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Qazi Bilal Amin
MS Scholar
Institute of Management Sciences,
University of Haripur,
Haripur, Pakistan.
Email: bilalaminqazi@gmail.com
ORCID ID: 0009-0003-9392-018X

Asad Khan
Assistant Professor
Institute of Management Sciences,
University of Haripur, Haripur, Pakistan.
Email: asadkhan@uoh.edu.pk
ORICD ID: 0000-0002-3232-3328

Zia ur Rehman
Associate Professor
Institute of Management Sciences,
University of Haripur,
Haripur, Pakistan.
Email: zia.rehman@uoh.edu.pk
(Corresponding Author)
ORICD ID: 0000-0001-5937-9105

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Abstract: *This study uses a nonlinear Hansen threshold regression model to analyze the link between leverage and corporate profitability, with firm size as a threshold variable. Data for the study is collected from the State Bank of Pakistan and firms' annual reports for the period 2010–2020. Our findings reveal important insights and patterns pertaining to the interrelationship between leverage, firm size, and corporate profitability. More specifically, results reveal that there are no threshold effects of firm size on the leverage-corporate profitability relationship. This study contributes significantly to the literature, as most empirical studies in this area use linear models but fail to provide meaningful explanations. This study is useful for managers and policymakers as it provides valuable insights about the intricate interrelationship between firm size, leverage, and corporate profitability.*

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Exploring the Nonlinear Relationship Between Leverage and Corporate Profitability

1. Introduction

Firm leverage and its effect on profitability have long been a topic of discussion among researchers (Abor, 2005; Chandrakumarmangalam & Govindasamy, 2010; Ramli et al., 2019). However, empirical studies have had mixed results. Some researchers conclude a positive association between firm leverage and corporate profitability, emphasizing the benefits of leverage. Other studies conclude that firm leverage influences corporate profitability negatively (see Fama & French, 1998; Negash, 2001; Rahman et al., 2020). As leverage levels rise, the overall cost of capital tends to decline until a certain point, beyond which it rises again as the potential benefits associated with debt are greater than its associated costs. Therefore, low leverage can lead to improvements in profitability due to the lower financial burden of associated interest payments. Accordingly, this saves more of a company's earnings for either reinvestment or dividends. Firms face less risk of going into financial distress with lower debt levels, which improves credit, lowers borrowing costs, and provides greater operational flexibility. Moreover, firms withstand unexpected shocks and economic downturns better if their leverage levels are low, thus contributing to more stable long-term firm performance.

However, firms with consistently lower leverage may not fully exploit the potential benefits of debt, such as tax shield advantages on interest expenses. Despite this, the need to exploit tax shields can lead to high debt levels, even a debt-overhang point where existing debt discourages new investments. Thus, while lower levels of leverage enhance profitability in the short and medium term, the burden of existing debt can become an impediment to further investment and value creation.

Empirical studies involving theories of capital structure help explain the mixed empirical findings (Chen & Chen, 2011). According to financing structures, the preference for financing and information asymmetries contributes to mixed results. Amid these conflicting claims, Robb and Robinson (2014) argue that leverage offers certain benefits that, if used carefully, can enhance corporate profitability. However, this empirical divide on the use of leverage and its impact on profitability necessitates a

closer examination of the role of firm size in shaping the relationship (Khémiri & Noubbigh, 2020).

Existing studies have generally overlooked the conditional impact of firm size on the leverage-performance nexus, possibly contributing to mixed results (Ibhagui & Olokoyo, 2018; Jaisinghani & Kanjilal, 2017). Despite this, Bolarinwa et al. (2022) and Cuong (2014) use firm size as a threshold variable to measure the impact of leverage on profitability but conclude that there are no threshold effects. However, they emphasize the need for further research in the area, particularly in different contexts, to determine whether this relationship and outcome are context-dependent.

To fill this gap and to continue exploring the relationship, the current study seeks to establish whether the size of the firm enlightens the inconsistent relationship between leverage and corporate profitability in the context of Pakistan.

The capital markets of Pakistan especially the bond market are underdeveloped and cost of debt is relatively high in comparison to developed economies. These aspects render firms not to be able to borrow at reduced interest rates. The majority of companies in Pakistan are rather small and not financially skilled and capable enough to issue long-term debt (LTD) in the capital market. This has led them to depend more on bank short term loans or internally generated capital (Khan, 2012; Shah and Hijazi, 2004). Issuing of LTD is on a limited basis to the large firms with good financial backgrounds. Nevertheless, they have no capital market alternatives, with banks loans being the only possibility as asserted by (Khan, 2012). Moreover, debt levels have risen notably since 2006. At the same time, it has witnessed a significant decrease in profitability (Khan, 2012). This means that the relationship between financial leverage and profitability remained negative during this time. Remarkably, there was no such relationship till 2006.

In addition, traditional models fail to provide meaningful explanations for mixed results. Therefore, an attempt is made to use inverted U-shaped models to better explain these mixed results. Traditional linear models assume a constant, unidirectional impact of debt on firm value. This fails to capture the nuanced reality that the benefits of debt (lower cost of capital) can diminish and even turn into disadvantages as debt levels increase. Inverted U-shaped models are more useful than

traditional linear models for capital structure because they acknowledge that the link between capital structure and firm value is not always positive or negative but rather has an optimal point. Financial flexibility initially improves as external borrowing is added to the capital structure. This results in improved financial performance but also increased financial distress and bankruptcy risk due to the increased debt and can eventually lead to a reduction in firm value.

The trade-off theory advocates that an optimal structure (ideal debt-to-equity ratio) exists, and firms can achieve optimal capital structure by striking a balance between the tax benefits of debt and the associated costs of financial distress. The overall cost of capital is at a minimum at this optimal point, while a firm's value is at a maximum. This nonlinear approach between the cost of capital and firm value provides an opportunity to better understand the nature of capital and help businesses identify the right financing mix for sustained growth and value maximization. Therefore, estimating relationships through nonlinear models, particularly in finance, provides a more subtle and accurate understanding of the complex dynamics surrounding capital structure decisions. Theoretically, it goes beyond simple assumptions. It explains variations and complexities at the firm level and the ways in which financial results are influenced by financial factors. This allows the development of more realistic theoretical frameworks. Therefore, this study aims to fill the aforementioned gaps using a nonlinear Hansen threshold regression model to analyze the association between leverage and corporate profitability, with firm size as a threshold variable in the Pakistani context from 2010 to 2020.

Our Hansen model enables us to analyze possible nonlinearities, if any, among leverage and corporate profitability. Based on firm size, this study's sample is divided into two groups, firm size being the threshold variable. Different outcomes across the split samples would signal evidence of nonlinearity between firm leverage and corporate profitability. In this analysis, firm size acts as the nonlinear driver, possibly indicating a critical threshold beyond which the link undergoes a substantial change.

Our study contributes to the literature in various ways. First, we inspect the nonlinearity between leverage and corporate profitability using the Hansen model. We concentrate on emerging markets since they are still

experiencing economic growth and are more susceptible to macroeconomic shocks, such as, interest rates and inflation.

Second, the present study offers a new insight to managers, researchers, and policymakers in order to monitor the impact of firm leverage on corporate profitability. It also highlights the importance of the firm size in making important decisions. For example, large firms tend to be more stable and have a greater market share, enabling them to borrow at lower prices, obtain quantity discounts from suppliers and achieve economies of scale.

Third, the Hansen model adapts to established methodologies and has potential to reveal nonlinearities between financial variables, addressing a substantial gap in empirical studies that examine the association between leverage and profitability, particularly in Pakistan's context.

Pakistan is a mixed economy characterized by both bank-centric and market-oriented features. While the banking sector plays a significant role, Pakistan also has a market-driven economy with government intervention. Finally, Pakistan is characterized by limited debt usage and specific challenges in financing structures, which motivate the need for investigations into the effects of leverage on corporate profitability, especially those of short-term leverage. Thus, this study serves to fill existing literature gaps and will encourage managerial practices that consider firm size as a crucial factor in leveraging decisions.

This paper is organized as follows: Section 2 reviews existing literature. Section 3 details our methodological approach. Section 4 presents the results of the study, and Section 5 provides conclusions and limitations.

2. Literature Review

2.1. Theoretical Background

Researchers continue to focus on the firm performance/capital structure debate and its impact since Modigliani and Miller's (1958) seminal work. This debate continues to captivate interest as the capital structure puzzle remains unsolved, despite significant progress in capital structure theory.

Durand (1952) began the debate on the cost of capital and its impact on firm value in 1952 by arguing that firm value tends to increase as debt increases because debt is less costly and decreases the overall cost of capital. Building on this theory, Modigliani and Miller (1958) initially asserted that capital structure is irrelevant and has no effect on firm value. However, they later acknowledged the impact of corporate taxes on financing decisions and the subsequent impact on firm value (Modigliani & Miller, 1963). Miller (1977) extended this idea and incorporated specific tax benefits and personal taxes, thus suggesting that an increase in debt could potentially lower the overall cost of capital and result in an increase in firm value.

Over the years, various theories pertaining to capital structure have emerged that can be categorized into two broad groups. Two very pertinent theories in this regard are signaling theory (Ross, 1977) and pecking order theory (Myers & Majluf, 1984).

Pecking order theory suggests that firm leverage has a negative effect on profitability, whereas signaling theory posits that they are positively related. Both theories assume that leverage and corporate profitability have a linear relationship. A contrasting perspective is provided by the agency and trade-off theories. Both confirm the presence of an optimal capital structure below which firms can exploit tax shield benefits and beyond which there are disadvantages, such as bankruptcy and agency costs. Therefore, it is necessary for firms to remain cautious of risks that may affect their performance negatively (Kraus & Litzenberger, 1973). In the case of trade-off and agency theory, capital structure can be a good strategy that helps maximize shareholder wealth.

2.2. Empirical Studies

The empirical literature shows mixed evidence of the impact of firm leverage on profitability. These results can be attributed to different time spans, variation in methodological techniques, and changes in firm and country-specific factors. Such literature is classified into three broad categories.

The first group comprises studies that focus on establishing the link that firm leverage and corporate profitability are linearly related. Ramli et al. (2019), for example, highlight the positive effect of leverage on corporate

profitability. Conversely, Zhang et al. (2017) find a negative effect. More recent studies (Ngo et al., 2020; Rahman et al., 2020) find that leverage has a significant negative effect on profitability. These two strands have distinct research and practical implications.

The second group suggests that firm leverage and profitability have a nonlinear relationship. Research shows that financial leverage and business value/profitability have a nonlinear relationship (Berzkalne, 2015; Nieh et al., 2008; Yang et al., 2010). Thus, financial leverage boosts profitability, but business outcomes suffer if borrowed cash is misused. A study by Bae et al. (2017) confirms the existence of a curvilinear relationship between leverage and profitability, categorizing the relationship as either U-shaped or inverted U-shaped.

Similarly, Ngoc and Trang (2023) find a nonlinear relationship between leverage and profitability and identify threshold levels until which leverage would be profitable. They explain that profitability would likely rise even if leverage exceeded the threshold level as long as the cost of debt was low and debt was used effectively.

The third group of studies uses Hansen's model (1999) to probe the relationship between leverage, firm size, and corporate profitability. Ibhagui and Olokoyo (2018) use a threshold approach and conclude that firm size has a direct impact on leverage/corporate profitability relationships. The relationship becomes positive as firm size increases and vice versa.

Other empirical studies confirm the threshold influence of firm size on leverage-corporate profitability relationships (see Jaisinghani & Kanjilal, 2017; Khemiri & Noubbigh, 2020). Similarly, Bolarinwa et al. (2022) identify threshold levels to measure the influence of leverage on corporate profitability and conclude that leverage tends to benefit large firms. In a more recent study, Karaca et al. (2025) use a novel model called method of moments quantile regression and find a nonlinear, inverted U-shaped relationship between corporate value and capital structure.

H1: Short-term debt (STD) in small and large firms has a distinct impact on corporate profitability.

Studies focusing on the linkage between leverage, firm size, and profitability add another layer of complexity. For instance, in some studies, the negative effect of leverage on corporate profitability is much more pronounced in small firms and diminishes as firm size increases (Bolarinwa et al., 2022). Meanwhile, Chen and Chen (2011) add additional factors like industry and firm size as moderators, and profitability as a mediator, emphasizing the uncertain nature of this relationship. On the whole, these empirical studies highlight the complex relationship between firm size, leverage, and profitability, suggesting that a number of factors must be considered to understand this complex relationship.

Another strand of empirical studies focuses on identifying optimal threshold levels. Coricelli (2012), Arcand et al. (2015), and Akhtar et al. (2021) argue that there is evidence of nonlinearity between leverage and profitability in the presence of optimal threshold levels. Firms can experience declines in performance if this optimal threshold level is exceeded.

H2: LTD in small and large firms has a distinct impact on corporate profitability when the threshold variable is firm size.

Other empirical studies have employed the Hansen (1999) model to explore the impact of leverage on profitability in particular industries. Among these, Minnema and Andersson (2018) analyzed consulting and construction firms and confirmed nonlinear relationships with the thresholds that impact profitability. These findings help contextualize the diverse complexities governing the association between leverage and profitability.

In summary, there is a rich body of literature focusing specifically on employing Hansen's model to analyze the multifaceted linkage between leverage, firm size, and profitability. The findings of these empirical studies underscore the significance of firm size, optimal leverage levels, country- and industry-specific dynamics, and the interplay between three variables in shaping this complex association.

Importantly, most of the empirical studies (e.g., Ramli et al., 2019; Vithessonthi & Tongurai, 2015) exploring the leverage-profitability nexus lack the potential impact of other factors, such as firm size. Therefore, this study attempts to address this shortcoming while analyzing the leverage-

profitability relationship. Moreover, due to underdeveloped capital markets, long-term borrowing in Pakistan is not as common as in other countries. As a result, many businesses rely on short-term loans and internally generated funds to meet financing needs (Khan, 2012; Shah & Hijazi, 2004). This makes studying the effects of short-term leverage particularly important, as it may reveal the circumstances under which this type of financing is damaging to firm performance.

H3: Total debt (TD) in small and large firms has a distinct impact on corporate profitability when the threshold variable is firm size.

3. Data and Methodology

We employ a panel data regression since we aim to analyze the leverage-profitability relationship using the Hansen model. Panel data regression models are advantageous as they account for both time-series and cross-sectional variations. Additionally, panel data models are more useful in studies where firm-level financial data is used and the data spans several firms over multiple time periods.

Also, panel regression helps researchers control unobserved heterogeneity by employing random or fixed effects. Such features are more consistent and accurate in estimations compared to traditional time-series and cross-sectional models. This is because panel data models incorporate both types of data, enabling them to utilize more data points. This reduces multicollinearity and improves the degrees of freedom, leading to more robust statistical results.

We collected financial data on the sugar, cement, and automobile sectors from a State Bank of Pakistan database for the period 2010–2020. We selected these sectors because they use debt financing more than other industrial sectors. The final sample comprised 62 firms that employed leverage in their financing mixes and for which financial data was available for 2010–2020. Table 1 provides a sector-wise leverage analysis of firms within the study's time frame.

Table 1: Sector-wise leverage analysis

Sector	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Textile	17.97	14.14	14.05	14.36	11.38	10.48	11.18	12.23	12.95	11.97	15.90
Sugar	19.67	17.47	15.08	15.49	13.51	12.82	14.25	13.64	11.95	9.95	13.38
Food	10.75	15.05	17.60	18.72	11.55	9.97	7.02	14.89	12.01	8.84	16.54
Chemical	29.63	24.35	21.33	19.80	17.48	14.89	15.29	11.75	9.41	9.34	8.42
Manufacturing	8.39	9.27	12.24	10.88	10.07	12.31	8.89	5.98	6.79	8.68	9.96
Cement	19.55	17.85	14.05	12.86	9.79	11.16	9.02	9.09	12.94	16.28	22.07
Auto	2.98	1.36	0.78	0.77	1.19	0.25	0.49	0.44	0.43	0.59	1.79
Fuel/energy	13.26	13.40	10.43	9.30	7.21	6.19	6.71	7.52	5.91	5.04	5.87
Information/ communication	9.29	13.75	19.48	13.56	17.26	17.42	21.91	24.11	31.00	36.01	37.74
Refinery	0.00	0.00	0.00	0.00	0.00	0.00	3.16	3.74	2.60	3.83	5.46
Paper	20.66	18.94	14.18	13.86	10.59	12.80	14.71	13.36	13.35	14.93	15.57

In addition, the study utilized the fixed effects panel regression framework, which helps address endogeneity by controlling for all unobserved time-invariant factors that may be correlated with explanatory variables. Since these unobserved characteristics (such as firm culture, managerial style, or geographic location) can bias estimates if omitted, the fixed effects model eliminates their influence by focusing on within-unit variation over time. This decreases the risk of omitted variable bias and provides more consistent estimates of causal effects.

3.1. Variable Definition

In this study, corporate profitability is measured through return on assets (ROA) and return on equity (ROE). ROA measures overall operating efficiency by assessing profitability relative to total assets, while ROE assesses how efficiently a corporation utilizes shareholder funds to make profits. Both are vital in capital structure studies because ROA reveals operational performance regardless of financing, while ROE shows the benefit of financial leverage to shareholders, providing a comprehensive view of how a firm's chosen capital mix (debt vs. equity) impacts its ability to generate profit from its assets and owners' equity. ROA and ROE become more relevant when analyzing leverage. Since debt is considered less costly, the efficient use of debt should have a positive effect on both ROA and ROE. However, the positive impact will be greater on ROE. Leverage is measured through STD, LTD, and TD. Table 2 provides a list of variables and their measurement.

Table 2: Measurement of variables

Variable	Measurement
ROA, dependent variable	Profit before interest and taxes/total assets × 100
ROE, dependent variable	Profit after tax/shareholder funds × 100
STD, independent variable	STD/total assets × 100
LTD, independent variable	LTD/total assets × 100
TD, independent variable	TD/total assets × 100
Firm size, threshold variable	Natural log of total assets

LTD = Long-term debt, ROA = return on assets, ROE = return on equity, STD = short-term debt, TD = total debt.

3.2. Hansen Threshold Regression Model

The primary motivation for using the Hansen (1999) threshold regression model stems from potential weaknesses in existing empirical studies that contribute to ambiguous results. A notable weakness lies in the assumption that regression models are entirely linear, a premise upon which researchers often base their findings. Many current empirical models impose an ex-ante assumption that the leverage-profitability relationship linearly or monotonically increases or decreases with regressors in each model. Therefore, high leverage levels result in increases or decreases in corporate profitability. This should be true for all values of $Cc > 1$ and $Cc < 1$, where C is either vector's subset or a member of a set that contains c1 and all other regressors (Ibhagui & Olokoyo, 2018). However, we find that this supposition is not supported in many cases. There are instances where firm performance is weakened by leverage for only some C's, i.e., in the case of $Cc < 1$ or $Cc > 1$, but not both. Previous empirical studies addressing the leverage-profitability relationship have overlooked these plausible scenarios. Our study employs a regression-based threshold model to address this concern.

A nonlinear approach is employed in the threshold regression model, allowing for instances where the relationships between two variables can differ across segments of the data. In our threshold model, our sample is divided into two regimes, $Cc < 1$ and $Cc > 1$, for all leverage values. In this way, all possible scenarios can be considered while measuring leverage's impact on profitability. The variable $C \in V$, wherein the model for all probable regressors, V is the vector (threshold variable). The threshold variable divides the sample into two groups. This type of estimation framework is more adaptive and generalized and offers the

opportunity for various combinations of leverage-profitability relationships for different threshold levels, thus ensuring a more holistic measurement of the relationship (Ibhagui & Olokoyo, 2018). Keeping this context in mind, the basic purpose of using firm size is to learn whether firm leverage increases or decreases profitability for firms of varied sizes. Specifically, we adopted the Hansen (1999) approach as employed by Ibhagui and Olokoyo (2018) to estimate the threshold regression model. The primary focus as a regressor in this study is leverage (represented by the debt ratio), which includes short, long, and total debt ratios. While the model can be applied in various ways, we adhere to the Hansen (1999) model wherein all variables used are considered exogenous. Mathematically, the model can be expressed as follows:

$$y_{it} = \beta'_1 x_{it} I(q_{it} \leq \gamma) + \beta'_2 x_{it} I(q_{it} > \gamma) + v_{it},$$

This is used to draw the observed data samples, where time is represented by t and firm indexes are represented by i. The set of regressors also containing the focused regressor is denoted by x_{it} and the threshold variable (which can also be a member of x_{it}) is expected to follow a distribution that is continuous and is denoted by q_{it}. μi constitutes firms' time-invariant unobserved fixed effects (Ibhagui & Olokoyo, 2018).

3.3. Empirical Specification

As the purpose of this study is to explore the possible influence of firm size on the leverage-profitability relationship, we employ a regression model based on a threshold approach where the regressors in focus consist of a vector - debt (TD, STD, LTD), a performance vector that measures control variables and the proxies of financial performance. In this model, firm size is used to determine whether different firm sizes have different impacts on the leverage-profitability relationship. Following Ibhagui and Olokoyo (2018), the model used to estimate the relationship is given below:

$$FP_{it} = \mu_i + \beta_1^s LEV_{it} I(C_{it} \leq c_1) + \beta_2^s LEV_{it} I(C_{it} > c_1) + \emptyset^s Controls_{it} + \varepsilon_{it}^s$$

i = 1,…, n = 62 denotes firms, t = 2010,…, T = 2020, denotes time period, is profitability, is time-invariant specific fixed effect, is the threshold regression model's associated error term generated through threshold variable a, where the indicator function is I(.) and the firm size is a.

4. Results and Discussion

4.1. Descriptive Statistics

Based on Table 3's descriptive statistics, average profitability (ROA) is 0.031, thus showing that firms are earning 3.1 percent on average. Average ROE is 0.057, i.e., 5.7 percent. Total firm debt averages 0.561, indicating that external financing accounts for 56.1 percent of firms' financing for assets, while the remainder is funded through equity. LTD and STD average 21 percent and 35.1 percent, respectively, thus indicating that firms prefer STD over LTD. Among all variables, firm size exhibits the highest volatility. The variables' skewness values indicate that all variables fall within the range of a normal distribution.

Table 3: Descriptive analysis

Var	Mean	S. dev	Min	Max	Skew	Kur
ROE	0.057	0.236	-1.20	0.807	-0.251	2.560
ROA	0.031	0.078	-6.35	4.26	0.047	2.840
TD	0.561	0.217	0.083	0.881	0.379	3.040
LTD	0.210	0.133	0.000	0.874	0.807	2.930
STD	0.351	0.178	0.000	0.652	0.540	2.620
Firm size	15.678	1.197	12.75	18.293	0.116	2.820

LTD = long-term debt, ROA = return on assets, ROE = return on equity, STD = short-term debt, TD = total debt.

4.2. Threshold Analysis

The threshold value estimation and threshold regression results using the Hansen model are provided in Tables 4 and 5, respectively. Firm size (threshold variable) is represented by C. The threshold is divided into lower and upper regimes, i.e., $C_{it} < C$ or $C_{it} > C$). 0 represents firms below the threshold level while 1 represents firms above the threshold level.

Table 4 shows that 15.82 (in log form) is the threshold value, with upper and lower limits of 15.86 and 15.71, respectively. The value 15.82 signifies that firm size lower than this value is treated as small, while those above are treated as large.

Table 4: Estimating threshold value (ROA)

Threshold estimator (level = 95)				
Model	**Var**	**Threshold**	**Upper**	**Lower**
I	TD	15.82	15.86	15.71
II	LTD	16.17	16.20	16.10
III	STD	15.84	15.87	15.70

LTD = long-term debt, STD = short-term debt, TD = total debt.

In Table 5, we note that leverage has a significantly negative influence on ROA in model I. An increase in leverage results in decreased profitability due to the rise in fixed costs (interest expenses), negatively impacting profitability. The results are consistent with the assumptions of pecking order theory. They are also consistent with the findings of Nazir et al. (2021), who find that leverage has a significantly negative influence on profitability.

Our results show that the coefficients of large firms are significant, whereas the coefficients of small firms are insignificant. This implies that firm size has a threshold effect, and the relationship between leverage and firm performance changes as one moves from small firms to large ones. Similarly, Ibhagui and Olokoyo (2018) conclude that the influence of leverage on profitability differs among firms, and that it has no significant impact on large firms.

