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Exploring Capital Structure Determinants for OECD Energy Firms

Gholamreza Zandi[1]*, Raja Rehan[2], Qazi Muhammad Adnan Hye[3], Sandy Low Bee Choo[1]

[1]Universiti Kuala Lumpur Business School, Malaysia, [2]Department of Business Administration, ILMA University, Karachi, Pakistan, [3]Academic Research and Development Wing, Dubai, United Arab Emirates. *Email: zandi@unikl.edu.my

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ABSTRACT

Energy is considered as a critical factor for supporting Economic Co-operation and Development (OECD) countries' economic growth. However, little is known about OECD-based energy firms' capital structure determinants. Hence, this investigation is an effort to explore the capital structure determinants for OECD countries' energy firms. In this context, 18 key OECD countries 43 energy firms are selected. The balanced panel data sample set of 14 years from 2007 to 2020 is constructed to perform empirical analysis. The eight selected determinants, which are tangibility, current ratio, non-debt tax shield, return on equity, annual gross domestic product, inflation, and energy consumption are examined in association with capital structure that is measured by debt-to-asset ratio. By engaging a Panel Data Static Model and Dynamic Model via Generalized Method of Moments (GMM), the outcomes expose that tangibility, profitability, gross domestic product, energy consumption, and lagged dependent variable are the key capital structure determinants for energy firms of OECD countries. Notably, the significant role of a lagged dependent variable specifies the existence of a dynamic capital structure and speed of adjustment for these firms. Also, the significant role of tangibility directly indicates the relevance of the Dynamic Trade-Off theory. The findings pave new ways for policymakers to develop similar policies that will enhance collaboration in OECD countries to knob forth seeing energy-connected issues. Likewise, the identification of key determinants will also be helpful for these firms to construct best mix of debt and equity that ultimately enhance their financial performance and market value.

Keywords: Capital Structure, Panel Data Models, GMM, Trade-Off Theory, OECD
JEL Classifications: G31, G32, P18

1. INTRODUCTION

From the preceding century, the topic of capital structure determinants has continuously been studied by scholars of corporate finance (Ghani et al., 2023; Myers, 1984). The hunt for exploring a precise blend of debt and equity that articulates an ideal capital structure is still continued. Unquestionably, scholars are not able to deliver a precise model which helps firms to formulate the best mix of debt and equity i.e. optimal capital structure. Technically, capital structure refers to the way a firm finances its assets through a combination of equity, debt, and retained earnings. Thus, it is a balance between the proportions of financing that comes from owners and the proportion that comes from lenders to frame an optimal capital structure. The optimal capital structure is the best mix of debt and equity financing that maximizes a firm's market value while minimizing its cost of capital (Abdul Hadi et al., 2018). Nevertheless, core capital structure theories namely Modigliani and Miller's (M&M), Pecking Order, Trade-Off and, now their dynamic versions are trying to explain how a firm chooses the best mix of determinants to formulate an optimal capital structure (Khan et al., 2021). Visibly, prior inquiries that detect capital structure determinants for energy firms are rare. On the flip side, soaring energy rates are leading global economy towards another largest energy crisis after 1970 (Guan et al., 2023).

Undoubtedly, energy is vital for modern societies and a key factor in supporting economic growth (Khan et al., 2022). Nevertheless, little is known about capital structure determinants of energy firms that are operational in the Organization for Economic Co-operation and Development (OECD). Besides, the former investigations that have been performed in the OECD background to explore capital structure determinants of energy firms are mainly country-specific (see Grabinska et al., 2021; Wieczorek-Kosmala, Błach and Gorzeń-Mitka, 2021), thus, unable to provide the holistic and conclusive outcomes. Therefore, identifying the capital structure determinants for energy firms that are operating in OECD member countries is still an unsettled issue. The OECD is an intergovernmental organization that was founded in 1961. It comprises 37 member countries, including the United States, Canada, Australia, Japan, and most of the European countries that cover 36% of overall world's GDP (Ozcan et al., 2020). The mission of the OECD is to promote policies that will improve the economic and socio-economic standard of people around the world (OECD, 2004).

Typically, the capital structure of energy firms in OECD countries can vary widely, depending on the nature of their operations, the regulatory environment, and market conditions. However, the prior literature on the energy firms of the OECD countries identified conflicting outcomes for the dynamic relationships (Ozcan et al., 2020). Notably, several investigations specified that the capital structure of the firms is a dynamic property (Halim et al., 2019; Rehan and Abdul Hadi, 2019; Yuang and Zhang, 2022). Moreover, like other regions, the capital structures of energy firms in OECD countries are also influenced by the regulatory environment and tax policies (Abbas et al., 2023). Another noteworthy issue is that hiking energy rates also pushed inflation that is not seen before (OECD, 2022). Thus, the capital structure of energy firms in OECD countries is shaped by a complex interplay of economic, regulatory, and market factors. Remarkably, the OECD countries have acknowledged the need of promoting several new sources of energy (OECD, 2020). OECD nations have also recognized the need of enhancing several energy generation options and forthcoming energy scarcity issues (OECD, 2020; OECD, 2019). Considering the recognized problem, this study is set to identify the key capital structure determinants for whole energy firms which are operating in the OECD member countries.

For this purpose, total 18 OECD countries' energy firms over the period of 14 years, from 2007 to 2020 are selected. To the best of researchers' knowledge, this inquiry is the first attempt to investigate capital structure determinants for the energy-generating firms which are operating in the whole OECD region. The outcomes elucidate that sales, tangibility, gross domestic products, inflation, and profitability are the main capital structure determinants for the OECD energy firms. The results help OECD economies to articulate a coordinated policy that speedily boosts integration among member countries to overcome predicted energy-related issues. Undoubtedly, the identification of key capital structure determinants for the whole OECD energy firms will be helpful to construct the best mix of debt and equity that ultimately enhances their financial performance and regional level integration to cope up the forthcoming energy issues.

