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Economic Determinants' Influence on the Scale Effect of Cross-Border Mergers and Acquisitions: A Comparative Study on Advanced and Developing Economies

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Abstract

This research paper explores the influence of globalisation and increasing economic interdependence on Cross-border mergers and acquisitions (CBM&A) in established and developing markets. It investigates how the economic status of a country impacts the encouragement or discouragement of CBM&As due to international strategic capital market developments. Addressing a research gap, this study empirically assesses the effects of economic growth drivers on CBM&As in advanced and developing nations. By categorising into small and large organisations based on their worth, a panel regression model is employed to examine the influence of GDP, the Employment rate (EMP), Market capitalisation (MC), Net export (X-M), and Inflation (I) on CBM&A agreements from January 2010 to December 2023. The findings indicate that GDP favours CBM&A agreements in large-scale organisations in advanced as well as developing countries.
Additionally, market capitalisation positively impacts all aspects except small-scale firms in advanced nations. However, the employment rate, net exports, and Inflation exhibit unfavourable effects on CBM&As in both advanced and developing nations. These findings have significant implications for potential investors and governments seeking strategic insights into implementing CBM&As.

Introduction

Mergers and acquisitions are crucial strategic agreements and businesses' dynamic strategies. In today's competitive era of business, firms are quick to expose their domestic and international plans and geographical strategies in terms of M&As (Datta et al., 2020). In the wake of the financial crisis, increased shareholder activism led to corporations being sold off entirely. Internal controls, organisational cultures, compensation of executives, and risk management practices gained attention due to the financial crisis (Ittner & Keusch, 2015). Some researchers describe this rise in CBM&As due to globalisation and growing economic integration among countries (Yang, 2015).

Domestic companies have followed CBM&As to gain synergy, i.e., obtaining and securing a firm's value (Erel et al., 2012; Ranju & Mallikarjunappa, 2019; Kumar et al., 2023). CBM&As differ from

domestic M&As due to institutional distances, cultural differences, lack of knowledge about local institutions, and legal procedures that increase the cost and risk for CBM&As (Yang, 2015). Unfavourable economic conditions, such as recession, depression, or limitations of capital, discourage international strategic changes (Vasconcellos & Kish, 1996). On the other hand, Petreski and Kostoska, (2007) expressed that growing economic conditions, cultural and managerial practices, liberalisation, and positive changes in capital markets enhance CBM&As (Vissa & Thenmozhi, 2023).

The impact of CBM&As on smaller-scale organisations can be offset by economic development i.e., institutional restraints relax when the economic development level increases, ultimately decreasing the scale effect of CBM&As and vice versa (Yu et al., 2020; Vissa & Thenmozhi, 2023). The country's National or per capita income, education level, and infrastructure are defined as Economic development (Meyer & Sinani, 2009). The economy is directly proportional to the level of national income, generating several financial resources for small businesses to pursue acquisition agreements. Increased urbanisation and higher education within the labour force help small businesses survive and compete with larger corporations. It enables small businesses to capitalise on contemporary technological advances to promote innovation, which improves their merger and acquisition success.

Moeller et al. (2004) and Moeller and Schlingemann (2005) agreed that the value of acquiring shareholders decreased in larger public acquisitions. Later on, Betton et al. (2008) and Alexandridis et al. (2017) are also likely to believe that Mergers and acquisitions radically decrease the shareholders' value for acquiring a firm more than it is created during deals. However, Alexandridis et al. (2017) found an improvement in acquiring firms' gains in more extensive mergers and acquisitions after the post-financial crisis period, i.e., post-2009 due to the positive development in the corporate governance structure that also resulted in more excellent reflection of improved merger & acquisition quality in larger deals. Changes in internal control systems influence management choices to make them more advantageous to shareholders, positively affecting acquiring funds and integrating post-merger procedures. Corporate policymakers have started directing toward more profitable and lucrative investment distributions that increase the value of acquiring firms (Deutsch et al., 2007).

Several studies are being undertaken on the nexus between CBM&As and economic growth, mainly in advanced nations. However, empirical research on developing nations is still being determined. Previously, it was hypothesised that advanced countries are ahead of developing economies because of their FDIs and the number of M&As (Wan, 2005). Later, developing economies were used to make M&A deals to enter the global market and elevated investment in Mergers and Acquisitions across the globe (Erel et al., 2012; Yang, 2015; Kukreja et al., 2022). Additionally, very few studies are available on economic development's effect on the scale effect of CBM&As (Bany et al., 2014; Du & Boateng, 2015). Our study differs significantly from previous studies in that we studied how economic development affects the size effect of CBM&As in the host nation, in contrast to advanced and developing economies, particularly for developing firm's investment and competitive decisions. For example, economic growth and interest rates can generate higher returns, attracting more foreign capital (Green & Meyer, 1997). This point is echoed by Oxelheim et al. (2001), who argue that macroeconomic factors are relevant to the overall cost of capital and should be treated as part of the overall concept of a firm's financial strength. This study examines corporations from India, a developing country, and the United States of America, an advanced country, to examine how economic growth affects the scale effect of CBM&As in both countries. We chose these nations based on their shifting trade openness.

For the following reasons, the use of a location-specific perspective is especially suited for this study. First, in providing the specifics that need to go into the location-specific advantages in the 1990s, Dunning (1980) indicated that the importance of macroeconomic variables is much greater now than 20 years ago due to the changing locational patterns, character, and geography of multinational activity. Moreover, by focusing on location theory, we may take advantage of macroeconomic effects, which constitute an essential element of location-specific benefits.

The remaining paper is arranged as follows. The second section contains theoretical research on the link between determinants of economic development and CBM&A transactions. The third portion includes the linear modelling methodology for accounting for macroeconomic results on CBM&As. The fourth portion reviews the modelling techniques used and summarises the findings of the study, and the last portion summarises the result, which also includes a discussion of the study's ramifications.

Literature Review

Size of the Organisation

CBM&As have recently received extensive attention from experts from various disciplines, including strategy, global enter prize, organisational behaviour, and economics, as a vital internationalisation approach. Theoretically, with splendid monetary and strategic possibilities and intents, multinational firms ought to generate extra prices and reintroduce their marketplace situations by accomplishing CBM&As (Haspeslagh & Jemison, 1991; Nalbantian et al.,2005). The efficiency with which large-scale organisations grasp these strategic and financial potentials to convert existing efficiencies into financial information successfully influences their value initiation. International firms require a larger, more experienced workforce and wealthy sources to persuade, collaborate and cooperate with subsidiaries to decrease and diversify the risk and for effective resource integration. The size of the firm is critical in both domestic and CBM&A transactions. The performance of the firms was positively affected after the acquisition (Wu et al., 2015). They observed that larger organisations' post-acquisition performance appeared to be superior to that of smaller ones. On the contrary, Kumar et al (2019) found that younger firms are most likely to be found in the liberalised era, and affiliated younger firms conduct CBM&As relatively faster. Furthermore, they discovered that in terms of CBM&As, unaffiliated organisations pursue competitive internationalisation.

In contrast, smaller-sized and less experienced corporations face several restraints in soaking up, integrating, or even reorganising sources, and for that reason, it is more challenging to manage significance in CBM&As (Madhok, 1997; Cui & Jiang, 2009; Fung et al., 2010). For instance, Pucik (2008) discovered that, compared to smaller multinational firms, large firms with more accrued knowledge and internationalisation experience could integrate the processes and cope with numerous managerial issues efficaciously, which increased their final performance.

After introducing merger and acquisition regulatory regimes, the European Union and China made conforming provisions for Merger and acquisition scales (Amewu & Alagidede, 2018; Yu et al., 2020). As a result of legal advancements, a substantial and well-established theoretical foundation exists for antitrust regulation, facilitating the potential for larger businesses to derive advantages from CB M&A activity in a straightforward manner. However, the imaginary foundation contradicts the academic research that finds an optimistic and pessimistic relationship between CBM&A and business growth.

Cho & Ahn (2017) examined 4720 CBM&As deals. They discovered a negative influence of target firm size on the anomalous collective rate of return, i.e., poorer market response perceived in bigger acquirer businesses. This shareholder value tends to grow for institutionally established acquirers. Conversely, Hu et al. (2020) expressed that deals valued over $500 m in international businesses destroyed shareholders' value in acquirer firms. However, they determine that acquirer businesses with robust acquisition expertise create positive anomalous yields on equities in both the long and short run.

Karels et al (2011) investigated the CBM&As between the U.S. and India in the context of whether the difference in CBM&As was due to the country's environment or the firm's characteristics and found a combination of results of U.S. and Indian acquiring firms where share prices of public and private firms varied after the M&As announcement. They observed that target acquirers from both countries were equally diverse. However, the market valuation of U.S. acquirers was more significant than that of India. Rather than buying publicly traded target organisations, both economies bought a substantial chunk of their interests in privately owned target firms. They discovered that purchasing Indian firms resulted in a negative and negligible irregular return for the U.S.

Economic development has a negative impact on the scale effect of CBM&As (Yu et al., 2020). It stated that although the economy is developing, it is not favourable for larger enterprises to make international acquisitions, as opposed to small-scale organisations, which are more likely to pursue overseas profits in order to grow. They also discovered that CBM&As from the home nation had a growing impact on the magnitude. Conversely, Aybar and Ficici (2009) found a positive influence of abnormal returns in large organisations on the announcement of CBM&As deals.

Foreign Direct Investment as a measure of CBM&As has been investigated that FDI positively affects economic growth, i.e., GDP in the short and long run, which encourages a reduction in technological gaps in emerging countries compared to advanced nations (Hudea & Stancu, 2012). Countries with a bigger

GDP encourage companies to participate in more acquisition deals Cartwright and Schoenberg (2006) due to the reallocation of economic resources with the intention of optimal usage. A high GDP encourages inward M&As because of greater demand and the possibility of higher profits within the host country (Globerman & Shapiro, 1999).

Merger and Acquisition deals get higher when the economy is booming and less when the economy is depressed (Choi & Jeon, 2010; Gan & Qiu, 2019; Kumar et al., 2023). He also states that the area and source of domestic and international acquirers differ across countries. In comparison, Gan and Qiu, (2019) and Lobanova et al (2016) expressed an adverse effect of FDI due to CBM&As on GDP per capita during the year of Mergers or Acquisitions and a positive impact only after one year. Ibrahim and Raji (2018) and Stefko et al (2022) also found negative variations in CBM&As inflows due to real GDP and Inflation in two different regimes of the U.K. Higher GDP discourages the acquisition of foreign firms as the cash reserves are usually utilised in acquiring local firms, increasing their sizes and expanding their influence in the Market (Chowdhury & Maung, 2018; Christofi et al., 2019).

CBM&As create downscaling in a variety of industries and weaken them. Employee turnover increases after an M&A because of increased uncertainty in the organisation, which negatively influences them. Instability in the organisations due to the M&A process causes psychological and behavioural impacts on employees (Sun et al., 2018; Cooke et al., 2021). Technical staff and senior management prefer to quit the organisation after mergers and acquisitions if they do not take significant measures to retain those employees (Liu et al., 2021).

Degbey et al (2021) expressed that domestic M&As increase the unemployment rate in each sector, though, from a foreign acquisition perspective, it only affects the service and construction industry. In weak labour-regulation countries, acquirers purchase labour-dependent firms, whereas, in stronger labour-regulation countries, they use CBM&As to enter new markets (Levine et al., 2019; Bandick & Koch, 2022).

Change in ownership due to M&As weakens the implicit and explicit contractual ties with the employees, which causes them to lose their job interests and wages (Levine et al., 2019; Bandick & Koch, 2022). However, leveraged buyouts with unrelated Private and non-private equities do not affect blue-collar employees and their wages, whereas related takeovers negatively affect employment (Benmelech et al., 2020). On the other hand, Hossain (2021) postulates that firms prefer to connect in the form of M&A with similar and well-connected human resource capital. Regarding this, the operating cash flows and the announcement returns increase after the merger deals occur in related human capital firms as wages and employment decrease, along with the increase in labour productivity and operating efficiencies (Dao & Bauer, 2021).

Firm limits are defined by national boundaries, which are convoyed by several frictions. Companies select target organisations to purchase resources in lower-cost nations to reallocate capital more efficiently. Bullish trend in the stock market encourages CBM&As (Chapcakova et al., 2022). Zhang et al (2020) expressed that in the short run, the stock performance of the firms increases right after the merger or acquisition deals. This gain in share value is sustained in the long term throughout the post-merger era. Firms tend to be more acquirers in those countries where the stock market and its market value have increased, while weak performer countries tend to target (Erel et al., 2012).

Macroeconomic factors influencing merger and acquisition activities

A growing economy leads to increased business activities, with M&As serving as a means of rapid business growth and macroeconomic environmental changes, thus impacting M&A deals (Ermolaeva, 2019). Macroeconomic factors shape the economy, and favourable macroeconomic conditions ensure growth (Fischer, 1993). Extensive research has shown that a country's investments are affected by economic stability. Given the effect of macroeconomic variables on M&A activity, this study selects the most important macroeconomic variables from the literature.

Gross Domestic Product (GDP)

GDP proxies the economic conditions, growth prospects, and local market size. A high GDP is associated with high profits and surplus funds, creating motivation for expansion (Ibrahim & Raji, 2018). Mixed results have been achieved regarding the effect of economy size on GDP on OMA for China, and it has been argued that latecomers utilise acquisitions to acquire strategic capabilities and attain competitive

advantage. Restrepo and Subramanian (2017) found that a U.K. outbound deal has a greater probability of completion when there is a growth in the target country's GDP. Li et al. (2019) found no impact of the target country's GDP on individual deal outcomes in Chinese firms' foreign acquisition attempts. He and Zhang (2018) found a positive impact of the target country's GDP on deal completion involving emerging firms as acquirers.

Employment Rate (EMP)

Lehto and Böckerman (2008) expressed that domestic M&A increase the unemployment rate in each sector, though, from a foreign acquisition perspective, it only affects the service and construction industry.

Furthermore, they particularised that the variation in employment rate is also influenced by the nature, nationality, and distance between the target and acquiring firm. In weak labour-regulation countries, acquirers purchase the labour-dependent firms, whereas, in stronger labour-regulation countries, they use CBM&As to enter new markets (Levine et al., 2019). Change in ownership due to merger and acquisition weakens the implicit and explicit contractual ties with the employees, which lose their job interests and wages (Shleifer & Vishny, 1988). However, leveraged buyouts with unrelated Private and non-private Equities do not affect the blue-collar employees and their wages, whereas related takeover negatively affects employment (Ughetto, 2023). On the other hand, Hossain (2021) postulates that firms prefer to connect in the form of M&A with similar and well-connected human resource capital.

Market Capitalisation (MC)

Studies show a strong positive correlation between market capitalisation growth and the volume of CBM&As. Larger market capitalisation tends to signal economic maturity and attract foreign firms seeking stable, scalable investment opportunities. This increase in market capitalisation often aligns with economic expansion, making it a prime determinant in scaling M&As within regions like the European Union and other financially liberalised markets (Stefko et al., 2022). The scale of M&A deals is also influenced by firm size and international experience. Larger firms with more accrued international knowledge often manage acquisitions more effectively, yielding positive post-acquisition returns. Conversely, smaller firms may face challenges in absorbing and reorganising resources, limiting their ability to capitalise on M&A activities fully (Cho & Ahn, 2017).

Net Worth (X-M)

Net exports also play a role in facilitating CBM&As by enhancing foreign exchange reserves and economic stability. Regions with higher net exports present opportunities for businesses looking to tap into a competitive and export-driven environment, making acquisitions in these markets strategically advantageous. These economies are more likely to attract M&A activity due to export surpluses' increased profitability potential and economic leverage (Globerman & Shapiro, 1999; Rossi & Volpin, 2004).

Inflation (I)

High Inflation harms the activities of consumers and investors. The inflation rate reflects internal economic tensions and future fiscal and monetary policy uncertainty (Boateng et al., 2017). . Higher Inflation negatively affects firms' Q (Tobin's Q is the ratio of a firm's market value divided by asset replacement cost), reducing investment returns and growing capital costs (Boateng et al., 2017). High Inflation is associated with greater uncertainty, deterring M&A activity (Todtenhaupt et al., 2020). However, a decrease in Inflation can lead to immense competition and an increased likelihood of abandonment. The financing forces and competition act in opposing directions for DMAs. Governments reduce the money supply by increasing interest rates. An increase in inflation hints at the possibility of an interest rate rise in the future, and firms speculate a change in revenues as the buying power of consumers gets impacted. The valuation of firms based on risk-free rates also changes in the discounted cash flow model. These changes can lead to an uncertain future; thus, firms reconsider their intent and commitment to the deal.

Theoretical framework

Dunning's location theory

In this study, the analysis of the macroeconomic influence on the trends of mergers and acquisitions is based on Dunning's location theory. Dunning (1980) eclectic paradigm focuses on the motivations of firms engaging in international production activities. According to this theoretical framework, a country's propensity to attract foreign investment can be attributed to three key components. These factors comprise the advantage of ownership, which encompasses a firm's capabilities and resources; location-specific advantages inherent in the target economy, which encompass both tangible and intangible resources fostering a favourable business environment; and organisational arrangements, which enable a firm to combine its ownership and location advantages to enhance its competitive edge.

Corporate control and market entry hypothesis

A recent study on domestic mergers and acquisitions Kinateder et al (2017) investigated both sides of domestic mergers and acquisition deals and found that target returns are negatively associated with preannouncement returns and firm size but positively related to GDP growth. On the other hand, Nguyen et al (2017) reported a broad-based and persistent result, which indicates that bidder returns might be more substantial for larger acquisitions and unrelated targets, irrespective of whether the transaction is domestic or cross-border.

Zhu et al (2011) consider domestic and cross-border acquisitions in emerging markets in an attempt to test the corporate control hypothesis and the market entry hypothesis, respectively. According to the corporate control theory, domestic acquisitions act as a corporate control market, improving the target companies' operational performance. As home acquirers are acquainted with the domestic market and likely to have superb information relative to foreign acquirers, such information is used to detect the targets that are not properly managed and to reorganise them at lower costs (Shimizu et al., 2004; Zhu et al., 2011).

On the other hand, the strategic market entry hypothesis motivates cross-border acquisitions (Zhu et al., 2011; Kumar et al., 2023). For instance, Western businesses are searching for methods to enter the growing Southeast Asian markets, as these nations offer enormous market potential. Organisations in these areas face information asymmetry and cultural barriers issues for foreign acquirers. As a result, offshore acquirers need more awareness of the target firm's worth and less expertise in conducting business in local marketplaces. Consequently, multinational corporations consider cross-border acquisitions an alternate method for accessing emerging markets. In doing so, they support the strategic market entry hypothesis (Zhu et al., 2011).