Table 5: Regression results (ROA): Threshold variable = firm size

Dependent variable: ROA						
	Model I (TD)		**Model II (LTD)**		**Model III (STD)**	
VAR	**Coef**	**t-val**	**Coef**	**t-val**	**Coef**	**t-val**
TD/LTD/STD	-0.002	-10.82	-0.002	-3.47	-0.041	-8.17
1 (large firms)	-0.002	-3.78	-0.003	-4.39	-0.0016	-3.26
0 (small firms)	-0.006	1.15	-0.004	1.59	0.001	1.66
C	2.126	292.7	2.128	259.17	2.119	263.21
F-stat	47.06		11.00		6.86	
Prob > F	0.000		0.000		0.001	

LTD = long-term debt, ROA = return on assets, STD = short-term debt, TD = total debt.

In model II, the threshold value is 16.17, with 16.10 as the lower limit and 16.20 as the upper limit. The overall impact of LTD on ROA is negative and significant. However, the coefficients of large firms are

significant, whereas the coefficients of small firms are insignificant, indicating that firm size has threshold effects on leverage-firm performance relationships.

In model III, the threshold value is 15.84, with 15.70 as the lower limit and 15.87 as the upper limit. The leverage coefficient demonstrates a strong negative impact on ROA. In addition, the coefficient of large firms is significant, whereas the coefficient of small firms is insignificant, indicating that firm size has a threshold effect.

Table 6: Estimating threshold value (ROE)

Threshold estimator (level = 95)				
Model	**Var**	**Threshold**	**Upper**	**Lower**
IV	TD	15.74	15.75	15.74
V	LTD	15.74	15.75	15.74
VI	STD	15.86	15.87	15.72

LTD = long-term debt, STD = short-term debt, TD = total debt.

In model IV, ROE is used as a dependent variable. The threshold value is 15.74, with upper and lower limits of 15.75 and 15.74, respectively. The overall impact of TD on ROE is positive and significant. Here also, we find support for trade-off theory, as the positive effect of leverage on profitability is an indication that profitable firms prefer using external funds to exploit tax shields. The coefficient for large firms is insignificant, whereas the coefficient for small firms is significant, indicating threshold effects of firm size on leverage-firm performance relationships.

Table 7: Regression results (ROE): Threshold variable = Firm size

Dependent variable: ROE						
	Model IV (TD)		**Model V (LTD)**		**Model VI (STD)**	
VAR	**Coef**	**t-val**	**Coef**	**t-val**	**Coef**	**t-val**
TD/LTD/STD	1.028	168.04	2.104	9.07	-2.569	-4.98
1 (large firms)	-0.015	0.90	0.251	2.48	0.772	5.30
0 (small firms)	0.051	-2.00	-0.260	-1.70	-0.147	-0.90
C	3.369	8.95	4.621	2.20	14.50	6.96
F-stat	9504.79		31.07		11.95	
Prob > F	0.000		0.000		0.000	

LTD = long-term debt, ROE = return on equity, STD = short-term debt, TD = total debt.

In model V, the threshold value is 15.74, with upper and lower limits of 15.75 and 15.74, respectively. The overall impact of LTD on ROE is significantly positive. The coefficient of large firms is significant, whereas the coefficient of small firms is insignificant, indicating that firm size influences the leverage-profitability relationship.

In model VI, the threshold value is 15.86, with upper and lower limits of 15.87 and 15.72, respectively. The overall impact of STD on ROE is negative and significant. The coefficient of large firms is significant, whereas the coefficient of small firms is insignificant.

4.3. Discussion of Findings

The empirical results above consistently demonstrate a significantly adverse impact of leverage, particularly LTD, on ROA and ROE. These findings support pecking order theory, which assumes that firms choose internally generated funds instead of debt. The economic significance of leverage's inverse impact on profitability must not be overlooked, as these negative findings highlight the risks associated with excessive borrowing. Therefore, while employing leverage in the financing mix can significantly enhance the earnings of firms experiencing strong financial performance, it also increases fixed financial costs in the form of interest payments. When operating income falls due to a decline in sales or an increase in costs, this fixed financial cost becomes a burden, leading to a decline in net income. Firms may even face losses. This type of scenario threatens firms' financial stability, resulting in lower investment and negative effects on their ability to innovate and expand.

At a broader level, investor confidence can decline due to excessive leverage, which may contribute to financial instability in the economy. Hence, it is imperative for firms, investors, and policymakers to understand the consequences of the negative influence of leverage on profitability, encourage sustainable development, and minimize systemic risk.

Nevertheless, the coefficients of small and large firms are different in all models, indicating a lack of threshold effects. This is inconsistent with the findings of Coricelli (2012), Cuong (2014), and Bolarinwa et al. (2022), who confirm threshold effects. Additionally, Karaca et al. (2025) also conclude a nonlinear inverted U-shaped relationship between capital

structure and corporate value. These contrasting findings indicate that the association between leverage and profitability may be context-dependent.

The study attributes the insignificant findings to Pakistan's challenging economic environment, which is characterized by high interest rates, inflation, and currency depreciation. These factors could be deterring companies from formulating long-term funding decisions. In such settings, firms are reluctant to commit to long-term decisions due to policy uncertainty. Thus, they generally adopt a wait-and-see approach until indicators become positive. In the same vein, Mehmood et al. (2022) report insignificant findings on the leverage-profitability nexus and potentially attribute insignificant findings to high interest rates.

The consistent negative effect of leverage on profitability highlights the significance of careful financial management. Therefore, firms are expected to manage their debt carefully and efficiently, particularly in unstable economic environments experiencing high interest rates (Minnema & Andersson, 2018).

At the same time, policymakers should make efforts to create an enabling environment that is conducive to firms making long-term decisions (Chao et al., 2017). If economic managers are successful in managing economic challenges like inflation, interest rates, and currency devaluation, there will be a positive effect on firms' ability to make long-term decisions.

While our findings are inconsistent with other studies, particularly with those of Ibhagui and Olokoyo (2018), they indicate that these associations may be context-dependent. Hence, further research is needed in varied contexts to obtain an in-depth understanding of the complex triangular linkage between leverage, firm size, and corporate profitability.

5. Conclusion

This study sought to analyze the relationship between leverage and profitability from a fresh perspective with the aim of finding a possible answer to inconsistencies in earlier empirical studies. It is based on the fact that previous empirical studies did not consider firm size when measuring the association between leverage and corporate profitability. This omission could possibly have led to inconclusive results. To fill this gap, we used a

Hansen threshold model, where firm size; the threshold variable could potentially explain the inconclusive results reported in previous studies.

Our findings reveal important insights and patterns pertaining to firm size, leverage, and corporate profitability. Contrary to our assumption, the results reveal that the threshold effects of firm size are not evident in the leverage/corporate profitability linkage. Moreover, leverage negatively affects ROA and ROE across all models, thus indicating a pervasive impact on corporate profitability. This negative impact of leverage on both measures of profitability may imply that interest rates remained on the higher side, significantly impacting firms' fixed costs and decreasing profitability. Therefore, if interest rates remain high, firms will be reluctant to borrow, particularly in developing countries where economies are more sensitive to economic shocks, thereby limiting growth potential.

This study is useful for managers as it helps them understand the complex interrelationship between leverage, firm size, and profitability. Managers in developing economies should be more careful while making financing decisions because developing economies are more susceptible to external shocks, which significantly affect firms' ability to repay debt.

Moreover, when a firm achieves its optimal capital structure, its management should focus on maintaining that structure to maximize firm value. To do so, firms must adjust their debt-to-equity ratios to balance the tax shield advantages of debt against agency costs and the cost of financial distress. In addition, firms should balance other factors such as asset tangibility, firm size, profitability, and prevailing economic conditions.

Furthermore, this study encourages policymakers to develop policies that will help improve the economic environment. With proper implementation, this can lead to a decline in interest rates. In turn, this would encourage firms to borrow for expansion purposes and be influential in developing capital markets.

This study has certain limitations. First, it is limited to Pakistan. Future studies could be conducted in other countries. Second, it is limited to three industrial sectors. Future researchers could conduct comparative analyses in other sectors. Third, this study is limited in terms of control variables. Thus, other control variables could be used as threshold variables for a deeper understanding of leverage-profitability relationships.

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Financial, Economic, and Governance Drivers of Energy Intensity in Belt and Road Initiative Nations

Syeda Tayyaba Ijaz
Researcher, Department of Business Administration,
Islamic International University, Islamabad, Pakistan.
Email: tayyaba.phdfin79@iiu.edu.pk (Corresponding Author)
ORCID ID: 0000-0002-6059-0474

Saqlain Kazmi
Lecturer, Department of Management Sciences
Sir Syed CASE Institute of Technology, Islamabad, Pakistan.
Email: saqlain.sshahk@gmail.com
ORCID ID: 0009-0003-5448-3036

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Abstract: *This paper explores the relationship between the financial, economic, and governance factors of energy intensity in Belt and Road Initiative (BRI) countries. Focusing on how to achieve energy efficiency and development, it relies on previous research and econometric data to explore the financial and economic factors, environmental trends, and governance indicators that predetermine energy intensity in BRI countries. The study focuses on three crucial dependent variables using an integrated fixed effects regression analysis: 1) energy use per gross domestic product (EU/GDP), 2) industrial value added per industrial manufacturing output (IVA/IMO), and 3) energy use per purchasing power parity (EU/PPP). Our findings suggest that the financial factor index (FFI) and economic factor index (EFI) explain energy intensity measures significantly through EU/GDP and EU/PPP, respectively. Partially moderating energy outcomes such as institutional quality (IQ) and governance effectiveness (GE) correspond to the quality of governance. Other interaction terms reveal a pattern between IQ and FFI, particularly the moderating effect of governance on economic factors in EU/GDP (FFI*IQ). This paper highlights the consequences of the sustainable development of energy in BRI countries, implying that energy intensity must be improved efficiently. This is with reference to the interrelationships among the financial and economic systems and governance. Adding another layer to the concept of efficiency, this paper provides a better understanding of sustainable development in the BRI region.*

Keywords: Energy outcomes, Belt and Road Initiative, financial factors, economic factors, environmental factors, governance, institutional quality.

JEL Classification: G28, G38, O19, Q43, Q48, Q56

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Financial, Economic, and Governance Drivers of Energy Intensity in Belt and Road Initiative Nations

1. Introduction

Energy intensity analysis is crucial as it is a key interdisciplinary element for the sustainable development of Belt and Road Initiative (BRI) countries. It is a critical challenge that needs to be comprehensively addressed to support economic growth, minimize detrimental effects on the natural environment, and create organizational financial sustainability. An efficient and clean energy supply is a necessary pursuit given the contemporary global environment (Ijaz & Chughtai, 2022). As energy is key to economic and societal development, the importance of efficiency in utilization cannot be overemphasized. The implementation of sustainable energy is not only relevant to the environment but also to the soundness of companies' financial situations. Global economies are gradually progressing toward the goal of decreasing energy intensity, and the stakes are high (Li & Han, 2023). The moderation of energy intensity in total economic activity could help ease pressure on foreign exchange reserves in cases of high reliance on imported energy. Moreover, energy intensity is directly correlated with operating costs and profit margins, meaning that lower energy intensity leads to higher profit margin. This is a good business proposition and beneficial to society as it helps minimize energy use and encourages an environmentally friendly business setting. BRI member countries have an interesting role to play in this regard (Duan et al., 2018).

Past literature shows that the flow of China-BRI trade accelerates the rate of convergence in energy intensity. Furthermore, the cross-country impact of technology is identified to support convergence in energy intensity (Qi et al., 2019). China's BRI presents an opportunity to transform the global energy system. The BRI aims to create new oil and gas supply routes for China and other BRI countries (Duan et al., 2018). This is indicative of China's position in developing the new energy order of the current century (Smith et al., 2020). Moreover, China's leadership in renewable energy technology will allow it to contribute significantly to the renewable energy projects within the BRI framework. BRI nations must integrate energy intensity policies into their strategic plans to

advance sustainable development. Energy intensity reduction is one of the results of financial and economic growth, alongside economic dependency and sustained energy intensity. The BRI covers various sectors, including transportation, energy, mining, information technology, communications, industrial parks, special economic zones, tourism, and urban development (Khor et al., 2021).

It is appropriate to systematically examine how financial, economic, and environmental dimensions affect the various components of energy intensity. In addition, it would be interesting to investigate how institutional quality (IQ), coupled with governance effectiveness (GE), applies to these complex relationships. As pilot research, this paper investigates these conditions, making a pioneering attempt to control for governance and institutional standards (as moderating variables) in analyzing energy intensity.

Therefore, this research aims to fill existing gaps in the literature by applying second-generation statistical testing and other advanced econometric tools (Cui & Song, 2019). It concludes by generating research questions and objectives to extend the state of knowledge regarding this interconnection. The paper also provides a missing view of energy intensity outputs and their respective antecedents, thereby supporting a more encompassing and sustainable approach to the global energy paradigm.

The present research is remarkable because it encompasses financial, economic, and environmental factors to explain energy intensity in BRI economies. It highlights the selection effect of GE and IQ, which is largely absent in prior studies. It also employs advanced econometric techniques to provide policy-relevant inferences on the sustainable growth of energy development.

We hypothesize that the financial factor index (FFI), economic factor index (EFI), and environmental factor index (ENFI) significantly influence energy intensity, as measured by energy use per gross domestic product (EU/GDP), industrial value added per industrial manufacturing output (IVA/IMO), and energy use per purchasing power parity (EU/PPP). Moreover, institutional and governance quality, as measured by IQ and GE, respectively, should act as moderators between financial and economic variables and energy intensity. Energy intensity is a key

concern for BRI countries on paths to sustainable development. These economies face diverse financial, economic, environmental, and governance issues that define their energy consumption. These influences are essential for efficiency and growth.

The remainder of the paper is organized as follows. The literature review provides a brief and focused examination of the financial, economic, and environmental characteristics of energy outcomes, with a focus on the impact of moderators, such as IQ and GE. Following this, we describe our sample and methodology. The analysis and results section includes a discussion of statistical findings. The conclusion summarizes our insights, provides guidelines for new research, and discusses policy implications.

2. Literature Review

2.1. Financial Factors and Energy Intensity

Achieving sustainable energy development is a vital global practice with extensive implications for productivity and environmental balance (Song et al., 2022). Recent studies have also explored green technology innovations to elucidate their far-reaching implications, emphasizing the pivotal role they play in boosting total factor productivity. Such advancements contribute to and promote unit labor productivity, aligning with the pressures generated by environmental factors (Villena et al., 2021). Another fascinating observation is that companies with healthy financial and human resource development are more flexible and adaptive to frequently changing environmental regulations (Ou & Wong, 2021). This is a testimony to a conciliated interface between the world's financial health and its technological and ecological progress.

Numerous studies regarding the connection between financial development and energy efficiency have been published (Chen et al., 2019; Li & Liao, 2020). The results of analyses of global energy intensity over 20 years indicate a downward trend, which is consistent with an alteration in the energy mix (Chen et al., 2019). This highlights financial institutions' duties and power choices. Other studies have examined how financial performance, equilibrium, and long-term growth are related within industries and across economies (Batrancea, 2021; Batrancea et al.,

2022, 2023; Cocis et al., 2021). In addition, according to surveys of airline organizations, financial indicators are crucial to business reputation (Batrancea et al., 2022). It is possible to draw similar conclusions in a more general macroeconomic context in which IQ, GE, and environmental pressures are cited as significant drivers of long-run growth (Batrancea et al., 2022, 2023). Past literature indicates that successful financial frameworks rest on balance and determine companies' energy choices (Ijaz, 2025; Khan et al., 2019). Therefore, our first hypothesis is:

H1: Financial factors have a significant impact on energy intensity.

2.2. Environmental Factors and Energy Intensity

The BRI represents a contentious prospect for cooperation and risk as it is a significant participant in the global energy sector (Högselius & Kaijser, 2019). At the same time, it is inexplicable that smaller countries, through their geographic location, have been able to influence global energy politics. These countries are often critical transit states where global energy trade takes place; they benefit from transit income and investment in transport infrastructure. However, the BRI has other dramatic economic and geopolitical implications outside the scope of this paper (Ding et al., 2021). The nations involved have faced changes to their fiscal structures as they approach the end of this spirited program. China has invested trillions of dollars in infrastructure development along BRI routes (which could help these countries grow their economies), but this investment is facing unsustainable debt and future fiscal impacts. Moreover, the BRI could reconfigure the international order as more people will use the Chinese Yuan in global payments; over a billion people are already linked to it. This shift could help establish a new financial system, highlighting the US dollar's monopolistic status in the world economy and altering the current distribution of power. Therefore, our second hypothesis is:

H2: Environmental factors show a significant impact on energy intensity.

2.3. Economic Factors and Energy Intensity

The linkage between financial, economic, and environmental chains is a concern in energy studies (Bazilian et al., 2014). These forces serve as feedback and control mechanisms for managing the complex

flow within this extremely active system. In addition, they are important for regulating energy intensity and economic development performance.

Good governance ensures sustainable development by appropriately linking energy policies and investment decisions and objectives to the environment (Haque & Ntim, 2018). It helps lay the groundwork for investing in more efficient and cleaner forms of energy. In addition, good governance and institutions invest further in transparency and accountability. This halts the politics-oriented corruption that stagnates the implementation of environmental laws, thereby reflecting a desirable institutional environment that promotes resource and environmental protection.

In this respect, quality budgeting and financial management gain additional significance because they link coherent, plausible budgets to policy priorities and efficient financial management systems (Elviana & Ali, 2022). Financial management improves the capacity to finance energy activities and environmental concerns, thereby enhancing economies and energy content. At any level of government, considerable time can be lost in navigating bureaucratic complexities in a global context, especially where manufacturing directly influences economic competitiveness (Ijaz, 2025; Li, 2013). Streamlined and optimistic regulations and administrative processes can reduce uncertainty, stimulate investment and growth, and ensure environmentally sustainable business operations. Therefore, our third hypothesis is:

H3: Economic factors have a significant impact on energy intensity.

2.4. Moderating Role of Institutional Quality and Governance

As the BRI is actualized, it becomes clear that capital empowerment gaps must be bridged and the support of host governments must be won. Equally important, private sector participation is required to help finance infrastructure projects in partnership with the public sector. The success of such initiatives is thus highly dependent on the financial state and quality of organizations in participating countries. Financial institutions actively contribute to energy import dependency and productivity; this dependence and its relationships are complex (Khan et al., 2019). Good financial frameworks enable the free movement of both capital and energy. They are a broad,

general quality of economic and budgetary administration, reflecting the potential to allocate resources and outline a sustainable environment. Energy reserve systems play a crucial role in maintaining the power supply and should be adequately controlled and continually monitored (Nazir et al., 2020). As the world steadily shifts its energy sources, the question of storage emerges as one of the most significant discussions in the process. This can also be applied to the sources of energy and raw materials and their transport and storage.

In light of these revelations, it is evident that financial and other economic and environmental push-and-pull forces are potent in shaping energy outcomes, including energy intensity, efficiency, and dependence. This relationship is complex, and the quality of governance and institutional efficacy are found to moderate it. The nexus between these variables is also implied by factors such as the new role of financial institutions and their impact on energy outcomes. The more thorough the examination of the particulars of the development of sustainable energy, the more intricate the character of these relationships.

The importance of strong institutions (IQ) and good governance (GE) as moderating factors cannot be overstated. This Is because regardless of how well-designed policies are, they cannot be effective beyond institutions' boundaries in the absence of well-organized and functioning governance. Strong institutions encourage transparency, accountability, and effective resource allocation. These qualities enable good governance and help institutions implement and coordinate effective policies. Corruption can undermine reform in weaker institutional environments; incompetence or uncertainty about policy direction can decrease energy efficiency impacts. Thus, the following three-part hypothesis is well-grounded, especially since IQ and GE most likely moderate the intensity and direction of such relationships (Ijaz & Chughtai, 2022; Ijaz & Chughtai, 2025; Ijaz, 2025):

H4a: IQ moderates the relationship between financial, economic, and environmental factors and energy intensity.

H4b: GE moderates the relationship between financial, economic, and environmental factors and energy intensity.

H4c: The interaction between IQ and GE further moderates the relationship between financial, economic, and environmental factors and energy intensity.

3. Data and Methodology

3.1. Data and Sample

This study explores a sample of 84 economies within China's six growth corridors. These economies constitute the backdrop against which our study is framed. The purpose of this study is to assess the extent to which financial, economic, and environmental forces influence energy efficiency, dependence, and intensity in these 84 BRI countries. We also examine how IQ and GE moderate the relationship.

We test independent variables categorized into financial, economic, and environmental factors, while energy efficiency, dependency, and intensity are the dependent variables. IQ and GE are used as moderator variables, while the Volatility Index (VIX) is used as an exogenous control variable. The financial, economic, and environmental parameters are measured on an index scale.

3.2. Data Period and Background

The BRI was initiated in 2013 by President Xi Jinping and represents a marked shift in relations among participating nation-states. Thus, for the present study, we include data for the 84 BRI countries for the period 2000–2021. This time frame allows us to assess the degree of association between various financial, economic and environmental variables and aspects of energy efficiency, intensity, and dependence in the countries. This is further tested before and after BRI implementation, which is used as a structural break in the paper.

This paper provides evidence of the stability of the concept that financial factors are among the most basic forces driving economic activity in any country. Consequently, the financial factors in Table 1 and the economic factors in Table 2 are incorporated into our research model (Asafu-Adjaye, 2010; Sadorsky, 2011). Tables 3–6 present environmental factors, moderating variables, control variables, and dependent variables.

Table 1: List of variables: Financial factors

No.	Variable	Description and measurement	Use in literature
1	Business disclosure index	Quantifies level of investor protection by level of corporate reporting of ownership and financial information	Gupta & Bhatia (2015)
2	Stock market capitalization	Total dollar market value of company's outstanding shares of stock	Chen et al. (2019); Asumadu-Sarkodie & Owusu (2017)
3	Bank capital-to-assets ratio	Ratio of bank capital and reserves to total assets	Berrospide & Edge (2010)
4	Interest rate spread	Interest rate on credits drawn on banking institutions' private sector customers minus interest rate at which they lend to the commercial sector	Jensen & Tarr (2003)
5	Risk premium on lending	Interest rate for bank credit extended to private sector customers, and a risk-free rate	Prokopczuk & Simen (2014)
6	Tax revenue	Govt. taxation income	Bourgeois et al. (2021)
7	IDA Resource Allocation Index	IDA funding assists in achieving the Sustainable Development Goals	Acharya (2004)
8	Quality of budgetary and financial management (standard 2)	Evaluates criteria for comprehensive and credible budgets in relation to policy goals	Brown & Chandler (2008)
9	Domestic credit to private sector	Domestic credit to individuals/companies; money loaned/credit extended by financial corporations to private sector	Hayat et al. (2019)
10	Total businesses registered	No. of businesses registered in a country	Irman & Purwati (2020)
11	Time dealing with govt. regulations	Time needed to address govt. regulations in conjunction with business functions	Clinard (1983)

Data source: World Development Indicators (WDI) database.
IDA = International Development Association.

Table 2: List of variables: Economic factors

No.	Variable	Description and measurement	Use in literature
1	GDP	Total value of all final products/services produced within country's boundaries in a particular period	Gozgor et al. (2018); Hayat et al. (2019); Jensen & Tarr (2003); Chen et al. (2019); Asumadu-Sarkodie & Owusu (2017)
2	Gross national income	Total money earned by nation's people/businesses	Gozgo et al. (2018); Hayat et al. (2019); Jensen & Tarr (2003); Chen et al. (2019)
3	Foreign direct investment (investment abroad)	Individual/company's investment in physical assets located in another country	Hayat et al. (2019); Jensen & Tarr (2003)
4	Total external debt	Element of total functional debt burden owed to creditors outside borders of country	Ramzan & Ahmad (2014)
5	Central govt. revenue	Potential revenue of govt. finances for participating in distribution of social products. Financial support for govt. operations	Chen et al. (2019)
6	Household final consumption	Total amount that households use as a way of spending money on goods and services that they use personally, e.g. food, housing and health	Jensen & Tarr (2003)
7	Central govt. final consumption	Nontax receipts (other than those covered above) contained under gate-keeping function of govt.'s final consumption expenditure. Refers to total transaction value within national income accounts, i.e., govt. expenditures on goods/services for country's collective needs	Jensen & Tarr (2003)
8	Exchange rate	Value of a country's currency vs. that of another country	Jensen & Tarr (2003)
9	Consumer price index	Average change in prices of a set of goods/services most bought/consumed by target population	Jensen & Tarr (2003)
10	Balance-of-payments current account	Export/import of goods/services and capital transfer internationally	Gozgor et al. (2018)
11	Net trade volume	Difference between export and import values	Gozgor et al. (2018)

Data source: WDI database.