After a thorough overview, the remaining inquiry is ordered as follows: Section number 2 emphasizes earlier literature; Section 3 clarifies the data collection and its type and documented approaches for this investigation; Section 4 explains the detected results. Subsequently, Section 5 describes in detail the answers to this study. Finally, Section 6 ends with the ending conclusion, implications, and core limitations of the research.

2. LITERATURE REVIEW

So far, there is no one-size-fits formula available that helps firms to construct the optimal capital structure (Rehan et al., 2019). However, capital structure theories such as M&M, Pecking Order and Trade-Off theories and now their latest dynamic version offer frameworks that explain how firms determine the optimal mix of debt and equity. M&M theory states that the value of a firm is independent of its capital structure in the world with no taxes and perfect capital markets. After this, the Trade-off theory explains that there is a trade-off between the benefits and costs of using debt and equity to finance a firm's operations. Later, the Pecking Order theory is introduced which states that firms have a preference for a specific order of financing sources, which start from internal funds i.e. retained earnings, followed by debt, and finally equity (Khan et al., 2021).

Consequently, the main capital structure determinants that have been designated for energy-generating firms by the above-discussed capital structure theories and former investigations are tangibility, profitability, size, and taxation. For instance, Berkman et al. (2016) discovered capital structure determinants for European energy firms by analyzing 74 firms' data which starting from the year 2009 to 2012. The findings explained that the liquidity of firms, profitability, and tangibility are the main and significant debt-equity determinants. Similarly, Jaworski and Czerwonka (2021) inspected the determinants of capital structure for European energy firms. This investigation accepted the multiple regression techniques and data from 6122 firms from total 25 main European countries. The results of this inquiry are in line with the former outcomes of Berkman et al. (2016). The results showed a positive, and significant association of capital structure with studied determinants which are size and tangibility. Likewise, significant and negative relationships between profitability, liquidity and capital structure are detected. Clearly, the discussed inquiries (Guedie et al., 2022; Berkman et al., 2016; Jaworski and Czerwonka, 2021; Abubakar and Abdullahi, 2022; Bahrami et al., 2022) suggest that liquidity, tangibility, sales, and profitability are the main determinants of the capital structure of energy firms.

In the same vein, Shrestha (2019) revealed capital structure determinants for the energy-generating firms that are functioning in main Asian countries. Shrestha (2019) examined capital structure determinants for energy firms of core Asian economies. The outcomes confirmed that capital structure decisions of energy-producing Asian firms are impacted by size, interest rate, market development, and profitability. Likewise, numerous researchers (Zhang et al., 2018; Liaqat et al., 2017; Ghani et al., 2023) performed inquiries to recognize the determinants of the capital structure of energy-producing firms in Pakistan. The results of all these investigations specified that profitability, tangibility, and size of the firms are the core determinants that construct the best debt-equity blend for energy firms. Similarly, in the Indian context, Chakrabarti and Chakrabarti (2019) and Panicker (2013) explored the capital structure determinants for energy-producing firms. The outcomes explained that debt capacity, profitability, liquidity, NDTS, and tangibility are the main capital structure determinants for these firms in the Indian context. Likewise, in Bangladesh, Uddin et al. (2022) indicated that tangibility, liquidity, size and NDTS are the key capital structure determinants for the firms that are producing energy.

Most recently, Ghani et al. (2023) explored capital structure determinants of energy firms that are operating in the SAARC region. This study adopted Panel Data from 34 energy-producing firms over the period from 2007 to 2020. The results explained tangibility, liquidity, profitability, size, and taxation are the key determinants of energy firms that are operating in the SAARC region. In the ASEAN region, the earlier investigations discovered only country-specific debt equity determinants for listed energy firms. For instance, in the Malaysian context, Foo et al. (2015) inspected capital structure determinants for the energy firms that are operating in the oil and gas sectors and concluded that profitability is the main significant capital structure determinant. Afterward, Mikurus (2019) reported that profitability significantly influences Malaysian energy firms' financing decisions. In the context of Indonesia, Suyono and Amin (2022) discovered the significant impact of liquidity, profitability, and risk on the capital structure of energy firms.

Remarkably, the deliberated inquiries from diverse settings and regions designated that energy firms' liquidity, asset tangibility, NDTS, size, and profitability are the key capital structure determinants (Ghani et al., 2023; Jaworski and Czerwonka, 2021; Shrestha, 2019; Berkman et al., 2016; Chakrabarti and Chakrabarti, 2019; Panicker, 2013; Guedie et al., 2022; Harun et al., 2022). However, there are rare inquiries that discovered determinants of capital structure for OECD member countries' energy-producing firms. Therefore, as per researchers' understanding, this investigation is the initial struggle to explore the capital structure determinants for the energy firms that are functioning in the OECD member countries.