Data and Methodology

Various methodologies have been used to analyse CBM&As and economic development drivers. CBM&As is a dependent variable in this study, measured by the value of M&A deals across the border in host and home countries in the particular year. The explanatory variable is economic development determinants, which assess GDP, employment rate, market capitalisation, net exports, and Inflation. Ibrahim and Raji (2018) studied the GDP as the most critical macroeconomic factor that causes fluctuating trends in CBM&As. Our exogenous variable is firm scale, quantified by firm size (total assets). Hashmi et al. (2020) took total assets as a measure of firm size. The data for CBM&As transactions comes from the Venture intelligence data source, while the data for market capitalisation, employment rate, GDP, net exports, and Inflation comes from the World Bank data sources and UNCTAD (WorldBankGroup, 2020; UNCTAD, 2023). Total assets were obtained from annual reports for the relevant period to measure the organisation's size. The exchange rate applicable in the particular time period, i.e. January 2010 to December 2023, was used to convert all data to U.S. dollars. The study period is from January 2010 to December 2023 as the CBM&As activities increased after the financial crisis, and more shareholders value was created by the acquiring firms (Alexandridis et al., 2017; Kumar et al., 2023; Vissa & Thenmozhi, 2023). Shareholders actively increased their influence by putting internal control and efforts towards selling the organisations (Ittner & Keusch, 2015). India has represented developing countries, and the United States of America has represented advanced countries (International Monetary Fund (IMF), 2023). For the analysis, only completed and successful M&A transactions are part of the sample, and their announcement

must happen between the study periods. Companies worth more than \$6.56 million in the sample are classified as large-scale, while those worth less than that are classified as small-scale. The data for CBM&As transactions comes from the Venture intelligence data source. Our ultimate sample contains 974 businesses participating in CB M&A transactions among the aforementioned nations, with 410 Indian firms acquiring United States of America firms and 564 United States of America firms acquiring Indian firms. Data cleaning was done, and we removed the samples with no deal value. This resulted in a final sample of 514 businesses participating in CBM&A transactions, with 215 Indian firms acquiring United States of America firms (163 Large and 52 small firms) and 299 United States of America firms acquiring Indian firms (189 Large and 111 small firms). To examine the proposed hypotheses, we utilised a linear regression model and further conducted a correlation analysis. We choose to use linear regression over advanced panel data techniques because when endogeneity is less of a concern or can be partially addressed through lagged variables, linear regression can be a viable option (Wooldridge, 2010). Moreover, linear regression may be sufficient in cases where the within-firm variation is not a primary focus, particularly when cross-sectional relationships are of interest across firms rather than changes within firms over time. Fixed Effects models, while powerful, can be restrictive by eliminating time-invariant variables, which might be central to the analysis (Greene, 2017). To decrease endogeneity, dependent variable is delayed by one period. To investigate the relationship between CBM&A and significant economic development indicators, the following models are used:

$$Y_{it} = \alpha_{it} + \beta Y(S, L)_{it-1} + \Sigma \gamma A_{it} + \Sigma \delta B_{it} + \Sigma \zeta C_{it} + \Sigma D_{it} + \Sigma F_{it} + \varepsilon_{it} \qquad (1)$$

In Equation (1), Y represents CBM&As, S and L represent small and Large scale organisations, i is a nation (Host Country), and t represents the respective period 2010-2023. α, β, γ, δ, ζ, λ and μ are the coefficients.

$$CBM\&A(S, L) = \alpha_{it} + \beta CBM\&A(S, L)_{it-1} + \gamma GDP_{it} + \delta EMP_{it} + \zeta MC_{it} + \lambda(X-M)_{it} + \mu I_{it} + \varepsilon_{it} \quad (2)$$

GDP, EMP, MC, X-M, I and ε are the gross domestic product, employment rate, market capitalisation variables, net exports, Inflation, and error term, respectively.

Results and Discussion

We created a linear regression model to conduct the study. This model discretely assesses economic growth drivers' influence on CBM&A agreements in developing and advanced nations

Descriptive Statistics

Table 1: Descriptive Statistics: Small-Scale Organisations

Variables	CBMA	EMP	GDP	MC	(X-M)	I
CBMA	1	0.025	-0.22	0.039	0.014	0.006
GDP	-0.022	-0.163**	1	-0.497**	-0.537**	0.402**
EMP	0.402	1	-0.163**	0.789**	-0.116*	-0.641**
MC	0.039	0.789**	-0.497**	1	0.23**	-0.674**
(X-M)	0.014	-0.116*	-0.537**	0.23**	1	-0.382**
I	0.006	-0.641**	0.402**	-0.674**	-0.382**	1
Mean	106.78	33.235	3.328	118.256	-3.111	3.909
Standard deviation	204.01	18.102	2.735	64.835	1.264	3.127
Number of Observations	455	455	455	455	455	455

**, * Significant at 10 and 5% level of significance

Table 1 indicates the number of observations, standard deviation (S.D.), mean, and correlation coefficient for each distinct variable in small-scale organisation sample. According to Table 1, each variable's total number of observations is 455, the average value of CBM&A agreements is 106.78, and SD is 204.01. The mean value of EMP rate, GDP, MC, Net Exports, & Inflation is 32.235, 3.328, 118.256, -3.111, and 3.909, respectively. The employment rate, GDP, MC, Net Exports, and Inflation SD is 18.102, 2.735, 64.835, 1.264, and 3.127, respectively. The correlation coefficient between all variables has a maximum value of 0.789.

Table 2: Descriptive Statistics: Large-Scale Organisations

Variables	CBMA	EMP	GDP	MC	(X-M)	I
CBMA	1	-0.362**	0.328*	-0.306*	-0.106	0.219
GDP	0.328*	-0.669**	1	-0.791**	-0.306	0.638**
EMP	-0.362	1	-0.669**	0.774	0.174	-0.709
MC	-0.306*	0.774**	-0.791**	1	0.44**	-0.689**
(X-M)	-0.106	0.174	-0.306*	0.44**	1	-0.562**
I	0.219	-0.709**	0.638**	-0.689**	-0.562**	1
Mean	134.148	55.696	2.943	90.215	-3.093	2.68
Standard deviation	198.705	25.001	2.418	33.633	0.88	2.395
Number of Observations	59	59	59	59	59	59

**, * Significant at 10 and 5% level of significance

Table 2 displays the number of observations, mean, S.D., and correlation coefficient for each distinct variable in a large-scale organisation sample. Table 2 indicates 59 observations for each variable, the average value of CBM&As agreements is 134.148, and standard deviation is 198.705. The mean Employment rate is 55.696, with a SD of 25.001. GDP has a mean value of 2.943 and a SD of 2.418. Market Capitalization has a mean value of 90.215 and a SD of 33.633. Net exports have a mean value of -3.093, with a SD of 0.88. Mean value of Inflation is 2.68, while SD is 2.395. The correlation coefficient of all variables has a maximum value of 0.774.

Regression Analysis

Table 3 shows findings of regression study between CBM&A and critical economic development drivers based on 455 CBM&A agreements between India and the United States of America. For smaller businesses, the regression model is as follows.

$CB\ M\&A(S)_{it} = 36.894 CB\ M\&A(S)_{it-1} + 0.234 GDP_{it} - 6.722 EMP_{it} + 0.345 MC_{it} + 13.621(X-M)_{it} + 20.488 I_{it} + \varepsilon_{it}$ …………………(1)

Table 3: Impact of GDP, EMP, MC, (X-M) and I on CBM&A in Small-Scale Organisations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	36.894	70.959	0.544	0.523
GDP	0.234	0.641	5.084	0.000
EMP	-6.722	14.746	-0.456	0.649
MC	0.345	0.264	5.408	0.000
(X-M)	13.621	24.393	0.532	0.595
I	20.488	20.268	1.011	0.313
CBMAS(−1)	0.863	0.0864	76.198	0.000

Adjusted R^2 = -.0936; Significance level at 5%, Durbin-Watson = 2.012; Prob(F-statistic) = 0.0000.

Table 3 shows, GDP (0.0000, $P < 0.05$) and MC (0.0000, $P < 0.05$) have a significant positive effect on CBM&As deals, whereas employment rate (0.649, $P > 0.05$), net exports (0.595, $P > 0.05$), and Inflation (0.313, $P > 0.05$) have an insignificant negative effect. This suggests that GDP and MC have a more significant influence on CBM&As agreements than employment rates, net exports, and Inflation. According to the findings, a one-unit rise in GDP and MC will enhance CBM&A agreements in small-scale businesses by 0.234 and 0.345, respectively. An increase in one unit of employment, net exports, and Inflation reduces the value of CBM&A transactions by -6.722, 13.621, and 20.488, respectively.

Table 4 provides the regression analysis results between the CB M&A and several economic development factors based on 59 larger firms CB M&A deals between India and the USA. Below is larger firms' regression mode.

$$CB\ M\&A_{(L)\ it} = 50.008 + 0.907CB\ M\&A_{(L)it-1} + 0.504GDP_{it} - 3.381EMP_{it} - 0.077MC_{it} - 2.57(X-M)_{it} + 21.357I_{it} + \varepsilon_{it} \qquad (2)$$

Table 4: Impact of GDP, EMP, MC, (X-M) and I on CBM&A in Large-Scale Organisations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-80.008	910.686	-0.088	0.93
GDP	30.504	31.999	0.953	0.345
EMP	3.381	18.895	0.179	0.859
MC	-0.77	2.917	-0.264	0.793
(X-M)	-2.57	74.871	-0.034	0.973
I	-21.357	36.181	-0.59	0.558
CBMAS (−1)	0.907	0.062	14.59	0

Adjusted R^2 = 0.973; Significance level at 5%, Durbin-Watson = 1.687; Prob(F-statistic) = 0.0000.

As Table 4 shows, GDP (0.045, $P < 0.05$) has a significant positive effect, whereas employment rate (0.065, $P > 0.05$) and net exports (0.073, $P > 0.05$) have an insignificant negative impact. MC (0.063, $P > 0.05$) and Inflation (0.558, $P > 0.05$) have a positive but insignificant effect on CBM&A deals. It demonstrates that, when compared to other variables, CBM&A has a substantial impact on GDP. The results reveal that a one-unit rise in GDP will boost CB M&A agreements in large-scale businesses by 0.504. Employment rate, market capitalisation, net exports, and Inflation will decrease the deal value by -3.38, -0.077, -2.57, and 21.357, respectively. As small-scale enter prizes, the value of CBM&A agreements in larger organisations has been positively influenced by the previous year's deals.

Regression statistics of the sample are reported in Table 4. It demonstrates that the suggested model is significant as a whole and performs well when it comes to the combined importance of variables. The F value is 0.0000 (probability 0.05). The model is considered to be significantly fitted. The higher adjusted R2 value (97.30%) suggests that the independent factors in our model very effectively explain the dependent variable.

Table 5 displays the findings of a regression analysis based on 201 Indian and 235 American smaller acquirer organisations in terms of CBM&A, GDP, employment rate, MC, net exports, and Inflation. Using a sample of smaller-scale enterprises, the research is carried out separately to empirically compare the differences between advanced and developing host countries to analyse the impact of independent variables on CB M&As.

In Table 5, all of the independent factors, namely GDP (0.0231, $P < 0.05$) and MC (0.0000, $P < 0.05$), had a substantial positive influence on CBM&A agreements for Indian small-scale enterprises. On the contrary, all of the independent variable's GDP (0.0000, $P < 0.05$), employment rate (0.0015, $P < 0.05$), MC (0.0026, $P < 0.05$), and net exports (0.018, $P < 0.05$) have a significant positive impact on CBM&As deals in small-scale firms of United States of America.

The regression data in Table 5 demonstrate the suggested model's significance since the F value is 0.0000 (Probability 0.0000). Furthermore, with an adjusted R square of 93.02 percent, this model may display a more significant percentage of emphasis on postulated economic factors in CBM&A negotiations.

Because the model's F value is 0.0000 (Probability 0.05), its importance is also reported on the other side of the Table. Furthermore, a higher corrected R2 value (91.37%) indicates that our independent variables accurately represent our model.

Table 5: A Comparison of Advanced and Developing Host Countries: Small-Scale Organisations

Variable	India			United States of America		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
C	-36.185	-1.366	0.041	15.605	12.611	0.0008
GDP	0.233	1.014	0.023	0.399	1.925	0.000
EMP	17.176	0.414	0.679	-35.562	-0.171	0.0015
MC	0.574	4.792	0.000	-4.643	-1.329	0.0026
(X-M)	-8.856	-0.468	0.640	47.394	1.345	0.018
I	13.867	0.706	0.481	69.748	1.752	0.081
CBMAS(−1)	0.003	0.028	0.028	-0.004	-0.055	0.957

Adj. R^2 = 0.9302; Prob(F-statistic) = 0.0000. Adj. R^2 = 0. 9137; Prob(F-statistic) = 0.0000.

Table 6: A Comparison of Advanced and Developing Host Countries: Large-Scale Organisations

Variable	India			United States of America		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
C	21.47	3.909	0.339	55.128	2.007	0.035
GDP	0.147	1.897	0.047	4.928	1.758	0.238
EMP	-34.288	-1.245	0.024	-31.183	-0.241	0.053
MC	53.956	0.34	0.745	4.118	0.434	0.667
(X-M)	-0.035	-0.765	0.127	6.162	0.572	0.063
I	-6.457	-0.155	0.073	-2.585	-0.704	0.946
CBMAS(−1)	0.609	19.14	0.00	0.741	25.988	0

Adj. R^2 = 0.9645; Prob(F-statistic) = 0.0000. Adj. R^2 = 0.9674; Prob(F-statistic) = 0.0000.

Table 6 displays the findings of regression analysis of 14 India and 45 United States of America large-scale acquirer firms among CBM&As deals and proposed determinants of economic variables to analyse the impact of independent variables on CBM&As by comparing the host nations India and the United States of America by using large-scale firm's samples.

Table 6 reveals that GDP (0.047, P < 0.05) significantly positively affects CBM&A deals for Indian large-scale firms. In contrast, the employment rate (0.024, P < 0.05) has a significant negative impact, and MC (0.745, P > 0.05) has an insignificant positive effect. Net exports (0.127, P > 0.05) and Inflation (0.073, P > 0.05) have a negligible negative influence on CBM&A transactions. The independent variable GDP (0.238, P > 0.05) has a negligible positive influence on CBM&A agreements for U.S. businesses, but the employment rate (0.053, P >0.05) has an insignificant negative effect. MC (0.667, P > 0.05) and net exports (0.063, P > 0.05) have insignificant favourable effects on CBM&A agreements, but Inflation (0.946, P > 0.05) has a negligible negative impact.

Table 6 shows that the overall significance of both models is 0.0000 (Probability 0.05). Higher adjusted R2 values, 96.45 % for Indian organisations and 96.74 % for USA firms, suggest that our independent variables significantly influence the model.

Discussion

The findings reveal that Gross domestic product favourably influences CBM&A in both advanced and developing nations. In contrast, the employment rate has a negative impact on the dependent variable.

Market Capitalisation influences CBM&A positively in small-scale organisations but negatively in large-scale organisations, whereas net exports and Inflation influence CBM&As positively in small-scale organisations but in the case of net exports, negatively in large-scale organisations, and positively in the case of Inflation. GDP and market capitalisation have a beneficial influence on CBM&A transactions in small businesses. Contrary to popular belief, the employment rate, net exports, and Inflation negatively impact CBM&A transactions. All the proposed independent variables, except employment, substantially influence CBM&As negotiations in small-scale firms. GDP benefits CBM&As agreements in major firms, but employment rate, market capitalisation, and net exports have a negative impact. Only GDP influences the dependent variable considerably, whereas other variables have minor values.

We looked at the effect of economic growth determinants on CBM&A between advanced and developing nations separately in small and large-scale acquirer companies. According to the findings, GDP and market capitalisation had a substantial and beneficial influence on CBM&A negotiations in small-scale acquirer organisations in developing nations. GDP and net exports substantially influence CBM&A agreements in the USA, size acquirer companies. For large-scale acquirer organisations in advanced and developing nations, all of the independent factors except market capitalisation have a negative but statistically significant, for GDP and employment. They are statically insignificant, for net exports and inflation influence on CBM&A transactions in Indian large-scale acquirer organisations. All the independent variables except employment and Inflation have a beneficial influence on CBM&A agreements in the USA big-scale acquirers; however, the employment rate has a negatively significant impact. All of the independent factors have a negligible influence on CBM&A transactions.

Empirical data reveal that the coefficients of variable GDP positively influence CBM&A, implying that whether the nation is advanced or developing, a rising economy invites both small and large businesses to execute merger and acquisition agreements. It supports the study of Ibrahim and Raji (2018) and Vissa and Thenmozhi (2023) and other researchers that mergers increase when the economy is booming. The Market Capitalization coefficients haven't any beneficial influence on large-scale acquirer organisations, but in the case of small-scale Indian organisations; it shows the beneficial influence. As a result, large-scale firms need to improve in advanced and developing countries, whereas small-scale organisations tend to be more acquirers in developing countries. These findings are aligned with the study of Erel et al. (2012), which states that firms used to be more acquirers in countries with good stock markets. For small-scale firms, Coefficients of Employment rate and net exports have a detrimental influence on CBM&A negotiations in developing nations, as compared to advanced countries. This may be explained by saying that nations with high employment rates discourage people from becoming acquirers. They believe that if they are involved in mergers or acquisition activities, the turnover rate might increase as Sun et al. (2018) assumed that mergers and acquisitions cause uncertainty in organisations, and turnover rate increases in post-merger periods.

Implications of the Study

The study has several important implications for various stakeholders, as mentioned below.

Societal Implications

Economic Growth Stimulation
The study highlights that a robust GDP correlates with increased CBM&As, suggesting that economic prosperity encourages business expansion. Societies can benefit from this growth through enhanced job opportunities and improved economic stability.
Employment Concerns
The findings that employment rates can negatively impact CBM&As indicate that high employment may reduce incentives for mergers. Societies with strong employment levels may experience reduced acquisition activities, potentially impacting the dynamism and competitiveness of industries.

Corporate Implications

Strategic Growth Through CBM&A

Companies, especially those in developing economies, should consider mergers and acquisitions as strategic tools for growth during periods of economic expansion. The positive effect of GDP and market capitalisation on CBM&A suggests that firms can leverage economic growth phases for international expansion.

Operational Challenge

Large firms may face challenges in utilising market capitalisation effectively in mergers, highlighting the need for more efficient capital allocation strategies.

Navigating Inflation and Trade Deficits

The mixed impact of Inflation and net exports on CBM&A suggests that corporates need to account for macroeconomic stability and trade policies when planning cross-border deals.

Implications for Policymakers

Policies to Foster CBM&A

Governments in developing and advanced countries should implement policies that stimulate GDP growth and stock market performance to encourage CBM&As. Regulatory frameworks supporting transparent and smooth merger processes can make countries more attractive for such activities.

Addressing Employment Trends

Policymakers must understand that high employment may deter mergers. Creating policies that balance labour market stability with business incentives can help maintain a conducive environment for CBM&A without negatively impacting employment levels.

Trade and Inflation Management

The influence of net exports and Inflation on CBM&A suggests that policies should focus on trade balance and controlling Inflation to sustain economic attractiveness for cross-border deals.

Conclusion

The research has emphasised the importance of major macroeconomic determinants in persuading multinational firms to locate investment activities. However, the impact of macroeconomic factors on acquisition activity has yet to receive much attention. Furthermore, research on the variables affecting CBM&A activity in established and emerging markets has paid scant or no consideration to the influence of crucial macroeconomic determinants. The linear regression model was designed and used to empirically investigate the impact of GDP, MC, employment rate, net exports, and Inflation on CBM&A deals by using a dataset of 514 small and large-scale organisations from India and the United States of America that engaged in CBM&A deals. We determined that a country's economic development is critical to internationalisation since it substantially influences CBM&As agreements. Besides large-scale acquirer corporations in India as a host nation, GDP benefits CBM&A agreements in advanced and developing countries. Market capitalisation has a beneficial influence on large-scale acquirer organisations, but it only positively impacts small-scale organisations in relation to Indian firms. Most corporations are likely to engage in CBM&As in nations with greater GDPs and stock markets trending upward, particularly in small-scale organisations. Except for small-scale organisations in developing nations, the employment rate appears to negatively influence CBM&As agreements in large-scale firms for both advanced and developing economies. Except for small-scale organisations in developing countries, the inflation rate appears to have a negative impact on CBM&A agreements in both advanced and developing countries. Net exports appear to influence CBM&A agreements in large-scale firms in advanced countries negatively.