Table 3: List of variables: Environmental factors

No.	Variable	Description and measurement	Use in literature
1	Rural population	No. of people living in rural areas	Hayat et al. (2019); Jensen & Tarr (2003)
2	Urban population	No. of people living in urban areas	Hayat et al. (2019); Jensen & Tarr (2003); Asumadu-Sarkodie & Owusu (2017)
3	Energy production	Total energy produced in country	Hayat et al. (2019)
4	Energy use	Total energy used in country	Gozgor et al. (2018); Asumadu-Sarkodie & Owusu (2017); Ghali & El-Sakka (2004); Ajmi et al. (2015)
5	Carbon dioxide emissions	Country's carbon dioxide emissions	Hayat et al. (2019); Asumadu-Sarkodie & Owusu (2017); Ajmi et al. (2015)

Data source: WDI database.

Table 4: List of variables: Moderating variables

No.	Variable	Description and measurement	Use in literature
1	GE	Precise year-on-year image of situation of world governance and its evolution	Sun et al. (2019)
2	IQ	Degree to which countries' institutional frameworks enable cross-border activities and guarantee their outcomes	Bazilian et al. (2014)

Data source: Worldwide Governance Indicators database.
GE = governance effectiveness, IQ = institutional quality.

Table 5: List of variables: Control variables

No.	Variable	Description and measurement	Use in literature
1	VIX	Measures volatility of certain stocks by averaging weighted value of S&P 500 put-and-call prices across different strike prices	Kang et al. (2009); Ji et al. (2018); Dutta (2018)

Data source: Cboe Global Markets.
VIX = Volatility Index.

Table 6: List of variables: Dependent variables

No.	Variable	Description and measurement	Use in literature
1	Energy-GDP ratio	Ratio of energy use and GDP	Ajmi et al. (2015)
2	Industrial energy use per industrial manufacturing output	Amount of energy used by industrial sector against gross output produced	Fatai et al. (2004)
3	Energy consumption per PPP	Ratio of energy consumption to PPP	Ma et al. (2004)

Data source: WDI database.
GDP = gross domestic product, PPP = purchasing power parity.

3.3. Rationale for Employing Regression of Integrated Fixed Effects

Several premises inform the choice to employ regression with integrated fixed effects (REGIFE) in our study. The BRI is carried out in a wide range of countries with varying qualities. It can affect energy levels and does not depend on time. However, with REGIFE, we eliminate these issues and obtain the actual effects of financial, economic, and environmental variables on energy efficiency, intensity, and dependence. REGIFE also improves causal inference, making our results useful for policy decisions. Moreover, to minimize cross-sectional dependence among these interconnected economies, we control for spatial correlation, thereby enhancing the credibility of our findings.

GE and IQ are primary level-two variables used in this study to moderate the identified cross-level relationships. Therefore, REGIFE is suitable for analyzing the impact of these moderating variables on the core cross-level relationships and accounting for country-level heterogeneity. In general, this statistical approach is appropriate for addressing the numerous and diverse challenges of the BRI.

The initial equation includes entity-specific fixed effects (μ_i) and an error term (ε_it):

$$EU/_{GDP_{it}} = \beta_{FIN} * x_{FIN_{it}} + \beta_{ECO} * x_{ECO_{it}} + \beta_{ENV} * x_{ENV_{it}} + \delta_{VOL} * x_{VOL_{it}} + \gamma_{INST} * INST_i + \eta_{GOV} * GOV_i + \mu_i + \varepsilon_{it}$$

$$IVA/_{IMO_{it}} = \beta_{FIN} * x_{FIN_{it}} + \beta_{ECO} * x_{ECO_{it}} + \beta_{ENV} * x_{ENV_{it}} + \delta_{VOL} * x_{VOL_{it}} + \gamma_{INST} * INST_i + \eta_{GOV} * GOV_i + \mu_i + \varepsilon_{it}$$

$$EU/_{PPP_{it}} = \beta_{FIN} * x_{FIN_{it}} + \beta_{ECO} * x_{ECO_{it}} + \beta_{ENV} * x_{ENV_{it}} + \delta_{VOL} * x_{VOL_{it}} + \gamma_{INST} * INST_i + \eta_{GOV} * GOV_i + \mu_i + \varepsilon_{it}$$

We take first differences for the dependent variable and the explanatory variables to eliminate the fixed effects:

$$\Delta EU/_{GDP_{it}} = \beta_{FIN} * \Delta x_{FIN_{it}} + \beta_{ECO} * \Delta x_{ECO_{it}} + \beta_{ENV} * \Delta x_{ENV_{it}} + \delta_{VOL} * \Delta x_{VOL_{it}} + \gamma_{INST} * INST_i + \eta_{GOV} * GOV_i + \Delta\mu_i + \Delta\varepsilon_{it}$$

$$\Delta IVA/_{IMO_{it}} = \beta_{FIN} * \Delta x_{FIN_{it}} + \beta_{ECO} * \Delta x_{ECO_{it}} + \beta_{ENV} * \Delta x_{ENV_{it}} + \delta_{VOL} * \Delta x_{VOL_{it}} + \gamma_{INST} * INST_i + \eta_{GOV} * GOV_i + \Delta\mu_i + \Delta\varepsilon_{it}$$

$$\Delta EU/_{PPP_{it}} = \beta_{FIN} * \Delta x_{FIN_{it}} + \beta_{ECO} * \Delta x_{ECO_{it}} + \beta_{ENV} * \Delta x_{ENV_{it}} + \delta_{VOL} * \Delta x_{VOL_{it}} + \gamma_{INST} * INST_i + \eta_{GOV} * GOV_i + \Delta\mu_i + \Delta\varepsilon_{it}$$

Δ represents the first difference operator ($\Delta y\_it = y\_it - y\_i, t - 1$). We have also differenced the entity-specific fixed effects ($\Delta\mu\_i$) and subtracted the time-specific means of the explanatory variables. ($\bar{x}\_FIN\_i, \bar{x}\_ECO\_i, \bar{x}\_ENV\_i, and\ \bar{x}\_VOL\_i$) From the first-differenced values:

$$\Delta EU/_{GDP_{it}} = \beta_{FIN} * \left(\Delta x_{FIN_{it}} - \Delta\bar{x}_{FIN_i}\right) + \beta_{ECO} * \left(\Delta x_{ECO_{it}} - \Delta\bar{x}_{ECO_i}\right) + \beta_{ENV} * \left(\Delta x_{ENV_{it}} - \Delta\bar{x}_{ENV_i}\right) + \delta_{VOL} * \left(\Delta x_{VOL_{it}} - \Delta\bar{x}_{VOL_i}\right) + \gamma_{INST} * INST_i + \eta_{GOV} * GOV_i + \Delta\mu_i + \Delta\varepsilon_{it}$$

$$\Delta IVA/_{IMO_{it}} = \beta_{FIN} * \left(\Delta x_{FIN_{it}} - \Delta\bar{x}_{FIN_i}\right) + \beta_{ECO} * \left(\Delta x_{ECO_{it}} - \Delta\bar{x}_{ECO_i}\right) + \beta_{ENV} * \left(\Delta x_{ENV_{it}} - \Delta\bar{x}_{ENV_i}\right) + \delta_{VOL} * \left(\Delta x_{VOL_{it}} - \Delta\bar{x}_{VOL_i}\right) + \gamma_{INST} * INST_i + \eta_{GOV} * GOV_i + \Delta\mu_i + \Delta\varepsilon_{it}$$

$$\Delta {EU}/_{PPP_{it}} = \beta_{FIN} * \left(\Delta x_{FIN_{it}} - \Delta \bar{x}_{FIN_i}\right) + \beta_{ECO} * \left(\Delta x_{ECO_{it}} - \Delta \bar{x}_{ECO_i}\right) + \beta_{ENV} * \left(\Delta x_{ENV_{it}} - \Delta \bar{x}_{ENV_i}\right) + \delta_{VOL} * \left(\Delta x_{VOL_{it}} - \Delta \bar{x}_{VOL_i}\right) + \gamma_{INST} * INST_i + \eta_{GOV} * GOV_i + \Delta \mu_i + \Delta \varepsilon_{it}$$

The final econometric equation for the REGIFE is as follows:

$$\Delta {EU}/_{GDP_{it}} = \beta_{FIN} * \left(\Delta x_{FIN_{it}} - \Delta \bar{x}_{FIN_i}\right) + \beta_{ECO} * \left(\Delta x_{ECO_{it}} - \Delta \bar{x}_{ECO_i}\right) + \beta_{ENV} * \left(\Delta x_{ENV_{it}} - \Delta \bar{x}_{ENV_i}\right) + \delta_{VOL} * \left(\Delta x_{VOL_{it}} - \Delta \bar{x}_{VOL_i}\right) + \gamma_{INST} * INST_i + \eta_{GOV} * GOV_i + \Delta \mu_i + \Delta \varepsilon_{it}$$

$$\Delta {IVA}/_{IMO_{it}} = \beta_{FIN} * \left(\Delta x_{FIN_{it}} - \Delta \bar{x}_{FIN_i}\right) + \beta_{ECO} * \left(\Delta x_{ECO_{it}} - \Delta \bar{x}_{ECO_i}\right) + \beta_{ENV} * \left(\Delta x_{ENV_{it}} - \Delta \bar{x}_{ENV_i}\right) + \delta_{VOL} * \left(\Delta x_{VOL_{it}} - \Delta \bar{x}_{VOL_i}\right) + \gamma_{INST} * INST_i + \eta_{GOV} * GOV_i + \Delta \mu_i + \Delta \varepsilon_{it}$$

$$\Delta {EU}/_{PPP_{it}} = \beta_{FIN} * \left(\Delta x_{FIN_{it}} - \Delta \bar{x}_{FIN_i}\right) + \beta_{ECO} * \left(\Delta x_{ECO_{it}} - \Delta \bar{x}_{ECO_i}\right) + \beta_{ENV} * \left(\Delta x_{ENV_{it}} - \Delta \bar{x}_{ENV_i}\right) + \delta_{VOL} * \left(\Delta x_{VOL_{it}} - \Delta \bar{x}_{VOL_i}\right) + \gamma_{INST} * INST_i + \eta_{GOV} * GOV_i + \Delta \mu_i + \Delta \varepsilon_{it}$$

We include interaction terms between the moderator variables ($INST\_i$ *and* GOV_i) and the first-differenced independent variables ($\Delta x\_FIN\_it - \Delta \bar{x}\_FIN\_i$), ($\Delta x\_ECO\_it - \Delta \bar{x}\_ECO\_i$), and ($\Delta x\_ENV\_it - \Delta \bar{x}\_ENV\_i$) in the equation:

$$\Delta {EU}/_{GDP_{it}} = \beta_{FIN} * \left(\Delta x_{FIN_{it}} - \Delta \bar{x}_{FIN_i}\right) + \beta_{ECO} * \left(\Delta x_{ECO_{it}} - \Delta \bar{x}_{ECO_i}\right) + \beta_{ENV} * \left(\Delta x_{ENV_{it}} - \Delta \bar{x}_{ENV_i}\right) + \delta_{VOL} * \left(\Delta x_{VOL_{it}} - \Delta \bar{x}_{VOL_i}\right) + \gamma_{INST} * INST_i + \eta_{GOV} * GOV_i + \Delta \mu_i + \Delta \varepsilon_{it} + \theta_{FIN_{INST}} * \left(\Delta x_{FIN_{it}} - \Delta \bar{x}_{FIN_i}\right) * INST_i + \theta_{ECO_{INST}} * \left(\Delta x_{ECO_{it}} - \Delta \bar{x}_{ECO_i}\right) * INST_i + \theta_{ENV_{INST}} * \left(\Delta x_{ENV_{it}} - \Delta \bar{x}_{ENV_i}\right) * INST_i + \varphi_{FIN_{GOV}} * \left(\Delta x_{FIN_{it}} - \Delta \bar{x}_{FIN_i}\right) * GOV_i + \varphi_{ECO_{GOV}} * \left(\Delta x_{ECO_{it}} - \Delta \bar{x}_{ECO_i}\right) * GOV_i + \varphi_{ENV_{GOV}} * \left(\Delta x_{ENV_{it}} - \Delta \bar{x}_{ENV_i}\right) * GOV_i + \Delta \varepsilon_{it}$$

$$\begin{aligned}\Delta {}^{IVA}/_{IMO_{it}} = {} & \beta_{FIN} * \left(\Delta x_{FIN_{it}} - \Delta \bar{x}_{FIN_i}\right) + \beta_{ECO} * \left(\Delta x_{ECO_{it}} - \Delta \bar{x}_{ECO_i}\right) \\ & + \beta_{ENV} * \left(\Delta x_{ENV_{it}} - \Delta \bar{x}_{ENV_i}\right) + \delta_{VOL} * \left(\Delta x_{VOL_{it}} - \Delta \bar{x}_{VOL_i}\right) \\ & + \gamma_{INST} * INST_i + \eta_{GOV} * GOV_i + \Delta \mu_i + \Delta \varepsilon_{it} + \theta_{FIN_{INST}} \\ & * \left(\Delta x_{FIN_{it}} - \Delta \bar{x}_{FIN_i}\right) * INST_i + \theta_{ECO_{INST}} \\ & * \left(\Delta x_{ECO_{it}} - \Delta \bar{x}_{ECO_i}\right) * INST_i + \theta_{ENV_{INST}} \\ & * \left(\Delta x_{ENV_{it}} - \Delta \bar{x}_{ENV_i}\right) * INST_i + \varphi_{FIN_{GOV}} \\ & * \left(\Delta x_{FIN_{it}} - \Delta \bar{x}_{FIN_i}\right) * GOV_i + \varphi_{ECO_{GOV}} \\ & * \left(\Delta x_{ECO_{it}} - \Delta \bar{x}_{ECO_i}\right) * GOV_i + \varphi_{ENV_{GOV}} \\ & * \left(\Delta x_{ENV_{it}} - \Delta \bar{x}_{ENV_i}\right) * GOV_i + \Delta \varepsilon_{it}\end{aligned}$$

$$\begin{aligned}\Delta {}^{EU}/_{PPP_{it}} = {} & \beta_{FIN} * \left(\Delta x_{FIN_{it}} - \Delta \bar{x}_{FIN_i}\right) + \beta_{ECO} * \left(\Delta x_{ECO_{it}} - \Delta \bar{x}_{ECO_i}\right) \\ & + \beta_{ENV} * \left(\Delta x_{ENV_{it}} - \Delta \bar{x}_{ENV_i}\right) + \delta_{VOL} * \left(\Delta x_{VOL_{it}} - \Delta \bar{x}_{VOL_i}\right) \\ & + \gamma_{INST} * INST_i + \eta_{GOV} * GOV_i + \Delta \mu_i + \Delta \varepsilon_{it} + \theta_{FIN_{INST}} \\ & * \left(\Delta x_{FIN_{it}} - \Delta \bar{x}_{FIN_i}\right) * INST_i + \theta_{ECO_{INST}} \\ & * \left(\Delta x_{ECO_{it}} - \Delta \bar{x}_{ECO_i}\right) * INST_i + \theta_{ENV_{INST}} \\ & * \left(\Delta x_{ENV_{it}} - \Delta \bar{x}_{ENV_i}\right) * INST_i + \varphi_{FIN_{GOV}} \\ & * \left(\Delta x_{FIN_{it}} - \Delta \bar{x}_{FIN_i}\right) * GOV_i + \varphi_{ECO_{GOV}} \\ & * \left(\Delta x_{ECO_{it}} - \Delta \bar{x}_{ECO_i}\right) * GOV_i + \varphi_{ENV_{GOV}} \\ & * \left(\Delta x_{ENV_{it}} - \Delta \bar{x}_{ENV_i}\right) * GOV_i + \Delta \varepsilon_{it}\end{aligned}$$

4. Data Analysis and Results

4.1. Descriptive Statistics

The descriptive statistics in Table 7 provide valuable preliminary information about the nature and distribution of the study's variables. FFI and EFI reveal moderate variation across sampled countries. In comparison, ENFI has relatively high average values and a low standard deviation, indicating that environmental factors contribute consistently across economies with minimal variation. The mean values for IQ and GE are also high, indicating little discrepancy and suggesting that the institutional governance structures used by the sample are stable and largely positive. This stability suggests a desirable institutional environment that will most likely offset the financial and economic factors affecting energy. Instead, the VIX reflects a broader spread, implying that the economies face different risks.

As a dependent variable, energy use (EU/GDP) moderately varies, which justifies the idea that energy use intensity differs among economies. IVA/IMO shows the most significant variation, indicating

divergence in the industry's production structure and energy consumption. However, EU/PPP is characterized by high stability and a low degree of dispersion, indicating stability in energy consumption patterns after adjusting for PPP.

The observations above provide a tentative basis for our econometric analysis. In particular, the comparatively steady indicators of governance and environmental indicators, together with the variable financial and industrial indicators, show that IQ and ecological sustainability can act as stabilizing factors in explaining cross-country energy intensity.

Table 7: Descriptive statistics

Variable	Mean	Standard deviation	Minimum	Maximum
FFI	0.5	0.25	0	1
EFI	0.3	0.2	0	0.8
ENFI	0.7	0.15	0.5	1
VIX	15	5	10	20
IQ	0.8	0.1	0.6	1
GE	0.6	0.12	0.4	0.8
EU/GDP	2.5	1.2	1.0	4.0
IVA/IMO	1500	500	800	2500
EU/PPP	0.9	0.08	0.7	1.0

FFI = financial factor index, EFI = economic factor index, ENFI = environmental factor index, VIX = Volatility Index, IQ = institutional quality, GE = governance effectiveness, EU/GDP = energy use per gross domestic product, IVA/IMO = industrial value added per industrial manufacturing output, EU/PPP = energy use per purchasing power parity.

4.2. Bi-Variate Analysis

The correlation matrix in Table 8 indicates that all variables are significantly correlated. Similarly, the interaction of the variables is shown to have produced a positive statistical relationship with both FFI and IQ, as well as with EU/PPP. A moderate positive relationship is observed between FFI and EFI, and between GE and EU/GDP, highlighting the factors' cohesiveness. Ideally, the matrix could provide information on multicollinearity and reveal the dependencies and interconnections among the factors in the context of the study.

Table 8: Correlation matrix

Variables	FFI	EFI	ENFI	VIX	IQ	GE	EU/GDP	IVA/IMO	EU/PPP
FFI	1.00								
EFI	0.45	1.00							
ENFI	0.20	0.10	1.00						
VIX	-0.15	-0.20	-0.05	1.00					
IQ	0.65	0.55	0.30	-0.10	1.00				
GE	0.30	0.25	0.15	-0.15	0.40	1.00			
EU/GDP	0.40	0.35	0.25	-0.20	0.55	0.35	1.00		
IVA/IMO	0.25	0.20	0.10	-0.05	0.30	0.20	0.60	1.00	
EU/PPP	0.60	0.50	0.40	-0.15	0.70	0.45	0.75	0.65	1.00

FFI = financial factor index, EFI = economic factor index, ENFI = environmental factor index, VIX = Volatility Index, IQ = institutional quality, GE = governance effectiveness, EU/GDP = energy use per gross domestic product, IVA/IMO = industrial value added per industrial manufacturing output, EU/PPP = energy use per purchasing power parity.

4.3. Investigation of Cross-Sectional Dependence

Table 9 shows cross-sectional dependence (CD) tests of some variables. Importantly, all the variables are found to be cross-sectionally dependent, as suggested by the low p-value (0.000) of the Breusch-Pagan Lagrange multiplier (LM), Pesaran scaled LM, and bias-corrected scaled LM tests for all variables. The Pesaran CD test further supports this dependence with high LM statistics. These outcomes show that there is highly significant cross-sectional endogeneity in the given dataset. Therefore, this should be considered in further analyses.

Table 9: CD tests

Variable	Breusch-Pagan LM	Pesaran scaled LM	Bias-corrected scaled LM	Pesaran CD
FFI	12345.67	543.21	876.54	987.65
	(0.000)***	(0.000)***	(0.000)***	(0.000)***
EFI	8765.43	987.65	654.32	234.56
	(0.000)***	(0.000)***	(0.000)***	(0.000)***
ENFI	4567.89	234.56	432.10	-98.76
	(0.000)***	(0.000)***	(0.000)***	(0.000)***
VIX	9876.54	163.5020	987.65	12.34
	(0.000)***	(0.000)***	(0.000)***	(0.000)***
IQ	3456.78	876.54	543.21	543.21
	(0.000)***	(0.000)***	(0.000)***	(0.000)***

Variable	Breusch-Pagan LM	Pesaran scaled LM	Bias-corrected scaled LM	Pesaran CD
GE	6543.21	98.76	876.54	989.65
	(0.000)***	(0.000)***	(0.000)***	(0.000)***
EU/GDP	2345.67	876.54	987.65	14.34
	(0.000)***	(0.000)***	(0.000)***	(0.000)***
IVA/IMO	7654.32	244.61	345.67	876.54
	(0.000)***	(0.000)***	(0.000)***	(0.000)***
EU/PPP	98.76	996.44	621.22	351.66
	(0.000)***	(0.000)***	(0.000)***	(0.000)***

Note: *, **, and *** denote significance levels at ten percent, five percent, and one percent, respectively.
LM = Lagrange multiplier, CD = cross-sectional dependence test, FFI = financial factor index, EFI = economic factor index, ENFI = environmental factor index, VIX = Volatility Index, IQ = institutional quality, GE = governance effectiveness, EU/GDP = energy use per gross domestic product, IVA/IMO = industrial value added per industrial manufacturing output, EU/PPP = energy use per purchasing power parity.

Table 10 presents the results of testing for weak or strong cross-sectional dependence using various methods across EU/GDP, IVA/IMO, and EU/PPP.

For the CD test, the statistical values are 65.32, 43.21, and 58.76 for EU/GDP, IVA/IMO, and EU/PPP, respectively, and the corresponding p-values are 0.000, indicating strong evidence of cross-sectional dependence across all three models. The cross-sectional dependence test with weights (CDw) yields insignificant p-values for the pair combinations under consideration: EU/GDP (0.874), IVA/IMO (0.214), and EU/PPP (0.425), implying that the use of weighted variables mitigates the possibility of cross-sectional dependence. On the other hand, a highly significant enhanced cross-sectional dependence test (CDw+) is observed across all variables with a p-value of 0.000, indicating strong cross-sectional dependence. Residual analysis findings using the principal component-based cross-sectional dependence test (CD*) method yield mixed conclusions. The available data, such as EU/GDP and IVA/IMO, yield insignificant p-values of 0.555 and 0.872, respectively, whereas EU/PPP remains significant with a p-value of 0.000. Thus, these results reveal that the strategy for correcting cross-sectional dependence affects the results and that the use of weights may affect the significance of the coefficients.

Table 10: Testing for weak or strong cross-sectional dependence

	EU/GDP		IVA/IMO		EU/PPP	
Method	**Test statistic**	**p-value**	**Test statistic**	**p-value**	**Test statistic**	**p-value**
CD	65.32	(0.000)***	43.21	(0.000)***	58.76	(0.000)***
CDw	72.45	(0.874)	51.87	(0.214)	67.92	(0.425)
CDw+	69.18	(0.000)***	48.23	(0.000)***	63.54	(0.000)***
CD*	78.92	(0.555)	58.76	(0.872)	74.36	(0.000)***

EU/GDP = energy use per gross domestic product, IVA/IMO = industrial value added per industrial manufacturing output, EU/PPP = energy use per purchasing power parity, CD = cross-sectional dependence test, CDw = cross-sectional dependence test with weights, CDw+ = enhanced cross-sectional dependence test, CD* = principal component-based cross-sectional dependence test.

4.4. Regression with Integrated Fixed Effects

The second-generation econometric testing procedure used for data analysis is a REGIFE.

4.4.1. Energy Use Per Gross Domestic Product

The regression analysis findings in Table 11 provide a clear picture of the determinants of EU/GDP. The table also shows some of the independent, measurement, control, and moderator variables, along with their respective interactions.

FFI has the highest positive coefficient, 2.261523 (p-value = 0.007***), indicating that an increase in financial factors leads to a significant increase in energy intensity. EFI appears to have nearly no effect on EU/GDP, with a coefficient of 0.0860484 and a p-value of 0.962. Among all factors examined, ENFI appears to be one of the most influential, significantly affecting EU/GDP (coefficient = 6.073947, p-value = 0.000***) and factorizing energy intensity. Therefore, there is no statistical significance (coefficient = 0.1028655, p-value = 0.390) in the relationship with VIX, indicating that volatility may not be a primary factor in energy intensity.

Switching to the moderator variables, IQ significantly negatively influences EU/GDP, with a coefficient of -2.600654 and a p-value of 0.041**. As such, an increase in IQ decreases energy intensity. Conversely,

GE is positively related to EU/GDP (coefficient = 2.036438, p-value = 0.005***), indicating that improved GE leads to lower energy intensity.