In addition, this investigation also considers inflation, GDP, and energy consumption as important determinants of capital structure for OECD region energy firms. Freshly, several OECD countries have experienced drastic inflation behaviors. According to OECD published report, after hiking, the energy inflation rate falls in the OECD countries i.e. from 35.3% in July 2022 to 30.2% in August 2022 and 10.2% in January 2023. Another important determinant that is found significant for OECD countries' energy firms is tax revenue (Jaworski and Czerwonka, 2021). Technically, tax revenue is explained as the income that is collected by the government from taxes on firms' profits. Besides, OECD countries contribute 36% to the overall GDP of the world (Ozcan et al., 2020). An increase in GDP growth and inflation rate decreases overall corporate sector debt, whereas, an increase in tax revenue results in an increase in a firms' debt ratio (Jaworski and Czerwonka, 2021). Furthermore, the former investigations explicate variations in the designated capital structure determinants (Ghani et al., 2023). Hence, it is presumed that the capital structure of energy firms is dynamic in nature. Consequently, the connected hypotheses with this empirical inquiry are:

H_1: There is a positive connection between capital structure and tangibility

H_2: There is a negative relationship between capital structure and profitability

H_3: There is a negative relationship between capital structure and liquidity

H_4: There is a positive relationship between capital structure and size

H_5: There is a negative relationship between capital structure and NDTS

H_6: There is a positive relationship between capital structure and inflation

H_7: There is a positive relationship between capital structure and energy consumption

H_8: There is a positive relationship between capital structure and tax revenue

H_9: There is a positive relationship between capital structure and GDP

H_{10}: There is a dynamic relationship between capital structure and studied determinants.

3. DATA AND METHODOLOGY

This empirical investigation comprises 43 energy firms from 18 main OECD countries that are Canada, the United States, the United Kingdom, France, Austria, Belgium, Poland, Denmark, Estonia, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Spain, and Sweden. For this purpose, the 14-year yearly secondary data from 2007 to 2020 of 43 energy firms is mined from the Thomson Reuters Eikon database. However, because of the inaccessibility of data, this inquiry eliminates the other OECD countries from the analysis. Additionally, to analyze the significant relationships, the data is extracted for the designated capital structure determinants that are explained in below-given Table 1.

Table 1 elucidates the capital structure and its designated determinants for this empirical study. The Debt to Total Asset ratio that is stated as DR is used as a measure of capital structure. Likewise, TANG indicates assets' tangibility, PROF explains profitability that is measured by return on equity. The liquidity is mentioned as LIQ which is measured by the current ratio. Size specifies the total annual sales of the energy firms. Moreover, NDTS is selected to calculate the impact of taxation on energy firms' capital structure. In addition, this inquiry presented inflation rate, gross domestic product, and energy consumption as core determinants of capital structure for OECD countries' energy firms.

Methodically, the Panel Data Analysis (PDA) is implemented to discover the robust relationships among the nominated variables and capital structure. Remarkably, Panel Data is a combination of two dissimilar types of data sets that are cross-sectional and time series which is also termed longitudinal data (Gujarati, 2003). Precisely, the raised Panel Data model is examined by applying Panel Data Static and Dynamic techniques. Importantly, the

Table 1: Nominated variables measurements

S#	Symbol	Variables	Measurement	References
01	DR (Y)	Debt to total assets	Total debt/total assets	Ghani et al. (2023), Demirhan (2009)
02	TANG (X_1)	Tangibility of firms' asset	Tangible fixed assets/total assets	Ghani et al. (2023), Berkman et al. (2016)
03	PROF (X_2)	Return on equity	Net income/equity	Demirhan (2009)
04	LIQ (X_3)	Current ratio	Current assets/current liabilities	Ghani et al. (2023)
05	SIZE (X_4)	Sales	Ln (sales)	Jaworski and Czerwonka (2021), Ghani et al. (2023)
06	NDTS (X_5)	Non-debt tax shield	Depreciation/total assets	Jaworski and Czerwonka (2021)
07	INF (X_6)	Inflation	Inflation, consumer prices (annual %)/100	Jaworski and Czerwonka (2021), Ghani et al. (2023)
08	ENG_CON (X_7)	Energy consumption per 1000 people	Final energy consumption×1000/population	Ghani et al. (2023), Jaworski and Czerwonka (2021)
09	Tax_REV (X_8)	Tax Revenue	(Revenue from tax) GDP %/100	Jaworski and Czerwonka (2021)
10	GDP (X_9)	Annual GDP growth	GDP growth (annual %)/100	Jaworski and Czerwonka (2021), Ghani et al. (2023)

In the above-given Table 1, DR indicates the dependent variable

former studies indicate that the capital structure of firms possessed dynamic properties (Halim et al., 2019). Statistically, the Panel Data Model (PDM) is clarified as follows:

$$y_{it}=\alpha_i+\gamma_t+\beta x_{it}+\varepsilon_{it} \quad (1)$$

Here, $i=1, 2,3 …., N$ which explains individuals, t is a nominated period of time $(t=1,2, 3,….,T)$, y_{it} describes the chosen dependent variable, α_i explains properties that are cross-sectional and γ_t are effects of dissimilar time series during the nominated period. Likewise, x_{it} is recognized as nominated independent variable and ϵ_{it} specifies models' error term. Analytically, this empirical study has designated the Panel Data Static and Dynamic models that was formerly implemented by Ghani et al., 2023, Zandi et al., 2022, Chakrabarti and Chakrabarti, 2019; Mubeen et al., 2022; Tahsin, 2022.

1. POLS Model

$$DR_{it}=\beta_0++\beta_1\,TANG_{it}+\beta_2\,PROF_{it}+\beta_3\,LIQ_{it}+\beta_4\,SIZE_{it}+\beta_5\,NDTS_{it}+\beta_6\,INF+\beta_7\,ENG_{CONit}+\beta_8\,Tax\_Rev_{it}+\beta_9\,GDP_{it}+\varepsilon_{it} \quad (2)$$

2. Panel Data Fixed Effects (FE) Model

$$DR_{it}=\beta_0+\beta_1\,TANG_{it}+\beta_2\,PROF_{it}+\beta_3\,LIQ_{it}+\beta_4\,SIZE_{it}+\beta_5\,NDTS_{it}+\beta_6\,INF+\beta_7\,ENG_{CONit}+\beta_8\,Tax\_Rev_{it}+\beta_9\,GDP_{it}+\varepsilon_{it} \quad (3)$$