Our work is important because it fills a research gap on the effects of CBM&As by various economic variables while accounting for the size effect of firms participating in CBM&As discussions. The findings indicate that macroeconomic variables influence the occurrence of merger and acquisition endeavours within both developed and emerging nations. The outcomes furnish substantiation that macroeconomic

factors, serving as principal constituents of geographically specific advantages, play a pivotal role in elucidating the patterns and geographical placement of merger and acquisition activities.

Limitations and Future Research Directions

Limitations of the Study

Data Constraints
The analysis only includes data from January 2010 to December 2023. Future CBM&A trends may change with evolving global economic conditions.

Scope of Variables
The study limits itself to GDP, employment rate, market capitalisation, net exports, and Inflation, excluding potential influential factors such as political stability, currency exchange volatility, and technological advancement.

Sample Size
The focus on India and the USA as representative developing and advanced nations may not be fully generalisable to other countries with different economic structures.

Firm Classification
The binary classification of firms into small and large scale based on a fixed threshold may not capture the nuanced differences in scale and scope.

Future Research Directions

Inclusion of More Variables
Future studies could incorporate variables like political risk, technological infrastructure, regulatory frameworks, and currency exchange rate fluctuations to provide a more comprehensive analysis of factors influencing CBM&A.

Comparative Analysis Across Regions
Expanding the scope to include more countries from various economic tiers (e.g., emerging economies in Asia and developed economies in Europe) could yield broader insights.

Longitudinal Study
Extending the timeline and employing a longitudinal analysis could reveal the impact of long-term economic cycles and crises on CBM&A activity.

Industry-Specific Analysis
Research focusing on different industry sectors could uncover sector-specific drivers of CBM&A, providing more tailored insights for businesses.

Impact of Technological Advancements
With the rise of technology-driven firms, future research should consider how technological integration and digital economy factors influence CBM&A.

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Empirical Obstacles in the Carhart Model — Insights from the Fama-Macbeth Analysis of Nifty 50 for the Period April 2008-June 2023

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Abstract

This research paper is an attempt to find the empirical challenges before the Carhart model which is the expansion of the Fama-French Three-Factor (FF3F) model which is itself an expansion of the Capital Asset Pricing Model (CAPM). The recent economic events, such as demonetization, GST implementation, and the COVID-19 pandemic, have impacted the Indian economy significantly. This study explores whether the Carhart model remains effective in this altered economic landscape, filling a gap in asset pricing literature specific to emerging markets like India. The study, further, aims to compare the model with the empirical power of other two well-known models i.e., FF3F model and the CAPM. The Carhart model has been empirically tested with reference to the stock portfolios constituted from the Nifty fifty data over the period April 2008 to June 2023 using the Fama-MacBeth regression. The findings of the paper show that the model is not empirically supported by the data suggesting the potential limitations of the same to explain asset returns in Indian context. It is found that neither of the three models is empirically supported, however, in relative terms, FF3F shows a relatively better explanatory power explaining the average returns. This paper can be regarded as a contribution to the limited amount of literature on the Carhart model in Indian context within the timeframe of the period April 2008 to June 2023 with an aim to expose the empirical validity of the Carhart model.

Keywords: Carhart Model, CAPM, Size factor, Value factor, Momentum, beta.

JEL Classification: G11, G12

Introduction

The Carhart model (Carhart, 1997) is an extension of the CAPM that incorporates the effect of an additional factor in explaining the cross-section of stock returns. The model adds a momentum factor, based on the study by (Jegadeesh and Titman, 1993), to the three-factor model (Fama and French, 1993) to capture the profitability of investing in winners and avoiding losers. The model is mathematically defined as follows:

$$R_i = R_f + \beta_i(R_m - R_f) + \beta_i^S SMB + \beta_i^V HML + \beta_i^M WML \quad …(1)$$

Where Ri means portfolio *i* return; β_i means portfolio beta as used in the CAPM; R_m is market portfolio return i.e., Nifty 50 in the present study; R_f is the risk-free rate; SMB the size premium, which captures the difference in returns between small and big stocks based on their market capitalisations; β_i^S is the sensitivity of the SMB factor; HML means the value premium, i.e., the difference in returns between high book to market ratio and low book to market ratio stocks; β_i^V means the sensitivity of the HML factor; WML means the momentum, which is the difference between winners and losers' returns, and β_i^M means its sensitivity.

The Carhart model is one of the popular models of asset pricing, but at the same time, subject to empirical testing specially in the US market. The momentum factor in the Carhart model plays a crucial role in explaining stock returns, even after considering other factors (Fama and French, 2015). Several studies have explored the implementation and performance of the Carhart model in international markets. For example, Bali et al. (n.d) examined the efficacy of the model in emerging markets and found that the momentum factor is also significant in explaining returns in these markets. Their results indicate that the Carhart model exhibits consistent performance across different regions. Moreover, researchers have investigated the robustness of the Carhart model by considering alternative factor specifications and methodologies. For instance, a liquidity factor in the Carhart model was introduced (Zhang, 2006) and demonstrated that it improves the explanatory power for stock returns, particularly for small stocks. Other studies have examined the impact of different weighting schemes and portfolio formation methodologies on the Carhart model's performance. Furthermore, some researchers have explored the economic intuition and behavioral explanations behind the momentum factor in the Carhart model. A model based on investor sentiment and limits to arbitrage to explain the persistence of stock price momentum was proposed (Hong and Stein, 1999). They argue that the momentum effect may result from investors' underreaction to information or gradual information diffusion. As far as India is concerned, then the studies are very few. As the literature review shows that only six studies could be found out in Indian context, therefore, the literature on the Carhart model is very limited in Indian context. Further, the relevance of the applicability of the Carhart model in the Indian context increases after the events like demonetization, the GST introduction, COVID-19 pandemic, etc. These events have caused structural shifts, affecting risk-returns dynamics. For example, demonetization led to significant short-term market disruptions, while GST altered sectoral profitability patterns. The COVID-19 pandemic further boosted volatility in demand and supply particularly in sectors driven by consumer demand. These factors might challenge the explanatory power of the Carhart model. This study, therefore, expands the limited Indian literature by examining applicability of the model throwing light on its obstacles in explaining asset returns in India post-2008.

Literature Review

The study (Chen and Fang, 2009) observed a trend in various markets across the Pacific Basin, encompassing economies such as Japan, Singapore, South Korea, Indonesia, Thailand, Malaysia, and Hong Kong. However, it is noteworthy that despite their research, they were unable to identify any supporting evidence for the impact of Carhart's Four-Factor model on momentum. Another study by (Fama and French, 2011) analyzed the stock markets across North America, Asia Pacific, Japan, and the European region using the Carhart model. They find that, with the exception of Japan, all regions demonstrated statistically significant value and momentum premiums. The efficacy of the Carhart model in emerging markets worldwide was assessed (Cakici et al., 2013). The study analyzed a dataset spanning from 1990 to 2011, encompassing over 800 stocks from various Asian countries including China, Thailand, Malaysia, Indonesia, Philippines, South Korea, Taiwan, and India. Consequently, their findings indicated a negative correlation between the value factor and the momentum component, with the latter playing a significant role in explaining stock returns in the Asian markets. They found significant effects related to value and momentum were observed in all regions except for Eastern Europe. An investigation of the FF3M and Carhart model was conducted using 100 stocks of the UK over the period January 1996 to December 2013 (Nwani, 2015). It was found that both the models had a good explanatory power, however, the size factor was not observed to a be a significant factor. The study (Abeysekera and Nimal, 2017) was concluded to find the validity of the Carhart model and compared its performance with the CAPM and FF3M with reference to Colombo Stock Exchange. According to the study, the Carhart model performs better than the CAPM and FF3M. A study (Momani, 2020) showed the FF3M and Carhart model using all the stocks listed on the Amman Stock Exchange (ASE) over the period 2002 to 2018. Both the models demonstrate their capacity to explain returns.

As far as Indian context is concerned, then the literature is very limited. In this regard, only six papers have been found which are related to the investigation of the Carhart model. A study (Banerjee et al., 2014) of the liquid stocks listed on Nifty over the period 2008 to 2011. They applied ordinary least squares and found that the Carhart model had restricted impact as compared to the CAPM. Another study

(Balakrishan, 2016) of four hundred eighty-four companies listed on the Bombay Stock Exchange was conducted to find the effect of size, value, and momentum. The study concludes the inability of the CAPM accounting the average returns on the portfolios and the FF3F model partly explains the average returns. He, further, concludes that the Carhart model is more relevant specially in case of small size winner portfolios. Another study was conducted using the Nifty 500 (from January 2004 to December 2013) listed stocks using Generalised Method of Moments (Bajpai and Sharma, 2018). They concluded that the findings demonstrate that the Carhart model beats the FF3F model. Momentum factor was concluded to be the best performing factor when compared to size and value factors (Agarwalla et. al., 2017). An investigation of the Carhart model to collect its evidences in Indian stock market was made (Misra et. al, 2019). Their study was based on 301 stocks listed on the BSE 500 over the time of March 2000 to December 2013. Their paper mainly aims to check the impact of the co-skewness and co-kurtosis along with Fama-French methodology with reference to the CAPM, FF3F model, and Carhart Model. They found that there is impact of the co-skewness and co-kurtosis, but silent at the point of the comparative performance of the models under study.

Table 1: Literature Review Summary in Indian Context

S.no	Author	Period covered	Methodology	Market studied	Comment on Momentum
1.	Banerjee et. al., 2014	2008-2011	OLS regression.	NSE Nifty	Not supported.
2.	Balakrishan, 2016	1997-2014	Descriptive statistics & Multiple Regression.	BSE.	Supported.
3.	Sharma et al.,2016	1993-2016	Quantile regression.	They studied the stocks as given in Aggarwalla et. al., 2013 i.e., BSE.	Supported.
4.	Agarwalla et al., 2017	1994 - 2017	Time-series and chart analysis.	BSE (Number of stocks in various years spread from 1500 to 3000)	Better than value and size factors.
5.	Bajpai and Sharma, 2018	2004-2013	Generalised Method of Moments (GMM)	NSE Nifty 500	Not supported this.
6.	Misra et. al., 2019	2000-2013	Fama-French methodology, co-skewness and co-kurtosis	BSE 500	No specific comment could be figured out.

Research Gap/Statement of the Problem

Most of the papers discovered on the model focus on the foreign markets, but there are a few studies in Indian context i.e., only six studies (Table-1 given above). These studies float on various time horizons with different methodologies. According to the table, we can say that most of the studies are pre-2016 while there have been numerous events (national as well as international) during 2016 only and onwards (e.g., the 2016 demonetisation, enactment of the GST Act, Covid-19, 2019 Lok Sabha election, the Brexit, the Surgical Strikes on Pakistan, the 2022 Russia-Ukraine war, etc.) which have impacted the Indian stock market significantly. For instance, as per an article (The Economic Times, 2017), the Sensex crashed around 1689 points and the Nifty fifty dropped by around 541 points due to demonetisation, while the Nifty and

Sensex recorded upward movements due to GST implementation. Thus, the available literature on Carhart model is limited by the time factor i.e., the data used in those studies may not be relevant now. The present study aims to create a new data set for the time period April 2008 to June 2023 on Carhart model with reference to Nifty fifty (consisting of fifty stocks) which has not been widely studied in earlier studies despite most studies focused on the BSE only.

Objectives of the Study

The prime objective of the paper is to collect the empirical proof of the Carhart model in Indian context and making its comparison with the FF3F model so that the very limited literature on the model can be enriched and the portfolio managers or analysts can decide whether to consider the momentum as a significant variable.

Research Methodology

Model Specification
As discussed in the introduction section that the Carhart model is an extension of FF3M by including a fourth factor i.e., the momentum so that we can capture the behaviour of stocks performing well (winners) or poorly (losers) to continue in their respective directions. The study (**Jegadeesh and Titman, 1993)** shows that momentum is a persistent anomaly because the stocks having high past returns continue to maintain better performance, while the stocks having low returns show underperformance. The theoretical backing of inclusion of the momentum factor is found in **behavioral finance**. Investor psychology (like underreaction to new information or delayed response) causes momentum. Further, the limits to arbitrage theory posits that mispricings persist because rational traders are either unwilling or unable to correct them quickly (**Hong and Stein, 1999).** The momentum factor was formalized to show demonstrate its power in explaining asset returns (**Carhart, 1997).** Incorporation of the momentum factor produces comprehensive model specifically in markets where traditional factors like size and value alone cannot explain the asset returns completely. Equation (1) of the Carhart model is the mathematical presentation, however, to test the model empirically, we need an econometric specification of the same. For this purpose, the risk-free rate is transferred to the left-hand side and a regression constant α_i and residual of regression u_i are added to the right-hand side. Thus, we have the following econometric equation:

$$R_i - R_f = \alpha_i + \beta_i(R_m - R_f) + \beta_i^S SMB + \beta_i^V HML + \beta_i^M WML + u_i \quad \text{... (2)}$$

Hypothesis
H$_1$: Momentum factor is insignificant i.e., $\beta_i^M = 0$.

Sample
The study is based on fifty stocks included in the preparation of Nifty 50 index. Therefore, sample size is fifty.

Data Collection
The monthly adjusted closing prices have been (extracted from the Prowess) used to calculate the past returns of the constituent stocks. For this purpose, equation (3) was used.

$$R_{it} = \ln\left(\frac{P_t - P_{t-1}}{P_{t-1}}\right) \quad \text{... (3)}$$

Similarly, to calculate the market returns, equation (4) was used.

$$R_{mt} = \ln\left(\frac{Nifty_t - Nifty_{t-1}}{Nifty_{t-1}}\right) \quad \text{... (4)}$$

Where ln (.) is natural log; P_t means closing adjusted price at time t; P_{t-1} means closing adjusted price at time t-1.

The study uses monthly data because of the following three reasons:

(a) Use of monthly data balances capturing market trends while mitigating high-frequency noise seen in daily data.

(b) Use of annual data significantly stretch the time horizon fading out the effect of economic events occurring during a given year. Moreover, use of annual data significantly reduces the sample points causing the model's statistical inability to capture meaningful patterns.

(c) Thus, monthly data is a good middle way because it aligns with how often the variables under consideration affect the returns with less effect of short-term noise of daily data.

Further, the 91-day T-bill yield (extracted from the RBI database) is put as risk-free rate R_{ft}. The 91-day T-bill yield is used due to the following reasons:

(a) The 91- days T-bills having short term maturity are considered highly liquid, and frequently traded, making their yields reliable to be used a risk-free rate.

(b) T-bills do not carry any interest, therefore, interest rate risk is also zero. Zero interest rate risk align with the meaning of a risk-free asset.

(c) The 91-day T-bill yield is widely used in Indian studies, making it a practical choice.

(d) Last but not the least, the data of other proxies e.g., 10-year G-Sec or 20-year G-Sec is not easily available over the time period under study.

Moreover, the values of SMB, HML, and WML are not directly observable, but they have been calculated using equations (5), (6), and (7).

$$SMB = \frac{(SH + SM + SL)}{3} - \frac{(BH + BM + BL)}{3} \quad ... (5)$$

$$HML = \frac{(SH + BH)}{2} - \frac{(SL + BL)}{2} \quad ... (6)$$

$$WML = \frac{(SW_* + BW_*)}{2} - \frac{(SL_* + BL_*)}{2} \quad ... (7)$$

where SH (Small and High), SM (Small and Medium), SL (Small and Low), BH (Big and High), BM (Big and Medium), BL (Big and Low) are the average returns of those six portfolios which have been created as per the steps given below.

(a) **Big (B) and Small (S) stocks** – Market capitalisation of a company is the base to classify it as a big stock or small. The median of the market capitalisation data has been calculated so that stocks having market capitalisation less than the median are labelled as small stocks and those having market capitalisation greater than the median are labelled as big stocks.

(b) **Low (L), Medium (M) and High (H) stocks -** Under this step, the book value to market value (or market price) ratios have been calculated. The data of the book value have been calculated from the audited balance sheets of the company concerned. The stocks with the ratios less or equal to 30th percentile are low stocks, those with the ratios greater than or equal to 70th percentile are high stocks, and the remaining ones are medium stocks.

(c) Now, we have small, big, low, medium, and high stocks, then the number of combinations is given by the following matrix (Table 2). These combinations are the required portfolios used in equations (5) and (6).

Table 2: Portfolio Matrix

	High(H)	**Medium(M)**	**Low (L)**
Small(S)	SH	SM	SL
Big(S)	BH	BM	BL

(d) **SW* (Small and Winners), SL* (Small and Losers), BW* (Big and Winners), and BL* (Big and Losers)** are the average returns of four portfolios which have been created by making suitable combinations of big, small, winner and loser stocks. To determine the performance of individual stocks as winners or losers within, we first compute the momentum of each stock during that period. The momentum of a particular stock in a given month is assessed using the following formula:

$$\text{Momentum} = R_{it} - \sum_{t-1}^{t-12} \left(\frac{R_{it}}{12} \right) \qquad \dots (8)$$

Thus, the momentum of a stock has been calculated by subtracting a stock's previous 12-month average return from its return in a specific month. After that, the momentum values which are below the 30th percentile are considered as losers (**L***), those above the 70th percentile are winners (**W***) and the remaining ones are neutral (**N***).

(e) Now, we have small, big, losers, neutral, and winner stocks, then the number of combinations is given by the following matrix (Table 3). These combinations are the required portfolios used in equation (7).

Table 3: Portfolio Matrix

	Losers (L*)	Neutral (N*)	Winners (W*)
Small(S)	SL*	SN*	SW*
Big(S)	BL*	BN*	BW*

Period of the Study

The period of study is April 2008 to June 2023. This period is strategically selected to capture a comprehensive range of events (including recovery from the 2008 global financial crisis, demonetization in 2016, GST implementation in 2017), and the unprecedented market disruptions caused by the COVID-19 pandemic. This timeframe allows for an assessment of the model's robustness and relevance across varied economic conditions, making it possible to observe how well the model adapts to both global and uniquely Indian economic challenges.

Tools used

To test the Carhart model empirically, the Fama-MacBeth regression (1973) has been used. This approach can be explained as follows: Suppose we have *n* number of portfolios with k number of factors affecting the dependent variable. In equation form,

$$y_{i,t} = \alpha_i + \beta_1^i x_{1,t} + \beta_2^i x_{2,t} + \beta_3^i x_{3,t} + \cdots \dots \dots \dots + \beta_k^i x_{k,t} + \mu_{i,t} \quad \dots (9)$$

where, $y_{i,t}$ shows the excess returns of the ith portfolio at time t such that i =1, 2, 3… n and t = 1, 2, … T and β_k^i shows the kth coefficient of an explanatory variable $x_{k,t}$ at time t such and $\mu_{i,t}$ is the residual term.