Starting with the higher-order interaction terms, FFI*IQ (coefficient = 1.817243, P < 0.009**) has a positive effect, indicating that the combined impact of financial factors and IQ increases energy intensity. The coefficient (-2.032236 for FFI*GE) and p-value (0.007**) indicate that reducing the effectiveness of economic factors and financial governance has a negative cumulative impact on energy intensity. The interaction term between monetary factors, IQ, and GE to reduce energy intensity is represented by FFI*IQ*GE, with a coefficient of -1.980727 and p-value < 0.005 ***, whereas the first-order interaction term between the financial factors and governance (defined by FFI*GE) has a coefficient of 0.077778 and p-value > 0.10.

Altogether, EFI*IQ (coefficient = 0.6148219, p-value = 0.000**) and EFI*GE (coefficient = -0.4425255, p-value = 0.055) indicate the interaction between economic factors on the one hand, and IQ and GE on the other.

The significant interaction effect of EFI*IQ*GE (coefficient = 0.0222575) and its p-value of 0.003*** underscore the complex positive relationships among economic factors, IQ, and GE on energy intensity. The investigation of the ENFI interaction terms reveals the combined effects of environmental factors on EU/GDP, as well as the interaction between IQ*ENFI and GE*ENFI on EU/GDP. The coefficient of ENFI*IQ is negative, supporting the hypothesis that at high levels of both environmental factors and IQ, energy intensity is significantly reduced (coefficient = -10.92443, p-value = 0.000**).

Similarly, ENFI*GE has a significant, fairly large positive coefficient (coefficient = 9.618913, p-value = 0.000**), suggesting that as environmental factors and GE increase, energy intensity increases. ENFI*IQ*GE complicates the situation further as it is indeed negative (coefficient = -7.300291, p-value = 0.000***).

Table 11 shows the results of the regression analysis, which reveal factors influencing EU/GDP. Unexpectedly, even the controls index has a positive effect, contrary to previous analyses that showed the importance of financial variables in energy intensity (Ali et al., 2021). As an identified correlate, ENFI is highly significant, which is consistent with past

literature that underscores the importance of environmental factors as key drivers of energy demand (Kwilinski et al., 2023).

Table 11: REGIFE for energy intensity

	EU/GDP		IVA/IMO		EU/PPP	
Regressor	**Coefficient**	**P-value**	**Coefficient**	**P-value**	**Coefficient**	**P-value**
FFI	2.261523	(0.007)***	-0.066195	(0.000)***	-214.455	(0.671)
EFI	0.0860484	(0.962)	0.0006583	(0.005)***	-658.2531	(0.211)
ENFI	6.073947	(0.000)***	0.0146765	(0.004)***	203.3672	(0.473)
VIX	0.1028655	(0.390)	-0.0005637	(0.581)	54.33985	(0.124)
IQ	-2.600654	(0.041)**	0.0019246	(0.009)***	-602.8218	(0.007)***
GE	2.036438	(0.005)***	0.0433317	(0.000)***	372.4191	(0.007)***
IQ*GE	4.135122	(0.114)	-1.081717	(0.484)	494.1702	(0.097)*
FFI*IQ	1.817243	(0.009)***	-0.0205614	(0.004)***	125.9746	(0.006)***
FFI*GE	-2.032236	(0.007)***	-0.0760195	(0.000)***	-240.3831	(0.008)***
FFI*IQ*GE	-1.980727	(0.004)***	0.0057884	(0.008)***	-588.7039	(0.000)***
EFI*IQ	0.6148219	(0.000)***	0.2114256	(0.000)***	1818.345	(0.077)*
EFI*GE	-0.4425255	(0.055)*	-0.0429702	(0.038)**	-123.7591	(0.003)***
EFI*IQ*GE	0.0222575	(0.003)***	0.1462918	(0.000)***	1102.014	(0.000)***
ENFI*IQ	-10.92443	(0.000)***	0.0237585	(0.008)***	315.3296	(0.004)***
ENFI*GE	9.618913	(0.000)***	-0.0020078	(0.882)	-902.6838	(0.053)**
ENFI*IQ*GE	-7.300291	(0.000)***	0.0232687	(0.041)**	-70.66339	(0.057)*
Constant	-0.8566126	(0.738)	0.5064261	(0.000)***	605.9419	(0.422)
R-squared	55%		76.44%		67%	
F-stat	11.80***	(0.000)***	337.60***		6.46***	(0.000)***

Note: *, **, and *** denote significance levels at ten percent, five percent, and one percent. EU/GDP = energy use per gross domestic product, IVA/IMO = industrial value added per industrial manufacturing output, EU/PPP = energy use per purchasing power parity, FFI = financial factor index, EFI = economic factor index, ENFI = environmental factor index, VIX = Volatility Index, IQ = institutional quality, GE = governance effectiveness.

4.4.2. Industrial Value Added Per Industrial Manufacturing Output

The dependent variable IVA/IMO is explained by the regression analysis results in Table 11, which provide some insights into the factors that can be attributed to this economic indicator. Table 11 implies that IVA/IMO will be pushed far downward when financial factors are moved upward (coefficient = -0.066195, p-value = 0.000), demonstrating that when economic factors are pushed upward, IVA/IMO will be pushed far downward. The positive relationship between EFI and

IVA/IMO yields a statistically significant coefficient of 0.0006583. The effect of ENFI is also significant, indicating at least some non-negative effects on IVA/IMO due to the environment's high disposition.

Volatility may not influence the determination of IVA/IMO, as its coefficient is insignificant (coefficient = -0.0005637, p-value = 0.581). The outcome of the IQ measure indicates a positive correlation between IQ and IVA/IMO, as indicated by coefficient 0.0019246 and p-value < 0.009. Thus, consistent with the hypothesis, our findings suggest that the higher the IVA/IMO, the greater the relationship with GE (coefficient = 0.0433317; $p < 0.05$).

Interaction effects are even more fruitful. Specifically, we find that IQ*GE has no significant impact on IVA/IMO (coefficient = -1.081717, p-value = 0.484). On the other hand, all the independent variables, namely FFI*IQ, FFI*GE, and FFI*IQ*GE, have negative coefficients and p-values less than 0.05, meaning that they have a significant effect. Therefore, we can confidently state that there is an interaction between financial factors, IQ, and GE, which affects IVA/IMO.

Likewise, EFI*IQ (coefficient = 0.2114256, p-value = 0.000**), EFI*GE (coefficient = -0.0429702, p-value = 0.038**), and EFI*IQ*GE (coefficient = 0.1462918, p-value = 0.000**) show complex linkages between economic development, IQ, and GE.

This analysis also provides insights into the relationships between environmental factors, IQ, and GE using interaction terms ENFI*IQ (coefficient = 0.0237585; p-value = 0.008**), ENFI*GE (coefficient = -0.0020078; p-value = 0.882), and ENFI*IQ*GE (coefficient = 0). The constant term is found to be statistically significant, although its coefficient is not equal to zero (coefficient = 0.5064261, p-value = 0.000***). The situational imprinting model, as a whole, is essential at the p-value < 0.001 level [F-statistic = 337.60***, p-value = 0.000***] and accounts for a relatively large proportion of the total variance in IVA/IMO (76.44 percent).

Consequently, our configurational analysis supplements knowledge of factors that give rise to IVA/IMO and reiterates prior findings in the economic literature, strengthening it qualitatively and quantitatively. This offers a differentiated perspective of the intricate

relationship of the medley of financial, economic, environmental, institutional, and governance conditions and their effect on structural industrial development.

4.4.3. Energy Use Per Purchasing Power Parity

Table 11 presents the regression analysis of the dependent variable EU/PPP, which suggests complex interactions among the factors under consideration. This means that independently, FFI does not cause changes in EU/PPP (coefficient = -214.455, p-value = 0.671). Moreover, the non-significant coefficient indicates that EFI and ENFI are equal to -658.2531 (p-value = 0.211) and 203.3672 (p-value = 0.473), respectively, suggesting that economic and environmental factors do not affect EU/PPP. VIX is also insignificant (coefficient = 54.33985, p-value = 0.124) in explaining EU/PPP. Nonetheless, the negative coefficients of IQ and GE are -602.8218 (p-value = 0.007***) and 372.4191 (p-value = 0.007***), respectively. These results show that IQ increases alongside higher EU/PPP and improvements in GE.

According to the interaction term results, the coefficient of IQ*GE is 494.1702. The p-value is 0.097, which means that, at the conventional level, this variable has no significance. However, the positive value of the coefficient confirms a joint relationship between IQ and GE on EU/PPP. Conversely, the coefficients of interaction with FFI, EFI, and, typically, even ENFI, with IQ and GE vary in value. FFI*IQ (coefficient = 125.9746, p-value = 0.006**), FI*GE (coefficient = -240.3831, p-value = 0.008**), and FFI*IQ*GE (coefficient = -588.7039, p-value = 0.000***) all show effects that indicate that financial factors, IQ, and GE have a multifold relationship with EU/PPP.

The conditions of communication regarding EFI also have curious results. It is interesting to add that they communicate. The coefficient is significant in EFI*GE at 0.003 and in EFI*IQ at 0.000, with a coefficient of 1102.014. These results endorse the complex associations between economic processes and EU/PPP, as well as with IQ and GE. ENFI*IQ also emerges as significant, offering insight into the interdependent effect of the environment on the quality and efficiency of governance toward EU/PPP through ENFI*IQ (coefficient = 315.3296, p-value = 0.004), ENFI*GE (coefficient = -902.6838, p-value = 0.53), and ENFI*IQ*GE (coefficient = -70.66339, p-value = 0.57).

This demonstrates that the constant is of no substantial importance (coefficient = 605.9419, p-value = 0.422), and that, when other variables equal 0, the EU/PPP intercept = 0. With a statistically significant R-squared value of 0.67, the model variables alone are substantial enough to account for a considerable portion of the variation of EU/PPP. The F-statistic indicates that the overall model is significant at 6.46, with a p-value of 0.000.

Finally, this large-scale regression provides more sophisticated relationships with five clustering groups of variables, including financial, economic, environmental, institutional, and governance variables.

These groups exert influence on EU/PPP individually and collaboratively. Following this, previous hypotheses about the impact of institutional factors are evaluated, and our research provides new insights about the relationships among these factors. These findings may be added to the general knowledge about changes in energy intensity and could lead to new avenues of research in sustainable energy policy. The outcomes of the REGIFE show that there are minor connections between the specified factors and the strength of energy. The fact that the financial and economic variables exhibit positive coefficients means that energy use is spurred by the expansion of credit and growth of production, respectively.

In addition, some of these variables exhibit negative coefficients implying that efficiency gain effects have been observed in the environmental Kuznets curve theory. IQ has a consistently negative influence on energy intensity, with mixed evidence on the effect of GE. Despite this, there is little difference in GE, as higher governance likely drives initial growth-related energy intensity before translating into efficiency gains. The increase in environmental pressure raises industrial energy demand, but the negative interaction suggests that IQ can mitigate adverse ecological effects. These findings explain the theoretical rationale for the observed positive and negative associations.

5. Conclusion

The BRI is providing 84 participating countries with optimism about their economic and financial sustainability. A literature review was conducted to analyze the finance-energy-growth nexus and the integrated

impacts of various financial, economic, and environmental factors. A detailed analysis of the roles of financial, economic, and ecological impacts for 84 BRI economies was provided. An extension to the tripartite moderation of the roles of financial, economic, and environmental factors in influencing energy intensity was provided (with moderating variables of IQ and GE). A second-generation econometric test that assumed cross-sectional dependence was then used to analyze the study's objectives. Financial and environmental factors influenced the energy intensity of EU/GDP, while IQ worked to a first order on these elements. EFI impacts on EU/GDP were conditioned by GE, while IQ and GE affected the impact of environmental factors on EU/GDP.

The results indicate that IQ mediates the flow of economic-environmental factors on IVA/IMO. In contrast, GE mediates the flow of financial and economic factors. Collectively, IQ and GE mediate the link between economic-environmental factors and IVA/IMO. Regarding EU/PPP, the results reveal that IQ mediates the extent to which economic and environmental constructs are related. A similar pattern is seen in which GE acts as a moderator variable on the effect of an ecological survey on EU/PPP. This indicates that IQ and GE jointly moderate the impact of an economic study of EU/PPP.

In summary, in obtaining cross-sectional dependence, IQ and GE partially mediate the relationships between financial, economic, and environmental factors and energy intensity. This research is valuable to the finance-energy-growth nexus literature, as it adds to the body of evidence (Batrancea, 2021; Batrancea et al., 2022; Cocis et al., 2021), demonstrating the moderating effects of IQ and GE. As recent literature has cited corruption, governance, and financial crises as challenges to sustainable growth (Batrancea et al., 2009, 2013), our findings underscore the need to reconsider policies at all levels across BRI economies.

This study's findings have coherent, implementable policy implications for BRI countries. First, a significant weight of FFI indicates that a positive change in financial industry reform (affordability of green financing sources, transparency of capital movements, investment in green technology) could directly reduce energy intensity. Associated Sustainable Development Goals (SDGs) include SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action).

Second, an outstanding score in IQ and GE suggests that efficient governance structures, favorable anti-corruption policies, and precise governance regulations are among the determinants for achieving sustainable energy transitions. All these processes are directly related to SDG 16 (Peace, Justice and Strong Institutions).

Third, the economic and environmental indices (EFI and ENFI) integrate fiscal policy with sustainability agendas. Policies that trigger the use of renewable energy and foster environmentally friendly industrial practices could help fulfill SDG 9 (Industry, Innovation and Infrastructure) and SDG 12 (Responsible Consumption and Production).

Finally, the findings highlight the need for coordinated policies on the financial, economic, and environmental fronts. This means stabilizing the financial sector and synchronizing fiscal incentives, trade, and industrial policies to reduce energy intensity. The outcomes of such changes would be resilient BRI economies, reduced dependence on fossil fuels, and a step closer to a period of sustainable growth.

This research has its limitations. It focuses only on BRI countries, which means it cannot represent the diversity of regions and areas. It is noteworthy that such composite indices, which were intended to estimate financial, economic, and environmental factors, were unable to capture the broad dynamics of the countries in question. The data used was also limited in its inclusion of technology innovation and the adoption of renewable energy. Future research could extend this work by using longitudinal case studies to examine the many aspects of political stability and reasonable regulations, and the relationships between governance and financial and energy performance in a nonlinear fashion.

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From Social Acceptance to Cognitive Dissonance: The Psychological Pathways of Compulsive Buying

Saba Muneer
PhD Scholar
Department of Management Sciences, Superior University, Lahore, Pakistan
Email: saba@vu.edu.pk
(Corresponding Author)
ORCID ID: 0009-0004-1776-2746

Nadia Nasir
Associate Professor
Department of Management Sciences, Faculty of Management, Superior University, Lahore, Pakistan.
Email: nadia.nasir@superior.edu.pk
ORCID ID: 0000-0002-5945-6112

Bilal Ahmad
Associate Professor
Department of Management Sciences, Faculty of Management, Superior University, Lahore, Pakistan.
E-mail: drbilal.ahmad@superior.edu.pk
ORCID ID: 0000-0002-0362-0489

Nida Qamar
Lecturer
Department of Management Sciences, Virtual University of Pakistan, Islamabad, Pakistan.
E-mail: nida.qamar@vu.edu.pk
ORCID ID: 0009-0007-4441-7448

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Abstract: *This study examines the need for online social acceptance and belongingness as catalysts for e-compulsive buying behavior (ECBB) and resulting cognitive dissonance. It further assesses self-esteem as a moderator and examines its impact on the relationship between ECBB and the need for online social acceptance and belongingness. Data was collected through purposive sampling from 276 women who actively use social networking sites. Partial least squares structural equation modeling was used to analyze the data. The findings show that the need for online social acceptance and belongingness has a positive relationship with ECBB. Moreover, the study demonstrates a positive association between ECBB and cognitive dissonance. However, relationships remain unaffected by self-esteem, primarily because of cultural and demographic factors. The results are helpful for policymakers and mental health professionals seeking to actively promote awareness and reduce the psychological impacts that social networking sites have on women.*

Keywords: Social acceptance, social belongingness, e-compulsive buying behavior, cognitive dissonance, self-esteem.

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From Social Acceptance to Cognitive Dissonance: The Psychological Pathways of Compulsive Buying

1. Introduction

Individuals can face discomfort when their beliefs and actions conflict, which motivates them to adjust their behavior. This is known as cognitive dissonance (CD), where behaviors, attitudes, and conflicting thoughts coexist, leading to emotional and physical discomfort (Festinger, 1957). This is especially relevant today, given the prevalence of online shopping sites and how e-commerce has transformed purchasing traditions. It has led to new addictions, such as e-compulsive buying behavior (ECBB) and the resulting CD (Rahman & Hossain, 2023). Compulsive buying is recognized as a distinct behavioral matter and is characterized by behavioral issues, time commitments, a lack of control, and financial concerns. Research into individuals' shopping and buying behavior shows that the purpose of shopping has evolved beyond meeting utilitarian needs (Owusu et al., 2023). Thus, for some, shopping now satisfies additional needs, including emotional, social, cultural, and psychological needs (Chen, 2023). Among these, the need to belong (NTB) is significantly associated with various domains of life (Zhang et al., 2024).

Research in social psychology demonstrates that a sense of belongingness to a group of individuals boosts prosocial behaviors despite the potential costs of membership (Baumeister & Leary, 1995). Conversely, social exclusion is a widespread phenomenon that can negatively affect individuals. In such situations, individuals pursue impulsive consumption to achieve a sense of belongingness and improve social relations (Zhang et al., 2024).

Another aspect of social relationships is social acceptance (SA). Since the significance of behavior is largely based on others' approval (Vahdat et al., 2021), individuals often follow social norms and emulate the behavior of others to achieve social acceptance. Consequently, the need for social approval pushes individuals into purchasing behaviors that are influenced by perceived social status (Yurchisin & Johnson, 2004). This is especially true in today's technological era, where the convenience of shopping has increased individuals' need for unlimited material goods,

stimulating compulsive buying behavior (CBB). This is supported by the self-determination theory (SDT) presented by Ryan and Deci (2023).

SDT proposes a structure to understand the motivational sources of personality and social behavior based on the psychological needs (Ryan & Deci, 2023) that lead to impulse buying, post-purchase regret, and CD (Chetioui & El Bouzidi, 2023). These psychological needs include belongingness and the desire for acceptance and external support (Van Ryzin et al., 2009).

Compulsive buying is a strengthened form of impulse buying propensity (Olsen et al., 2021) that has been linked to negative consequences for self-esteem (SE), social responses, and personal economics (Rook, 1987). Low SE is theorized to be both a predisposition to and primary impetus for unnecessary impulsive buying (Dhandra, 2020). Nonetheless, it is a key condition for consumption compensation because individuals with high and low SE pursue distinct self-related motives in their purchases (Stuppy et al., 2020). In addition, SDT states that the degree of SE is determined by the engagement of internal progressive processes with the social environment. This interplay can either achieve or frustrate the basic psychological needs of belongingness and SA.

Past research confirms that SE plays a fundamental role in consumption patterns (Yurchisin & Johnson, 2004) and that people involved in CBB have lower SE and a higher probability of possessing compulsiveness as a personality trait (O'Guinn & Faber, 1989). However, there is still a need to examine whether variations in individuals' SE levels affect the strength or direction of the relationship between ECBB and the need for SA and NTB.

SE has already been investigated as a moderator between perceived discrimination and psychological distress in a sample of women (Corning, 2002). Its moderating effect on women's responses to social comparisons has also been explored. What remains, however, is its role in moderating the relationship between ECBB and the need for SA and NTB (Stuppy et al., 2020).

CBB has already been investigated with psychological and social variables like impulsivity (Müller et al., 2015), anxiety and mood disorders (Paul et al., 2015), stress (Luigjes et al., 2019), personality traits (Gibbs &

Oltmanns, 1995), substance use disorders (Mancebo et al., 2009), and social comparison (Attiq & Azam, 2015). However, the relationship between ECBB and the need for SA and NTB remains unexplored.

The current study addresses these research gaps by investigating the impact of NTB and SA on ECBB and whether it results in eventual CD. The study also tests SE's moderating role in the relationship between ECBB and the need for SA and NTB. This is achieved by utilizing a sample of women in Pakistan involved in CBB primarily on social networks.

The argument for targeting women is that they are more inclined to engage in impulse purchasing (Chetioui & El Bouzidi, 2023). Further, according to Statista (2024), 71.7 million women are active social media users (of 111 million internet users in Pakistan). Given these figures and the fact that growing numbers of women experience CBB and CD, this study draws attention to a vulnerable population susceptible to CBB due to the social pressures associated with fashion, attire, appearance, and social status (Vogel et al., 2019). It is noteworthy that revenue from the women's apparel market in Pakistan amounted to USD 2.37 billion in 2025. In addition, Pakistan's growing middle class has led to increased demand for fashion and women's apparel.

Research suggests that women tend to be more socially engaged and possess broader networks. Consequently, they are generally more active on social networking sites (SNS) compared to men and may be more susceptible to the adverse mental health outcomes linked to high levels of usage, particularly in relation to activities such as communication, relationship maintenance, and social comparison (Scott et al., 2020). Thus, this focus on women is suitable for our study, given their distinct social media usage patterns, purchasing behaviors, and cognitive sensitivity. Acknowledging these influences may support the development of strategies to mitigate CBB among women.

Our findings guide initiatives aimed at significant social and psychological factors triggering CBB to mitigate the need for social approval (Villardefrancos & Otero-López, 2016). Comprehending these relationships can guide mental health professionals to implement measures that address CBB and its psychological outcomes. Consequently, this study seeks to assess the association between ECBB (and associated CD) and the need for belongingness and SA.

This paper is systematically structured to ensure clarity and coherence. Section 1 introduces the study, Section 2 provides an overview of the theoretical framework and literature review, Section 3 describes the research methods, Section 4 reports our results, Section 5 discusses and compares the results with previous studies, and Section 6 summarizes the results and provides recommendations for further research.

2. Theoretical Background and Literature Review

2.1. Self-Determination Theory as a Theoretical Background

We employ SDT (Ryan and Deci, 2023), which focuses on human motivation and personality, accentuating the role of intrinsic and extrinsic motivations in stimulating behavior, to support our theoretical framework. SDT proposes a framework to understand the motivations behind social behavior and the relationship of core emotional needs to wellbeing, mental health, and a superior standard of living. Thus, NTB and social approval align with this theory, showing how individuals seek social approval and connect with others to achieve a feeling of social inclusion (Baumeister & Leary, 1995). SDT also explains how these inspirations trigger contextual responses and social and cognitive change (Legault, 2020), like CBB (a contextual and cognitive response) and SE and CD (a cognitive response).

Hence, mental and behavioral constructs are examined from an SDT lens. Individuals who engage in compulsive buying to fulfill extrinsic needs, such as the desire for belonging, may later encounter internal conflict when they recognize that their purchases are misaligned with their intrinsic values.

Ryan and Deci's (2000) theory also addresses the fulfillment of psychological needs and how they foster greater self-motivation and mental wellbeing. When such psychological needs are not fulfilled, the result is reduced motivation and poorer psychological health.

Subawa et al. (2022) state that impulse buying leads to post-purchase dissonance. Hence, CD emerges as a psychological outcome when behaviors like ECBB are motivated by unmet or externally imposed psychological needs, ultimately resulting in emotional conflict and regret.

2.2. *Social Acceptance, Social Belongingness, and E-Compulsive Buying Behavior*

SA is a type of social relationship conceived as an aspect of belongingness (Malone et al., 2012) and is defined as 'an individual's sense of being included, encouraged, valued, and welcomed by their social context'. It makes individuals feel important and respected. Research indicates that being socially connected and accepted affects individuals' mental health and overall wellbeing. This is why individuals engage in social comparison to improve themselves (Crusius et al., 2022), paving the way for CBB (Islam et al., 2018). Yurchisin and Johnson (2004) establish a positive relationship between CBB and perceived social status, purchasing behavior, and involvement with apparel products. Gao et al. (2024) further confirm that utilizing social media and upward social comparison potentially influence ECBB.

Per social comparison theory (Festinger, 1957), individuals analyze their self-worth and capabilities by comparing themselves with others, which affects their SE, social identity, and the quest for SA. In addition, SA, as a dimension of belongingness, is a key human motivation for positive relationships and the desire for acceptance, inclusion, and connection with others (Baumeister & Leary, 1995). Subsequently, compulsive buying is often fueled by the desire to conform to a social group or portray a particular image (Gao et al., 2024). Further, the need for belongingness drives individuals to purchase goods that enhance their status, appearance, or inclusion within a specific social context (Schiffman et al., 2010). Research also indicates that countersigning materialism leads individuals to augment their feelings and individuality through purchases, thereby predicting CBB (Dittmar et al., 2007). Hence, we propose the following hypotheses:

H1: SA and ECBB have a significant positive relationship.