3. Panel Data Random Effects Model (RE)

$$DR_{it}=\beta_0++\beta_1\,TANG_{it}+\beta_2\,PROF_{it}+\beta_3\,LIQ_{it}+\beta_4\,SIZE_{it}+\beta_5\,NDTS_{it}+\beta_6\,INF+\beta_7\,ENG_{CONit}+\beta_8\,Tax\_Rev_{it}+\beta_9\,GDP_{it}+\varepsilon_{it}+\mu_{it} \quad (4)$$

Here, debt ratio is dependent variable that is specified by "DR." "$\delta DRi,_{(t-1)}$" designates lagged value of selected dependent variable that is main function of models' error term "$\varepsilon_{it.}$" Moreover, TANG, PROF, LIQ, SIZE, NDTS, INF, ENG_{CON}, TAX_REV and GDP indicate all the nominated independent variables. Notably, all these variables are described with their measurements in above Table 1. Likewise, ε_{it} designates an error term of constructed model and μ_{it} is individual random difference. Typically, the Pool Ordinary Least Squares is considered best for homogeneous sample (Chakrabarti and Chakrabarti, 2019). Technically, the Breusch Pagan Lagrange Multiplier test i.e. BPLM test is employed to check the individual effects. Likewise, the Hausman test is used to recognize the Random Effects (RE) or Fixed Effects (FE) features. Principally, the BPLM test uses Hausman's (1978) test m statistics to accept the correct hypothesis for the model. The null hypothesis (H_0: Pooled OLS Model is appropriate) of Hausman's test explains that the model of Pooled OLS is the appropriate selection for the analysis. Moreover, if null hypothesis (H_0) is rejected then the model of Random Effects (RE) is adopted for the analysis purpose (H_1: Random Effects Model is appropriate). Remarkably, if null hypothesis (H_0) of the BPLM is not accepted for the Pooled OLS, then the Hausman test is executed to discover the existence of Fixed Effects (FE). Hence, Hausman's test is executed to adopt an appropriate model of Panel Data between Fixed and Random Effects models (Breusch and Pagan, 1980). The econometric model of Hausman's test is explained as below:

$$H=(b_1-b_0)\,(Var\,(b_0)-Var\,(b_1))\,(b_1-b_0) \quad (5)$$

Moreover, to investigate dynamic relationships among the selected determinants, this study also hired a robust estimator that is a difference Generalized Method of Moments (GMM) proposed by Arellano and Bond (1991) to inspect the dynamic connection among the capital structure and selected determinants. Technically, the difference GMM is considered best to discover the dynamic relationships and speed of adjustment (SOA). Moreover, the idea of SOA is clarified by the dynamic capital structure theory of Trade-off that explains the concept of targeted capital structure. According to the SOA concept, firms normally deviate from their maintained capital structure level, however, in the existence of SOA, they rapidly move back to their targeted level (Ghose, 2017). Technically, the difference GMM is considered best to alter the selected dependent variable into independent variable by taking the first difference which is constant over time. Importantly, the difference GMM is constructed to handle dynamic model bias and fixed effect related problems (Arellano and Bond, 1991; Liu, 2022; Maheswaranathan and Bhavan, 2022). In addition, this study adopts two-step GMM procedure to perform analysis. Notably, the One-step GMM is used as a default estimator, however, to handle the panel data associated diagnostic issues that are autocorrelation and heteroskedasticity, the two-step GMM estimator is implemented which modifies the co-variance matrix of the dynamic model (Miteza, 2012). The single-liner equation of difference GMM is explained as follows:

$$y_{it} = (1-\lambda)\, y_{i,t-1} + \beta_1 k_{it} + \beta_2 X_{it} + \mu_{it} \quad (6)$$

$i = 1\ldots.\ 43,\ t=1, 2, 3,\ldots, 14$

Here, "y_{it}" indicates a dependent variable, λ denotes SOA and is measured as a rate of convergence of y_{it} towards targeted capital structure, $y_{i,t-1}$ specifies lagged dependent variable of dependent variable. Moreover, k_{it} is a fixed effects (FE) factor that fluctuate crosswise over an individual in a selected time frame, "x_{it}" specifies the selected independent variables. Notably, in above model 2, if SOA is misplaced, then relation suffer from error of misspecification (Aderajew et al., 2018). Therefore, in order to avoid misspecification error equation 2 is revised as follows:

$$y_{it} = (1-\lambda)\, y_{it-1} + \lambda \sum_{n=1}^{N} \beta_k X_{kit} + \varepsilon_{it} \quad (7)$$

This investigation uses this model 3 to inspect SOA for targeted capital structure by using first difference GMM, suggested by Arellano and Bond (1991). Thus, the econometrics model of this study is articulated as follows:

$$DR_{it} = (1-\lambda)\, DR_{i,(t-1)} + \beta_1 TANG_{it} + \beta_2 PROF_{it} + \beta_3 LIQ_{it} + \beta_4 SIZE_{it} + \beta_5 NDTS_{it} + \beta_6 INF + \beta_7 ENG_{CON\,it} + \beta_8 Tax\_Rev_{it} + \beta_9 GDP_{it} + \varepsilon_{it} + \mu_{it} \quad (8)$$

Here, a variable of interest i.e. dependent variable is debt to asset ratio which is written as "DR." Similarly, "$\delta DR_{i,(t-1)}$" designates lagged variable of the dependent variable which influences on error term "$\varepsilon_{it.}$" Besides, TANG, PROF, LIQ, SIZE, NDTS, INF, ENG_CON and GDP indicate nominated independent determinants which are explained in above Table 1. Whereas "ε_{it}" specifies an error term and "μ_{it}" shows random alterations in individuals. Furthermore, for difference GMM, the first adjustment for dynamic capital structure model of this investigation is given below:

$$\Delta DR_{it} = \Delta DR_{i,t-1} + \beta_1 \Delta TANG_{it} + \beta_2 \Delta PROF_{it} + \beta_3 \Delta LIQ_{it} + \beta_4 \Delta SIZE_{it} + \beta_5 \Delta NDTS_{it} + +\beta_6 \Delta INF_{it} + \beta_7 \Delta ENG\_CON_{it} + \beta_8 \Delta TAX\_REV_{it} + \beta_9 \Delta GDP_{it} + \Delta\varepsilon_{it} + \Delta\mu_{it} \quad (9)$$