Further, the Fama-MacBeth regression is a two-step procedure which is briefly explained as follows:

Step 1: **Time-series regression**

Under this step, multiple regression is run to obtain the OLS estimates of $\beta_1^i, \beta_2^i, \beta_3^i, \dots \beta_k^i$. In the present study, n = 6 (being the number of portfolios) and t = 183 (being the number of months from April 2008 to June 2023) and m = 4 (being the number of factors i.e., $R_m - R_f$, SMB, HML, and WML). Thus, we regressed the excess returns $R_i - R_f$ on the explanatory variables (or factors). Therefore, we obtain the following regression equations:

$$y_{SL,t} = \alpha_1 + \beta_1^1(R_m - R_f) + \beta_2^1 SMB + \beta_3^1 HML + \beta_4^1 WML + \mu_{1,t}$$
$$y_{SM,t} = \alpha_2 + \beta_1^2(R_m - R_f) + \beta_2^2 SMB + \beta_3^2 HML + \beta_4^2 WML + \mu_{2,t}$$
$$y_{SH,t} = \alpha_3 + \beta_1^3(R_m - R_f) + \beta_2^3 SMB + \beta_3^3 HML + \beta_4^3 WML + \mu_{3,t}$$
$$y_{BL,t} = \alpha_4 + \beta_1^4(R_m - R_f) + \beta_2^4 SMB + \beta_3^4 HML + \beta_4^4 WML + \mu_{4,t}$$
$$y_{BM,t} = \alpha_5 + \beta_1^5(R_m - R_f) + \beta_2^5 SMB + \beta_3^5 HML + \beta_4^5 WML + \mu_{5,t}$$
$$y_{BH,t} = \alpha_6 + \beta_1^6(R_m - R_f) + \beta_2^6 SMB + \beta_3^6 HML + \beta_4^6 WML + \mu_{6,t}$$

Step 2: **Cross-sectional regression**

Under this step, we run cross-sectional regression where the simple average excess return of a portfolio is the serves as the dependent variable. In equation form,

$$\bar{y}_i = \gamma_0^i + \gamma_1 \beta_1^i + \gamma_2 \beta_2^i + \gamma_3 \beta_3^i + \cdots \dots \dots \dots + \gamma_m \beta_m^i + e_i \quad \dots (10)$$

where

$$\bar{y}_i = \frac{\left(\sum_{t=1}^{T} y_{i,t}\right)}{T} \qquad \dots (11)$$

Such that T means the counting of cross-sections equal to the number of months 183 in our study. Since, i = 1,2,3….,6, therefore, at one time, there should be six dependent variables and β_1^i, β_2^i, β_3^i, … β_m^i calculated in step 1 serve as independent variables. Apart, the robust (or Fama-MacBeth t-statistic) of the mth factor is given by equation (12)

$$t = \frac{\gamma_m}{\sigma_m/\sqrt{T}} \qquad \dots (12)$$

However, the Newey-West (or HAC- Heteroscedasticity and Autocorrelation corrected) standard errors should be used to calculate the t-static instead of the Fama-Macbeth standard errors to correct the effect of heteroscedasticity and autocorrelation **IHS EViews (2014).** In the present study, we have calculated HAC errors only, therefore, there is no necessity to check heteroscedasticity and autocorrelation assumptions of classical linear regression model (CLRM). Apart, the assumptions of normality of residual errors and multicollinearity have been validated on the basis of Chi-square test and variance inflation factor (VIF) respectively. Consequently, no serous multicollinearity has been observed and the residuals are found to be normally distributed.

Results and Discussion

Table-4 given below shows the cross-section regression results. We can notice that the adjusted R-squared value of 0.978983 (or 97.89 percent) and the p-value against the F-statistic is 0.097114 (or 9.71 percent) exceeding the significance level of five percent. This suggests that the Carhart model does not significantly account for variations in average excess returns. It should be noted that average excess returns are positively related to the beta and WML, but negatively related to SMB and HML. Moreover, HML is significant. This implies that the HML is a crucial factor to explain the average excess returns, despite the observed inverse relationship. This inverse relationship may be due to high growth potential of Indian economy i.e., there may be a tendency of the investors to gravitate towards growth-oriented stocks (e.g., Technology, IT, Energy) instead of value stocks (e.g., Metal and Mining). Apart, the momentum factor does not explain the average excess returns. This result is consistent with the studies by Banerjee et. al., (2014), Bajpai and Sharma (2018), Chen and Fang (2009).

Table 4: Cross-Section Regression (Carhart Model)

Variable	Coeff.	Std. Error	t-Stat	P-value
Constant	0.004548	0.006168	0.737317	0.5955
Beta	0.002329	0.006681	0.348657	0.7864
SMB	-0.000649	0.000435	-1.492452	0.3758
HML	-0.013410	0.000601	-22.31685	0.0285
WML	0.007499	0.011069	0.677439	0.6209

R^2	0.995797
Adjusted R^2	0.978983
F-stat.	59.22625
P-value(F-stat.)	0.097114

Source: Author calculations

The insignificance of the momentum factor in the Indian context may be interpreted by several economic and behavioural reasons. Some of the reasons may be attributed to the following:

(a) **Market Efficiency and Trading Restrictions:** Indian stock markets may be informationally inefficient in the context of the efficient of market of hypothesis. Legal restrictions, transactional cost, etc. may break the momentum. So, the assumption of efficient market may not hold good.

(b) **Behavioural factor:** Retail investors are generally found engaged in short-term trading based on their sentiments or their reaction to the prevailing news is generally different than those of institutional or professional investors. These behavioural differences may result in insignificant momentum.

(c) **Effect of Economic Events:** Indian economy has gone through various changes (as discussed in research gap section) during last 15 years. These changes may cause inconsistent results for momentum factor. For example, these events might cause prices to revert or shift abruptly instead of following a predictable path.

Further, Table 5 here shows the cross-section regression results for the FF3F Model (in which the WML factor is dropped) under the same methodology. It can be noticed that the adjusted R-squared is now 0.985362 (or 98.5362 percent). It implies that the adjusted R-squared under the Carhart model decreases when compared to the FF3F Model, which implies that out of the two models, the FF3F offers a better fit.

Table 5: Cross-Section Regression (FF3F Model)

Variable	Coeff.	Std. Error	t-Stat	P-value
Constant	0.001591	0.003833	0.414949	0.7185
Beta	0.005494	0.004014	1.368636	0.3046
SMB	-0.000742	0.000286	-2.599345	0.1216
HML	-0.013419	0.000619	-21.68835	0.0021
R^2			0.994145	
Adjusted R^2			0.985362	
F-stat.			113.1915	
P-value(F-stat.)			0.008770	

Source: Author calculations

If we drop the SMB, HML factors, then we arrive at the CAPM. Table 6 here shows the cross-section regression results for the CAPM. The adjusted R-squared value is 0.937710 (or 93.77 percent) which is the lowest of all the three models, but the p-value against the F-statistic being less than the significance level of five percent shows that this significant. However, amongst the three model, the FF3F MODEL secures the highest adjusted R-squared value implying that it is best fit.

Table 6: Cross-Section Regression (CAPM)

Variable	Coeff.	Std. Error	t-Stat	P-value
Constant	0.027300	0.002231	12.23680	0.0003
Beta	-0.022518	0.002086	-10.79664	0.0004
R^2			0.950168	
Adjusted R^2			0.937710	
F-stat.			76.26954	
P-value (F-stat.)			0.000947	

Source: Author calculations

Findings of the Study

Table 7 here summarises the cross-section regression results and give us a comparative view. Concerning the Carhart model, its empirical validity is questionable due to the lack of statistical significance in its adjusted R-squared value. It loses the game of explanation in favour of the CAPM and FF3F model. The table shows, within the CAPM framework, beta is statistically significant, but negatively related with the average excess returns. Therefore, the CAPM is partially supported here in terms its explanatory power, but the beta is not found to be positively related with the average excess returns as predicted by the CAPM. However, the FF3F model is able to explain 98.536 percent of this variation, indicating that the FF3F model

provides superior explanatory power compared to the CAPM. This suggests that if we include the SMB and HML factors, then the explanatory power of the model rises, but if we include WML, then power reduces. Moreover, the HML is statistically significant in the Carhart model which indicates that value factor is an important factor in explaining average excess returns despite its negative relationship. HML is significant in FF3F model also. Further, the CAPM, found significant, shows the lowest adjusted R-squared among the three models, indicating that it captures less variation in average excess returns. This reminds us about the notion that single-factor models like the CAPM may be insufficient for capturing the complexities of asset returns during the study period.

Table 7: Cross-Section Regression Results Summarised

Models	Adj. R^2	Sig. or No.	Explanatory Variables Significant or not			
			Beta	**SMB**	**HML**	**Coeff. WML**
CAPM	0.93771	Yes	Yes (-)	-	-	-
FF3F MODEL	0.98536	Yes	No (+)	No (-)	No (-)	-
Carhart Model	0.97898	No	No (+)	No (-)	Yes (-)	No (+)

Source: Author calculations

Suggestions

On the basis of the findings, the following suggestions can be listed:
(a) **Revaluation of Momentum Factor** – The statistical insignificance of the momentum factor in the Carhart model is an indication that its inclusion is not always desirable in asset pricing.
(b) **Model Selection for Asset Pricing** – Investors, portfolio managers, researchers should consider using the FF3F model when explaining the variations in average excess returns, as it has demonstrated the highest explanatory power in this study.
(c) **Focus on HML Factor** – Since the HML is found statistically significant, therefore, investors portfolio managers, researchers should consider the value factor while evaluating the average excess returns. Although, it exhibits a negative relationship, yet it appears to be significant.

Conclusion

This study aimed to empirically test the Carhart four-factor model and compare its performance with the CAPM and FF3F model using the stocks of Nifty 50 from April 2008 to June 2023. The findings indicate that while the Carhart model offers a reasonable explanation for average excess returns, its overall performance is not as robust as the FF3F model, as evidenced by the lower adjusted R-squared value and the lack of statistical significance in its F-statistic. Notably, the momentum factor (WML), a key component of the Carhart model, does not significantly contribute to explaining returns in this context.

On the other hand, the FF3F model emerges as the superior model, with the highest adjusted R-squared value of 98.5362 percent, indicating a stronger fit and better explanatory power compared to both the Carhart model and the CAPM. The significance of the HML (value) factor within the Carhart model highlights the importance of value stocks in the Indian context, even though the relationship is inversely correlated with returns.

The CAPM, while statistically significant, is less effective in capturing the complexities of asset returns, as indicated by the lowest adjusted R-squared value among the three models. This suggests that single-factor models may be insufficient for explaining returns in the Nifty 50, underscoring the importance of multi-factor models like the FF3F model in financial analysis.

Overall, this study contributes to the ongoing debate about the efficacy of asset pricing models, particularly in emerging economies like India. The findings reinforce the relevance of the Fama-French three-factor model (a multi-factor model) in explaining stock returns and suggest that the Carhart model's momentum factor may be less applicable in the Indian context during the study period. Thus, this is

suggested that the FF3F model, with its higher explanatory power, is better suited to the Indian context than the Carhart model and CAPM, suggesting that multi-factor models provide a more robust framework (with more emphasis on HML) for explaining asset returns in emerging markets.

Limitations and Scope for Future Research

The study has the following limitations:

(a) The study is constrained to the National Stock Exchange only that too Nifty 50 only, therefore, the results cannot be generalised to the whole Indian stock market because Indian stock market is not only represented by the NSE, but there are other stock exchanges also specially the Bombay Stock Exchange. Therefore, if the Bombay stock exchange or other indices like Nifty 500, etc. is also covered, then the results may be appropriately said the representation of the Indian scenario.

(b) The 91-days Treasure bill yield is used as the risk-free rate, therefore, if some other proxy (e.g., Government bonds yield), then the results may differ.

(c) The reliance on monthly data may smooth out short-term fluctuations, potentially missing intra-month effects captured by daily data. Therefore, daily data may be used.

(d) The study may be broken into sub-periods e.g., pre-covid period and post -covid period to observe the behaviour of the model. Breaking the period into sub-periods will alter the sample data causing the statistical changes in the results. Moreover, each period contains its economic and non-economic dynamics causing the changes in the results.

(e) Additionally, testing the model in other emerging markets (e.g., Brazil, South-Africa, Indonesia, etc.) undergoing similar macroeconomic transitions could assess the Carhart model's applicability beyond India and offer broader insights into its relevance for developing markets.

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CSR and Tax Aggressiveness of NSE NIFTY Companies: Evidence from Indian Emerging Economy

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Abstract

This research paper intends to empirically investigate the association between Corporate Social Responsibility (CSR) disclosures and a corporation's tax aggressiveness. Additionally, it seeks to perform an empirical examination to inspect the applicability of legitimacy theory within the context of Indian companies. The data used in this empirical research work include companies included in the National Stock Exchange Nifty 50 collected from running multiple queries on the Prowess Database. Panel data analysis was performed in the study. A Hausman test was performed to identify the usage of a random effect model to assess the hypothesized relationship / equation. Broadly, the experimental results substantiate legitimacy theory in the light of corporate tax aggressiveness by repeatedly demonstrating a positive and statistically significant causal relationship between corporate tax aggressiveness and public disclosure of CSR. The outcome of the study contributes valuable comprehension into the interplay between CSR transparency and tax behaviours, shedding light on corporate tactics within the context of social accountability and regulatory compliance. The results reliably display a positive and statistically substantial relationship amongst tax aggressiveness and public disclosure of CSR, therefore sanctioning legitimacy theory in the framework of corporate tax aggressiveness. The present study offers a novel test of the theory of legitimacy and delivers a reasonable clarification why a few organizations release more information about corporate social responsibility than others. The limitation of the study includes usage of companies listed on the Nifty 50 index only along with use of a limited time period .This study proposes forthcoming studies to investigate a longer time frame to more accurately evaluate the emergence of corporate tax aggressiveness over the period of time. Legitimacy theory can also be examined in relation to the size of the company and CSR reflections.

Keywords: CSR, Tax Aggressiveness, Legitimacy Theory, Corporate

Introduction

In today's international dynamic business environment scholars, lawmakers, and practitioners are focusing more and more attention on two key elements of company behaviour: tax aggression and corporate social responsibility (CSR). While corporate social responsibility (CSR) indicates a business's commitment

to environmental, social, and governance (ESG) issues, tax aggressiveness relates to the extent to which a company adopts aggressive tax planning to lessen its tax obligations (Bhattacharyya & Ramesh, 2019) It is particularly critical to recognize how each of these variables interplay in the context of emerging economies like India, where companies are often compelled to strike a compromise between satisfying social expectations and achieving financial success. There are many facets and complexities to the relationship between tax aggression and CSR. On the one hand, companies may take an active role in social responsibility programs that enhance their brand, gain the confidence of stakeholders, and lessen reputational challenges (Chen et al., 2010). The outcome of this will result in a reduction in tax aggression. On the other hand, a few companies may take delight in CSR programs to evade taxes or to cover up aggressive tax planning tactics. To assure tax compliance and encourage responsible corporate behaviour, policymakers, and investors must possess a detailed understanding of the nature and direction of this relationship. Previous literature put due emphasis on the fact that substantially large enterprises are displaying mounting concern in developing robust CTP initiatives to lessen their taxable income (Chen et al., 2010). Corporate tax planning is the process wherein attempts have been made by the organizations to manage the tax positions in commercial policy making with the goal to maximize their post-tax earnings (Scholes et al., 2014). There exists a huge difference amongst corporate tax planning, tax aggressiveness and tax evasion. On one hand, tax evasion is considered as illegal while tax aggressiveness strategies and behaviour comprises business transactions which are purely performed for tax reasons. Hanlon & Heitzman (2010) contended that these practices fall on a continuum from the seamlessly legal to the absolute illegal. Further, often socially irresponsible is the perception about tax aggression. It is incompatible with the expectations of the corporations and establishments. From a social stance, if a company introduces a policy whose only or foremost determination is to evade tax, then it is primarily criticized for not having owed its "fair share" of taxes to the administration to ensure the financing of public goods. The subsequent deficit in the corporate tax revenue receipts often lead to aggression, harm to the company's credibility among its numerous (Hartnett, 2008).

The joining node of tax aggressiveness and CSR arises when corporations face scrutiny for their tax evasion practices while simultaneously claiming to be socially answerable. Opponents contend that businesses engaging in aggressive tax planning may challenge the very communities and societies they claim to upkeep through CSR initiatives. This stiffness highlights the necessity for transparency and ethical conduct in both tariff approaches and CSR efforts. Companies need to strike a sense of balance amongst lessening tax liability, which is a lawful commitment, and gratifying their CSR obligations, which are driven by ethical and societal expectations. Achieving this stability is vital for upholding a positive public image, nurturing trust among shareholders, and circumventing legal and reputational risks. In contemporary years, administrations and controlling bodies have become progressively more watchful in addressing tax evasion, and public consciousness of the ethical implications of tax practices has augmented. Subsequently, concerns are under bigger pressure to bring into line their tax approaches with their CSR aims to safeguard that their commercial operations are both economically sustainable and socially responsible. The present work attempts to look into the association that exists between organizations' tax aggression and the company's corporate social responsibility disclosures. Also, the paper attempts to test the legitimacy theory empirically. Corporate social responsibility (CSR) tax aggressiveness denotes the degree to which corporations involve in tax planning approaches that may be perceived as aggressive or controversial from a societal or ethical perspective, while legitimacy theory focuses on how organizations justify their actions to maintain legitimacy and support from stakeholders, including the public, regulators, and investors. A corporate tax invading force occupy an integral part in inciting public anxiety about establishments and is, by definition, a strategy that is erratic with overall societal expectations (Lanis & Richardson, 2013) This delivers us with a rock-hard substance to assess legitimacy theory. Consequently, we assess the scheme that tax aggressive firms reveal surplus CSR statistics in their yearly publications to lighten probable communal apprehension regarding the detrimental effects that corporate tax aggression has on the community and to confirm that they are fulfilling the expectations of the public in additional capacities that offset that detrimental influence. Although tax aggression and corporate social responsibility (CSR) are gaining momentum, there is still a dearth of empirical data relevant to the Indian context, particularly about NSE NIFTY companies. Due to their prominence in the nation's economy, corporations registered on the National Stock Exchange (NSE) NIFTY have been the focus of concerns about corporate behaviour

in recent years. The conduct of these companies influences a wide range of stakeholders, including shareholders, employees, customers, and society at large, as the Indian economy grows quickly and becomes more integrated into the global economy. With a focus on NSE NIFTY enterprises operating in the Indian developing market, this study aims to bridge this gap through investigating the connection amid CSR initiatives and tax aggression. The purpose of this project is to add to the body of knowledge on corporate social responsibility (CSR), taxation, and emerging economies by utilizing a thorough dataset that spans several years and using robust empirical methods to present insightful analyses of the dynamics of business activity in India. The paper's next section addresses the theoretical framework of the paper. This segment examines the body currently published literature. This is subsequently followed by discussions on the research methodology, data analysis, and findings. Afterwards, the paper discusses the findings and provides major conclusions along with the study's shortcomings and potential directions.

Literature Review

The framework, the development of the hypotheses, and research approach used to conduct this study has been addressed in this section of the paper.

