57	0.116	-.0091436	.0010106
AGE	.0031565	.0017281	1.83	0.068	-.0002305	.0065434
GDPC	.0077445	.0029789	2.60	0.009	.001906	.013583
FIND	-.0282458	.0054609	-5.17	0.000	-.038949	-.0175426
_cons	.177922	.0294881	6.03	0.000	.1201265	.2357175

Source: results analysis

The table provides materials that enable us to draw some major concluding remarks. Starting with the statistical significance of the variables in the model, noticeably, all the independent and control variables, not counting liquidity and age, have a significance value of less than 0.05, indicating that they are all statistically significant, controlling the confidence level at 95%. These are the factors that contribute to shaping the financial performance of oil and gas companies during the examined period (2018-2020).

The factors or contributors identified, however, differ one another in terms of the direction as well as the magnitude of the vector of impact. In terms of vector's direction, two indicators, namely annual growth in revenue (GROW) and national economic development (GDPC), are found positively correlated with the financial performance of oil and gas firms. That is, corporate financial functioning is enhanced when the company itself witnesses a stable growth in annual revenue, or when national economic strength is actively promoted. At this point, the study coincides with the research findings within the existing literature (see [Ma, Zhang & Yin, 2021; Sun et al., 2020]). Quite the contrary, negative standardized beta values of the remaining group of factors show that these indicators adversely affect the financial health of oil and gas companies during the examined period. On the one hand, the result offers compelling evidence to support our proposed hypothesis, which suggests that the government's stringent policies on environmental issues will do harm to the financial functioning of oil and gas companies. On the other hand, the conclusions regarding firm size, capital investment, liquidity, and financial development, rather seem to argue against the research findings in previous papers (see [Alkaraan et al., 2022; Ang, 2022; Erdogan & Yamaltdinova, 2019; Ma, Zhang & Yin, 2021]). Nevertheless, the inconsistency does not necessarily interpret an opposition, but presents a comprehensive view on the related issue. The arguments are advanced as follows. Firstly, in terms of firm size, considering a group of firms with the same profits, firms with less total assets will accordingly generate more profits in one unit of asset they own, meaning they are more financially efficient when compared with their competitors. Secondly, while it is accepted that capital investment aims to unlock production potentials of oil and gas firms by investment in long-term assets, it also requires additional expenditures, resulting in an increase in overall costs. Meanwhile, ROA is described as a short-term measurement of corporate financial performance [He et al., 2021], and the positive effect of capital investment is a long-term process, any expenditure on additional capital assets will only result in the decline of short-term financial outcome. Thirdly, the root cause of the adverse impact of the national financial strength on the level of efficiency in performing financial activities lies in the mounting concerns over environmental issues. For example, banks have become increasingly skeptical about loan provision for fossil fuel firms and have started to require stringent carbon exposure disclosures from fossil fuel sectors [Nauman & Temple-West, 2020]. Barriers regarding loan provision have limited growth opportunities of oil and gas companies, even in the case of sound national financial development.

Additionally, the disparity in terms of the extent to which the explanatory factors produce an impact on ROA of oil and gas firms is also reported. Firstly, the estimated value of standardized beta for revenue growth is 0.2074, the highest absolute value recorded among all explanatory variables, which indicates the primary role of revenue growth in terms of financial enhancement, as compared with other determinants. Specifically, a 1% increase in revenue growth of oil and gas firms will improve their corresponding financial results by 0.2074%. Adding to the point, the development of the national economic base, albeit ranked second in terms of effect on financial performance of fossil fuel companies, only contributes a part equal to one-third of that by revenue growth, if compared. Expectedly, a 0.008% enhancement of financial results of fossil-based companies will be achieved given that the overall economic health is improved by 1%. Furthermore, national financial capacity and capital investment are presented with evidence of moderate level of impact, illustrated by their coefficients, which equal -0.028 and -0.025, respectively. Comprehensively, a 1% rise in financial strength of the economy in which oil and gas companies are operating and firm's investment in long-term assets are projected to contract financial results of firms by about 0.025-0.028%. Stringency of state environmental regulations is another factor that poses a financial risk to the fossil energy sector, albeit at a very modest level. By figure, if the government imposes a 1% increase in the stringency of environmental regulations, fossil fuel companies are supposed to incur a loss of 0.007% in ROA. Lastly, firm size produces the least level of impact on the financial performance of oil and gas companies, with a 0.003% decline in ROA being observed as a result of a 1% growth of total assets.

V. CONCLUSION

In the context of soaring energy prices, it is questioned whether energy security is disregarded in preference for environmental issues. The research on the impact of environmental policies on the financial performance of oil and gas companies is, therefore, of relevance, as it addresses the question of the opportunity cost between energy security and energy transition. The study aims to gauge the effect of state environmental regulation on the financial functioning of oil and gas firms during 2018-2020, based on which implications for countries are discussed.

In this effort, the study employs a quantitative approach for a panel data model of 72 oil and gas firms in 21 countries in a three-year period (2018-2020). Four models, including Pooled OLS, FEM, REM and GLS are run and one of them is sensibly selected to interpret the results.

Research results show that increased stringency of environmental policy will exert a reverse impact on the financial health of oil and gas firms, although at a moderate level. Considering the global move towards more stringent environmental policy, a moderate negative impact may also lead to a significant level of losses. In this regard, implications for countries may vary considering country-specific economic characteristics. In emerging, energy-import dependent countries (e.g. China), demand for energy is expected to soar in some years to come due to economic expansion. Attempting to phase out oil and gas will only do harm to the economic growth. Therefore, step-by-step energy transition (e.g. from coal to gas) could be an optimal choice while investing on technology to realize the fourth transition. In developed, energy-dependent markets (e.g. Japan, Korea, EU), stringent environmental policy may hurt the industrial sector, especially amid the persistent energy crisis since winter 2021. While it is important to promote R&D investment in clean technology, diversifying energy trading partners to ensure energy security is worth being considered. In the developed, energy-independent countries (e.g. the United States, Canada), environmental issues should be prioritizing over economic benefits, as energy is available to support the industrial sector of the countries, while demand for it is not much of a matter as compared to emerging markets due to the convergence of economic growth rate and improved energy efficiency.

The author, however, admits that the study bears some major limitations, which are mostly connected with data availability: i, the number of observations is relatively small in a research involving a country-level indicator as a subject of focus; ii, bias in the distribution of oil and gas firms chosen for analysis, with the number of U.S firms accounting for roughly 50%, which is again not appropriate for a research involving a country-level variable; iii, deviations resulting from the forecast model, which may increase the error of the estimate; iv, failure to address the 2020 economic crisis as a result of the COVID-19 pandemic.

Given what has been discussed, further research aims to address the issues mentioned. For example, future study will select a different period to eliminate the possible effect of the global economic shock of 2020. Furthermore, data on corporate financial performance will be extracted from a different source, such as COMPUSTAT , which is currently inaccessible to the author.

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