In addition, this inquiry also performs model fitness tests to measure the diagnostic issues. For this purpose, the Pearson Correlation test is implemented which is used to check the statistical association among all selected determinants (Ghani et al., 2023). The Pearson Correlation test clarifies at what level the significant association occurs between the investigated variables. Statistically, the coefficient value of "r" of the Pearson Coefficient test lies among the figures of −1 to +1. The +1 indicates a positive and perfect relationship, though, −1 indicates the perfect but negative relationship among the variables. Nevertheless, if the coefficient figure is placed at value "0," then, it explains the absence of any type of relationship (Hernawati et al., 2021). The formula of Pearson's correlation is given below:

$$r = \frac{n\left(\sum xy\right) - \left(\sum x\right)\left(\sum y\right)}{\sqrt{[n\sum x^2 - (\sum x)^2][\,n\sum y^2 - (\sum y)^2]}} \quad (10)$$

Here, the Pearson correlation is indicated by "r," likewise, $\sum xy$ denotes the total value of the investigated variables that is a product of "x" and "y," $\sum x$ postulates the total figure of variable x. Besides, $\sum y$ designates the total of the variable "y" and "n" explain the total available number of variables x and y.

Furthermore, to get precision for the GMM estimation, the autocorrelation test i.e. AR(m) test is executed which is also recognized as a diagnostic test for detecting autocorrelation, likewise, the Sargan test is performed to diagnose the exogeneity issue. An exogeneity identifies an analytical problem in which the explanatory variables are not dependent on the other variables of regression. Likewise, another diagnostic test which is known as the Autocorrelation test i.e. AR(m) test is also conducted to find the selected variables' reliance on their own earlier values. Exactly, the GMM estimator drops these two diagnostic issues from the constructed model (Arellano and Bond, 1991). Figure 1 explains the conceptual framework for this study. Debt to Total Asset is designated as a dependent variable to measure OECD energy firms' capital structure. Whereas, all nominated independent variables are adopted to check their influence on these firms' capital structure.

4. FINDINGS

To perform the empirical analysis, all of the selected variables' data which are debt to asset ratio, asset tangibility, firms' profitability, sales, liquidity, non-debt tax shield, GDP, and inflation rate are programmed into robust statistical software SAS. The descriptive analysis which is explained in below given Table 2, is executed to study the behaviour of the selected variables such as their mean, standard deviation (Std. Dev.), minimum (Min), maximum (Max), and median.

The outcomes explain that the mean value of the debt-to-asset ratio i.e. DR is 0.611. Similarly, the outcomes show that the TANG mean value is 0.543, PROF mean value is 0.965, LIQ mean value is 1.331, and the SIZE mean value is 1.601. Moreover, NDTS which indicates taxation of energy firms, its mean value standing at 0.041. Then, INF mean value is 0.031, ENG_CON mean value is 1.533, Tax_Rev mean value is 0.432 and the GDP mean value is reported as 0.810%. Visibly, the extracted data is not exhibiting

Table 2: Descriptive statistics of designated determinants

Variable	Mean	Median	Max	Min	Std. Dev.
DR	0.611	0.413	1.833	0.048	0.053
TANG	0.543	0.354	2.214	0.031	0.211
PROF	0.965	0.077	1.512	−1.010	0.021
LIQ	1.331	1.234	19.35	0.066	1.043
SIZE	1.601	1.021	33.11	−0.799	0.211
NDTS	0.041	0.054	0.012	0.011	0.014
INF	0.031	0.021	0.021	−0.015	0.002
ENG_CON	1.533	1.011	32.13	−0.435	0.211
TAX_REV	0.432	0.023	0.031	0.543	0.121
GDP	0.720	0.011	0.021	0.662	0.302

any sort of variations as all extracted numbers are observed closer to each other. Besides, the standard deviations of the designated variables are not more than the average values.

Remarkably, this inquiry also executed several analytical tests to check the constructed Dynamic Panel Data model's overall fitness. For instance, the statistical test of a Pearson Correlation is performed to discover the association in the selected capital structure determinants.

Table 3 demonstrates the Pearson Correlation results of all the elected eight determinants and debt to asset ratio which is used to measure the capital structure. The coefficient values of the Pearson Correlation test range between −0.2221 and 0.6821. Statistically, the highest coefficient correlation value is noticed between debt to asset ratio (DR) and current ratio (LIQ) i.e. 0.6711. Importantly, the LIQ is found significant at 1% level. Therefore, LIQ may be included in one of those variables which significantly influence OECD energy-producing firms. Besides, the preliminary outcomes which are obtained from the Pearson Correlation analysis specified that selected determinants which are TANG, PROF, GDP, INF, and ENG_CON are enough to impact capital structure i.e. nominated by DR. In addition, this inquiry also performed the test of Variance Inflation Factor to examine the multicollinearity issue in the selected predictors. The Variance Inflation Factor (VIF) is judged on the measure which is explained by numerous econometries (Akinwande et al., 2015; Gujarati and Porter, 2009; Kennedy, 2008; Hieu et al., 2021; Hussain et al., 2021) who explained that extreme multicollinearity problem exists in the selected variables if their VIF test outcomes are more than 10. The outcomes attained from the test of Variance Inflation Factor (VIF) are presented in below given Table 4.