Corporate Culture Theory and Legitimacy Theory

The decisions taken by the organization must mirror the worth of the right conduct (Col & Patel, 2016). This implies a negative association amid public disclosure of CSR and extent of tax aggressiveness. Furthermore, companies must not undertake acts that can negatively impact the community at large. The business houses undertake CSR activities for the well-being of numerous patrons including stockholders, workforce, clients, dealers, authorities, financiers, and community. Tax aggression ought to be at odds with CSR if the government is regarded as one of these stakeholders. Hence, companies that care about society have a lower incidence of tax antagonism if corporate culture impacts company choices. Though morally amount spend on CSR can be thought as a symbol for commercial morality (Garriga & Mele, 2004), other studies (Lanis & Richardson, 2013; Amidu et al., 2016) have reported that many times CSR is being used by business houses to conceal immoral activities like business dodged taxes methods. Also, the company wants to provide maximum returns to the shareholders by providing them maximum dividends. But as a corporate tax payer, they also need to keep aside a certain amount of profits to pay-out the corporate taxes. To achieve a balance amongst two aspects tax aggressive is the only choice. However, tax aggressiveness is not a preferred choice by the shareholder's owing to legitimacy theory. According to legitimacy theory, organizations strive to preserve their credibility by making certain that their conduct complies with social norms, expectations, and values. Companies can employ legitimacy-enhancing tactics in the context of tax aggressiveness to defend their tax policies and uphold public confidence. Therefore, this research work will discuss the corporate culture theory as discussed by Col and Patel (2016) and legitimacy theory as discussed by Sari & Prihandini (2019).

Corporate Tax Avoidance

The process of lessening a company's tax liability by conducting transactions, company-specific interactions, operations, and deeds is commonly referred to as tax avoidance. (Dyreng et al. 2008; Hanlon & Heitzman 2010). A specific way of carrying out tax evasion is by organizing business dealings in a bellicose manner with a prime objective of evading taxes (Lanis & Richardson, 2013). Previous investigations by utilizing both the agency philosophy and the legitimacy philosophy as the theoretic basis examined the financial impact of tax evasion. Desai &Dharmapala (2006) and Desai et al. (2007) argued that tax evasion's complexity dealings may provide chances for administrators to execute out and conceal up self-interested behaviours (including transactions between related parties, earnings management, and other resource redistribution) by using intricate taxation procedures. The results of their investigation validate the hypothesis that agency expenses might diminish the worth of tax evasion companies' shareholders. Desai & Dharmapala (2009) recommended that robust governance framework can decrease the capability of administration to conceal less-than-ideal behaviour and identified an encouraging relationship between avoidance of taxes and the worth of a business.

Tax Evasion by Corporations and Reporting of Corporate Social Responsibility

Convergence of corporate tax evasion with corporate social responsibility (CSR) reporting has sparked a lot of research attention from academics, decision-makers, and practitioners nowadays. Many aspects, such as financial rewards, corporate governance frameworks, and legislation, were identified in studies to be the primary drivers of corporate tax evasion. The importance of financial incentives has been emphasized by Hanlon et al. (2015), who believe that enterprises experiencing more tax savings using tax evasion are more prone to adopt aggressive tax techniques. Research demonstrates that there exists a complicated relation amid CSR reporting and tax avoidance. Wang et al (2023) examined the contention that CSR reporting is an effort to allay worries about legitimacy spurred on by avoidance of taxes through their study in China. They observed that the avoidance of taxes by corporates and CSR report readability were closely associated. This relationship is somewhat weaker among state-owned businesses, as they often benefit from inherent legitimacy derived from their affiliation with the government. Furthermore, there is a weaker interaction between businesses in China's less established regions since these areas lack the structures necessary to monitor the validity of organizations. Raithatha & Shaw (2022) stated that corporations that abide by with CSR guideline end up having a lesser amount of tax aggressiveness, which lends credence to the idea that increased visibility and firm-level concerns about reputation constitute significant aspects of determining the manner in which CSR and taxation regulations interact. Hajawiyah et al (2021) depicts that while capital concentration and inventory intensity had no bearing on tax aggression, CSR disclosure has a considerable positive impact. Hajawiyah et al. (2021) found an instantaneous association amongst tax aggressiveness and disclosures of CSR. Aggressive taxation seriously undermines corporate social responsibility. Additionally, Corporate Social Responsibility (CSR) demonstrates a significant negative impact on tax aggressiveness. Risk management amplifies both the influence of tax aggressiveness on CSR and the influence of CSR on tax aggressiveness. Mohanadas et al (2020) in their study found there is no statistical evidence linking business tax aggression in Malaysia to CSR success. In a related vein there are no conclusive associations between corporate tax aggression and marketplace- and environment-related CSR success. The research results confirm the hypothesis that businesses with excellent levels of corporate governance, social consciousness, and corporate environmental performance are less likely to resort to aggressive tax tactics (Ortas and Alvarez, 2020). Vacca et al (2020) through their study highlighted that there is no direct relationship between tax aggressiveness and CSR reporting. They investigated the impact of gender diversity on corporate boards in enhancing companies' focus on CSR disclosure. However, they did not find any significant influence of gender diversity on the connection between tax aggressiveness and CSR disclosure. It was also discovered that the degree of CSR disclosure by corporate filers drastically decreases their likelihood for aggressive taxation. It indicates that a company's tax aggressiveness declines with increasing CSR disclosure. The research corroborated up the notion that businesses with additional social responsibility incline to be less tax-aggressive. In Nigeria, there is an unfavourable relationship amongst tax aggressiveness and performance in corporate social responsibility. In addition, they claimed that a company's propensity for tax aggression varies based on its perspective on corporate social responsibility, its size, and other corporate attributes. Lanis and Richardson (2012) regression analysis in their study demonstrated that a company's degree of tax aggression dips as it improves public disclosure of CSR. The study established a statistically significant and adverse relationship amid tax aggressiveness and the degree of corporate social responsibility (CSR) disclosure. The relationship was noticed across the model's multiple regression parameters, indicating that companies with higher levels of social responsibility are probably less tax aggressive. The literature on corporate tax evasion and corporate social responsibility (CSR) reporting emphasizes the complexity of corporate conduct and its impact on stakeholders. Although the existing field of study provides insightful information about the causes and effects of tax evasion, present investigation is required to address methodological issues and develop theoretical frameworks. Present study will assist in the creation of more sustainable and ethical business practices by researching the relationships between tax and corporate social responsibility (CSR) policies. Aronmwan et al. (2021) stated a negative significant relationship amongst corporate tax planning and corporate social responsibility. Araujo et al (2024) highlighted the interdisciplinary nature of corporate tax planning and corporate social responsibility. They supported transparency in the tax policies and practices and encouraged more and more CSR activities.

H1: There is significant association with CSR disclosure and tax aggressiveness in selected NSE NIFTY companies.

Research Design

The research design of the current study has made use of different statistical tools to examine the hypothesis framed. Firstly, we have presented descriptive statistics of the different variables followed by the correlation statistics among all the dependent, independent and control variables.

Proposed Model
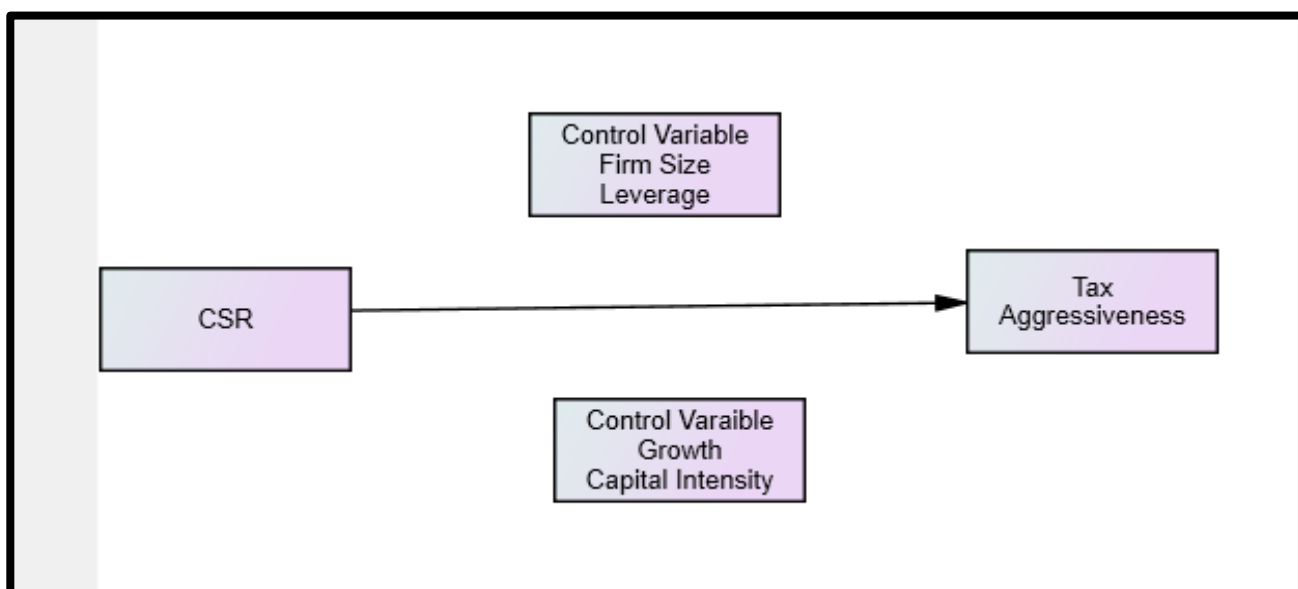
Source: Author's own output

Dependent Variable

Our statistical analysis's dependent variable is the corporate tax aggressiveness. Methodology to measure the tax aggressiveness is the usage of current ETR. ETR stands for the percentage of corporate tax paid over the amount of profits before tax. ETR is often used as a representation for corporate tax aggressiveness because it reveals the book-tax discrepancy induced by tax-aggressive acts (Lanis & Richardson, 2012). Information about ETR is also easily available from the financial statements of the corporations (Hanlon & Heitzman, 2010). A larger ETR value determines that a corporation has paid or accrued generous tax compared to its income, consequently signifying little corporate tax aggressiveness (Noor et al., 2010).

Independent Variable

Our empirical study's independent variable is the amount spent on corporate Social Responsibility, which is fetched from the annual reports of the companies or organizations.

Control Variables

The regression model in the study makes use of a number of control variables to account for additional effects. Control variables used in the study include firm size represented by COSIZE. It is included as it is believed to be positively associated with CSR disclosure (Patten, 2002; Clarkson et al., 2008; Cho et al., 2010), leverage statistics shown as LEVER. As per the findings of Clarkson et al (2008) managers opt disclosing more amount of CSR information as leverage generally increases to cut down the level of asymmetry information. Capital intensity is represented by CAPITAL as in the previous literature it was shown that investment in large plants and equipment makes a company more familiar or known amongst the public at large Cormier, 2009). The last control variable used in the study is the corporate growth factor represented by GROWTH. It is assumed in the literature that companies with high growth

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factors disclose more information about CSR as compared to the firms with low growth factor (Smith & Watts, 1992; Gaver & Gaver, 1993).

Leverage is expressed as total debt over total assets, capital intensity is estimated as total net property, plant, and equipment over total assets, and growth is calculated as the price at the market over book value of the share. Firm size is evaluated as the natural logarithm of total assets.

Sample and Its Characteristics

The present study considers companies listed on National Stock Exchange as the target population. Hence, this empirical research work includes companies included in the National Stock Exchange Nifty 50 for the last five years i.e. from 2019-2023. Fifty companies with 1500 firm year observations make up the first sample. However, due to missing information, the final dataset which is used for testing the hypothesis included 48 companies with 1440 firm year observations. The required data is being collected from running multiple queries on the Prowess Database.

Model for Panel Data Set

$$CETR_{it} = \beta_0 + \beta_1\, CSR_{it} + \beta_2\, COSIZE_{it} + \beta_3\, LEVER_{it} + \beta_4\, GROWTH_{it} + \beta_5\, CAPITAL_{it} + E_{it}$$

Where:
CERT = current ETR i.e. Corporate Tax Amount/ Profit before Taxes *100
CSR = Amount spend on Corporate Social Responsibility
COSIZE = Size of the Firm (natural log of total assets)
Lever = Leverage (Total Debt/ Total Assets)
Growth = Growth Rate (Market Price / Book Price)
CAPITAL = Capita Intensity (Total Net Property and Equipment / Total Assets)

Data Analysis

Panel Data Estimation Model

The current research work makes use of panel data methodology for analysing the proposed model outlined in the preceding section. Panel data analysis comprises of three estimation models; pooled regression model, fixed effect model and random effect model. The computation is based on all models; however Hausman test is used to select the best model out of three estimates. Using panel data presents numerous advantages, foremost among them being its ability to control for unobservable heterogeneity by acknowledging the inherent diversity among items. Furthermore, it is also argued that panel data helps in studying the dynamics of adjustments inherent in cross sectional data. Before running analysis it is imperative to test different assumptions of the regression model. Running and testing assumptions of the model give more efficient, reliable and accurate results. To ensure the reliability of the analysis, the study assessed for multicollinearity amongst the variables using the variance inflation factor (VIF) test and it was observed that multicollinearity was not a cause of concern as VIFs for all independent variables were less than 10 (Field, 2005). Afterwards the test for heteroscedasticity was performed using Modified Wald Statistics (Greene, 2001). It was found that the test statistic was significant at 1 per cent level. Hence, the null hypothesis was rejected in favour of the alternate hypothesis which implied presence of heteroscedasticity in the model. Furthermore, Wooldridge test was used to check serial correlation in the dataset (Wooldridge, 2002). The test statistic was found insignificant at 1 per cent level indicating presence of no serial correlation. Following table No. 1 and 2 highlights the results for heteroskedasticity and serial correlation along with the cross sectional dependency.

After testing all assumptions, dataset was analysed further.

Table 1: Results of Diagnostic tests

Test	Method	Null hypothesis	Test Statistic	P-value
Heteroskedasticity	Breusch-Pagan test	Residuals are homoscedastic	3.800***	0.000

| Serial Correlation | Breusch-Godfrey Lagrange multiplier test | No serial correlation | 3.186*** | 0.000 |

Source: Authors' calculations

For Breusch-Pagan test, the p value was found to be less than 1 per cent, indicating presence of heteroscedasticity. Further, the existence of serial correlation was tested using Breusch-Godfrey Lagrange Multiplier Test. The p value for this was found to be less than 1 per cent, implying no serial correlation.

Table 2: Results of Cross-sectional dependency

Variable	CD-test	value
etr	4.528***	0.000
csr	9.370***	0.000
cosize	57.548***	0.000
lever	4.188***	0.000
capital	2.414**	0.016
growth	7.388***	0.000

Note: Notes: Under the null hypothesis of cross-section independence, CD ~ N (0,1). P-values close to zero indicate data are correlated across panel groups.

Pesaran (2004) cross-sectional dependence test was performed to test for cross-sectional dependence. The results of Table-2 indicate p value less than 1 per cent and 5 per cent (for capital); thereby, rejecting the null hypothesis of cross-section independence. Consequently, the cross-correlations are significant.

The statistical characteristics of all parameters, encompassing dependent, independent, and control variables, are presented in Table No. 3. This fundamental analysis paved the way for a more in-depth and elaborates investigation.

The mean score of Current ETR is equal to 21.9% which is less than the corporate tax of 30%. This strongly indicates that the companies are tax aggressive by paying a lesser amount of tax as compared with the actual legal requirement. The ETR's lowest and highest values come out to be 0 % and 88.98% respectively implying few companies are not paying any tax amount while others are paying more than the statutory requirements. The overall dispersion notice in the ETR is 11.77%. The average amount spent on CSR activities is equal to 136.2087 however the minimum amount of CSR is equal to 0 implying still few companies are not spending on CSR activities although a mandate has come up for the same. The highest spending on CSR equals 922.0. The average firm size equals 4.704 times whereas the mean score of leverage equals 0.2363 times. The mean scores of growth and capital intensity are equal to 23.59 times and 0.7947 times respectively.

Table 3: Descriptive statistics

	Mean	Median	Maximum	Minimum	Std. Dev.
Independent Variable					
CSR	136.2087	77.62500	922.0000	0.000000	174.6958
Dependent Variable					
ETR	21.93360	22.96946	88.98103	-4.102474	11.77082
Control Variables					
CAPITAL	0.794703	0.177294	37.66999	0.002639	4.166755
COSIZE	4.704345	4.799863	6.742572	0.002410	0.947479

GROWTH	23.59850	5.940000	820.8900	0.830000	92.76058
LEVER	0.236322	0.076008	4.530000	0.000000	0.638183

Source: Author's own output

The following table i.e. Table No.4 represents the correlation matrix. As all the correlations are less than 0.95, multi-collinearity among the variables is not a cause for concern.

Table 4: Correlation statistics

	CAPITAL	COSIZE	CSR	ETR	GROWTH	LEVER
CAPITAL	1.00	-0.72	-0.10	-0.20	0.92	0.96
COSIZE	-0.72	1.00	0.38	0.21	-0.76	-0.69
CSR	-0.10	0.38	1.00	0.01	-0.14	-0.08
ETR	-0.20	0.21	0.01	1.00	-0.17	-0.26
GROWTH	0.92	-0.76	-0.14	-0.17	1.00	0.93
LEVER	0.96	-0.69	-0.08	-0.26	0.93	1.00

Source: Author's own output

Fixed Effect Panel Regression Analysis

Every now and then this methodology is called as the Least Squares Dummy Variable (LSDV), where every individual or time period is permitted to have an own intercept. µi is considered to be fixed in this technique, and the other disturbances are assumed to be stochastic, with each independent and identically distributed IID. One may say that the constant of each firm's slope coefficient and the intercept variation are considered while determining the individuality of each cross-sectional unit. This approach is also known as LSDV given that it involves use of an assortment of dummy variables that provide for the fixed effect. To predict how the explanatory variables will affect the explained variable while limiting the influence of the unobserved variables, a fixed effect model is applied.

Table No. 5 showcased the results of CSR spending on tax aggressiveness with control variables using the Fixed Effect Model". In fixed effect model, each and every unit of test or unit of time periods are permissible to have their personal intercepts The statistics of F-test of the guesstimate model is 4.1791 along with its allied probability value is 0.000 which stipulates that the guesstimate model is suitable to elucidate the tax aggressiveness by CSR and control variables. In the model, there exists an absence of autocorrelation since the statistics of DW is equivalent to 1.6685, which lies as per the threshold value of less than 3 and more than 1. The CSR is observed with insignificant positive coefficient 0.209691 along with 0.1098 p values, therefore, there is positive but insignificant relationship between CSR and tax aggressiveness. Likewise capital, size and leverage are insignificant with p value 0.8507, 0.1602 and 0.833 respectively with negative coefficients (0.059607) and (3.470104) and positive coefficient 0.028258. Leverage is coming out to be significant with p value 0.046 with positive coefficient. The R^2 refers to percentage of variance elucidated by independent variables to the dependent variable. In the present study CSR spending, size, growth, leverage and capital together explain tax aggressiveness by 55.86%. The model is considered well-fitted due to its high F-statistic and statistical significance, indicated by a p-value of less than 0.05%.

Table 5: Statistics Fixed Effects Estimation

Variable	Coefficient	Prob.
LGROWTH	4.592021	0.0467
LLEVER	0.028258	0.8334
LCOSIZE	-3.470104	0.1602
LCSR	0.209691	0.1098
LCAPITAL	-0.059607	0.8507
C	-1.045351	0.8576

Other Statistics	
Parameter	**Value**
R-squared	0.558600
Adjusted R-squared	0.424937
F-statistic	4.179161
P value	0.00000
Durbin-Watson stat	1.668516

Source: Author's own output

Random Effect Panel Regression Analysis

In contrast to a fixed effect model, random effects approach avoids a loss of degree of freedom by varying the intercept between cross-sectional data. This indicates that the Random Effect Model (REM) is useful for examining variations in error variances. According to the random effects specification, there is no correlation between the effect and the residual. The OLS estimator will be biased and the estimates may be erroneous when there is a finite sample size and μ is random.