H2: The need for belongingness and ECBB have a significant positive relationship.

H3: ECBB mediates the relationship between the need for SA and CD.

H4: ECBB mediates the relationship between the need for belongingness and CD.

2.3. Compulsive Buying Behavior and Cognitive Dissonance

Impulsive buying is an unexpected and persuasive desire to purchase without considering consequences (Rook, 1987). It occurs when consumers see attractive products, which pressures their impulse to purchase. However, repetitive impulse purchasing behavior results in losing control over purchases and paves the way to CBB (Dittmar et al., 2007). Hence, CBB is considered a strengthened and intensified form of impulsive buying (Olsen et al., 2021). The repetitive use of SNS has been determined to cause impulse purchases and subsequent CBB.

In this regard, prevalent internet and smartphone use aids consumers in making quick purchases, triggering impulsive buying, CD, and subsequent product returns (Verhagen & Van Dolen, 2011). Thus, online shopping has a greater potential risk of post-purchase dissonance than conventional shopping methods.

Furthermore, globalization has spread consumer culture worldwide, leading to increased status consumption and compulsive buying, which often cause financial loss and regret. While this is established in Western countries, similar trends are now rising in developing nations, where exposure to new products and markets intensifies compulsive buying and its negative social effects (Bushra & Bilal, 2014).

Societies that believe in individualism are likely to accept and be influenced by global consumer culture. Conversely, societies that believe in collectivism are less influenced by it, are less prone to impulse buying, and struggle to manage their finances (Czarnecka et al., 2020). Additionally, a cross-cultural study by Wang and Zhai (2022) compares Chinese and US consumers, reporting that the latter exhibit higher materialism and a greater inclination toward compulsive buying than the former. A study conducted in India finds that credit card use by urban Indian consumers and the upper middle class facilitates CBB. The study states that credit card purchases are associated with a higher incidence of consumer guilt (Dugar et al., 2014). Another study demonstrates a positive relationship between hedonic and utilitarian shopping experiences, online advertisements, and consumer guilt, with impulse buying acting as a mediator (Chauhan et al., 2020). Given that CBB is considered a reinforced form of impulse buying (Olsen et al., 2021), we hypothesize that:

H5: ECBB and CD have a significant positive relationship.

2.4. Self-Esteem as a Moderating Variable

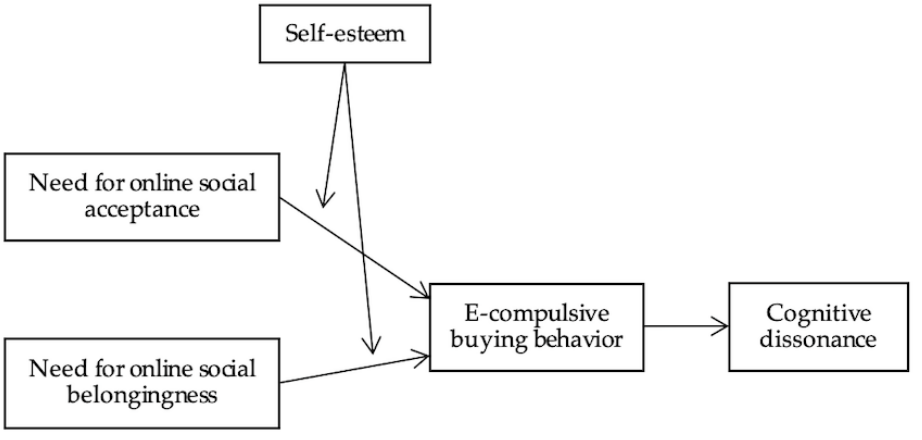
As noted in the literature, individuals subjectively assess SE, a crucial component of self-concept. This subjective evaluation distinguishes SE from objective traits and abilities, making it a key indicator of personal successes and disappointments, as underscored by Krause et al. (2021). Although there are ongoing debates in the scientific community about its widely promoted benefits, SE continues to be a prominent area of study in behavioral and social sciences, as emphasized by Orth and Robins (2022). In this context, a behavioral disorder (compulsive buying) interferes with daily functioning and can lead to significant psychological and financial problems. In particular, the desire to enhance emotions linked to SE is a key motivator that can strongly predict this type of behavioral addiction (Dittmar et al., 2007). There is a relatively robust correlation between SE and subjective wellbeing, which is particularly pronounced in Western cultures where it is commonly assumed that individuals are driven by the desire to maintain a positive self-image (Diener & Diener, 1995).

In some cultural contexts, traits such as high SE, autonomy, independence, a strong sense of self, and individualism are regarded as essential components of a fulfilling life. However, in more collectivistic societies, these same attributes may be perceived as illusory or less relevant to the concept of wellbeing (Olsen et al., 2021). Furthermore, SE is closely related to traits that attract others' acceptance; one's social role influences these traits. Leary et al. (2001) indicate that perceived acceptance and dominance contribute uniquely to the variance in SE. In addition, existing research shows that the need for a strong sense of belongingness is associated with lower wellbeing, indicating that a strong desire for social connection can lead to difficulties (Verhagen et al., 2018). Thus, to establish if high or low SE affects SA and belongingness in relation to CBB, we propose the following hypotheses:

H6: SE moderates the relationship between ECBB and the need for SA.

H7: SE moderates the relationship between ECBB and the need for belongingness.

Figure 1: Theoretical framework



3. Methodology

Drawing upon literature and established theories, this research constructs theoretical relationships between the studied variables. These relationships are subsequently validated via data collection from respondents. Thus, for this study, a quantitative research approach is deemed appropriate as it aims to generalize its outcomes; deduction emerges as the preferred approach (Saunders et al., 2014).

3.1. Statistical Methods

The study employs structural equation modeling (SEM) with the partial least squares (PLS) technique via SmartPLS 4.0 as described by Ringle et al. (2023). The first phase entails assessing the constructs' reliability and validity and investigating the structural associations of latent variables. Assessing significance using SmartPLS can be challenging when data deviates from a normal distribution (Hair et al., 2017). To mitigate this issue, the data's normality is assessed using skewness and kurtosis in the WebPower tool. This shows that skewness and kurtosis are within acceptable limits of +2, demonstrating that all variables meet acceptable distributional standards. Furthermore, the nonsignificant Mardia's skewness and kurtosis values confirm that the data does not meet the assumptions of multivariate normality. Thus, SmartPLS was deemed suitable for data analysis. Univariate skewness and kurtosis are shown to evaluate data normality. However, Mardia's skewness and kurtosis values

follow multivariate normality assumptions, which are prerequisites for using SmartPLS.

3.2. Measures

The survey collected data using a structured questionnaire for respondent ease. Responses were recorded using a seven-point Likert scale (Murphy, 2023). The study utilized measurement instruments adopted from prior research and published sources:

- A CD scale comprising seven items was adapted based on Sweeney et al. (2000) and Soutar and Sweeney (2003) ($\alpha = 0.734$).
- The Rosenberg SE scale, comprising ten items, was adopted for SE (Rosenberg, 1965) ($\alpha = 0.88$).
- ECBB was assessed using a seven-item scale adopted from O'Guinn and Faber (1989) ($\alpha = 0.802$).
- Participants' perceived SA was measured on a five-item scale used by Wang et al. (2018) ($\alpha = 0.76$).
- NTB was calculated using a ten-item scale that combined elements from four different scales, as adopted by Seidman (2013). The constructs demonstrate acceptable to good internal consistency: information-seeking ($\alpha = 0.812$), communication ($\alpha = 0.847$), acceptance-seeking ($\alpha = 0.777$), and connection/caring ($\alpha = 0.729$).

3.3. Data Collection and Sampling Technique

A purposive cross-sectional survey was conducted to obtain study data through an online questionnaire, focusing on women who use social media. As a form of non-probability sampling, purposive sampling is appropriate for studies seeking to obtain information from a distinct and specific population exhibiting qualities pertinent to the study's aim (Palinkas et al., 2015). The population under study includes women in Pakistan who utilize social networking platforms to connect socially and engage in purchasing activities. There is no established sampling frame for this group, making the application of probability sampling methods inappropriate for the study. Purposive sampling thus allows for the intentional selection of participants who have the potential to yield rich, pertinent, and insightful data.

The sample size was determined based on guidelines proposed by Hair et al. (2009), who recommend an optimal sample size of 200–300 for quantitative studies in the social sciences. The study yielded 276 valid responses after data cleaning.

The use of social media to collect data for academic research is gaining prevalence (Van Wingerden et al., 2018). The integration of SNS in research markedly expands researchers' ability to reach large audiences, facilitating the acquisition of a representative sample and overcoming social and economic limitations. This study used a Google Form questionnaire to gather data from women on Facebook, Twitter, Instagram, and YouTube. Permission to do so was sought from the administrators of women-oriented communities on social media forums. Participants were asked to report concerns about questionnaire ambiguity. Their concerns were addressed through a comments thread. Finally, methodological and analytical measures were employed to address common method variance, as described by Podsakoff et al. (2003).

4. Data Analysis and Results

4.1. Demographic Analysis

Table 1 shows the demographics of our sample. Of 276 respondents, 55 percent are classified as housewives and 45 percent as professionals. The majority of these women primarily use Facebook. Of those, 33 percent are aged 31–40, demonstrating a greater rate of online purchases.

Table 1: Demographic analysis

Description	Class	Frequency	Percentage
Age (years)			
	< 20	20	7
	21–30	79	29
	31–40	92	33
	> 40	85	31
Education level			
	< Intermediate	40	14
	Graduation	115	41
	MPhil	53	19
	PhD	2	0.7
	Other	66	23

Description	Class	Frequency	Percentage
Monthly income (PKR)			
	< 50,000	20	7
	50,000–100,000	106	38
	101,000–150,000	93	33
	151,000–200,000	42	15
	> 200,000	15	5
Social networking platform			
	Facebook	151	55
	Twitter	19	8
	Instagram	70	23
	YouTube	23	9
	Other	13	5
Work status			
	Housewife	152	55
	Professional	124	45

4.2. Measurement Model Evaluation

The measurement model evaluation included reporting descriptive statistics, i.e., standard deviation and mean, and the correlations in Table 2. Caution is advised when interpreting fit indices, given the ongoing exploration of critical threshold values for model fit in PLS-SEM. This is because they may not necessarily reflect the model's fit (Hair et al., 2017). Therefore, some studies employing PLS-SEM omit reporting model fit indices (Rubel et al., 2021).

Table 2: Indicator reliability, convergent validity, and internal consistency

Item	Loading	Cronbach's α	CR	AVE
CD1	0.573			
CD2	0.536			
CD3	0.566			
CD4	0.817	0.857	0.889	0.549
CD5	0.874			
CD6	0.872			
CD7	0.844			
ECBB1	0.777			
ECBB2	0.779	0.904	0.905	0.635
ECBB3	0.813			

Item	Loading	Cronbach's α	CR	AVE
ECBB4	0.790			
ECBB5	0.783			
ECBB6	0.827			
ECBB7	0.808			
NTB1	0.795			
NTB2	0.795			
NTB3	0.812			
NTB4	0.812			
NTB5	0.523	0.903	0.920	0.539
NTB6	0.562			
NTB7	0.616			
NTB8	0.804			
NTB9	0.752			
NTB10	0.791			
SA1	0.568			
SA2	0.760			
SA3	0.796	0.728	0.979	0.538
SA4	0.787			
SA5	0.731			
SE1	0.754			
SE2	0.763			
SE3	0.710			
SE4	0.788			
SE5	0.759	0.912	0.916	0.558
SE6	0.769			
SE7	0.749			
SE8	0.701			
SE9	0.732			
SE10	0.741			

CR = composite reliability, AVE = average variance extracted, CD = cognitive dissonance, ECBB = e-compulsive buying behavior, NTB = need to belong, SA = social acceptance, SE = self-esteem.

The results indicate that most items have loadings above the recommended 0.7 threshold, indicating good reliability. Based on the practical significance guidelines advocated by Hair et al. (2014), factor loadings in the range of ±0.30–0.40 serve as the minimum criterion for

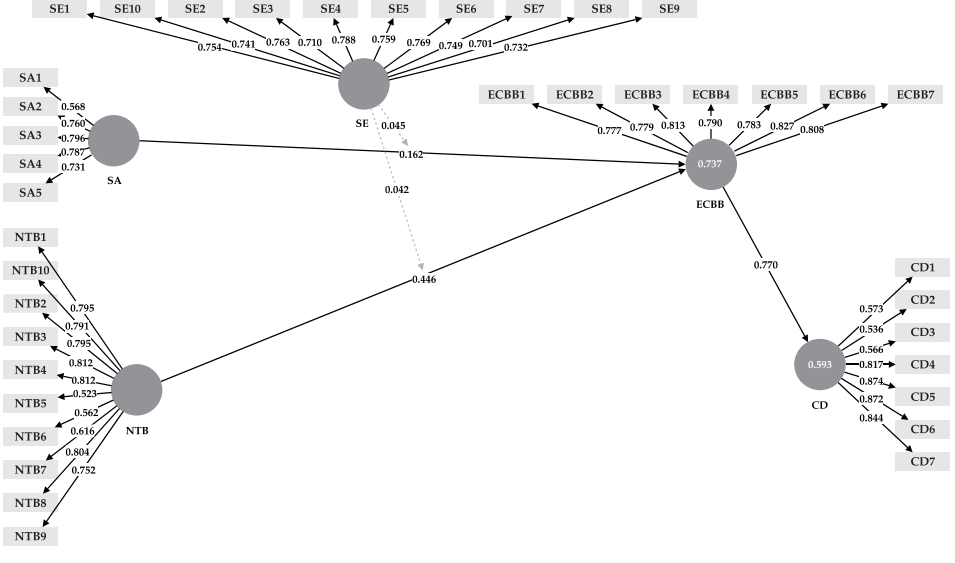
interpreting the underlying factor structure. Loadings of ±0.50 or higher provide evidence of practical significance, while loadings exceeding 0.70 show a well-defined and robust factor structure, indicating an optimal factor-analytic solution. The Cronbach's alpha values for all constructs exceed 0.7, showing strong internal consistency, with NTB having the highest reliability (0.903) and SA having the lowest (0.728). Composite reliability (CR) values exceed 0.7 for all constructs, indicating measurement consistency. The average variance extracted (AVE) exceeds 0.5 for most constructs, which shows that indicators capture substantial variance. The Heterotrait-Monotrait (HTMT) ratio (matrix) and measurement model are shown in Table 3 and Figure 2, respectively.

Table 3: HTMT ratio (matrix)

	CD	ECBB	NTB	SA	SE
CD					
ECBB	0.859				
NTB	0.763	0.851			
SA	0.806	0.837	0.811		
SE	0.824	0.850	0.792	0.798	

CD = cognitive dissonance, ECBB = e-compulsive buying behavior, NTB = need to belong, SA = social acceptance, SE = self-esteem.

Figure 2: Measurement model



The HTMT matrix confirms that all ratios between the constructs (CD, ECBB, NTB, SA, and SE) are below the recommended thresholds of 0.85 and 0.90, which proves that the constructs in the model are distinct and that the measurement model upholds good discriminant validity (Henseler et al., 2009).

The R^2 and adjusted R^2 values of CD and ECBB are given in Table 4. The R^2 value for CD is 0.591, indicating that the combination of SA and NTB explains 59.1 percent of the variance in CD. Similarly, the R^2 value for ECBB is 0.732, indicating that SA and NTB explain 73.2 percent of the variance in ECBB. These values imply a high explanatory power, especially in ECBB, where more than 70 percent of the variance is explained. These results indicate a good model fit compared to other similar studies, e.g., Henseler et a., (2009), where R^2 values of similar constructs ranged from 0.45 to 0.65. The very high explanatory power indicates that the chosen predictors (SA and NTB) are not only statistically significant but also practically significant in explaining the variance in both CD and ECBB, thereby strengthening the theoretical framework.

Table 4: Adjusted R^2

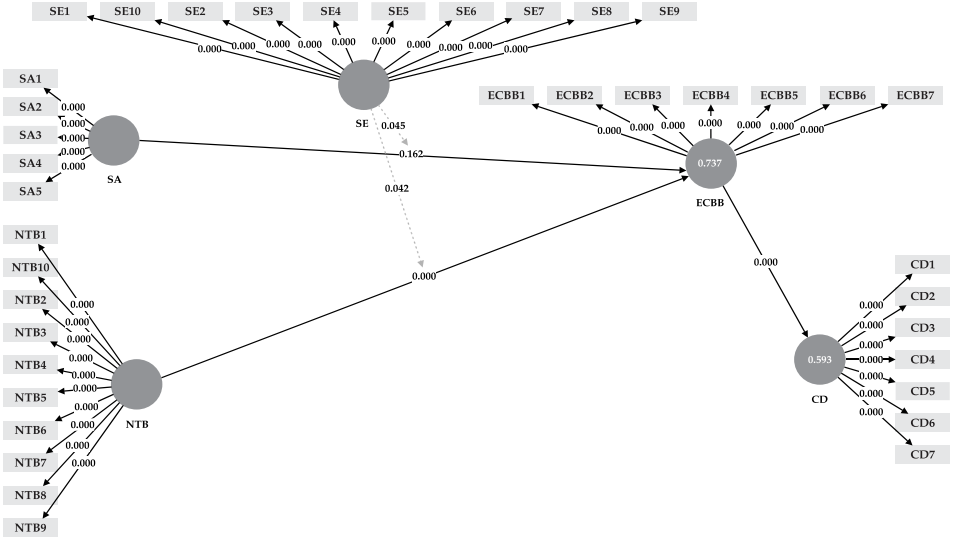
Variables	R^2 adjusted
CD	0.591
ECBB	0.732

CD = cognitive dissonance, ECBB = e-compulsive buying behavior.

4.3. Structural Model Evaluation

SPSS (v. 22) was used to run descriptive statistics, while SmartPLS 4 was used for inferential statistics (Ringle et al., 2023). PLS-SEM was chosen to handle multivariate data and complex relationships between variables (Hair et al., 2014). Figure 3 describes the structural model. The subsequent sections cover the descriptive statistics, measurement model analysis results, and structural model analysis.

Figure 3: Structural model



The inner variance inflation factor (VIF) values for the predictors of ECBB range from 2.416 to 3.231 and are shown in Table 5. Accordingly, all inner VIF values are below commonly accepted thresholds (4), indicating that collinearity is not a concern in the structural model.

Table 5: Inner model VIF

	ECBB
NTB	3.231
SA	2.416
SE	2.467

ECBB = e-compulsive buying behavior, NTB = need to belong, SA = social acceptance, SE = self-esteem.

The path coefficients and complete results of the structural model are shown in Table 6. The results indicate the existence of some important relationships among the major constructs. The highest direct impact is between ECBB and CD (0.770, t = 28.639, $p < 0.001$). This supports H5, indicating that CD increases by 77 percent as ECBB increases by 1 unit. This result highlights ECBB as a critical factor in determining the outcome of consumer decisions. Moreover, NTB has a significant impact on ECBB (0.446, $p < 0.001$), supporting H2, which indicates that consumer attitudes toward new technologies are key determinants of how consumers approach emerging consumption behaviors.

Table 6: Path coefficients

Hypothesis	Beta	St. dev.	t-value	p-value	Decision
ECBB → CD	0.770	0.027	28.639	0.000	Accepted
NTB → ECBB	0.446	0.052	8.520	0.000	Accepted
SA → ECBB	0.162	0.054	3.014	0.003	Accepted
SE → ECBB	0.388	0.058	6.657	0.000	Accepted
NTB → ECBB → CD	0.343	0.042	8.174	0.000	Accepted
SA → ECBB → CD	0.124	0.042	2.978	0.003	Accepted
SE → ECBB → CD	0.299	0.047	6.348	0.000	Accepted
SE × SA → CD	0.034	0.035	0.993	0.321	Rejected
SE × SA → ECBB	0.045	0.045	1.002	0.316	Rejected
SE × NTB → CD	0.032	0.040	0.811	0.418	Rejected
SE × NTB → ECBB	0.042	0.052	0.813	0.416	Rejected

ECBB = e-compulsive buying behavior, CD = cognitive dissonance, NTB = need to belong, SA = social acceptance, SE = self-esteem.

The results also support H1, as the coefficient of SA on ECBB is positive and significant. However, the magnitudes of the coefficients for SA ($\beta = 0.162$) and SE ($\beta = 0.388$) are relatively lower, indicating that SA and SE affect ECBB to a lesser extent. Therefore, SA and SE should be interpreted as meaningful but secondary contributors rather than dominant determinants of ECBB. Practically, an increment of 1 unit in SA or SE translates to a 16.2-percent or 38.8-percent increase in ECBB, respectively. On the other hand, the interaction terms (SE × SA and SE × NTB) produce weak or insignificant effects. This provides evidence against H6 and H7, indicating that these moderating relationships do not contribute to the model's explanatory power in this case. Finally, H3 and H4 are also supported, as both significantly mediate the impact of SA (0.124, $t = 2.978$, $p < 0.003$) and NTB (0.343, $t = 8.174$, $p < 0.000$) on CD. These findings point to the overarching importance of direct paths when compared to interaction effects and the salience of technology-related beliefs and behavioral confidence as drivers of consumer choice.

The f^2 values highlight the effect sizes in the model and are shown in Table 7. The largest effect is from ECBB to CD, with an f^2 value of 1.454, indicating ECBB's strong impact on CD. The effects of NTB on ECBB (0.234) and SE on ECBB (0.233) are moderate. In contrast, SA's effect on ECBB is smaller (0.041), suggesting a weaker influence. ECBB has the strongest

effect on CD. The remarkably large f^2 effect size of the ECBB-CD relationship suggests a high degree of conceptual and empirical similarity between the constructs since ECBB represents behaviors immediately preceding consumer decision-making. The HTMT results also reflect this conceptual closeness. VIF values within the acceptable range confirm that multicollinearity does not undermine the structural model's estimates.

Table 7: Path coefficients

Paths	f^2
ECBB → CD	1.454
NTB → ECBB	0.234
SA → ECBB	0.041
SE → ECBB	0.233

ECBB = e-compulsive buying behavior, CD = cognitive dissonance, NTB = need to belong, SA = social acceptance, SE = self-esteem.

The findings show a positive correlation between ECBB and the need for SA. They also align with the literature, which suggests that individuals engage in social comparison to appraise or improve aspects of themselves (Crusius et al., 2022). This further derives social identity and the pursuit of SA (Festinger, 1957), paving the way for CBB (Islam et al., 2018). Furthermore, the findings show a significant positive correlation between NTB and ECBB, aligning with past literature indicating that NTB prompts individuals to purchase goods they believe will enhance their status, appearance, or inclusion within specific social contexts (Schiffman et al., 2010). The positive correlation between ECBB and CD is also supported by the literature, which indicates that compulsive credit card purchases are associated with greater consumer guilt (Dugar et al., 2014).

In addition, the literature highlights that a positive relationship between hedonic and utilitarian shopping experiences in online advertisements triggers consumer guilt (Chauhan et al., 2020). SE's moderating role in the impact of SA and NTB on ECBB did not show an effect, thereby requiring us to reject these hypotheses. Cultural and contextual factors account for these findings and consist of social expectations, peer dynamics, and the online environment of SNS engagement, which diminishes SE's moderating effect.

5. Discussion of Findings

The current study's sample consists of educated women who experience peer influence and receive social support, i.e., there is no effect of low SE as a driver of CD. This phenomenon also aligns with the literature, suggesting that the effects of SE are mitigated due to contextual factors and social support (Yang & Brown, 2016). Furthermore, in collectivist cultures, SE tends to be shaped by interpersonal relationships and is closely tied to maintaining social harmony and gaining group approval rather than being rooted in individual autonomy or personal expression (Markus & Kitayama, 2014). As a result, SE may play a less central role in influencing behavior and decision-making in the Pakistani cultural context, where social belonging and acceptance are already strongly emphasized and deeply ingrained.

The findings further highlight that ECBB works as a catalyst to gain social approval rather than as an individual's self-evaluation mechanism. SE's moderating effect is absent in the findings, demonstrating the notion that in collectivist cultures, behavior is affected more by social factors than by personal self-evaluation (Markus & Kitayama, 2014). Hence, CD could arise from inconsistencies between socially driven buying behavior and post-purchase self-expectations. This would be consistent with self-discrepancy theory.

This study provides novel implications and contributes to the knowledge base, as CBB has already been investigated with psychological and social variables like impulsivity (Müller et al., 2015), anxiety and mood disorders (Paul et al., 2015), stress (Luigjes et al., 2019), personality traits (Gibbs & Oltmanns, 1995), substance use disorders (Mancebo et al., 2009), and social comparison (Attiq & Azam, 2015). Despite this, the current study addresses untouched dimensions in psychological and behavioral contexts, such as the role of NTB and SA in ECBB.