Evidently, the attained outcomes from VIF test clarify the absence of multicollinearity in the nominated variables as all the values are not more than the explained threshold i.e. 10. Subsequently, this inquiry also performs Breusch Pagan Lagrange Multiplier test i.e. BPLM test. Table 5 shows the outcomes attained from the execution of BPLM test. Noticeably, the outcome figures for P ($P < 0.05$) suggests the rejection of null hypothesis (H_0). The outcomes specify that the Random Effects (RE) model is more suitable than the Pooled OLS model.

Moving forward, after the acceptance of Random Effects (RE) model, this inquiry executed Hausman test. Technically, this test is performed to identify the appropriate Static Model to perform the investigation. The outcomes achieved from this test execution are displayed in below mentioned Table 6.

Clearly, the outcomes display that the P value is not <0.05. Thus, the Random Effects (RE) model is more appropriate for the analysis. The results obtained from the Random Effects assessment are described in below Table 7.

Table 7 displays the findings achieved from the execution of Random Effects (RE) Two-Way Wallace-Hussain model. Visibly, the outcomes postulate designated variables that are tangibility (TANG), return on assets that indicates profitability (PROF), sales (SIZE), inflation (INF) and energy consumption (ENG_CON) have significant effect on capital structure maintaining practices of OECD energy firms. However, the all-other studied variables, which are non-debt tax shield (NDTS), liquidity (LIQ), tax revenue (TAX_REV) and gross domestic products (GDP) are insignificant determinants for the energy firms which are functioning in the OECD region. Evidently, the model is also considered fit as R-square designates high figures (0.7051).

Moreover, this inquiry performs GMM evaluation to examine robust associations among the chosen determinants. The outcomes of the Panel procedure through GMM indicates that the total selected firms for analysis are 43, whereas, the time series size is just 14 years, from 2007 to 2020. The fit statistics in Table 8 explain that good model is fit with the data. The value of SSE which is nearer to zero explains that model has small random error, thus more suitable for forecasts. However, in this case SSE

Table 3: Pearson correlations matrix

Variables	DR	TANG	PROF	LIQ	SIZE	NDTS	INF	ENG_CON	TAX_REV	GDP
DR (P-value)	1	−0.2221	−0.2338	0.6821	0.3731	0.3211	0.6332	0.6114	0.6142	0.6233
		(0.0001)	(0.0344)	(0.0155)	(0.0001)	(0.0111)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
TANG (P-value)	−0.2221***	1	0.5325	0.6431	−0.2231	0.6211	0.6661	0.5201	−0.1124	−0.1264
	(0.0001)		(0.1202)	(0.1220)	(0.1201)	(0.3332)	(0.3022)	(0.1611)	(0.1045)	(0.1231)
PROF (P-value)	−0.2338**	0.5325	1	0.6134	0.43273	0.33122	0.6253	0.6343	0.5327	0.3100
	(0.0344)	(0.1202)		(0.1231)	(0.2119)	(0.2213)	(0.1100)	(0.1100)	(0.1200)	(0.0100)
LIQ (P-value)	0.6821	0.6431	0.6134	1	0.21330	0.3223	0.2232	0.3131	0.3452	0.2230
	(0.0155)	(0.1220)	(0.1231)		(0.0100)	(0.0753)	(0.0643)	(0.0602)	(0.0512)	(0.0100)
SIZE (P-value)	0.3731	−0.2231	0.43273	0.21330	1	0.3120	0.2231	0.3310	0.2113	0.2013
	(0.0001)	(0.1201)	(0.2119)	(0.0100)		(0.0113)	(0.0221)	(0.0100)	(0.0100)	(0.0102)
NDTS (P-value)	0.3211	0.6211	0.33122	0.3223	0.3120	1	0.2331	0.3112	0.3211	0.3121
	(0.0111)	(0.3332)	(0.2213)	(0.0753)	(0.0113)		(0.0120)	(0.0001)	(0.0001)	(0.0001)
INF (P-value)	0.6332***	0.6661	0.6253	0.2232	0.2231	0.2331	1	0.2210	0.2311	0.1221
	(0.0001)	(0.3022)	(0.1100)	(0.0643)	(0.0221)	(0.0120)		(0.0100)	(0.0120)	(0.1202)
ENG_CON (P-value)	0.6114***	0.5201	0.6343	0.3131	0.3310	0.3112	0.2210	1	0.2156	0.2120
	(0.0001)	(0.1611)	(0.1100)	(0.0602)	(0.0100)	(0.0001)	(0.0100)		(0.0140)	(0.1011)
TAX_REV	0.6142	−0.1124	0.5327	0.3452	0.2113	0.3211	0.2311	0.2156	1	0.6156
	(0.0001)	(0.1045)	(0.1200)	(0.0512)	(0.0100)	(0.0001)	(0.0120)	(0.0140)		(0.0100)
GDP (P-value)	0.6233***	−0.1264	0.3100	0.2230	0.2013	0.3121	0.1221	0.2120	0.6156	1
	(0.0001)	(0.1231	(0.0100)	(0.0100)	(0.0102)	(0.0001)	(0.1202)	(0.1011)	(0.0100)	

*** Significant at 1% and **significant at 5% level

Table 4: VIF test for multicollinearity diagnosis

Variables	VIF	1/VIF
DR	2.321	0.431
TANG	2.101	0.476
PROF	2.453	0.408
LIQ	3.250	0.308
SIZE	2.413	0.414
NDTS	6.321	0.158
INF	3.107	0.322
ENG_CON	2.802	0.357
TAX_REV	3.040	0.329
GDP	2.010	0.498