Table No. 6 showcased the results of CSR spending on tax aggressiveness in the presence of control variables by means of the Random effect model. This model avoids loss of degree of freedom as here; intercept is varied between cross-sectional data. The statistics of F test of the guesstimated model is coming out to be 6.869 along with probability value of 0.000, which stipulates that the guesstimated model is fit to explicate the tax aggressiveness by CSR and control variables. Absence of autocorrelation is observed in the guesstimated model as statistics of DW is 1.797, which lies amid the threshold limits if less than 3 and more than 1. The CSR is observed with positive coefficient 0.182127 along with .0280 p values, it can be said that there is positive and significant relationship between CSR and tax aggressiveness. Likewise, capital is significant with p value 0.000 with positive coefficient whereas growth and size are insignificant with positive and negative coefficient respectively. Leverage is coming out to be significant with p value 0.009 with negative coefficient. The R2 refers to percentage of variance elucidated by independent variables of the study to the dependent variable. In the present study CSR spending, size, growth, leverage and capital together explain tax aggressiveness by 16.02%. Adjusted R2 is close to R2 which is 13.69 %. The model is considered well-fitted due to its high F-statistic and statistical significance, indicated by a p-value of less than 0.05%.

Table 6: Statistics Random Effects Estimation

Variable	Coefficient	Prob.
LGROWTH	0.134992	0.1608
LLEVER	-0.201456	0.0095
LCOSIZE	-0.842189	0.4641
LCSR	0.182127	0.0280
LCAPITAL	0.449820	0.0000
C	3.505018	0.0405
Other Statistics		
Parameter	**Value**	
R-squared	0.160238	
Adjusted R-squared	0.136911	

F-statistic	6.869299
Prob(F-statistic)	0.000007
Durbin-Watson stat	1.273634

Hausman Test: Specification of Best Estimation Model

After assessing the outcomes of the two different methodologies i.e. Fixed Effect Model and Random Effect Model, the present research work performs a test called as Durbin–Wu–Hausman (DWH) to examine which regression model is best suited for the gathered data i.e. whether to use fixed effect model or to use random effect model. This test essentially indicates that the fixed effect methodology will be acceptable if the error term of the model is connected with the independent variables of the study, but the random effect approach will be appropriate if the error term is not correlated with independent variables. The random effect model is the one that is favoured, according to the model's null hypothesis. Following the thumb rule the model used for conducting this empirical study is a random effect regression model as p value is coming out to be 0.1210 which is larger than 0.05 (>0.05).

Table 7: Hausman Test Statistics

	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	8.715051	5	0.1210

In the panel regression using the random effects method, the study has provided the following values of different variables as per the appropriate model specification.

$$CETR_{it} = \beta_0 + \beta1\ CSR_{it} + \beta2\ COSIZE_{it} + \beta3\ LEVER_{it} + \beta4\ GROWTH_{it} + \beta5\ CAPITAL_{it} + E_{it}$$
$$CETR_{it} = 3.505018 + 0.182127\ CSR_{it} - .0842189\ COSIZE_{it} - 0.201456\ LEVER_{it} + 0.134992\ GROWTH_{it} + 0.449820\ CAPITAL_{it} + E_{it}$$

Conclusion and Discussion

The association amongst a firm's CSR performance and its level of tax aggressiveness of NIFTY 50 companies is the subject of this study. It likewise inspects in what way CSR performance in the field of public, environment, market, and office narrate about the corporate tax aggressiveness. In order to evaluate the proposed relationship or equation, a random effect model was employed, as indicated by the Hausman test. The outcomes of the analysis displayed that the amount spent for CSR activities have a statistically important association with the companies' tax aggressiveness. With the results they demonstrated that corporate tax aggression is considerably increased with performance in corporate social responsibility (CSR). This work contributes uniquely to the existing literature by specifically examining aspects relevant to India which is a developing nation, having extraordinary dependency on its tax receipts as a source of revenue to the government. The results of the investigation are consistent with the corporate cultural theory wherein it was found that many a times CSR is being used by business houses to conceal immoral activities like corporate tax avoidance practices (Lanis & Richardson, 2013; Amidu et al., 2016). Results are also in line with the results on an empirical survey being conducted by Graham et al. (2012) wherein the findings recommended that tax managers consider the potential for bad press and the risk of sanctions when deciding on tax avoidance strategies. There are high chances of increasing the CSR activities by the organizations if they believe that the degree of negative publicity and the sanction risk can be minimized through the favourable press that comes from CSR implementation.

This research investigates the legitimacy theory empirically by investigating the relationship between disclosures of amount spent on CSR activities with corporation's tax aggressiveness. To test the hypothesis that tax-aggressive commercial enterprises have larger CSR announcements to offset potential

communal distresses which culminated from their tax-aggressive practices on society and to validate that they are constantly meeting societal expectations in other ways, the present study conducted a model of random effects evaluation considering the sample. Overall, our analyses show a statistically significant and positive connection amid tax aggressiveness and disclosure of CSR, supporting the legitimacy theory within the context of corporate tax aggressive behaviours. The present study offers a novel test of legitimacy theory and delivers a reasonable clarification as to why some businesses release more CSR statistics than others. Furthermore, our outcomes are reliable with the fact that there is an amplified community awareness of tax as an imperative measure of CSR ever since the international economic meltdown. Thus, in every country, issues and concerns on corporate tax are gradually increasing within the public sphere (D'Ascenzo, 2010, p. 3). Finally, this work offers more evidence in favour of a developing paradigm for research on tax aggressiveness and social responsibility among businesses.

The findings of the study also emphasized that encouraging CSR performance and tax-aggressive actions necessitate perpetual and reliable business planning and implementation. Therefore, it is valuable predominantly in developing an active outline to recognize establishments with high inclination towards tax aggressiveness. This will further aid to augment the degree of adherence to corporate tax laws in developing countries like India. This research work also proposes an assessment on corporate tax enticements provided, specifically those connected to CSR activities in the community. Mohanadas et al (2020). An upsurge in relevant tax credits might motivate greater numbers of businesses to invest in societal advancements, as these are vital corporate contributions. It stated the universal applicability of the relationship between taxes and public well-being, irrespective of the county's financial status. It marks and suggests to the corporate world at large that for building good rapport it is a natural and prudent way to work for the community or adopt CSR practices. Besides, by gladly honouring their rational portion of levies, companies substantiate their claims to be socially responsible. Consequently, the assertion that income tax functions exclusively as a business expense can be reconsidered.

Limitations and Future Scope of the Study

There have been several constraints to this research work. Its sample is mainly composed of companies that are listed on the Nifty 50 index. Moreover, this study is performed using the data for the years 2019-2023 for performing the empirical investigation. The researcher has performed the regression analysis with four variables as control variables. In the future, other variables like ownership structure (Ganguli and Guha, 2021); board independence (Khatri ,2023) etc. can also be used as control variables. The study permits to undertake a comparative study among developed and developing economies with respect to exploring relationships among CSR performance and corporate tax aggressiveness. Finally, this study suggests that future research should look into a longer time frame in order to more accurately evaluate how corporate tax aggressiveness has changed over time. Legitimacy theory can also be examined concerning the size of the firm and CSR discussions. Future research work can also be conducted to look into how ethics integrate with the company's tax strategies and corporate social responsibility (CSR) initiatives.

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Input Tax Credits and Electricity Pricing Under India's GST Regime: A Thermal Power Generation Study

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Abstract

The implementation of the Goods and Services Tax (GST) framework has brought about significant changes in India's power sector. This requires a thorough analysis of the tax impact on energy producers and consumers. This study uses a quantitative approach to examine the effects of the GST regime on the power sector, with a specific focus on coal-based thermal generation projects. Our analysis looks into the interaction between Input Tax Credit mechanisms, rationalized tax rates, and existing electricity regulatory frameworks. While the exclusion of electricity from the GST framework aims to simplify regulations, it has created disparities in the tax structure that need to be studied. Considering the changes in indirect taxation and the unique nature of the power sector, this study evaluates the impact of the GST regime on electricity pricing dynamics in India. The research identifies potential ways to reduce per-unit generation costs and investigates how tax efficiencies can lead to lower electricity tariffs for end consumers.

Introduction

The initiation of the Goods and Services Tax (GST) in India has been a pronounced reform in India's indirect taxation system, aiming to create a harmonised market and simplify tax compliance. The key mechanism of Input Tax Credits (ITC) allows businesses to offset input tax liability against the output tax liability. ITC has been identified as a powerful tool for reducing cascading effect of taxes aimed at improving efficiency, while, its outcomes for specific sectors, such as thermal power generation, are challenging and multifaceted.

Power infrastructure plays a pivotal role in the development and sustenance of a nation's economy and well-being. India is the third largest producer and consumer of electricity globally with an installed power generation capacity of 429961 MW as on May 31, 2023 (Ministry of Power, 2023). India's power sector has experienced a significant transformation post 2015, primarily aimed at electricity generation through non-fossil fuel-based sources in the energy mix (Debnath et.al., 2020).

Electricity plays a crucial role in various aspects of daily life and economic activities. Coal is a major input in thermal power generation (Rao, et.al., 2019). In 2017, 80 percent of coal was consumed by the power sector (Ray, 2017). It has historically been a predominant fuel in electricity generation due to its abundance and relatively low cost in comparison to other energy sources. Even today, coal plays a significant role in global electricity production, accounting for approximately 40% of the total electricity

generated worldwide. China, USA, and India have been the largest consumers of domestic coal for power generation (Farnoosh, 2022).

In the pre-GST regime, tax on supply of electricity was a state government subject. Central Excise and Value Added Tax (VAT) was not applicable on supply of electricity. The GST regime, working on similar lines, transmission or distribution of electricity by a transmission or distribution utility (Mishra & Kawdia, 2022) is excluded from GST. The determination of electricity tariffs involves considering various factors, and input prices, like fuel prices, operational expenses, regulatory and compliance expenses, return on equity are certain crucial components (Muralidharan, 2016). The tariff of a generating station typically consists of two main components - capacity charges and energy charges (CERC, 2020). Electricity has been kept outside the purview of the GST in India (Satpathy, 2018). This exemption implies that GST is not applicable on transmission or distribution of electricity by the utility companies. The aim behind this exemption is to avoid double taxation and ensure that consumers are not over-burdened with GST being applicable on essential services like electricity transmission and distribution (Khandelwal, 2021).

The exclusion of final output of electricity from GST and inputs being taxed under GST leads to spill over effect by way of higher costs being recovered from buyers of electricity in terms of higher tariffs. Electricity is a crucial input for all the industries. Inclusion of final output of electricity under GST will benefit the manufacturers across the industries by way of reduced prices of inputs (Kelkar et. al., 2021) and end-consumer by way of overall reduced prices. This paper analyses the impacts of implementation of GST on the Power Sector with coal as a major input.

This study develops an understanding of the impact of GST on prices of electricity. We focus on power plants with coal as the major input. A scenario has been analysed wherein electricity output has been subjected to 5% GST and input tax credit has been claimed for the tax paid on inputs. The detailed calculations showing the inputs for calculation of electricity prices and comparison of electricity prices in pre and post - GST scenarios is the gist of this paper. This exclusion of final output of electricity from GST leaves a big scope for improvement and the study tries to support this claim through the shown calculations. State governments may have apprehensions for inclusion of electricity under GST as they might be losing their revenues because electricity is subject to state levies. Coal based thermal power plants will be benefitted because of the availability of ITC (Baruah & Prasad, 2023). Thus, it becomes imperative for the policymakers and the industry to be acquainted with the possible outcomes of bringing electricity under the GST ambit for the benefit of various stakeholders

The remainder of this paper is organized as follows. Section 2 provides a comprehensive overview of the research context, including a review of existing literature and a description of the identified research gap. In Section 3, the research hypotheses are formulated, and the methodological approach employed in this study is outlined. Section 4 presents the data collection, analysis, and findings derived from the conducted interviews. Finally, Section 5 offers concluding remarks, including potential avenues for future research.

Background and Literature Review

The electricity sector can be divided into three sub-sectors: (a) Generation, (b) Transmission, and (c) Distribution (Ministry of Law and Justice, 2003). Generation is the process through which electricity is produced. Transmission involves the transportation of electricity from generators to distribution companies (discoms), and lastly, electricity is distributed from discoms to consumers (PWC, 2013). Electricity plays a critical role in industrial and agricultural output as well as overall economic growth. Lower costs due to tax exemptions help to achieve these goals. Supply of electricity through transmission and distribution is exempt from GST in India (Powerline, 2017). Whereas, electricity supplied by a source other than the designated utility company is subject to 18% GST (Khandelwal, 2021).

Addressing challenges related to power generation, transmission, distribution, and pricing is crucial for ensuring sustained economic growth and enhancing global competitiveness (Satpathy, 2018). The implementation of GST over VAT can offer several advantages, but its success heavily relies on effective planning and execution (PWC, 2022).. GST has subsumed all the central and state taxes into a single tax (Thowseaf et.al., 2019). GST makes the nation a unified market where consumer are liable to pay a single tax called GST in the destination state (Bharat, 2017). Early studies on GST broadly focussed on evaluating

the awareness of and willingness to accept GST (Othman et.al., 2020). and assessing tax implementation and its progress.

Under the GST regime, tax is levied at every point of sale. Intra-state sales are liable to Central GST (CGST) and State GST (SGCT). Inter-state sales are chargeable to Integrated GST (IGST). GST is levied at every stage of the transaction or wherever supply is in picture. Another important concept that emanates from this dimension of GST is "supply" (Ministry of Finance, 2019). The tax revenue accrues to the state, where the final consumption takes place, the chain of events is studied to identify the flow i.e. supply. GST is therefore levied on "supply".

GST is charged on the monetary value added at each stage till the final supply to the end customer (PWC, 2022). Broadly, the superiority of GST over the existing laws can be summarised as follows (Annapoorna, 2023): Removal of Cascading Tax effect, Higher threshold for registration, Composition scheme for small businesses, streamlined procedures for e-commerce, online systems and lesser compliances, increased efficiency in logistics, tapping the unorganized sector into tax regime.

Taxation on coal-based power generation and distribution

The thermal sources of power generation are oil, gas, coal and other sources are hydro energy, nuclear energy, wind energy, geothermal energy, tides and waves. The power generation plants are typically capital-intensive projects. The initial investment costs constitute a major portion of the total cost of establishing such facilities (Hafner & Luciani, 2022). Coal based thermal power generation is a major contributor to the national grid, and studying this sector helps capture the critical impact of GST on the energy market. Any changes in cost structure of electricity will affect the affordability of consumers of electrical energy. Thus, it is an important area to study tax reforms influence energy sector directly or indirectly.

Electricity pricing schemes can exhibit significant variations, affected by a myriad of factors like storage of thermal inputs, renewable energy sources, taxation of electricity etc which collectively shape the economic landscape of power generation and consumption. Thus, understanding the interplay of crucial factors is essential for comprehending the complexities inherent in contemporary electricity pricing models (Dutta & Mitra, 2017). Under VAT regime, power producer/distributor procured inputs against C-Form in an interstate purchase by paying a CST of 2% only. Also, some movements of inputs had to be routed through multiple states to take the benefit of lower tax rates applicable during inter-state transactions. There is no concept of CST or lower tax rates in interstate transactions under the GST regime.

Exemptions or concessions can lower tax burdens or provide certain benefits to businesses, thereby, reducing overall project expenses. Without these benefits, costs might rise due to increased taxes or compliance requirements (PWC, 2019). Excluding electricity, petroleum products from the GST list might have been a measure aimed at simplification or addressing specific concerns, but it doesn't necessarily resolve all issues related to taxation on those goods (Gopakumar, 2016). VAT on electricity in Belgium was retracted reduced from 21% to 6% and the resultant benefit was passed on to the consumers by way of reduced prices. Political reasons pushed the VAT rate to the original 21% and there was a symmetry in the results as it made electricity dearer for the consumers.

In pre-GST regime, a contractor supplying goods to a mega power project enjoyed exemption from Excise Duty. Such goods were subject to VAT/CST and entry tax as per respective state laws. Now, all those goods are covered under 18% slab of GST. The earlier savings to the tune of 10% -14% have disappeared under GST regime. Thus, cash flows of contractors supplying goods to Mega power projects have been negatively impacted (Saha, 2019). The contractors had to bear the additional burden of taxation where the project owner had declined to bear the incremental burden of GST.

The Clean Environment Cess imposed on coal at a rate of INR 400 per tonne in pre-GST regime has been revamped into GST Compensation Cess of INR 400 per tonne on coal in GST regime to tax the negative impacts of usage of coal in electricity generation (Soman et.al, 2019). The study compared the Levelized Cost of Energy (LCOE) from renewable source - solar photovoltaic (PV) with non-renewable source of energy-coal and found the introduction of GST had differentiating effects on the LCOE for PV which increased by almost 6% and LCOE for existing coal based thermal power plants decreased by 1- 2 percent (Soman et.al, 2019). Tax credits play a significant role in various industries, including the power

sector, by providing relief from taxes paid on inputs. The power sector experienced issues where the VAT imposed on inputs by the state did not benefit from tax credits, it posed challenges for the industry. GST is imposed on inputs within the power sector and there are no corresponding tax credits or mechanisms in place to offset or reclaim these expenses, it can indeed negatively impact the sector[9]. The research endeavours to address these potential anomalies.

Table 1: Comparison of tax rates

Nature of Transaction	Tax Category	Rates	Effective Rate
Intra- State	VAT	5% to 14.5%	5% to 14.5 %
Inter-State 3(a) of CST Act,1956	CST	2%	3% to 10%
	Entry Tax (Few States)	1% to 8%	
Inter-State 3(b) of CST Act,1956	Entry Tax (Few States)	1% to 8%	1% to 8%
GST regime (Interstate/Intrastate)	GST	18% to 28%	18% to 28%

(Saha, 2019)

The inputs of a coal-based power plant are subject to taxation. It is suggested that applying a modest GST rate of 5% on electricity could enable these plants to use Input Tax Credit (ITC) available on inputs to fulfil their GST liability (Baruah & Prasad, 2023). Substantial savings from ITC could decrease their effective tax burden, potentially leading to improved cash flows and reduced operational costs. The industry anticipates that including electricity under GST will result in lower electricity prices due to the availability of input tax credit. However, many states have opposed the inclusion of electricity under GST due to concerns about losing revenue from existing duties. Duty rates on electricity vary across the country, and the level of opposition from states varies depending on the potential revenue impacts (Baruah & Prasad, 2023).

The GST rate applicable to coal is 5%, which is a reduction from the previous effective tax rate of 11% - 11.5% for domestic coal. This reduction could have significant implications. It is uncertain whether financially strained discoms will pass on these benefits to consumers, but even if they do, it will take time (Powerline, 2017). Under the GST regime, plants dependent on domestic coal are expected to see a 3-4 paise per unit decline in variable cost, while plants dependent on imported coal will experience an increase of 7 paise per unit, according to ICRA's estimates (Surya & Vipra, 2022). In contrast, the GST rate applicable on electricity in Australia is 10%. Proposals to make electricity GST-free were rejected due to concerns about the impact on state revenues. Embedded taxes currently constitute almost 30% of the cost of electrical energy. Including electricity under GST would have far-reaching implications for the Indian economy, as it would help improve cost efficiency across industries. Since electricity is a fundamental input in all sectors, GST on it would make businesses eligible for ITC and help lower production costs (Thirteenth Finance Commission, 2009)

Research questions and methodology

The previous studies have looked into the positive and negative effects of GST on the Indian economy and its impact on major sectors such as manufacturing, services, and logistics. However, there has been limited research on the specific effects of GST on coal-based thermal power generation and power pricing. Since coal is a significant input in power generation in India, it is crucial to understand how GST affects operational costs and pricing patterns of coal-based power plants. This study aims to address these

gaps and provide valuable insights for policymakers, industry, and researchers into the operational and pricing dynamics of the energy sector under the GST regime.