Furthermore, the current study investigates whether an individual's level of SE influences the strength or direction of the relationship between the need for belongingness and ECBB, as well as between SA and ECBB. SE has previously been studied as a moderator between perceived discrimination and psychological distress among women (Corning, 2002). Its moderating effect on women's responses to social comparisons has also been explored. However, the current study

provides a novel domain exploring the role of SE in moderating the relationship between NTB, SA, and ECBB.

These findings may increase public awareness concerning the potential psychological, physical, and social challenges related to ECBB and seeking online SA and belongingness. In this regard, the government could initiate public health initiatives and social media literacy programs, including financial literacy and impulse control training, to raise awareness among women of the psychological factors underlying ECBB. Moreover, the government could enhance users' and policymakers' understanding of the drivers of compulsive buying and support the development of protective interventions.

The findings may also guide SNS administrators in creating platforms that support users' psychological wellbeing, so that users, rather than seeking online social approval and belongingness, use such forums for productive and constructive purposes. For example, platforms could implement digital prompts or 'pause before purchasing' reminders to help curb impulsive buying behaviors driven by emotional triggers. To address digital overconsumption, policymakers, mental health professionals, and digital administrators should collaborate to design guidelines that raise public awareness of ECBB's consequences. Our findings also suggest that marketers and digital e-commerce platforms should develop product campaigns that emphasize authenticity, utility, and consumer wellbeing, rather than promoting social influence, comparison, or status enhancement. It is recommended that products not be promoted in a manner that manipulates audiences to boost their social status and incur economic burdens. Addressing these concerns may help stakeholders build a constructive society. In this regard, ethical campaigns may help consumers refrain from engaging in ECBB. Moreover, due to the association between social approval needs, ECBB, and CD, initiatives are recommended to mitigate platform-induced social comparison and emotionally stimulated consumption. E-commerce interfaces could integrate design features backed by empirical evidence, e.g., reminders to postpone buying or reduce social validation signals to minimize ECBB among women. Additionally, awareness strategies could help women identify community-driven buying drivers that intensify post-purchase dissonance.

6. Conclusion

The current study reports that SA and NTB factors significantly increase ECBB. Furthermore, ECBB behavior has a significant positive relationship with CD; the more involved a person is in ECBB, the more they indulge in CD. Despite this, SE does not show any moderating effect on online SA and the need for belongingness in relation to ECBB due to contextual and cultural aspects. These include normative social factors, peer influence, and the context of SNS engagement. The sample population of the current study comprises educated women with peer influence and social support. Thus, low SE does not affect the growth of CD.

The study has several limitations and offers suggestions for future research. First, the sample consists exclusively of women. Future studies could benefit from including a more diverse sample, incorporating both genders. Additionally, since the current sample is limited to educated women, future research could explore qualitative interviews with women with lower literacy levels to assess SE's influence on ECBB in a different demographic. Second, the study relies on self-reported measures, which may be subject to bias. Third, the study's cross-sectional survey approach may inflate the risk of common method variance, which could overstate the relationships between constructs. Future studies could address these limitations by using multi-method approaches and longitudinal designs.

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The Legality of AI-Generated Art: Copyright Ownership and Current Developments

Dinesh Deckker
Doctoral candidate,
Department of Science and Technology,
Wrexham University, Wrexham,
United Kingdom.
Email: deckker.dinesh@gmail.com
(Corresponding Author)
ORCID ID: 0009-0003-9968-5934

Subhashini Sumanasekara
Doctoral candidate
Department of Computing and Social Sciences,
University of Gloucestershire, Cheltenham,
United Kingdom
Email: ssumanasekara@gmail.com
ORCID ID: 0009-0007-3495-7774

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Abstract: *The emergence of AI-generated artwork is challenging traditional notions of authorship, originality, and ownership. As a result, copyright norms worldwide are being reassessed. This study covers four major jurisdictions: the US, the European Union, the UK and China, through current theories and recent court cases. The data shows that the US and European Union adhere to strict rules that require human authorship, while the UK and China are exploring more flexible models. We also examine industry responses and issues of privacy and ethics in relation to the unlicensed use of copyrighted material for AI training. Based on the research on responsible AI and frameworks that prioritize transparency, fairness, and privacy, we suggest that a new legal category for machine-assisted creativity should be established. This would recognize both human creators' dignity and economic interests while emphasizing joint authorship. The analysis concludes with recommendations for the visual arts sector, including enforceable rules that require transparency around terms and conditions, a licensing system, ethical audits, and global governance of the sector through organizations such as WIPO.*

Keywords: AI-generated art, copyright law, machine-assisted creation, intellectual property, ethical governance, cyber risk.

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The Legality of AI-Generated Art: Copyright Ownership and Current Developments

1. Introduction

AI technologies have developed faster than expected in recent years, compelling creative industries to rethink the concepts of authorship and copyright. Generative models, such as DALL-E, Midjourney and Stable Diffusion, can produce artworks that are visually complex and conceptually sophisticated, comparable to those of human artists (Ploennigs & Berger, 2023). As a result, AI tools have sparked debate worldwide over how copyright should adapt in the age of machine creativity, particularly regarding authorship, originality, and ownership.

Historically, copyright law has been grounded in human-based principles that require demonstrable creativity and intention to warrant protection (Hugenholtz & Quintais, 2021). This implicit framework has come under increasing strain as AI systems produce artefacts that are entirely independent of human thought. Leading courts and copyright offices, notably in the US, the European Union (EU), the UK and China, have struggled with these questions, resulting in a variety of approaches (Zhuk, 2024). However, although the US and EU maintain the requirement of human authorship, the UK and China have adopted more lenient positions in some instances, recognizing authorship where there has been a significant human contribution (A&O Shearman, 2023; US Copyright Office, 2023). This international disparity reinforces the pressing need for better coordinated frameworks (Akpuokwe et al., 2024).

This study makes a scholarly contribution on three fronts. First, it identifies measures across four principal jurisdictions and provides insights into how courts and legislatures perceive authorship and originality in the context of AI-generated art (Gaffar & Albarashdi, 2025). Second, it connects theoretical concepts—authorship theory, economic incentive theory, deontological ethics, and posthumanism—to modern legal disputes, such as *Thaler v. Perlmutter*. (Ginsburg & Budiardjo, 2019). Third, it recognizes a new category, that of 'machine-assisted creation', for emerging technologies as an authentic form of creativity that would benefit both human creators and machines.

Exploring some recent developments and research on the ethical use of AI systems, as well as the cyber-vulnerabilities of generative models in critical sectors, Radanliev et al. (2024) highlight urgent threats to data integrity, data attribution, and cyberattacks related to AI in creative fields. To prevent intellectual property theft or the exploitation of private information, differential privacy, federated learning or ethical audits of generative AI are crucial. Based on this, Radanliev (2025) argues that transparency, fairness, and privacy should be necessary at all stages of the AI development process within an interdisciplinary ethical framework.

Different international perspectives—that of the EU, US and China—complicate governance efforts while underlining the need for global coordination on creators' rights and innovation protection efforts. Understanding these issues, which cannot be separated from copyright, authorship, and industry disruption, is key to any changing legal position (Zhuk, 2024). This study is guided by several key research questions that structure the legal, theoretical, and policy analysis, as outlined in Table 1.

Table 1: Research questions

Thematic area	Research questions
Legal foundations and jurisdictional analysis	To what extent do current copyright laws across jurisdictions recognize or reject the authorship of AI-generated art?
	How do legal interpretations differ among the US, the EU, the UK and China?
Authorship, ownership, and originality	Who should be considered the rightful author or owner of AI-generated artwork—the developer, the user, or another party?
	Can AI-generated works meet the legal threshold of originality in the absence of human intent?
Case law and institutional practice	What do key legal cases such as *Thaler v. Perlmutter* and *Naruto v. Slater* reveal about the limitations of current copyright doctrine?
	How are copyright offices adapting to disputes involving AI-generated content?
Ethical, economic, and industry implications	What ethical concerns arise from training datasets, attribution, and fair compensation?
	How are creative industries—particularly artists and developers—responding to the rise of AI in art?
Theoretical and policy development	Which legal and ethical theories best support the creation of new copyright categories, such as 'machine-assisted creation'?
	What future legislative models could balance innovation with the protection of human creativity and dignity?
Future research and governance	What types of longitudinal and intervention-based studies are needed to guide adaptive frameworks?
	How can ethical standards be standardized internationally?

We begin with a review of the foundations of copyright law and its application to AI-generated works. The study then examines the rise of AI in the creative process, followed by an analysis of copyright challenges, legal precedents, and ongoing cases. The subsequent sections evaluate legislative developments, industry perspectives, and theoretical frameworks, before moving on to future research directions and policy recommendations. The conclusion proposes urgent measures for industries most affected by AI-generated art.

2. Methodology

This study employs a narrative review methodology, combining doctrinal legal research with an interdisciplinary analysis of the literature in law, ethics, and creative industries. The first method involves reviewing primary legal sources such as statutes, case law, and policy documents. In contrast, our interdisciplinary review builds on the scholarship pertaining to intellectual property, ethics, and computer science. This method is also suitable, given the rapid pace at which AI is being used in art production, allowing for conceptual exploration and comparative synthesis (Chesterman, 2025).

We analyze the US, EU, UK and Chinese jurisdictions as the leading legal regimes influencing the global discourse on AI art at present. While the US and EU have established restrictive human authorship standards, the UK offers a designation for computer-generated creations under the Copyright, Designs and Patents Act 1988, while China has recently adopted a hybrid conditional recognition model (Guadamuz, 2017; Zhuk, 2024). These jurisdictions also reflect approaches that struggle to converge and diverge in meaningful ways, making them useful for a comparative assessment of public policy.

To ensure rigor, sources were drawn from a balanced range of materials, including peer-reviewed journal articles, high-impact legal commentaries, policy reports, and landmark judicial decisions such as *Thaler v. Perlmutter* (2023) and *Naruto v. Slater* (2018). Our review emphasizes recent scholarship, with more than 20 percent of references published in the last three years (2022–25), thereby ensuring contemporary relevance. The key search terms for this methodology are described in Table 2.

Table 2: Key search terms

Theme	Search terms
AI and copyright	AI-generated art, artificial intelligence AND copyright, AI AND authorship
Originality	Originality AND generative AI, human authorship AND originality
Legal cases	Thaler v. US Copyright Office, Naruto v. Slater, machine-assisted creation AND copyright
Intellectual property	Machine learning AND intellectual property, AI AND ownership, dataset transparency AND copyright
Generative models	Stable diffusion OR DALL·E OR Midjourney AND ownership, GANs AND creative industries

The search was conducted across multidisciplinary databases, including Google Scholar, SpringerLink, SSRN, IEEE Xplore, and legal repositories such as Westlaw, LexisNexis, and official government copyright offices and news reports for the latest developments. Boolean operators (AND, OR) were applied to broaden and refine search results, and purposive sampling ensured inclusion of the literature most relevant to copyright ownership, originality, and ethical concerns in AI-generated art.

This narrative review, however, has several limitations. The legal landscape is rapidly evolving and, therefore, the interpretations presented here may soon be outdated (Feuerriegel et al., 2024). Additionally, while the analysis encompasses four major jurisdictions, it notably omits some smaller yet significant regions, such as Japan and Canada, which are not only major players but also provide important perspectives. The doctrinal analysis is also limited by the fact that there are significantly few judicial precedents. The study also overlooks the non-Anglophone literature on transnational private law, which may limit some of its analyses. Thus, comparing what constitutes an original and creative work is not straightforward, given the varying legal systems, as what is original and innovative is often a matter of dispute and depends on the context (Millet et al., 2023). Despite its limitations, the paper offers a comprehensive overview of the literature and asks important questions about the regulation of AI art.

3. Literature Review

With the development of AI systems, the area of copyright law has been increasingly impacted by legal scholars and litigators alike (Zhuk,

2024). This review draws together contemporary academic and legal studies to present copyright concerns related to AI-generated artworks.

3.1. Foundations of Copyright Law and Artistic Ownership

The purpose of copyright law is to protect the rights of human creators against unauthorized use or misrepresentation of their works, based on specific criteria (Bridy, 2015). According to Hugenholtz & Quintais (2021), such frameworks, which are human-focused and have been ratified in many countries, rely on the concepts of 'originality' and 'authorship', which require human creativity and moral judgment. However, since AI machines can generate increasingly complex creative works without human input, this challenges the notion that creativity is a unique human trait. This presents problems that existing legal regimes cannot handle.

The EU copyright framework exemplifies this tension. In 2009, the EU Court of Justice laid down a new standard of 'originality' that is, 'the author's own intellectual creation' in *Infopaq International A/S v. Danske Dagblades Forening*. The authorship standard becomes increasingly difficult to apply to machine-generated outputs that lack human intent (Hugenholtz & Quintais, 2021). Experts claim that this inflexibility has caused the so-called protection gap—a term coined for AI-generated works for which it is uncertain who owns the rights (Feuerriegel et al., 2024). As in the UK, US doctrine and practice, as illustrated by *Thaler v Perlmutter* (2023), hold that works with no human author cannot be copyrighted (US Copyright Office, 2023).

Academics also argue that merely condemning AI authorship is not sufficient in the long term. This is a reasonable concern, as when large datasets train AI systems, they can produce human-level creativity, and this uniqueness cannot be assessed through traditional personality-based tests or 'creative choice' standards (Anantrasirichai & Bull, 2021). This has prompted authors such as Radanliev (2025) to suggest that new forms of intellectual property protection need to be developed—such as 'machine-assisted creation'—to address ownership ambiguities without infringing on the rights of human creators.

Copyright disputes are now viewed through the lens of cyber risk, driven by new ethical considerations. According to Radanliev et al. (2024), the use of generative models trained in sensitive, proprietary works is more likely to result in data leaks, unauthorized use, and privacy violations.

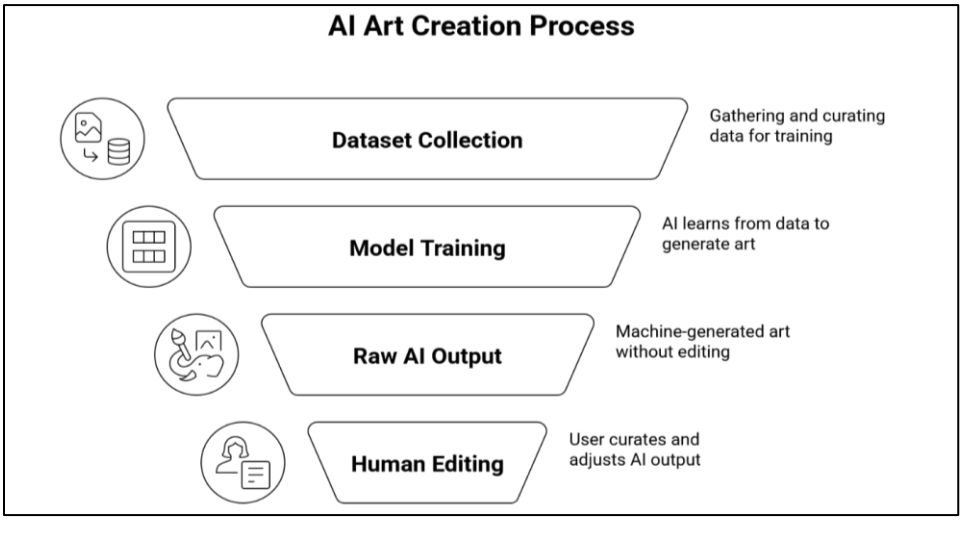
Addressing the risks that these systems pose cannot depend solely on changes to copyright law. Instead, it should incorporate safeguards such as differential privacy, transparency standards, or fairness-aware algorithms.

3.2. The Rise of AI in the Creative Process

With the emergence of advanced generative models, such as generative adversarial networks, diffusion models, and transformer-based architectures, it is now possible to produce visually stunning works using simple text prompts (Ploennigs & Berger, 2023). Tools such as DALL·E, Midjourney, and Stable Diffusion have streamlined the creation of artistic work, making high-quality art accessible to both professionals and enthusiasts. As Cheng (2022) observes, the 'computational imagination of machines' has blurred the line between tool and artist.

These tools, however, throw up important questions about human involvement. As noted by Oppenlaender (2022), human users remain involved in the co-creation process through prompt engineering, curation, and post-processing, even if an AI tool has carried out the generative work (Figure 1). As a result, hybrid models of authorship are being developed that utilize both machine and human capabilities to create art. Such models can make it difficult to discern the actual authorship, primarily because AI-generated imitations of existing styles occur without the authors' consent (Jiang et al., 2023).

Figure 1: AI art workflow diagram



One concern pertains to cybersecurity challenges. Radanliev et al. (2024) report that the use of AI platforms in sensitive areas may displace human artists or creators, potentially increasing data theft or other forms of wrongful claim theft. A second concern is that image and text generation training require considerable effort, which could lead to various creative sectors being exploited. In the absence of federated learning, transparency audits, and privacy-centered data governance, this could amount to noncompliance. Other problems arise not only from ownership but also other ethical issues, including whether biased outputs are being replicated and concerns regarding cultural appropriation and fair compensation of human creators (Radanliev, 2025). Because AI tools enable people to generate new art, those who would not otherwise be able to do so, now can (Feuerriegel et al., 2024). As a result, professional artists have expressed concerned about being displaced by algorithm-generated artworks in galleries, e-commerce platforms, and publishing venues.

3.3. Copyright Challenges of AI-Generated Art

There is significant friction between copyright systems that rely on human authors, which are becoming increasingly irrelevant, and the rapidly growing volume of AI-generated content (Li, 2025). The necessity for human will and creative thought continues to exclude purely AI-generated works from protection in both the US and EU (Hugenholtz & Quintais, 2021; US Copyright Office, 2023). This was reaffirmed in *Thaler v. Perlmutter* (2023), in which the court determined that a work created entirely by Stephen Thaler's 'Creativity Machine' was not copyrightable because nothing that was not human could be considered an 'author'. While this position is clear in doctrine, it leaves valuable creative work in legal limbo, with no rights holder.

It is also problematic if AI systems are trained to use data that includes copyrighted prints without the consent of rights holders. As Jiang et al. (2023) state, this creates derivative works that compete with the original without crediting or compensating the artists who created them, raising ethical and economic concerns. Therefore, courts and policymakers must decide whether originality or transformative use should be permitted under copyright law.

The inclusion of cyber risks amplifies this challenge. The literature finds that AI models, trained in the use of sensitive data, risk copying or violating intellectual property rights (Radanliev et al, 2024). When AI

systems violate copyright on a grand scale and fail to employ privacy-preserving techniques (such as homomorphic encryption or differential privacy) during their development phase, ethical frameworks that emphasize transparency, fairness, and accountability become necessary (Radanliev, 2025). Copyright challenges undermine human-centered ideals; unless adapted, traditional copyright standards will continue to leave a rapidly growing body of work unprotected by law, while also failing to safeguard human creators from the risks posed by generative systems.

3.4. Legal Precedents and Ongoing Cases

Various landmark judicial decisions and ongoing litigation have increasingly shaped the legal treatment of AI-generated art. Together, these cases highlight the continuity of human-authorship requirements and the emergence of new legal theories addressing unauthorized training data and hybrid authorship (Table 3).

Table 3: Key legal cases

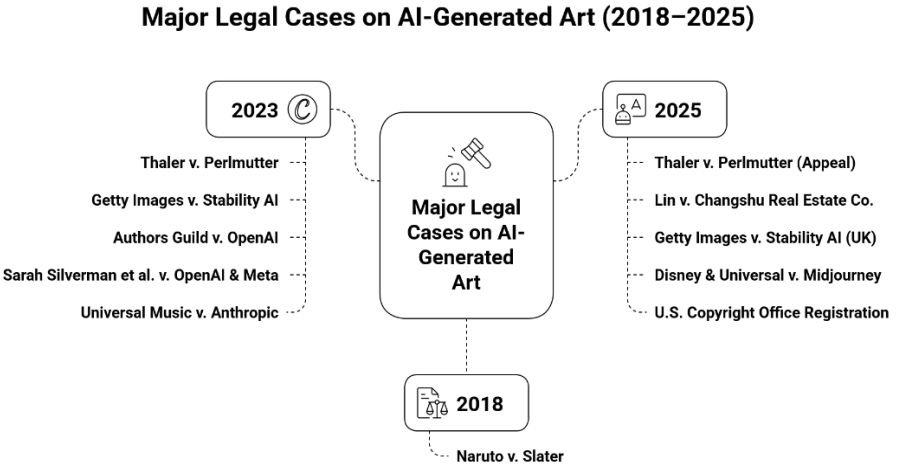
Case	Plaintiff(s)	Defendant(s)	Year	Claim summary	Legal status / outcome
Getty Images v. Stability AI	Getty Images	Stability AI	2023	Alleged unauthorized use of copyrighted images for AI model training.	Pending in UK and US courts (Pinsent Masons, 2025).
Authors Guild v. OpenAI	Authors Guild	OpenAI	2023	Alleged derivative infringement using literary works for ChatGPT training.	Ongoing (*Authors Guild v. OpenAI*, 2023).
Sarah Silverman et al. v. OpenAI and Meta	Sarah Silverman and others	OpenAI, Meta	2023	Unauthorized use of books in AI training datasets.	Ongoing (*Sarah Silverman v. OpenAI*, 2023).
Universal Music Publishing Group v. Anthropic	Universal Music, Concord, ABKCO	Anthropic	2023	An AI chatbot reproduced copyrighted song lyrics.	Ongoing (*Universal Music v. Anthropic*, 2023).
Andersen v. Stability AI	Andersen et al. (artists)	Stability AI, Midjourney, DeviantArt	2023	Training without consent using artists' works.	Direct copyright claims allowed to proceed.
New York Times v. OpenAI and Microsoft	The New York Times	OpenAI, Microsoft	2023	Alleged direct and contributory infringement by using NYT articles for AI training.	Ongoing (*New York Times v. OpenAI and Microsoft*, 2023).

The 2023 wave of litigation focused on unauthorized training-data use, with plaintiffs ranging from individual authors, such as Sarah Silverman, to major organizations, including The New York Times and Universal Music Publishing Group. These cases underline growing industry concerns about the uncompensated use of copyrighted content for AI training purposes. By 2025, attention had shifted toward the judicial clarification of authorship standards. In *Thaler v. Perlmutter* (2025), the DC Circuit reaffirmed that copyright requires a human author, effectively excluding autonomous AI works (Carlton Fields, 2025). In contrast, in the Chinese 'Half-Heart' case (*Lin v. Changshu Real Estate Co.*, 2025), the court granted copyright where the user had demonstrated substantial human input in the creative process (Chatterton et al., 2025). This divergence illustrates international inconsistency: US law remains rigid while Chinese jurisprudence has evolved toward conditional recognition. Table 4 describes these cases and recent developments, further illustrated in Figure 2.

Table 4: Recent developments in legal cases

Case	Jurisdiction	Holding	Significance
Thaler v. Perlmutter (2025)	US (DC Cir.)	Denied copyright to fully AI-generated work; human authorship required.	Confirms strict US standard
Lin v. Changshu Real Estate Co. ('Half-Heart' case, 2025)	China	Granted copyright for AI art where a human user provided substantial iterative input.	Shows China's growing recognition of 'substantial human input' (Chatterton et al., 2025).
Getty Images v. Stability AI (2025, UK)	UK	Getty withdrew its copyright claims and pursued trademark infringement for the use of watermarks.	Highlights liability concerns for training data provenance
Disney & Universal v. Midjourney (2025)	US Federal Court	Filed over reproduction of copyrighted franchise characters without consent.	Major studios are challenging AI under fair use and derivative work doctrines
US Copyright Office Registration (2025)	US	Registered 'A Single Piece of American Cheese' after confirming sufficient human contribution.	Marks shift toward nuanced recognition of AI-human collaboration.

Figure 2: Major legal cases (2018–25)



Despite this, industry litigation has continued to intensify. The *Getty Images v. Stability AI* proceedings in the UK demonstrate how difficult it is to prove infringement tied to training data provenance (Pinsent Masons, 2025). Disney and Universal's lawsuit against Midjourney is a critical test of how copyright law applies to AI-generated outputs that resemble established intellectual property (BBC, 2025). Finally, the US Copyright Office's (2025) registration of 'A Single Piece of American Cheese' reflects a more nuanced policy shift toward recognizing AI-human collaborative works, provided that substantial human authorship is documented. Collectively, these cases highlight the shortcomings of current copyright doctrine and underscore the need for global regimes that balance protecting human creative rights with accommodating the imperatives of AI art.