Table 5: Two way BPLM test

H_0: Pooled OLS is appropriate	
H_1: Random effects is appropriate	
m value	**P>m**
9581	0.008

*BPLM: Breusch pagan lagrange multiplier test

Table 6: Hausman test

H_0: Random effects (RE) is appropriate	
H_1: Fixed effects (FE) is appropriate	
Chi-square test value	8.022
P-value	0.638

Table 7: Random effects (RE) model outcomes

Two-way random effects				
Wallace-Hussain				
Variables	**Coefficient**	**Standard Error.**	**t-value**	**P-value**
Intercept	0.0145	0.0221	0.6561	0.5118
TANG	0.221	0.0631	3.5024	0.0005**
PROF	−0.246	0.0442	−5.5656	0.0001**
LIQ	0.3138	0.50872	0.6168	0.5374
SIZE	0.2121	0.04321	4.9086	0.0001**
NDTS	0.1311	0.1871	0.7007	0.4835
INF	−0.2554	0.0311	−8.2122	0.0001**
ENG_CON	0.2164	0.0321	6.7414	0.0001**
TAX_REV	0.3221	0.4413	0.7299	0.4655
GDP	0.3314	0.4312	0.7686	0.4421
R-square				0.7051

**significant at 5% level

is not suitable for further predictions as its value is more than zero. Therefore, it applies on MSE and Root MSE where values are closer to zero, hence, possess better potential for forecast.

For this purpose, the diagnostic tests which are Sargan and Autocorrelation AR(m) tests associated with GMM analysis are performed to check the validity of the constructed dynamic model. The outcomes shown in below Table 9 indicate that GMM model is free from the exogeneity problem, thus, the null hypothesis (H_0: The Instruments are valid) is not rejected. Moreover, the outcomes of Sargan test indicates that the selected instruments of the dynamic model are not connected with each other and the selected residuals, thus, the instruments are valid.

Table 10 displays the outcomes obtained from the autocorrelation test i.e. AR(m) test. The AR(m) autocorrelation test is performed to check the problems of autocorrelation in the model. The results postulate that the null hypothesis is not rejected, hence, recommend that the selected determinants are not correlated with model residuals.

Table 8: Fit statistics of GMM model

Fit statistics			
SSE	34.1315	DFE	75
MSE	0.4861	Root MSE	0.6821
R-square			0.6402

Table 9: Diagnostic test for exogeneity analysis (sargan test)

H_0: The instruments are valid	
H_1: The instruments are not valid	
Statistics	**Prob >Chi-sq**
36.01	0.1811

Having confirmed that model is free from diagnostic issues, the GMM estimator is executed. The attained outcomes from GMM analysis are shown below in Table 11.

The results in Table 12 reveal that lagged dependent variable (DR_1), assets tangibility (TANG), inflation (INF), profitability (PROF), consumption of energy (ENG_CON), and, taxation revenue (TAX_REV) have a significant relationship with the energy firms' capital structure i.e. debt to assets ratio (DR). Besides, the positive and significant lagged dependent variable i.e. DR_1 designates the presence of dynamic capital structure and speed of adjustment (SOA) for the energy firms that are operating in the settings of OECD. The significant and positive lagged dependent variable coefficient value i.e. 0.2881 and its P-value i.e. 0.0001** specify that the speed of adjustment (SOA) for the OECD countries' energy firms is 71% (1-0.2881 = 0.7119). Thus, this elucidates that in OECD countries energy firms may deviate from their optimal level of capital structure, however, in the presence of SOA they rapidly returned toward their optimal level by 70%. In short, the OECD energy firms move back toward their targeted capital structure level not more than 1 year and 4 months (100 ÷ 71 = 1.408). Therefore, this explains the application of the Dynamic Trade-Off theory in the OECD countries' energy firms.

5. DISCUSSION

Capital structure determinants is still an unsettled issue for the OECD countries' energy firms. To fill this gap, this study is set to explore capital structure determinants for whole energy firms operating in the OECD countries. The results obtained from both dissimilar procedures of Panel Data have revealed several significant determinants such as lagged dependent variable of DE ($\delta DR_{i,(t-1)}$) tangibility (TANG), profitability (PROF), inflation (INF), energy consumption (ENG_CON), tax revenue (TAX_REV) and gross domestic product (GDP) are the key capital structure determinants for OECD energy firms. Besides, the Panel Data Static model i.e. Random Effects analysis specifies that sales (SIZE) is another key capital structure determinants that help OECD energy firms to formulate the best mix of debt and equity. Evidently, the results forecast that OECD energy firms are

Table 10: Diagnostic test for autocorrelation analysis (test AR[m])

H_0: Autocorrelation does not exist		
H_1: Autocorrelation exists		
Lag	Statistics	Prob >Chi-sq
1	−4.26	0.831

Table 11: Dynamic model GMM analysis

GMM: First differences transformation					
Estimation method: Two-step GMM					
Parameter estimates of OECD energy firms					
Variables	DF	Estimate	Standard Error	t value	Pr > |t|
Intercept	1	−0.0123	0.0221	−0.5566	0.5778
DR_1	1	0.2881	0.0613	4.6998	0.0001**
TANG	1	0.2931	0.0686	4.2726	0.0001**
PROF	1	−0.2863	0.0541	−5.2921	0.0001**
LIQ	1	0.3128	0.3864	0.8095	0.4182
SIZE	1	0.2311	0.2114	1.0932	0.2743
NDTS	1	0.12301	0.1097	1.1213	0.2621
INF	1	−0.2154	0.0325	−6.6277	0.0001**
ENG_CON	1	0.2213	0.0314	7.0478	0.0001**
TAX_REV	1	0.2112	0.0512	4.1250	0.0001**
GDP	1	−0.2613	0.0460	−5.6804	0.0001**