Entry No. 338 of notification No. 12/2012-Central Excise, dated 17th March 2012, provided an exemption for central excise duty on machinery, apparatus, instruments, cables, components, or raw materials supplied to specified mega power projects. These projects typically involve large-scale electricity generation, and the exemptions were part of government initiatives to incentivize their development and ensure a reliable power supply. However, Notification No. 11/2017-Central Excise, dated 30th June 2017, discontinued all such exemptions from central excise duty for the supply of inputs to mega power projects under the GST regime[10].

The exemption of electricity output from the Goods and Services Tax (GST) framework precludes power generators from collecting GST from end consumers. Conversely, the inputs utilized in power generation remain subject to GST, obligating power companies to remit tax on procured inputs. This tax structure potentially causes increased electricity prices for final consumers, leading to our primary research hypothesis:

H1: The incorporation of electricity output within the GST framework will result in a reduction in electricity prices for final consumers.

The transition to GST has precipitated the withdrawal of various exemptions and concessions previously available for capital goods and other inputs employed in power generation. The majority of these inputs are now taxable at 18% under the GST regime. Despite India's significant advancements in power generation capacity, with coal and lignite-based plants historically serving as principal contributors due to the country's abundant coal reserves, a taxation asymmetry persists. While coal—a critical input—is subject to GST, the final product, electricity, remains outside the GST purview. This exclusion prevents producers from availing input tax credits on purchased inputs, potentially resulting in price escalation for consumers. Under the previous Value Added Tax (VAT) regime, coal was subject to multiple levies including stowing excise duty, central excise duty, VAT, and entry tax, culminating in an effective tax rate of approximately 12%. The GST regime has rationalized this to a single 5% rate. This study aims to empirically examine the impact of revised tax rates for coal on electricity generation costs and subsequent pricing dynamics. Our investigation focuses on the relationship between input goods taxation and electricity generation costs, leading to two distinct hypotheses:

H2a: The increase in tax rates on input goods and services has resulted in higher electricity generation costs.
H2b: The reduction in the tax rate on coal under the GST regime has decreased electricity generation costs.

Methodology

This study examines the implications of India's restructured indirect taxation framework on the power sector, addressing a notable gap in the extant academic literature. The research employs a qualitative, interview-based case study methodology to explain the complexities of the issue and gather empirical data. The scope is deliberately constrained to a single Public Sector Undertaking (PSU) and one consumer category to enable detailed analysis.

The methodological approach involves a comparative analysis between baseline and post-GST scenarios for power tariffs. This research design facilitates an examination of the current regulatory environment resulting from the transition in the indirect taxation regime. Data collection utilizes both primary and secondary sources. Primary data is obtained through semi-structured interviews with key stakeholders. Secondary data sources encompass: Policy documents and analytical reports from the National Institution for Transforming India (NITI Aayog); Corporate documentation from the subject PSU, including annual reports; Regulatory frameworks, specifically the Draft Central Electricity Regulatory Commission (Terms and Conditions of Tariff) Regulations 2019-24, and supplementary online resources for taxation guidance and regulatory clarifications (e.g. www.cleartax.com, www.cbic.com)

This mixed-method approach enables triangulation of data sources, enhancing the robustness of our findings and facilitating a comprehensive understanding of the taxation-induced changes in the power sector ecosystem.

Data and analysis

The company selected for study is a prominent public sector undertaking (PSU) under the Ministry of Power, ranking among India's largest electricity producers. It holds Maharatna status and is among the top 500 companies in the Forbes Global 2000. Taxation data and related information were gathered through online interviews with the Procurement Manager and DGM Finance, both with at least five years of industry experience. Semi-structured open-ended questions were used to explore the company's taxation practices, and its publicly available data was analyzed. Based on this information, two scenarios were developed: one without GST on electricity and the other with GST.

Hypothesis 1

Transmission and distribution cost analysis

For the computations presented below, the Transmission and Distribution (T&D) cost (Table 1) components have been considered based on the NITI Aayog Report (NITI Aayog, 2020). The AT&C Losses are taken at 18.22%. The Per Unit T&D cost is taken as Rs. 2.35 per unit (for *Chhattisgarh* state) being levied on the final output. Electricity Duty assumed as 10 paisa/unit is included. T&D components have ITC eligibility of approximately 10-12%, out of the input supplies. The details are tabulated in Table 2.

Table 2: Components of Electricity Tariff

Description	Particulars	Applicable GST %
Tarif for a Quarter (Rs. per unit)	2.55	NA
Aggregate Technical & Commercial (AT& C) Losses*	18.22%	NA
T&D cost (*Chhattisgarh*)	2.35	NA
GST on coal	5%	NA
Coal cost including freight	1730	NA
GST Compensation cess on Coal (Rs./MT)	400	NA
GST on coal cost including freight	86.5	NA
Landed cost of Coal including GST	2216.5	3.90%
Average Gross Calorific Value (GCV)	3709	NA
Employee Cost on % of Operations & Maintenance (O&M) expenses	29.12%	0 %
Repair & Maintenance on % of O&M expenses	42.97%	18 %
Station & Administrative Overheads on % of O&M expenses	27.91%	15 %
Weighted Average Input Tax Credit (for Generator & Distributor)	10.19%	NA
GST on generation, transmission and distribution	5%	NA

*AT&C losses owed to losses for which the discoms do not receive any payment (Thirteenth   Finance Commission, 2009); Source: Author's calculation using collected data

To comprehend the Input Tax Credit (ITC) flow and calculate the GST-inclusive actual costs, quarterly financial data from the power generation company was analysed. The tariff structure comprises two primary components:

1. Energy Charges: Variable costs directly correlated with fuel expenses (refer to Table 2)
2. Capacity Charges: Fixed costs encompassing, Return on Equity (ROE), Loan Interest, Depreciation, Working Capital Interest, Operations & Maintenance (O&M) Expenses (refer to Table 3)

The GST on inputs which can be availed as ITC in the subsequent stages are available only on the following components: Repairs & Maintenance Expenses, Security Expenses (both part of O&M Charges) and Fuel Charges. It is assumed that out of O&M Expenses, approximately, 29%-35% comprises Employee Expenses, 40%-42% comprises Repairs & Maintenance, and the balance constitutes Station & Administrative Overheads. These composition values have been apportioned as weights for arriving at the GST rate as a % of cost.

Applied GST Rates: (a) Employee Costs: NIL (b) Repairs & Maintenance: 18% (standard rate for majority of goods and services) (c) Overheads: 15% (d) Coal: 5%. These weights are for old operating plants only and the same may fluctuate for new operating plants. 5% GST paid on the Coal cost is also considered for ITC. After arriving at the ITC figures (Table 3), the ITC has been separated from the total revenue and GST @ 5% is applied. The net reduction in the Generation cost to the next level is approximately equal to the difference of GST levied and ITC claimed. The percentage reduction of such an amount with reference to the Total Revenue (before GST) is calculated and is applied on per Unit rate to arrive at the Per Unit GST loaded rate.

Table 3: ITC calculation

					(Rs. in Cr.)
Description	Pre-GST	%	Appl. of GST %	Revenue excl. GST	ITC available
Capacity Charges					
Return on Equity	122.46	12%	0%	122.46	NA
Interest on Loan	27.18	3%	0%	27.18	NA
Interest on WC Loan	23.12	2%	0%	23.12	NA
O & M Expenses	112.86	11%	10.19%	102.42	10.44
Depreciation	110.23	11%	0%	110.23	NA
ED, Cess	46.44	5%	0%	NA	46.44
Security Expenses	4.58	0%	18%	3.88	0.7
Water Charges	14.55	1%	0%	14.55	NA
Energy Charges					
Fuel Cost Recovery	521.03	53%	3.9%	500.70	20.33
Total Revenue	982.44	100%	NA	904.53	77.91
% of Input Tax Credit to Revenue	NA	NA	NA	NA	7.93%
Total Revenue	982.44	NA	NA	949.76	NA

Reduction in Generation cost of electricity to DISCOM	32.68	NA
% of Reduction in Generation cost of electricity to DISCOM	3.33%	NA

Source: Author's calculation using collected data

The net generation cost considering the AT&C losses is Rs 3.12 per unit in pre-GST regime and will be Rs 2.88 per unit in post-GST regime. The transmission and distribution cost will reduce by 44 paisa per unit and total cost per unit will reduce by 0.68 paisa excluding GST value and 45 paisa per unit inclusive of GST value. The amount per unit seems insignificant, but will result in savings in the electricity bill of households and industrial consumers as larger units of electricity is consumed per month by different category of consumers. The calculation shows the reduction in electricity prices if final output of electricity is made taxable under GST @ 5%. This validates first hypothesis.

Table 4: Cost Per Unit of Electricity to Consumers

Particulars	Pre-GST	% of Reduction in bill	After GST (including GST value)	After GST (excluding GST value)	Decrease in Cost
Generation cost (Rs. per unit)	2.55	3.33%	2.47	2.35	0.20
AT&C Losses	18.22%	-	18.22%	18.22%	-
Net Generation Cost	3.12	-	3.02	2.88	0.24
Transmission and Distribution Cost	2.35	10.19%	2.11	1.91	0.44
Total Cost Per Unit	5.47	-	5.02	4.79	0.68

Source: Author's calculations based on inputs from respondents

Hypothesis 2

Table 5 shows that the landed price of coal decreased in the Post GST scenario. This change will make coal-based power generation more cost-effective and have mixed impacts for various states and different categories of consumers. Few states might face revenue challenges due to merging of duties into GST[12]. But, according to a respondent, the coal companies increased the base price of coal for power generation companies with effect from 8th January 2018. This increase in base price of coal coupled with increase in GST rates on procurement and services to 18% increased the overall cost of generation of electricity using coal. The increase ultimately had to be borne by the consumers by way of increased electricity bills. This supports hypothesis 2a.

The implementation of the GST in India's power sector yielded complex and sometimes counterintuitive outcomes. According to a key respondent, the average landed cost of coal decreased by approximately 5% post-GST implementation, resulting in a 12-12.5% benefit for generation companies. However, this apparent advantage was offset by an overall increase in tax incidence for the power sector.

The increased tax burden stemmed from the withdrawal of previously available exemptions, such as excise duty and basic customs duty for mega power projects. Under the new GST regime, these taxes became applicable to domestic supplies, foreign supplies, and imports, with Integrated GST (IGST) levied on imports. This shift created a challenging environment for the power sector during the GST transition period.

A significant issue arose because most procurement and services for the power sector fell under the 18% GST slab. Suppliers should have absorbed this higher tax incidence. However, the reality proved more complex. Public Sector Undertakings (PSUs) sought government guidance on managing this additional GST burden, highlighting a lack of clarity in policy implementation. The government's decision to eliminate long-standing exemptions (in place for 8-9 years) without fully considering the implications on existing contracts exacerbated the situation.

The distribution of this 18% additional tax burden was heavily skewed towards power companies, who bore 14% of the increase as suppliers refused to execute projects under the new tax regime. Only 4% of the burden was successfully passed on to suppliers. Even this seemingly small percentage had significant repercussions for procurement and service providers, many of whom were simultaneously managing multiple high-value projects. The financial strain led to several suppliers, particularly in ash and coal handling, abandoning projects or declaring bankruptcy.

Table 5: Landed Price of Coal

Pre-GST Landed Price of Coal	Amount in Rs/MT	Post GST Landed Price of Coal	Amount in Rs/MT
GCV billed	4150	GCV billed	4150
GCV Grade*	11	GCV Grade*	11
Basic Price	810	Basic Price	810
Royalty (14%)	113.4	Royalty (14%)	113.4
NMET Fund (2% on Royalty) + DMFT (30% on Royalty)	36.29	NMET Fund (2% on Royalty) + DMFT (30% on Royalty)	36.29
Sizing Charges	79	Sizing Charges	79
Rapid Loading Charge	26	Rapid Loading Charge	26
Surface Transport	-	Surface Transport	-
Paryavaran Upkar	7.50	*Paryavaran Upkar*	7.50
Vikas Upkar	7.50	Vikas Upkar	7.50
Clean Environment cess (CEC)	400	Clean Environment cess (CEC)	NA
Stowing Excise Duty (SED)	10	Stowing Excise Duty (SED)	NA
Central Excise duty @6.00 %	65.38	Central Excise duty @6.00 %	NA
Sub Total	1555.07	Sub Total	1079.69
Entry Tax (1%)	15.55	GST (5%)	53.98
VAT(5%)	78.53	GST Compensation Cess	400
Cost as Delivered	1649.15	Cost as Delivered	1533.67
Landed Price	1649.15	Landed Price	1533.67

(Source: Author's calculation using collected data).

The GST introduction also led to quality compromises as suppliers attempted to cut costs. Project delays and cash flow issues resulted in many suppliers abandoning ongoing projects mid-execution. PSUs were forced to engage directly with sub-contractors to complete these projects, a challenging task given the technical nature of the work and the difficulties in introducing new contractors midway through a project. These extraordinary measures, often beyond contractual obligations, were necessary due to the interdependencies between various projects.

Table 6: Impact of GST on price of different grades of coal

	Grade	Coal Rate PMT (Post-GST)	Coal Rate PMT (Pre-GST)	Change in Rate PMT	Entry Tax @2%	Change in % after Entry Tax
		(1)	(2)	(3)=(1) – (2)		
CCL	G3	4598.12	4741.67	-143.55	-94.83	-5.03
	G4	4336.87	4472.66	-135.79	-89.45	-5.04
	G5	3963.91	4088.62	-124.71	-81.77	-5.05
	G6	2906.48	2999.77	-93.29	-60.00	-5.11
	G7	2595.21	2679.25	-84.04	-53.59	-5.14
	G8	2371.29	2448.67	-77.38	-48.97	-5.16
	G9	1973.19	2038.76	-65.57	-40.78	-5.22
	G10	1823.91	1885.03	-61.12	-37.70	-5.24
	G11	1612.42	1667.26	-54.84	-33.35	-5.29
	G12	1550.22	1603.21	-53.00	-32.06	-5.31
	WASH COAL-PIPARWAR	2711.81	2380.50	331.31	-47.61	11.92
	WIV-RAJARAPPA	3179.92	3281.33	-101.41	-65.63	-5.09
	WASH COAL POWER - RAJARAPPA	3702.25	3400.37	301.88	-68.01	6.88
BCCL	WIV-HVMC	3403.15	3448.17	-45.02	-68.96	-3.31
	WIII-HVMC	3553.70	3603.12	-49.42	-72.06	-3.37
	Grade	Coal Rate PMT (Post-GST)	Coal Rate PMT (Pre-GST)	Change in Rate PMT	Entry Tax @2%	Change in % after Entry Tax
		(1)	(2)	(3)=(1) – (2)		
CCL	G3	4598.12	4741.67	-143.55	-94.83	-5.03
	G4	4336.87	4472.66	-135.79	-89.45	-5.04
	G5	3963.91	4088.62	-124.71	-81.77	-5.05
	G6	2906.48	2999.77	-93.29	-60.00	-5.11
	G7	2595.21	2679.25	-84.04	-53.59	-5.14
	G8	2371.29	2448.67	-77.38	-48.97	-5.16
	G9	1973.19	2038.76	-65.57	-40.78	-5.22
	G10	1823.91	1885.03	-61.12	-37.70	-5.24
	G11	1612.42	1667.26	-54.84	-33.35	-5.29
	G12	1550.22	1603.21	-53.00	-32.06	-5.31
	WASH COAL-PIPARWAR	2711.81	2380.50	331.31	-47.61	11.92
	WIV-RAJARAPPA	3179.92	3281.33	-101.41	-65.63	-5.09
	WASH COAL POWER - RAJARAPPA	3702.25	3400.37	301.88	-68.01	6.88
BCCL	WIV-HVMC	3403.15	3448.17	-45.02	-68.96	-3.31
	WIII-HVMC	3553.70	3603.12	-49.42	-72.06	-3.37

Source: Author's calculation using collected data

Despite these challenges, power generation companies experienced some mitigation of the negative impacts due to reduced coal prices. The net negative effect on these companies was estimated at 1.5-2%, but this was limited to a six-month period. Ultimately, this additional cost was passed on to end consumers. The resolution of the extra tax burden for existing projects was a protracted process, causing delays of approximately one year. Subsequently, the industry adapted to the new GST law, with contracts and prices adjusted to incorporate the non-creditable GST on inputs into the final output prices.

A significant development occurred on January 8, 2018, when coal companies implemented a broad price increase of approximately 15%. This increase was particularly pronounced for coal grades typically supplied to power plants. Consequently, despite the initial reduction in tax rates on coal, the price of electricity ultimately increased. This outcome contradicts our initial hypothesis (2b) regarding the expected effect of GST implementation on electricity prices. It highlights the need for comprehensive policy impact assessments and the importance of considering both tax reforms' direct and indirect effects on critical infrastructure sectors.

Implications

Implementing GST at a rate of 18% on the majority of inputs in the power sector has led to significant economic ramifications and policy challenges. The analysis presented is based on inputs received from respondents and the above discussion. It examines the multi-faceted impact of this tax reform on various stakeholders within the industry. In response to the increased tax burden, sector stakeholders-initiated policy advocacy efforts and entered into negotiations with both government entities and suppliers. The objective was to redistribute the additional tax liability resulting from GST implementation. However, suppliers demonstrated reluctance to absorb this extra financial burden, leading to protracted negotiations. The GST-related uncertainties exacerbated existing project delays, with many experiencing setbacks of approximately one year during supplier settlements. The ultimate distribution of the GST burden varied on a case-by-case basis, with partial absorption by suppliers and partial by power companies. This financial strain contributed to insolvency issues among some suppliers, resulting in bankruptcy filings under the Insolvency and Bankruptcy Code (IBC).

During the initial six-month transition period following GST implementation, project owners reported making quality concessions to manage cost pressures and maintain operational continuity.

Our simplified economic model gives policymakers insights into the determinants of electricity end prices. Key findings include: Rates for new power plants exhibit lower sensitivity to GST changes due to the non-transferability of Input Tax Credit (ITC) on capital expenditures and Lower share of variable charges in total cost structure. The increase in taxes on capital equipment purchases is amortized over the asset's lifetime, mitigating short-term price shocks. The model is particularly effective in cost-plus pricing scenarios, specifically in two-part tariff structures, irrespective of the energy source (fossil fuels or renewables).

The model explains how average electricity rates for end-consumers are a function of input costs. This relationship provides a policy lever for the government to influence economic growth through strategic tax adjustments in the power sector. It may be noted that this model assumes a complete and frictionless pass-through of Input Tax Credit from the point of origin to the end consumer. Real-world constraints in this process may lead to deviations from model predictions.

Conclusion

This study contributes to the growing body of literature on taxation policy in the energy sector, specifically addressing the implications of Goods and Services Tax (GST) on electricity pricing and market dynamics in India. The potential application of GST to electricity represents a significant step towards realizing the "One Nation-One Tax-One Market" policy objective. However, our findings indicate that despite reduced tax rates on coal, electricity prices have experienced an upward trend. The availability of Input Tax Credit (ITC) has the potential to reduce electricity prices for end consumers, and this study provides a framework for policymakers to evaluate the inclusion of electricity under the GST regime.