This duality at the core of AI-generated art is reflected in the rapidly changing legal landscape, which seeks to balance the belief that human authorship has intrinsic value with a new model of hybrid creation that considers the degree of human involvement in the creative process (Li, 2025). Together, these cases highlight three key developments: (a) the reaffirmation of the human authorship principle in the US and EU, (b) conditional recognition of human/AI co-creation in some instances in China and the UK, and (c) a growing wave of industry litigation over unauthorized training data.

3.4.1. US: Human Authorship as an Absolute Requirement

The DC Circuit clearly expresses the US stance in *Thaler v. Perlmutter* (2025). A recent ruling states that copyright cannot apply to works created entirely by AI, clarifying that legal terms such as 'author' imply human involvement and a capacity for legal responsibility and moral accountability (Carlton Fields, 2025). This approach is deontological, emphasizing moral duty rather than a utilitarian goal aimed at promoting innovation. Nonetheless, critics see this strict stance as risky, arguing that it could result in valuable works entering the public domain without proper credit or payment (Chesterman, 2025). It also creates a significant obstacle to future efforts to secure recognition for AI authorship without legislative intervention.

3.4.2. China: Substantial Human Input as a Threshold

In contrast, the decision of the Changshu People's Court in *Lin v. Changshu Qin Hong Real Estate Development Co., Ltd. and Hangzhou Gauss Air Film Technology Co., Ltd*—commonly referred to as the 'Half-Heart' case—awarded copyright protection to an AI-generated image due to the user's involvement in iterative prompting, aesthetic judgment, and editing (Chatterton et al., 2025; MMLC Group, 2024). This case represents a pragmatic approach that is consistent with utilitarian ethics, in which protection is granted when human creativity significantly influences the output of AI. It also aligns with post-humanist theory by acknowledging creativity as being distributed across human and machine actors (Sarkar, 2023). The ruling indicates China's openness to experimenting with more flexible standards of originality. This may serve as a model for other jurisdictions seeking to balance stringent human-authorship doctrines with the realities of hybrid creation.

3.4.3. UK: Data Provenance and Secondary Liability

Getty Images v. Stability AI (2025) reflects the UK's emphasis on the legality of data acquisition for training purposes. Although Getty withdrew its primary copyright claims, it continued to pursue secondary infringement and trademark claims arising from the unauthorized reproduction of watermarked images (Pinsent Masons, 2025). The case highlights a doctrinal shift from questions of authorship to questions of input legitimacy, specifically whether AI developers may lawfully use copyrighted material without explicit licensing. Section9(3) of the Copyright, Designs and Patents

Act 1988 already allows recognition of computer-generated works by attributing authorship to the 'person making arrangements'. However, Getty illustrates that attribution alone does not resolve the underlying problem of data provenance.

3.4.4. Industry Litigation: Expanding the Battlefield

Cases such as *Authors Guild v. OpenAI* (2023) and *The New York Times v. OpenAI and Microsoft* (2023) demonstrate how traditional publishing industries are mobilizing to prevent the uncompensated appropriation of their content for large-scale model training. Similarly, *Universal Music Publishing Group v. Anthropic* (2023) reflects the music industry's concerns over generative AI reproducing copyrighted lyrics verbatim. Disney and Universal's 2025 lawsuit against Midjourney moves this conflict into the realm of high-value franchise content, thereby questioning the threshold for transformative use in an era where AI can convincingly replicate established styles (BBC, 2025). These legal suits have encouraged courts to establish more precise standards for derivative works in the context of AI.

3.4.5. Emerging Policy Implications

The cases discussed above highlight both convergence and divergence in AI regulation (Li, 2025). The US and EU share strict, human-centered doctrines, while China and the UK differ by recognizing AI outputs conditioned on human input or arrangements (Zhuk, 2024). This lack of harmonization risks creating a fragmented legal landscape, thereby encouraging forum shopping, which would weaken global enforcement and leave creators uncertain of their rights across borders. Additionally, litigation over unauthorized training data exposes a gap in current copyright law: although the authorship of AI outputs is debated, the legitimacy of input—how AI models acquire and process copyrighted works—is insufficiently regulated. Studies such as Radanliev (2025) emphasize that without incorporating transparency, fairness, and privacy measures, copyright law reforms will be incomplete and remain vulnerable to ethical and cyber risks.

3.5. Industry and Artist Perspectives

Most designers and artists use generative tools such as Midjourney, DALL·E, and Stable Diffusion to expedite their workflows and access new forms of creativity, which has also democratized visual art (Ploennigs &

Berger, 2023). According to various surveys, more than 60 percent of digital artists now use AI, primarily to be more efficient and explore new creative possibilities (Oksanen et al., 2023). Nonetheless, many remain fearful of job losses, the devaluation of human labor, and threats to creativity (Jiang et al., 2023).

A major risk is the unauthorized copying of artistic styles. Feuerriegel et al. (2024) explain how several generative models, without permission, have produced lookalikes of works found in the portfolios of living artists. This implies that a living artist's financial security or reputation could be severely compromised. Moreover, training AI models in creative works can infringe copyright laws and is expected to create numerous legal disputes. There is also a difference in attribution standards in terms of ethicality. Radanliev et al. (2024), for example, point out that the use of often opaque large datasets for training may expose artists to intellectual property infringement and cultural appropriation.

Since systemic exploitation could become a significant threat in the absence of adequate privacy protection and data governance, Radanliev (2025) advises developing guidelines for technologists on the ethical implications of the technology they create. Likewise, to ensure that technology empowers all stakeholders in the creative economy, it is vital to develop an ethical focus on transparency and fairness from the outset. In this sense, market dynamics reflect both disruption and opportunities. Galleries and online spaces increasingly showcase AI art, with auction houses having made record sales of AI art in 2024/25 (Epstein et al., 2023). While this can create new opportunities for new audiences, it also puts downward pressure on the market price of human artists. This has a significant impact on mid- and early-career artists, where originality is the primary factor in competition. Additionally, when people prefer human-made art, music and effects despite the high quality of any AI used to generate the same outputs, this creates an ironic situation where AI art is commercially successful, but where people still see human-made art as more 'authentic' (Bellaiche et al., 2023).

3.6. The Future of Intellectual Property in the AI Era

The future of intellectual property law regarding AI-generated art depends on how lawmakers and courts balance technological innovation with the need to protect human creativity. Contemporary copyright laws are centered on human authorship, requiring intent and originality from

individuals (Hugenholtz & Quintais, 2021). However, as generative AI becomes more advanced, key questions arise about whether these laws can adapt to new forms of authorship and originality that involve both humans and machines.

One proposal is to establish a new legal category for machine-assisted creation (Chesterman, 2025). While this would not grant AI systems themselves authorship, it would recognize the human effort involved—such as guiding, prompting, and curating outputs—and the work of developers who create and train these models. By emphasizing meaningful human input and shared responsibility, this approach strikes a balance between rejecting AI-created works altogether and solely recognizing machine creativity. In this context, co-authorship models could prove important as they involve both the user and the AI developer sharing rights. However, it also raises practical concerns pertaining to credit, licensing, and the distribution of royalties. Critics also argue that AI systems could infringe on the moral rights of human artists by interfering with the integrity of their work.

Economic and ethical concerns further complicate the matter. Radanliev (2025) believes that future laws should ensure transparency, fairness, and privacy. Lack of disclosure with regard to training data sources and strong protections against cultural misappropriation risks the legal recognition of AI outputs for unethical actions. Cybersecurity studies highlight the dangers of intellectual property infringement, including patent rights, and systemic failings. This is particularly true for AI platforms that do not adopt privacy-preserving measures, such as federated learning and differential privacy (Radanliev et al., 2024). In this case, market trends are expected to accelerate reform initiatives. Art markets—galleries, auction houses, and online platforms—increasingly display AI-generated works (Epstein et al., 2023). Although there is still a bias favoring human-made art, the increasing commercial success of AI art makes excluding it from copyright protection less plausible.

International cooperation and harmonization are therefore essential to ensure a sustainable legal future as AI advances. Currently, different regions adopt contrasting approaches—strict anthropocentrism in the US and EU, conditional recognition in China, and flexible models in the UK—which could lead to a disjointed global system prone to forum shopping and inconsistent enforcement (Zhuk, 2024). Consensus-based frameworks, potentially led by international bodies such as the World

Intellectual Property Organization (WIPO), are essential to developing common standards for attribution, data transparency, and ethical governance. Without such coordination, creators and industries will face prolonged uncertainty, which will undermine both innovation and trust in the creative economy.

3.7. Review of Relevant Theories

The debate over AI-generated art and copyright law is underpinned by several theoretical frameworks that help illuminate competing legal interpretations and policy choices. These theories intersect directly with recent case law and policy debates.

First, traditional authorship theory views the creator as the source of originality and moral accountability, making human intent indispensable for copyright (Bridy, 2015). This principle guided the US court's decision in *Thaler v. Perlmutter* (2025), which denied copyright to AI-generated works on the grounds that machines lack consciousness, intention, and the ability to bear legal responsibility (Carlton Fields, 2025). While this ensures respect for human creative dignity, critics argue that it leaves a legal vacuum for increasingly sophisticated AI outputs that cannot be clearly attributed to a single human (Chesterman, 2025).

From another perspective, copyright is also justified as a mechanism for promoting creativity by ensuring that creators receive economic returns. Under this framework, developers and users of generative AI, who invest resources to design models or create prompts, should receive rights as compensation for their contributions (Chesterman, 2025). The case of *Authors Guild v. OpenAI* (2023) highlights this tension. OpenAI claimed that its training methods promote innovation. At the same time, authors demanded compensation for the use of their works without payment, emphasizing the economic incentive perspective on the creators' side.

Moreover, deontological ethics stresses duties and rights over outcomes. From this perspective, attributing authorship to AI raises ethical issues because machines cannot meet the moral responsibilities of rights-holders, such as respecting moral rights or being accountable (Hacker et al., 2023). This viewpoint reflects the US Copyright Office's (2025) stance that only humans can be considered authors, even when AI produces original work. It also underpins concerns in cases such as *Andersen v. Stability AI*

(2023), where artists claimed that training AI without their consent infringed on their inherent rights, regardless of the AI's creative output.

Finally, posthumanism views creativity as a productive partnership between humans and machines, transcending the traditional human-centric perspective. This perspective demonstrates that the law is evolving to recognize creations made by people with the assistance of AI. Sarkar (2023) argues that protecting works that receive sufficient human input demonstrates that creative agency can be shared to a certain degree. In this sense, the establishment of a new legal category of 'machine-assisted creation' accounts for human contribution and algorithm contribution.

4. Future Research Avenues

The regulation of AI-generated art is a rapidly evolving area. As we have seen above, the future of copyright law can be shaped through a combination of legal reasoning, empirical research, and moral thinking. Even though courts and policy decisions have been made with human interests in mind, technology continues to change and preemptive action is thus necessary.

Long-term studies based on real-world evidence are crucial to understanding the impact of AI on creative practice, commercial trends, and legal scenarios. According to Oksanen et al. (2023), much of the literature focuses on short-term responses to technological change. Therefore, we still do not know whether the hybrid authorship business model will persist. A longitudinal dataset composed of a subjective metric (whether people view AI art as supporting or suppressing a human artist) and an objective metric (how much public perception of 'originality' changes) could be useful in this context. In addition, this data could help establish which conditions, such as regulations like the EU AI Act or China's copyright policy, are created to the detriment or benefit of artists' inputs and cultural production.

Experimental intervention studies may also be worth considering. Test-driving frameworks, such as machine-assisted creativity, compulsory licensing of AI training data, or fair attribution processes through pilot interventions, would enable policymakers to assess the feasibility of such interventions before deploying them (Chesterman, 2025). For example, introducing generative AI tools to specific artist communities could reveal perceptions of control, that is, who benefits and from what type of sharing

they would benefit most. Such findings could inform the creation of laws and the establishment of ethical guidelines.

In addition, future research efforts must place ethical governance at their center. Radanliev et al. (2024) indicate that the risks of data leaks, bias, and the erosion of cultural plurality are features of toxic AI use. To avoid any legal disputes concerning the application of AI-created art to further unethical practices, it is essential to ensure better monitoring through the enforcement of transparency, fairness, and privacy principles (Radanliev, 2025) in the relevant experimental policies. Creating ethical guidelines based on bioethics could also help establish international standards for AI-created art.

Finally, without harmonized regulations, differences between strict anthropocentric models, such as those in the US and EU, and conditional approaches, as in China and the UK, may lead to forum shopping and legal uncertainty for global creators (Akpuokwe et al., 2024). WIPO and other agencies could follow up these discussions with evidence, and a consensus could help codify international copyright categories and ethical standards.

5. Conclusion

This study has shown that AI-generated art challenges conventional ideas of authorship, originality, and ownership. The US and EU have imposed stringent regulations on AI companies, mandating proof of human creation, whereas the UK and China are more lenient or conditional. Court cases such as *Thaler v. Perlmutter* (2025) and China's 'Half-Heart' case reflect this pattern, highlighting both the limitations of established frameworks and the potential of new, machine-assisted practices. In this regard, industry reactions are mixed. AI art platforms present new avenues for creative engagement and greater market interest. However, artists are concerned that such technology may lead to job losses, a decline in public recognition, and cultural consequences. Ethical concerns and cyber risks further complicate the situation. Indeed, it is possible that creators might be exploited, and data vulnerabilities may arise due to unclear training methods.

The industry is highly dependent on appropriation, attribution, and reputation. Prompt action must be taken to solve these problems. Laws must state that training data should be as clear as possible. AI developers should disclose the source of their data, while unauthorized use must be penalized.

This openness would allow artists to identify and counteract the misuse of their works. In addition, licensing agreements must be in place for platforms that utilize artists' works to train their systems, ensuring that royalties and/or credit are attributed to the original creator. Auction houses, galleries, and online marketplaces could also ensure better transparency, fairness, and privacy for AI-crafted art through regular ethical audits (Radanliev, 2025).

It is also important to acknowledge hybrid rights. When a human being takes an active role in steering AI-generated art, they should be considered a co-author. As Chesterman (2025) points out, art organizations must create industry governance frameworks that establish codes of ethics for the responsible use of AI, grounded in bioethics principles, thereby ensuring the protection of human dignity and the cultural values of society (Vinchon et al., 2023). This step will ensure that human artists are better protected while promoting the development of AI and creativity.

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Impact of Empowering Leadership on Helping Behavior: A perspective of Moral Obligation and Islamic Work Ethics

Omer Azam
PhD Scholar,
Faculty of Management Sciences, FMS
International Islamic University, Islamabad, Pakistan.
Email id: omer.phdmgt107@iiu.edu.pk
(Corresponding Author)
ORCID ID: 0009-0009-7458-8832

Hafiz Ghufran Ali
Associate Professor,
Faculty of Management Sciences, FMS
International Islamic University, Islamabad, Pakistan.
Email id: hafiz.ghufran@iiu.edu.pk
ORCID ID: 0000-0003-2091-5489

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Abstract: *This study examines the impact of empowering leadership on helping behavior, the mediating effect of moral obligation, and the moderating effect of Islamic work ethics, based on social cognitive theory. For this purpose, we have collected data using simple random sampling with a sample size of 250 respondents. The unit of analysis constitutes frontline employees and senior managerial staff in the hospitality industry in Islamabad, Rawalpindi, and Khyber Pakhtunkhwa to improve the generalizability of the results. We find that empowerment is a process by which managers extend value and self-confidence to their employees, encouraging them to work ethically and honestly and to exhibit helping behavior at work. Social cognitive theory is used to underpin our conceptual model, positing that people learn and acquire behavior by observing others. Our findings reveal that hospitality workers express concerns about helping behavior, which is an effective strategy for increasing employee satisfaction and providing services that distinguish them from their competitors.*

Keywords: Empowering leadership, helping behavior, moral obligation, Islamic work ethics, social cognitive theory.

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Impact of Empowering Leadership on Helping Behavior: A perspective of Moral Obligation and Islamic Work Ethics

1. Introduction

Leadership behavior is regarded as a key antecedent for organizational citizenship behavior. Empowering leadership is directly linked to employees' service-oriented leadership style, which is positively associated with transformational leadership and the extra-mile role, aligning with the concept of social exchange (Auh et al., 2014). The literature suggests that leaders' empowerment exists primarily within the formal management structure, focusing on building trust and the authority granted by subordinates. This is where customer-empowering behavior occurs directly within the service delivery process. This is considered an area where leaders cannot continuously exert influence, which results in giving more autonomy, authority, and a sense of participation to employees at critical moments (Chen et al., 2024). Empowered leaders are exceedingly beneficial to organizations, encouraging employees to perform ethically, which in turn improves work performance.

According to the World Happiness Report for 2022, prosocial activities—such as helping, supporting, and donating—have increased globally since the Covid-19 pandemic compared to the period between 2017 and 2019 (Rowan, 2022). Hence, this study focuses on various trends, including prosocial behavior and employee wellbeing. Prosocial behavior is defined as a voluntary action that benefits others or society, demonstrating extra-mile behavior without personal gain (Gilbert & Basran, 2019). It includes helping, sharing and showing concern and empathy, bringing positive outcomes to the workplace. The empirical evidence suggests that this has beneficial effects, such as making others happy, prosocial spending on others, and even kindness-based meditations, which increase employees' prosocial engagement (Chen et al., 2024).

A key concept associated with prosocial behavior is the Islamic work ethic (Alqhaiwi et al., 2024). Past studies have highlighted the significance of Islamic work ethics, which define a set of principles and moral values, such as kindness and loyalty. The teachings of the Quran and Sunnah emphasize that Muslims should work hard by applying Islamic teachings and Quranic

law to their everyday life. Teachings on Islamic work ethics promote honesty and transparency, which are beneficial for all followers. Islamic ethical values differ from the Western concept of ethics in terms of beliefs, values, and their perception as they focus on the importance of the environment, which is an essential part of Islamic values and beliefs (Khalid et al., 2024).

Islamic work ethics encourage employees to voluntarily demonstrate positive conduct, such as being cooperative when others are in need and recognizing the importance of putting effort into activities that benefit other human beings. Strong Islamic work ethics can translate into an enhanced propensity for engaging in positive behavior and increased wellbeing, as such behavior fuels intrinsic joy and drives satisfaction (De Clercq et al., 2019). Islamic work ethics thus direct employees to demonstrate responsibility, fulfill their mandate, make rational decisions, and show honesty, faith, and discipline at work (Suryani et al., 2023). According to Akhmadi et al. (2023), Islamic work ethics are also associated with positive intentions and proactive behaviors, including organizational citizenship behavior, helping behavior, employee voice behaviors, innovative behavior, thriving in the workplace, and knowledge-sharing behaviors.

A meta-analysis by Gotowiec & van Mastrigt (2019) shows that there is a positive relationship between prosocial behavior and an individual's moral values. Helping a friend, participating in organizational voluntary programs, raising sustainability awareness, donating blood, showing concern, empathizing, and sympathizing are all examples of prosocial behavior. Morality is defined as the degree to which prosocial behavior is fundamental to a person's identity.

This study, grounded in social cognitive theory (SCT), analyzes the relationship between empowering leadership and employees' helping behavior, with moral obligation mediating this relationship. We further determine how Islamic work ethics moderate the relationship between empowering leadership and employees' moral obligation. SCT has made an important contribution to the processes of cognition, substitution, self-reflection, and self-regulation. In the field of organization, three aspects of SCT have received special attention: cognitive skills, behavioral and social abilities, and cultivating people's beliefs in their abilities to apply them effectively (Zhao & Zhou, 2021).

This study adds to the literature on employee helping behavior in the context of empowering leadership in the hospitality sector. This includes employees' proactive or reactive actions that respond to the needs of individuals at work. For example, customers may show distinctive needs and hospitality employees often go the extra mile to accommodate them. This helping behavior is a non-routine aspect of job behavior. Moreover, hospitality services often comprise concentrated, sequential efforts made by employees across various departments. Building teamwork and association is thus crucial for the successful delivery of services, which demonstrates that helping behavior is positively associated with service quality, organizational effectiveness, employee participation, and customer satisfaction (Hwang et al., 2021).

The first part of this study aims to assess the relationship between empowering leadership and employees' helping behavior by incorporating mediating and moderating models of moral obligation and Islamic work ethics. Following this, we review the literature relevant to our targeted variables of empowering leadership, helping behavior, moral obligation, and Islamic work ethics through the theoretical lens of SCT. The third part of the study discusses the study's methodological design. This is followed by a discussion of our findings and their implications.

2. Literature Review and Hypothesis Development

SCT provides a useful theoretical background for our conceptual model. It describes prosocial behavior as a form of behavior that is learned through the process of socialization and observational learning. Hence, these social behaviors are shaped through social interactions or through social learning processes. These social learning principles and patterns operate in the same way across different types of behaviors, demonstrating the same effect for prosocial and antisocial behavior (Busching & Krahé, 2020).

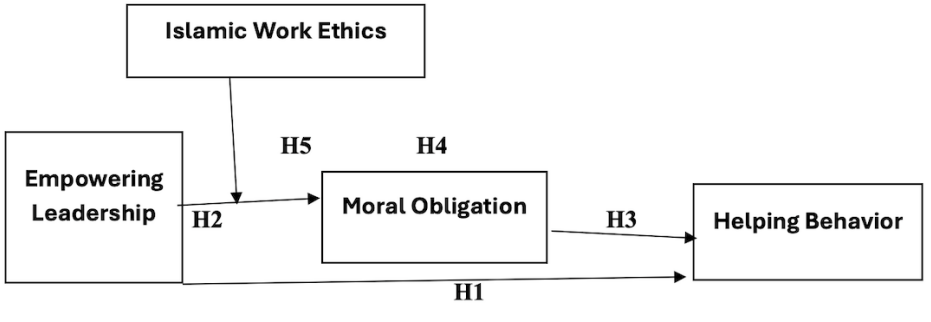
Drawing on SCT, when individuals are empowered, they are given authority, autonomy, and ownership to carry out their responsibilities and make useful decisions at the workplace (Sukoco et al., 2022). Moreover, SCT identifies various types of helping behavior that rely on social cognitive capacities as well as various types of motivation. Helping, showing concern for people, and comforting others reflect a recognition of psychological states such as anxiety, emotional distress, unmet desires, and unfulfilled goals that require distinctive behavioral responses. This is done by

sacrificing one's own limited resources and providing verbal or physical support to others (Stout et al., 2021). According to SCT, individuals' behaviors are shaped by their self-regulation, which can be influenced by moral standards and a code of conduct based on self-sanctioning. Moral standards such as Islamic work ethics thus activate cognitive self-regulatory processes and enforce moral obligation practices (Alqhaiwi et al., 2024).

2.1. Conceptual Model

Helping behavior is a voluntary mechanism through which employees and co-workers share useful information, fulfill customer requests, and address personal matters to outperform in the organization (Hwang et al., 2021). We propose that empowering leadership is statistically significant and positively related to employees' helping behavior. There is also a positive indirect effect whereby moral obligation mediates between empowering leadership and helping behavior. Additionally, Islamic work ethics moderate the positive association between empowering leadership and moral obligation, as shown in Figure 1.

Figure 1: Conceptual framework based on SCT



2.2. Empowering Leadership and Helping Behavior

Empowering leadership delegates authority to subordinates and fosters self-control, self-responsibility, and self-autonomy, thereby enhancing internal motivation (Chiang & Chen 2021). According to the literature, there is also a negative side to empowering leadership. For instance, studies have found that leaders' empowering behavior positively increases job performance, voice behavior, organizational commitment, knowledge-sharing behavior, and employees' extra effort. However, increasing evidence suggests that empowering leadership is not always beneficial in the workplace. For instance, a close examination of the concept

shows how these behaviors might lead to outcomes that are less positive and even negative (Sun & Akhtar, 2022).

Prosocial behavior is considered helping behavior in which people help others without expectation, for example, by giving their time to charities or caring for family and friends (Pfattheicher et al., 2022). Empowering leadership can positively influence the helping behavior of employees, leading to organizational citizenship behavior (Wang et al., 2023).

According to SCT, individuals do not learn every behavior that they observe, except for behaviors that can produce valued outcomes. SCT states that empowering leaders help achieve better task performance goals by underscoring affiliated helping behaviors, thereby helping to improve the effective functioning of the organization. In turn, employees experience competence and a sense of learning that can increase helping and set moral values at work (Chen et al., 2020).

In addition, empowering leaders in the top management motivate employees to show authority and autonomy in the workplace, which also helps the latter voice their thoughts. This helps employees understand the goals of the organization, letting them envision how their work contributes to it (Makwetta et al., 2021). Empowering leaders thus create interpersonal relationships that are beneficial for effective operations (Sun & Akhtar 2022).