**significant at 5% level

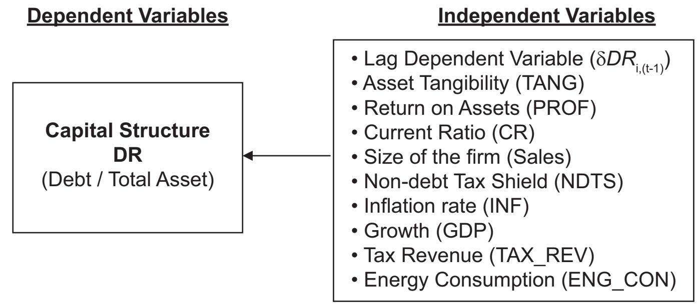
Table 12: GMM model description

Model description	
Estimation method	Two-step GMM
Number of cross sections	43
Time series length	14
Estimate stage	2

preserving gainful businesses, therefore, their sales are significant and able to produce appropriate revenue. This statement is in line with the findings of Zhao (2022) who explained that increasing energy prices in Asian continent caused in high inflation. Visibly, the mounting prices also result in an upsurge of these firms' sales.

Interestingly, the dynamic investigation has introduced new significant determinants of capital structure for the OECD energy firms which are inflation, energy consumption, tax revenue, and gross domestic product. This validates the strength of these newly studied determinants for the whole OECD energy firms. Visibly, inflation rapidly surged in most of the OECD countries at the end of 2021 which is derived by hiking prices of food and energy (Causa et al., 2022). Certainly, increasing energy prices due to the hiking inflation rate also resulted in an upsurge of the profitability of these firms. Therefore, profitability, energy consumption, and inflation are key capital structure determinants for energy firms that are functioning in the OECD countries. Likewise, tangibility is also found significant capital structure determinant for the OECD energy firms. However, dynamic analysis indicates that profitability is significantly negative, whereas, tangibility is found significantly positive determinant. The negative sign of profitability and insignificant size i.e. sales of these firms designate that the OECD energy firms' sales revenue is not enough to settle their debt. On the other side, the significant and positive tangibility mention that these firms can increase their sales by enhancing their production.

Figure 1: Conceptual framework



(Source: Authors' own elaboration)

The results are in line with the outcomes of Cole et al. (2015) and Harc (2015) who described the significant relationship of firms' profitability and assets tangibility with the capital structure of US-based energy firms. Likewise, the results are also parallel with the postulation of Ghani etal. (2023) who declared a substantial relationship between tangibility and profitability with the capital structure of Pakistani energy. On the flip side, the findings are not consistent with the explained results of Tailab (2014) who investigated determinants of capital structure for American energy-generating firms and reported an insignificant relationship among the investigated determinants that are tangibility and profitability.

Besides, the results also explained that energy consumption, tax revenue, and gross domestic products are also significant determinants of capital structure for the OECD energy firms. Notably, the OECD countries shared 36% of the world's overall GDP (Ozcan et al., 2020). Hence, the energy firms of the OECD region are consuming enough energy for production, thus, significantly contributing to the global GDP. Undoubtedly, increasing GDP is because of energy firms' profitability which also boosts taxation revenue for these countries' governments. The results are consistent with the outcomes of Jaworski and Czerwonka (2021) who described energy consumption and inflation rate as significant determinants for European energy-producing firms. Furthermore, the results are inconsistent with the findings of Chakrabarti and Chakrabarti (2019) who reported an insignificant relationship between Indian energy firms' capital structure and taxation. Most importantly, the significant lagged dependent variable indicates the existence of dynamic capital structure and speed of adjustment for these energy firms. Thus, in case of any deviation in these firms' capital structure, it returns rapidly toward their optimal level, not more than 1 year and 4 months' time period. The positive significant role of tangibility and lagged dependent variable confirm that the application of the Dynamic Trade-Off theory is more prominent in the OECD countries' energy firms. Overall, the results extremely support the confirmation of Hypothesis 1 for tangibility, Hypothesis 2 for profitability, Hypothesis 4 for sales, Hypothesis 7 for energy consumption, Hypothesis 8 for tax revenue, and Hypothesis 10 for the existence of dynamic capital structure.

6. CONCLUSION AND POLICY IMPLICATIONS

This empirical investigation is set to explore the significant capital structure determinants of the OECD countries' energy firms. The results confirm a significant relationship between capital structure, tangibility, energy consumption, sales, inflation, taxation, and GDP. Evidently, the positive and significant role of lagged dependent variables explained the existence of dynamic capital structure and speed of adjustment for energy firms. Thus, the results indicate that in case of any deviation from the targeted level, OECD countries' energy firms return back to their optimal level within 1 year and 4 months. Subsequently, the significant role of lagged dependent variable and tangibility explain the application of the Dynamic Trade-Off theory in the OECD countries' energy firms. The outcomes explain a new understanding for OECD countries' policymakers that helps them to construct matching strategies for the formulation of capital. Undoubtedly, this will help in controlling the soaring energy prices in the OECD countries (OECD, 2022). In long term, parallel policy for the formulation of the capital structure of energy-generating firms will enhance an interconnected energy zone and alliance in the OECD countries.

The main limitation of capital structure-connected investigations is the accessibility of financial data which is the core restraint for identifying capital structure determinants (Pandey, 2002). Similarly, due to the inaccessibility of required data, this empirical inquiry removes several OECD countries from the data sample set. Another significant restraint is that this inquiry only adopts nine core capital structure determinants. Technically, only those variables are added in the sample set whose 14-year selected time frame data is accessible. Hence, future researchers may add other OECD countries to test studied capital structure determinants. Similarly, some other core capital structure determinants for OECD-based energy firms such as renewable energy and energy efficiency can be added to the framework.

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