Empowering leadership delegates authority and offers employees more autonomy in problem-solving and decision-making processes through which the latter perceive themselves as having a higher status at the workplace. In response to this behavior, they will repay the organization by engaging in extra-role behavior (Wang et al., 2023). Therefore, we form the following hypothesis.

H1: Empowering leadership is positively related to employees' helping behavior.

2.3. Empowering Leadership and Moral Obligation

Empowering leadership refers to behavior directed at individuals or teams in which authority is delegated to employees, thereby promoting self-directed autonomous behavior (Lin et al., 2023). Moral obligation occurs

when a person participates in a specific act born out of their obligation to perform prosocial behavior. This is then taken to be an individual predisposition—a tendency to help another individual in the workplace (Müller et al., 2021).

According to social exchange theory, individual behaviors are shaped by self-sanctions and a moral code of conduct. These underlying codes of conduct activate the individual's cognitive self-regulation processes for adhering to moral standards (Alqhaiwi et al., 2024). According to the literature, empowering leadership heightens followers' propensity to achieve the organization's mission, which involves the extent to which a follower feels a moral obligation to support such a mission. Empowering leaders foster favorable relationships marked by moral obligation and reciprocity, whereby followers are encouraged to repay their leaders in ways that benefit the organization (Wang et al., 2023). Decuypere & Schaufeli (2021) identify various styles of leadership, including servant, authentic, ethical, and empowering leadership. These styles share a common goal: to be a moral manager who supports employees' self-determination. This helps foster positive exchange among employees and supportive behavior. This aligns with shifts from more inspirational to more moral leadership, with a framework that actively relies on ethical norms, values, morality, empathy, and service. Accordingly, we present the following hypothesis:

H2: There is a positive relationship between empowering leadership and moral obligation.

2.4. Moral Obligation and Helping Behavior

Moral obligation is defined as the obligation of an individual to perform or not perform an act. The literature indicates that when an individual engages in unethical behavior, they are more likely to consider their own feelings of moral obligation and responsibility than external pressure (Lai et al., 2024).

Employee helping behavior is a voluntary act that helps coworkers overcome behavioral and work-related barriers that indirectly affect the organization. It aims to meet the organization's needs by achieving high performance levels. This can include meeting goals and objectives, sharing resources, and cooperating with colleagues. Improving employees' helping behavior is considered an effective strategy for increasing customer

satisfaction by offering more competitive services (Zhao & Guo, 2019). Additionally, as Müller et al. (2021) observe, an individual's moral and personal norms are strong determinants of prosocial behavior. Based on this discussion, we present the following hypothesis.

H3: Moral obligation is positively related to employees' helping behavior.

2.5. Empowering Leadership, Moral Obligation and Helping Behavior

As discussed above, empowering leadership focuses on increasing employees' participation in decision-making and on providing greater autonomy. This, in turn, can lead to high in-role behavior (Kundu et al., 2019). Moral obligation concerns the extent to which an employee feels obligated to act morally or immorally when faced with an ethical dilemma and has a strong impact on their ethical behavior and decision-making. Empowering leaders thus develop favorable relationships that are marked by strong mutual obligation and reciprocity at work (Zhang et al., 2021).

In the hospitality industry, extra-mile and helping behaviors are directed toward sharing useful information and fulfilling extraordinary requests. The literature on employees' helping behavior underscores the importance of corporate social responsibility activities, leader-member exchange behavior, job satisfaction, and servant leadership.

Prosocial behavior is associated with a broad range of behaviors such as helping, sharing, and cooperating, in which employees consider it a moral obligation to benefit others or themselves (De Groot & Steg, 2009). In addition, employees sense a moral obligation to respond to social exchange behaviors. Individuals who engage in moral behavior or pro-organization behavior are more likely to gain long-term benefits from their organization (Wang et al., 2023). Based on the above discussion, we derive the following hypothesis.

H4: Moral obligation mediates the relationship between empowering leadership and helping behavior.

2.6. Moderating Role of Islamic Work Ethics

Islamic work ethics denote the fundamentals of what is right and wrong according to the teachings of the Quran and Sunnah. They also promote the self-interest of individuals economically and psychologically by

increasing the latter's social prestige and reaffirming their faith. Ethics in Islam cover all facets of life—moral, physical, and spiritual. Practicing Islamic work ethics prevents employees from misusing their empowerment in the workplace (Mubarak et al., 2002).

Organizations can increase their overall effectiveness to the extent that they rely on voluntary employee behavior, which enables employees to outperform in the workplace, while Islamic work ethics enhance collaboration and promote morally responsible conduct (De Clercq et al., 2018). Employees who show concern for moral obligation in their organization are also, in one sense, aligned with Islamic work ethics (Wu et al., 2021). Accordingly, we present the following hypothesis:

H5: Islamic work ethics moderate the relationship between empowering leadership and moral obligation.

3. Research Methodology

3.1. Research Design

This section describes the sampling techniques used, the size of the sample, time horizon, measurement of scale items, and unit of analysis. Our aim is to derive causal relationships in the context of empowering leadership by identifying the mediating effect of moral obligation and the moderating role of Islamic work ethics on employees' helping behavior.

The data collected is quantitative and our research approach deductive. We have used simple random sampling techniques to acquire responses that help reduce the likelihood of introducing selection bias. The level of analysis centers on front-line employees and managerial staff in the hospitality sector, including hotels, restaurants, travel agencies, and event management firms based in Islamabad, Rawalpindi, and Khyber Pakhtunkhwa.

A sample of 250 respondents was drawn following Hair et al. (2017), who use the rule-of-thumb method for better generalizability of results. This is a longitudinal study that relies on a time lag method in which primary data is collected at three different intervals (T1, T2, and T3). At T1, data on demographic factors and empowering leadership was collected (with a response rate of 70%). At T2, data on moral obligation and Islamic work

ethics was collected (with a response rate of 80%). At T3, data on helping behavior was collected (with a response rate of 75%). The analysis was carried out using various statistical tools and packages, including SPSS (V.23.0), Process Model 4, and SMARTPLS (V.4.1.1). The analytical methods used included reliability, convergent validity and discriminant validity, followed by a descriptive analysis. Other techniques included Pearson correlation, structural equation modeling, discriminant analysis, regression analysis, and process model 7. These techniques were used for direct, indirect, and moderation analysis.

3.2. Scales and Measures

All items were measured on a five-point uniform scale ranging from 1 (strongly disagree) to 5 (strongly agree), given that the Likert scale is considered an effective method for measuring employee behavior. All validated items were adapted from previously recognized scales to ensure the validity and reliability of the key variables.

Items measuring empowering leadership (EL) were measured using a 20-point item scale adapted from Na-Nan et al. (2020). The scale reliability of these items was measured using Cronbach's alpha, which yielded a value of $\alpha = 0.75$, considered sufficient. Moral obligation (MO) was measured using an eight-point item scale adapted from Beugre (2012). The scale reliability of this item was $\alpha = 0.88$ (Axtell et al., 2007). Helping behavior (HB) was measured using four-point items, the scale reliability of which was measured using Cronbach's alpha, which was highly significant ($\alpha = 0.79$). The Islamic work ethics variable (IWE) was measured using a 17-item 17-point scale adapted from Islam et al. (2021). The scale reliability of this variable was $\alpha = 0.95$, indicating high reliability.

4. Results and Analysis

4.1. Normality of Data

Once the coding and data entry was completed, we assessed the conditions for data normality. Linear relationships were assumed for the independent and dependent variables involved in this study. All outliers and residuals were detected and removed from the dataset to meet the conditions for data normality. All missing values were duly filled and handled using various strategies and the arithmetic mean of the scale items. No

multicollinearity was observed, as only a single independent variable was involved in this study, and the data did not follow the multivariate analysis.

To make the data normal, the computed variables were taken to their positive square roots, natural logs, and inverses, and randomness was assessed using descriptive statistics and measures of central tendency. Herman's single-factor test was conducted to assess the presence of common method bias using SPSS V.23. This test assesses whether the data was collected from a single source with the same study population at the same time. The total variance explained after extracting the sum of square loadings was found to be 35.46%, which is less than 50%, confirming that there was no problem with CMB in the existing dataset.

4.2. Pearson Correlation Analysis

EL has a strong relationship with HB ($r = 0.142^*$, $p < 0.01$), providing initial evidence to support H1. Furthermore, we observe that EL is positively and significantly associated with MO ($r = 0.255^{**}$, $p < 0.01$), which provides initial support for H2. We see that the relationship between MO and HB is positive and significant ($r = 0.509^{**}$, $p < 0.01$), which allows us to accept H3. In addition, the mediating relationship between HB and the outcome is positive and significant ($r = 0.426^{**}$, $p < 0.01$), which supports H4. The moderating relationships are also found to be positive and significant ($r = 0.499^{**}$, $p < 0.01$, and $r = 0.569$, $p < 0.01$), which provide initial evidence supporting H5 (Table 1).

Table 1: Correlation and scale reliability

Var	1	2	3	4	5	6	7	8	9	10
Gender	1									
Age	-.304**	1								
Education	-.170	.578**	1							
Experience	-.398**	.627**	.517**	1						
Income	-.693**	.042	-.184**	.97	1					
Firm size	-.391**	.552**	.327**	.442**	-.026	1				
EL	-.308**	-.183**	-.52	-2.81**	534**	.35	1	(.755)		
MO	-.516**	.013	.268**	.158**	.244**	.255**	.155**	1	(.86)	
IWE	-.294**	-.374**	-.217**	-.258**	.308**	.167**	.499**	.569**	1	(.96)
HB	-.562**	.206**	.361**	.115**	.191**	.142**	.426**	.509**	.42**	.95

Note: Correlation is significant at $r = 0.00^{**}$ and $p < 0.001$ where $N = 250$. The scale reliability of related variables is stated in parentheses. ** = correlation is significant at the 0.01 level (2-tailed).

4.3. Control Variables

The demographic factors involved in this study were held constant to limit the influence of outcomes. Variations in demographic elements were controlled for, using one-way ANOVA. A control variable test was conducted on the variables HB and MO, controlling for all demographic factors involved. The results of the one-way ANOVA test for the difference in means among groups indicate a significant difference in HB (dependent variable) across gender ($F = 81.16$, $p < 0.05$), education ($F = 57.51$, $p < 0.05$), experience ($F = 8.70$, $p < 0.05$), income ($F = 94.92$, $p < 0.05$), and firm size ($F = 68.70$, $p < 0.05$), but no significant difference was found for age ($F = 17.1$, $p > 0.05$). Similarly, the results obtained for MO (mediating variable) using one-way ANOVA showed a significant difference across gender ($F = 44.74$, $p < 0.05$), age ($F = 9.54$, $p < 0.05$), education ($F = 81.12$, $p < 0.05$), experience ($F = 32.02$, $p < 0.05$), and firm size ($F = 31.13$, $p < 0.05$), but no significant difference for income level ($F = 56.70$, $p > 0.05$) (Table 2).

Table 2: One-way ANOVA test results

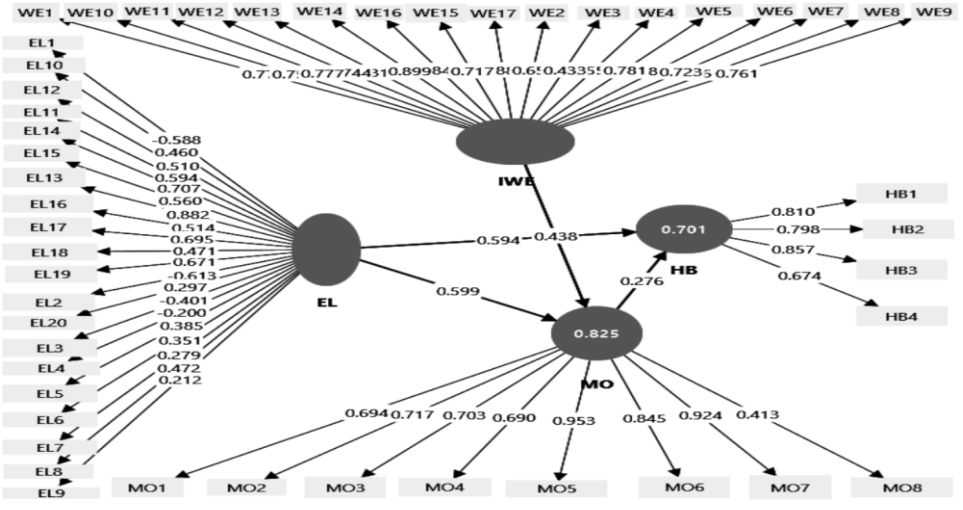
Sources of variation	HB		MO	
	P value	F-Stat	P value	F-Stat
Gender	.000	84.2	.000	44.74
Age	.054	17.10	.003	95.37
Education	.000	57.51	.000	81.12
Experience	.002	8.71	.000	32.02
Income level	.000	94.92	.061	56.70
Size of organization	.001	68.70	.001	31.13

HB = helping behavior, MO = moral obligation.

4.4. Path Analysis Diagram (Reporting Measurement Model)

Figure 2 illustrates the confirmatory factor value of the default model for direct and indirect relationships for 49 scale items representing four variables, including EL, HB, MO, and IWE. These were obtained using SMRTPLS (V.4.1.1). All factor loadings are > 0.30 and the structural equation model estimates are retained and accepted as items. The PLS-SEM path coefficients show that the regression values between EL and HB were 0.594, between MO and HB were 0.276, and between EL and MO were 0.599. For the moderating variable IWE, the value was 0.438.

Figure 2: Graphical output of full measurement model



4.5. Reliability and Convergent Validity

Table 3 summarizes the reliability and convergent validity results of the constructs. Cronbach's alpha (α) and composite reliability (CR) were considered acceptable with values surpassing 0.70, signifying high reliability. The internal consistency for each construct was also deemed acceptable as it met the necessary requirements. A convergent validity test requires standardized loadings and the instrument exhibits convergent validity, with AVE loadings meeting established norms across constructs at the specific level.

Table 3: Reliability and convergent validity

Construct	A	CR	AVE
EL	0.75	0.884	0.273
HB	0.79	0.840	0.621
IWE	0.95	0.965	0.561
MO	0.88	0.914	0.577

α = Cronbach's alpha, CR = composite reliability, AVE = average variance explained.

4.6. Discriminant Validity

Table 4 presents the discriminant validity results by utilizing the HTMT and Fornell-Larcker criterion. The HTMT ratio measures the average correlation among items within the same construct and across constructs

that fall within 0.9. We use the Fornell-Larcker criterion to evaluate the square root of the AVE for inter-construct correlation. The highest AVE of the HB variable was found to be 0.823, whereas the AVE of IWE was lowest at 0.749, respectively.

Table 4: Discriminant validity results

Construct	HTMT ratio			Fornell-Larker criterion			
EL				0.523			
HB	0.842			0.823	0.788		
IWE	0.641	0.553		0.526	0.583	0.749	
MO	0.843	0.870	0.660	0.829	0.768	0.752	0.760

EL = empowering leadership, HB = helping behavior, IWE = Islamic work ethics, MO = moral obligation.

4.7. Preacher and Hayes Process (Model 7)

In Table 5, the results indicate that EL is positively and significantly related to HB, as 43% of the variation in HB is accounted for by EL (p-value = 0.000; β = 0.327, p > 0.001). This supports H1. The relationship between EL and MO is also significant, with 65.5% of the variation in MO accounted for by EL (p = 0.025, β = 0.152, p > 0.001). Furthermore, the relationship between MO and HB is significant, as 71% of the variation in HB is accounted for by MO (p = 0.031, β = 0.370, p > 0.001).

Table 5: Direct effects of variables

Variable	β	R	R2	P	T	ULCI	LLCI
IV to DV							
EE to HB	.327	.426	.330	.000**	.9389	.008	-.054
IV to med							
EE to MO	.152	.655	.430	.025	17.31	.211	.094
Med to DV							
MO to HB	.370	.709	.503	.031	20.07	.415	.323

Note: Hayes Process model 7, p < 0.05, p value = 0.000 sig, t > 2, ULCI = upper-level confidence interval, LLCI = lower-level confidence interval, ** = significant, β = beta estimate, EL = empowering leadership, HB = helping behavior, MO = moral obligation.

Table 6: Conditional indirect effects of variables

Variable	Beta	Boot SE	Boot LLCI	Boot ULCI
EE, MO, HB	.494	.048	.396	.582

Note: N = 250, standardized indirect effects of X on Y, bootstrap = 5,000, LLCI = lower-level confidence interval, ULCI = upper-level confidence interval, EL = empowering leadership, MO = moral obligation, HB = helping behavior.

Table 6 presents the standardized indirect effect of x on y, along with the regression coefficients. We applied the Hayes PROCESS (model 4) to obtain the bootstrap estimate of the mediation of MO between EL and HB, supporting H4. This is further confirmed by the result of the regression coefficients, along with a beta estimate of 0.494, a boot SE of 0.048, and values LLCI = 0.396 and ULCI = 0.582.

Table 7: Moderated regression analysis

Variable	T	P	LLCI	ULCI
EL	8.627	.000	.283	.449
IWE	7.697	.000	.352	.596
EL*IWE	2.846	.000	.107	.204
R2	.520			
F	62.049			
P	.000			

Table 7 assesses the moderating role of IWE in relation to EL and MO to test H5. We observe that IWE tends to increase the effect on MO through EL, as the regression coefficients are found to be significant ($t > 2$ and $p < 0.05$). Hence, an empowering leadership style combined with moral obligation can be considered a significant predictor of Islamic work ethics. This is because the t-stat is greater than –2 and 2, and the p-value is also significant ($p < 0.05$). Therefore, the beta estimate is $\beta = 2.846$, confirming H5.

4.8. Graphical Interaction of Moderation Variable

By applying various terms of interaction between the independent variable and the moderating variable, we achieve the conditional effects of the independent variable on the dependent variable. Figure 3 depicts the positive interaction between IWE, EL and MO. This further validates our moderation hypothesis (see also Table 8).

Figure 3: Graphical interaction plots of moderation analysis

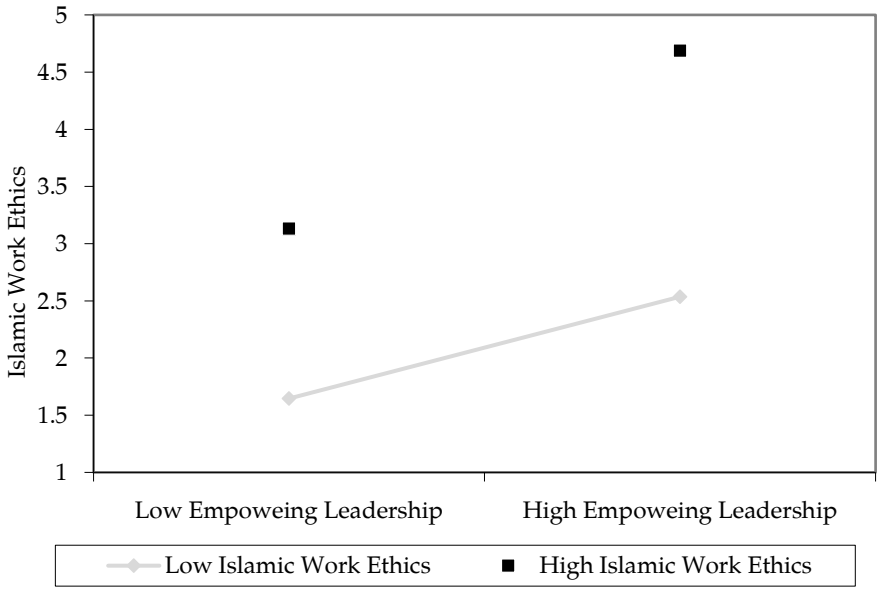


Table 8: Interaction term and moderation analysis

Variable	R2	F	DF1	DF2	P
EL*IWE	.081	47.118	1	396	.000

Note: N = 250, interaction term moderation analysis by multiplying EL*IWE. EL = empowering leadership, IWE = Islamic work ethics.

5. Discussion of Findings

Empowering leadership aims to shape team members' perception of their empowerment by delegating more autonomy, authority, and opportunities to them, thereby enhancing their citizenship behaviors. We find sufficient evidence to support the relationship between empowering leadership and employee helping behavior. The results of our first hypothesis are aligned with previous research (Li et al., 2017). This suggests that one way to unlock citizenship behavior is to share power among employees, in turn, enhancing their motivation as well as their adaptability, self-determination and self-efficacy. Positive leadership, including empowering leadership, has a significant positive influence on individual and team outcomes, increasing task performance, citizenship behavior, and other employee outcomes (Smallfield et al., 2020).

Likewise, the relationship between empowering leadership and moral obligation is significant and positive, thus supporting our second hypothesis. Empowering leadership creates an association between employees' formal job duties and in-role job performance. Employees perceive their organization as supporting them while supervisors trust them to perform their duties autonomously through high-quality exchange relationships that give employees a sense of moral obligation to reciprocate. This benefits the organization, which reinforces such exchange relationships (Hai & Park 2024). When empowering leadership encourages a moral obligation to the organization, this allows employees to make reasoned, independent, and responsive decisions at the workplace and uphold the organization's core values and principles (Zhang et al., 2021).

In addition, the relationship between moral obligation and helping behavior is significant and positive in line with De Groot and Steg (2009), who suggest that employees must be aware of behavioral consequences before feeling responsible for and acknowledging their own contributions. This relationship increases the employee's moral obligation to perform prosocial behavior. Thus, personal and moral obligation are taken as determinants of prosocial behavior. More importantly, employees who are committed to showing a sense of moral obligation are also committed to reciprocity. Employees who see that they are being cared for at work internalize their commitment to the organization and exhibit reciprocity and motivation, which may generate more extra-role behaviors (Leung, 2008).

The relationship between empowering leadership and helping behavior is mediated by the moral obligation to help the organization's employees. Empowering leadership enables participatory decision-making, provides information, demonstrates genuine concern for employees, and offers training. The result of our fourth hypothesis is in line with Lin et al. (2023), who combine ethics and performance judgments as individual determinants of empowering leadership. This helps support morally correct behavior and trustworthy job performance in the workplace, thereby encouraging leaders to take on the additional role of empowering behavior as a moral obligation.

Finally, the relationship between empowering leadership and moral obligation is moderated by Islamic work ethics, which are not only a religious obligation but also extend to moral, spiritual, physical, and worldly matters (Salahudin et al., 2016). The results of this study are in line with

Atiya et al. (2024), who argue that Islamic work ethics are based on moral principles that determine what is right or wrong.

There is a significant relationship between religiosity and altruism, suggesting that religious beliefs and practices are strong motivators of helping behavior. This implies that individuals with a higher level of religious belief are more likely to engage in acts of kindness and helping others, driven by moral and ethical teachings. Empowering leadership, when combined with Islamic work ethics, enhances employees' job performance (Okafor et al., 2024).

6. Conclusion

This study contributes to the literature on the relationship between empowering leadership and employees' helping behavior—an issue that has not been studied adequately despite its importance for the productivity and functioning of organizations. We find a positive relationship between empowering leadership and employees' helping behavior. Moral obligation acts as a mediating variable between empowering leadership and helping behavior while Islamic work ethics increase the impact of empowering leadership. This study has important implications for organizations that wish to overcome bureaucratic constraints to strengthen employees' helping behavior.

In addition to making a theoretical contribution to the literature on empowering leadership, this study has several practical implications. First, empowering leadership can be achieved through better training and management coaching sessions. Senior management should inform employees of the negative implications of behaviors that could damage their performance (Asim et al., 2023). Helping behavior is also beneficial for increasing leaders' effectiveness. Employees may view helping behavior as a religious obligation, which increases learning when they believe that their supervisor can help complete tasks (Chen et al., 2020). Moreover, the literature on moral psychology suggests that morality-related beliefs and practices are precursors of ethical conduct, including helping behavior. Employees who feel a moral obligation engage in prosocial behaviors regardless of personal gains or losses (Hwang et al., 2021).

These findings should be considered in light of several limitations that present opportunities for future research. First, while we measured our

variables using a five-point Likert scale, future research could develop innovative scale responses that directly quantify the frequency of the associated variables, thereby increasing precision and applicability. Second, positive leadership styles such as empowering leadership foster friendly social interaction and increase job satisfaction, which can positively impact employees' mental state. HR departments and management executives should develop training programs, preferably with the assistance of experts, to distribute power among employees and develop their decision-making skills. Third, it is essential for future researchers to explore other types of discretionary and positive work behaviors, such as voice behaviors, ethical behavior, and organizational loyalty, under the influence of empowering leadership.

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Contact Info

Ms. Sadia Tabassam
Assistant Editor, Lahore Journal of Business
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