Implementation of GST on electricity could enhance the competitiveness of Indian exports in the global market, as electricity is a crucial input across various industries. This policy change is expected to have positive economic ramifications. Our analysis suggests considering a uniform 5% GST rate across Generation, Transmission, and Distribution components. Additionally, policymakers should evaluate the option of zero-rating electricity, which could reduce exchequer revenues but potentially stimulate sector investments through full ITC availability for generators.

This research provides a foundation for informed policy decisions on GST application to electrical energy, the development of long-term energy pricing strategies, and enhanced policy coordination between state and central governments in energy taxation. However, it is essential to note the limitations of this study. Our focus was limited to coal-based thermal power projects, and we assumed a 5% GST rate on final electricity output. The analysis was based on a single company and consumer category, which limits the generalizability of results. Furthermore, there is a scarcity of existing literature on GST impact in the power sector, which constrained our comparative analysis.

Looking ahead, several avenues for future research emerge from this study. Scholars should explore alternative tax regimes, such as applying 5% GST on all power sector inputs and outputs, or implementing 5% GST on output while maintaining pre-GST era exemptions. There is a need to analyze scenarios with varying GST rates on inputs and outputs to understand their differential impacts. Additionally, investigating the effect of electricity GST on state revenues would provide valuable insights for fiscal policy. Given the dual nature of coal inputs in power generation, quantifying the effect of the coal input mix (domestic vs. imported) on overall costs and electricity tariffs would further enrich our understanding of the sector's dynamics under GST.

While this study offers meaningful insights into the potential impacts of GST implementation in the electricity sector, it also highlights the need for further comprehensive research. The complex interplay of taxation policy and energy markets in India requires ongoing investigation to fully understand its implications. As the energy landscape continues to evolve, particularly with the increasing integration of renewable sources, future studies should also consider how GST might interact with and influence the transition to a more diverse energy mix.

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The Dynamic Interrelations of Commodity Futures Return: The Role of Economic Policy Uncertainty and Geopolitical Risk

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Abstract

We examine the dynamic interrelations of commodity futures returns and the role of economic policy uncertainty and geopolitical risk. We consider the daily near-month contract futures price of nine commodities covering from 4th January 2012 to 29th September 2023. We employ wavelet power spectrum, wavelet coherence, and wavelet-based Granger causality tests to verify the dynamic interrelations and causality relationship of commodity futures return and the role of global risk factors such as economic policy uncertainty and geopolitical risk at different time horizons. The results reveal a strong interrelation between commodity futures return and economic policy uncertainty (EPU) except for silver and mentha oil. However, the geopolitical risk (GPR) shows a weak relationship with precious metal, base metals, and energy commodities such as gold, lead, zinc, crude oil, and natural gas across all-time frequencies. Next, the Wavelet-based Granger causality test provides strong evidence that commodities futures return cause the EPU in all the time horizons. On the other hand, the geopolitical risk provides significant evidence that commodities futures return causes GPR in all time horizons. The study provides significant policy implications to the various stakeholders of the commodity derivatives market participants such as policymakers, speculators, traders, hedgers, investors and other stakeholders.

Keywords: Commodity futures return, economic policy uncertainty, wavelet power spectrum, wavelet coherence, wavelet causality, geopolitical risk

JEL Classification: E62, G13

Introduction

Since 2003, the commodity markets in India have grown rapidly, and it holds a crucial place in the global commodity market. As the fifth largest economy in terms of GDP (IMF, 2024)[1] And being the world's major importer and consumer of commodities. At present, there are five active national-level exchanges in operation. Especially, the multi-commodity exchange became the seventh-largest commodity derivatives exchange in the world in terms of the number of contracts traded[2]. Recently, commodity futures markets have gained popularity as an asset class for market players such as investors and portfolio managers. It is also used as a risk mitigation tool against any adverse price movements of the underlying assets (Andreasson, et al., 2016). In the recent past, commodity markets have been a major source of global

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[1] sourced from IMF data (as of April 30, 2024)

[2] FIA data, 2023 https://www.mcxindia.com/home

concern due to tremendous changes in commodity prices and rising investors' demand for commodities (Rajput, et al., 2021).

With liberalization, privatization, and globalization (LPG), the economic and financial systems are interconnected across the globe. Any economic uncertainty that happens in one country may have direct or indirect effects on other countries. Further, the magnitude of the impact is high when it originates from leading economics (Dakhlaoui and Aloui, 2016; Ellis and Liu, 2021; Forbes and Chinn, 2004). Economic policy uncertainty plays a pivotal role in influencing financial assets. Since the global financial crisis, economic uncertainty has substantially increased (Li et al., 2020). Indeed, economic policy uncertainty has considerably affected the stock and commodity markets (Bessler et al., 2021; Batabyal and Killins, 2021; Dakhlaoui and Aloui, 2016; Das and Kumar, 2018; Zhang and Broadstock, 2020). A few studies also examine the global risk factors and find a significant impact of EPU in different dimensions. Kido (2016) and Bilgili, et al., (2022) investigate the connection between economic policy uncertainty, geopolitical risk, and exchange rates. Demir and Ersan (2017) and Guizani, Talbi, and Abdalkrim (2023) study the impact of EPU, geopolitical risk, and corporate cash holdings. (Zhang et al., 2015; Jumah, et al., 2023; Schwarz and Dalmacio, 2020) examine the relationship between economic policy uncertainty and corporate leverage. Farooq, et al., (2022) and Liu and Zhang (2020) explore the impact of economic policy uncertainty on corporate investment. On the other hand, the geopolitical risk factor drastically affects the stock market. Bouri et al., (2019) document that Islami bonds and stocks may hedge geopolitical risks. Subsequently, Balcilar et al., (2018) study the geopolitical risk issues on the returns and volatility of BRICS stock markets. In recent years, the newly proposed news-based uncertainties have received significant momentum due to unprecedented economic conditions like the pandemic and increasing geopolitical uncertainty such as the Ukraine invasion. According to Brogaard and Detzel (2015) document that policy decisions taken by the government are likely to cause uncertainty called EPU. However, it also increases the risk by fostering a vicinity of uncertainty about future economic policy decisions. Further, the uncertainty about economic policies, such as fiscal and monetary policies as well as regulatory policies, substantially affects the county's economic growth and investment (Baker et al., 2016). A handful of studies extensively examine the impact of EPU on commodity markets. Studies like (Kang and Ratti, 2013; Wang and Sun, 2017; Yin, 2016) document that EPU significantly affects oil prices. It is noteworthy that economic policy uncertainty could cause shocks to the commodities market. In other words, the EPU is an important factor that drives commodity price volatility (Li et al., 2023). The study also seeks to answer the following questions: how are economic policy uncertainty and geopolitical risk interrelated to commodity futures return? Second, do economic policy uncertainty and geopolitical risk cause commodity futures return? Against this backdrop, the present study examines the dynamic interrelations of commodity futures return and the role of global risk factors such as economic policy uncertainty. The present study contributes to the existing body of literature in various ways. First, we use daily near-month contracts commodity futures return. Second, we consider the newly proposed news-based global risk factors such as economic policy uncertainty, and geopolitical risk proposed by Baker et al. (2016) and Caldara and Iacoviello (2018). Third, the study also finds that most of the studies employ standard econometric techniques to study the comovement and causal relationship between commodity futures return. The study employs wavelet power spectrum and wavelet coherence analysis to overcome this issue. These models are found to be a better method to address the dynamic interrelations relationship between commodity futures return and global risk factors. Next, these models provide more valid and robust results. The study employs a wavelet Granger causality test to verify the causal relationship between commodity futures returns. Further, the study results show a strong comovement between the US economic policy uncertainty (EPU) and commodity futures return except silver and mentha oil. Next, the wavelet Granger causality test results provide strong evidence that commodities futures return cause the EPU in all the time horizons. The study results provide some policy implications to the policymakers and market participants.

The rest of the paper is organized as follows. Section 2 deals with a brief literature review. Section 3 represents data and methodology, Section 4 presents empirical results, and Section 5 provides concluding remarks.

Review of literature

Prior studies have extensively studied the relationship between commodities markets and newly proposed news-based uncertainties such as economic policy uncertainty, and geopolitical risk in the developed countries. However, these studies have employed various econometric techniques to study the impact of policy uncertainty and commodity futures prices. Poncela et al., (2014) confirm that uncertainty plays an important role in identifying comovements among non-energy commodity prices. Yin and Han (2014) document that uncertainty leads to enhanced commodity prices and volatility. Andreasson et al., (2016) find some significant associations between EPU and commodity futures returns except energy commodities. Scarcioffolo and Etienne (2021) study the volatility patterns of oil and natural gas prices and the role of economic policy uncertainty in the pre-and post-shale era. The study employs Markov switching GARCH models. The study finds that economic policy uncertainty significantly increases the probability of agitated market conditions. Liu et al., (2022) examine the complex connection between the international commodity market and uncertainties. The study employs a wavelet approach and detrended cross-correlation analysis. The authors find a significant comovement between the international commodity market and uncertainties in the short and medium terms. Similarly, Jiang, Ao, and Mo (2023) study the risk spillover association between commodity markets and China's economic policy uncertainty (CNEPU). They use closing prices of 14 commodities spanning from January 2007 to November 2020. The study employs a quantile connectedness approach and finds a short-term risk spillover association between CNEPU and commodity futures. Li, et al., (2023) investigate the dynamic linkage and extreme risk spillover between uncertainties and the USA and Chinese commodity markets. The overall results show that both commodity markets show higher complexity and volatility in response to uncertainty shocks during the initial stage. Recently, Tiwari et al. (2024) studied the dynamic spillover and time-varying relationship between energy markets and international monetary policy uncertainty. The study documents that economic uncertainty is significant and positively influences energy prices. On the contrary, there are few studies that found a negative impact between economic policy uncertainty and commodity markets. For instance, Lyu, et al., (2021) and Zhu, et al., (2019) analyze the economic policy uncertainty shock on the commodities market. The study finds that the domestic EPU shocks adversely affect commodity futures. Xiao, et al., (2022) study the impact of economic policy uncertainty on US commodity markets during the pandemic outbreak. The study results show that EPU significantly affects the commodity markets. Tian, et al., (2019) explore the impact of economic policy uncertainty on China's grain futures prices. The study shows that EPU has significantly affected the price of grain futures in China. In the Indian context, limited studies examine the global risk factors and commodity futures returns. For instance, Shahabad and Balcilar (2022) verify the dynamic relationship between EPU and commodity prices in India. The study results show that the changes in the price of goods are not much affected by Indian EPU. Shaikh and Vallabh (2023) investigate the impact of economic policy uncertainty on the gold price in India and the World Gold Council. They find a positive association between economic policy uncertainty and gold prices in India. After the rigorous review process, it was found that very few studies have examined the Indian commodity futures markets. Next, they also employ standard volatility spillover and causality models to examine the causality and spillover effects. To address this concern, the present study verifies the dynamic comovement between global risk factors and commodity futures returns in the Indian context by employing wavelet analysis and wavelet Granger causality tests.

Data and methodology

The present study uses daily commodity futures prices for nine commodities, including two precious metals (gold and silver), three base metals (aluminum, lead, and zinc), two energy commodities (crude oil and natural gas), and two agricultural commodities (cotton and mentha oil). We select the commodities based on the availability of data for the whole study period. Next, we use the recently proposed news-based US economic policy uncertainty index (EPU)[3] and geopolitical risk (GPR)[4] constructed by Baker et al. (2016) and Caldara and Iacoviello (2021). The daily commodity price data are downloaded from the official

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[3] USEPU news-based index is constructed based on the news related to "economic", "policy" and "uncertainty" which is published in the United States newspapers.
[4] It generates automated text search results of the electronic archives to construct GPR index using ten newspapers.

website of the commodity exchange (MCX)[5]. In addition, the EPU, and GPR data are obtained from (http://www.policyuncertainty.com) website. The data used for the study covers from 4th January 2012 to 29th September 2023. Further, the study uses commodity futures daily prices to calculate the daily commodities futures return using the following equation (1). The return series are expressed in terms of percentage by multiplying with 100.

$$r_t = ln(P_t / P_{t-1}) \times 100 \tag{1}$$

Where r_t represents the daily commodity futures return, P_t indicates daily commodity futures price at the time t and $t-1$.

Wavelet approach

The wavelet technique (ψ) is employed in the study. It is a square integral element with real value, and an average is equal to zero. For instance, $\int_{...\infty}^{\infty} \psi(t)dt = 0$. The element (ψ) will waggle along with the t-axis, functioning like a wave. The precise wavelet employed here, and it is belonging to the family of morlet wavelets of Goupillaud et al., (1984), which is expressed in equation (2) as follows:

$$\psi(t) = \pi^{-\frac{1}{4}} e^{-i\omega t} e^{-\frac{1}{2}t2} \tag{2}$$

In this case, a wavelet functions on the finite time series $p(t), t = 1, 2, 3 ..... T$. Next, the study includes time and frequency (indicated by c, and f) parameters which are related to the wavelet as well as translating $\psi_{c,f}$ could be made, and it is presented in equation (3).

$$\psi_{c,f}(t) = \frac{1}{\sqrt{f}} \psi\left(\frac{t-c}{f}\right), c, f \in \mathbb{R}, f \neq 0 \tag{3}$$

Further, the continuous wavelet transformation equation by including the time series data $p(t)$ could be obtained from the wavelet.

$$W_p(c,f) = \int_{-\infty}^{\infty} p(t) \frac{1}{\sqrt{f}} \Psi\left(\frac{\overline{t-c}}{f}\right) dt \tag{4}$$

Where c represents time or location, and f is scale or frequency, the bar denotes complex conjugation.

By merging the original time series coefficient ψ included in the equations (5) and (6) are restored.

$$p(t) = \frac{1}{C\psi} \int_0^{\infty} \left[\int_{-\infty}^{\infty} |W_p(c,f)|^2 dc\right] \frac{df}{f^2} \tag{5}$$

Next, it is possible to construct the wavelet power spectrum (WPS) from equation (4) to obtain more information about the amplitude behavior of the variables' time series.

$$WPS_P(c,f) = |w_P(c,f)|^2 \tag{6}$$

However, the study employs the cross-wavelet transform (CWT) technique to find the time-scale causality relationship between $p(t)$ and $q(t)$. The CWT is expressed in the equation (7).

$$W_{pq}(c,f) = W_p(c,f) \overline{W_q(c,f)} \tag{7}$$

Where $W_p(c,f)$ and $W_q(c,f)$ indicate the CWT of $p(t)$ and $q(t)$ and the bar signifies the complex conjugation. CWT represents the two-time series covariance at a specific scale. CWT could be interpreted as a covariance for a specific scale and time.

Torrence and Compo (1998) state that the squared wavelet coherence could be presented in equation (8)

$$R^2(c,f) = \frac{|S(_b^{-1}W_{pq}(c,f)|^2}{s(b^{-1}|w_p(c,f)|^2 \, s(b^{-1}|w_q(c,f)|^2} \tag{8}$$

Where S presents the smoothing function over time and scale with $0 \leq R^2(c,f) \leq 1$. If the $R^2(c,f)$ approaches 1. The value of the squared correlations between 0 and 1, implies the strongest

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[5] It is country's first listed commodity derivatives exchange in India. Also, MCX is the leading commodity derivatives exchange with a market share of 95.64% in terms of the trading value of commodity futures contract for the current fiscal year 2023-24. https://www.mcxindia.com/market-data/historical-data.

relationship between $p(t)$ and $q(t)$ and it is denoted by red color. Further if cap R squared, open paren c, f close paren lies 0, it indicates weak comovement between p of t and q open paren t close paren, and it is indicated in blue color.

Furthermore, Torrence and Compo (1998) propose the chi-square method to estimate the accurate level of significance of wavelet coherence and approximate the WPS of $AR(0)$ or $AR(1)$. The wavelet coherence is represented by a thick black contour.

However, the wavelet coherence coefficient is a squared value, and it could not be possible to differentiate between positive and negative comovement. Hence, Torrence and Compo (1998) document an average by which to find the wavelet coherence differences through indications of deferrals in the wavering of two-time series. The wavelet coherence difference phase is determined as follows:

$$\Phi_{pq}(c,f) = tan^{-1}\left(\frac{\Im\left\{S\left(f^{-1}W_{pq}(C,f)\right)\right\}}{\Re\left\{S\left(f^{-1}W_{pq}(C,f)\right)\right\}} \right) \tag{9}$$

Wavelet based granger causality

The present study employs a wavelet-based Granger causality test (Granger, 1969) between global risk factors and commodity futures returns. Next, we use both decomposed time series of variables to systematically understand the causal relationship between global risk factors and commodity futures returns. According to Diebold's (1998) document, the Granger causality tests the predictive causality of one variable to another variable. Further, Hamilton (1984) reports that it exhibits only short-term relationships between the variables. The following VAR equations (10 and 11) represent the predictive relationship between the lag value of independent variables X and Y and the lag value of dependent variables Y and X. Also, the F test explains equation (12) shows that information on any market (X_{t-1}) is statistically significant to represent the forecast values of another market (Y_t). The study employs the following equations to run the Granger causality of the variables X on variable Y as follows:

$$Y_t = \sum_{i=1}^{n} \alpha_i X_{t-1} + \sum_{j=1}^{n} \beta_j Y_{t-j} + \mu_t \tag{10}$$

$$X_t = \sum_{i=1}^{n} \omega_i X_{t-i} + \sum_{j=1}^{n} \delta_j Y_{t-j} + \varepsilon_t \tag{11}$$

$$F = \frac{(RSS_1 - RSS_2)/m}{RSS_2/(n-k)} \tag{12}$$

Where RSS_1 and RSS_2 represent restricted and unrestricted residual sum of squares, m or $n-k$ show the degree of freedom and k depicts the number of estimated parameters.

Empirical results

Table 1 presents the descriptive statistics for commodities futures return, EPU, GPR and Unit root test results. The average daily futures return is positive for all commodities. Based on the unit root test results indicate that all commodities futures return, EPU, and GPR are statistically significant at 1% level and confirm that all the return series are stationary at level (Elliott et al., 1992). Figure 1 shows a time series plot for nine commodities futures return, the trend of EPU and GPR.

Table 1: Descriptive statistics

Commodities	Mean	Std. dev	Min	Max	ADF	PP
Gold	0.02	0.88	-8.56	5.61	-54.44***	-54.42***
Silver	0.00	1.49	-11.90	8.86	-54.90***	-54.86***
Aluminium	0.02	1.21	-9.41	10.25	-53.23***	-53.23***
Lead	0.02	1.33	-5.93	17.22	-54.14***	-54.27***
Zinc	0.03	1.44	-6.72	9.36	-53.97***	-53.96***

Crude Oil	0.00	2.58	-34.57	23.38	-20.95***	-51.14***
Natural Gas	0.01	3.21	-17.62	17.97	-53.94***	-54.03***
Cotton	0.02	1.30	-24.09	14.29	-50.48***	-50.55***
Mentha Oil	0.00	2.03	-18.61	15.28	-50.84***	-51.26***
EPU	-0.02	53.19	-239.94	322.46	-23.58***	-406.73***
GPR	0.01	44.36	-299.59	234.49	-25.92***	-580.08***

Source: Author's calculations

Figure 1 time series plots of commodities futures return, economic policy uncertainty, and Geopolitical risk

Figure 1 Continued

Mentha Oil Futures Returns

US Economic Policy Uncertainity

Geopolitical Risk
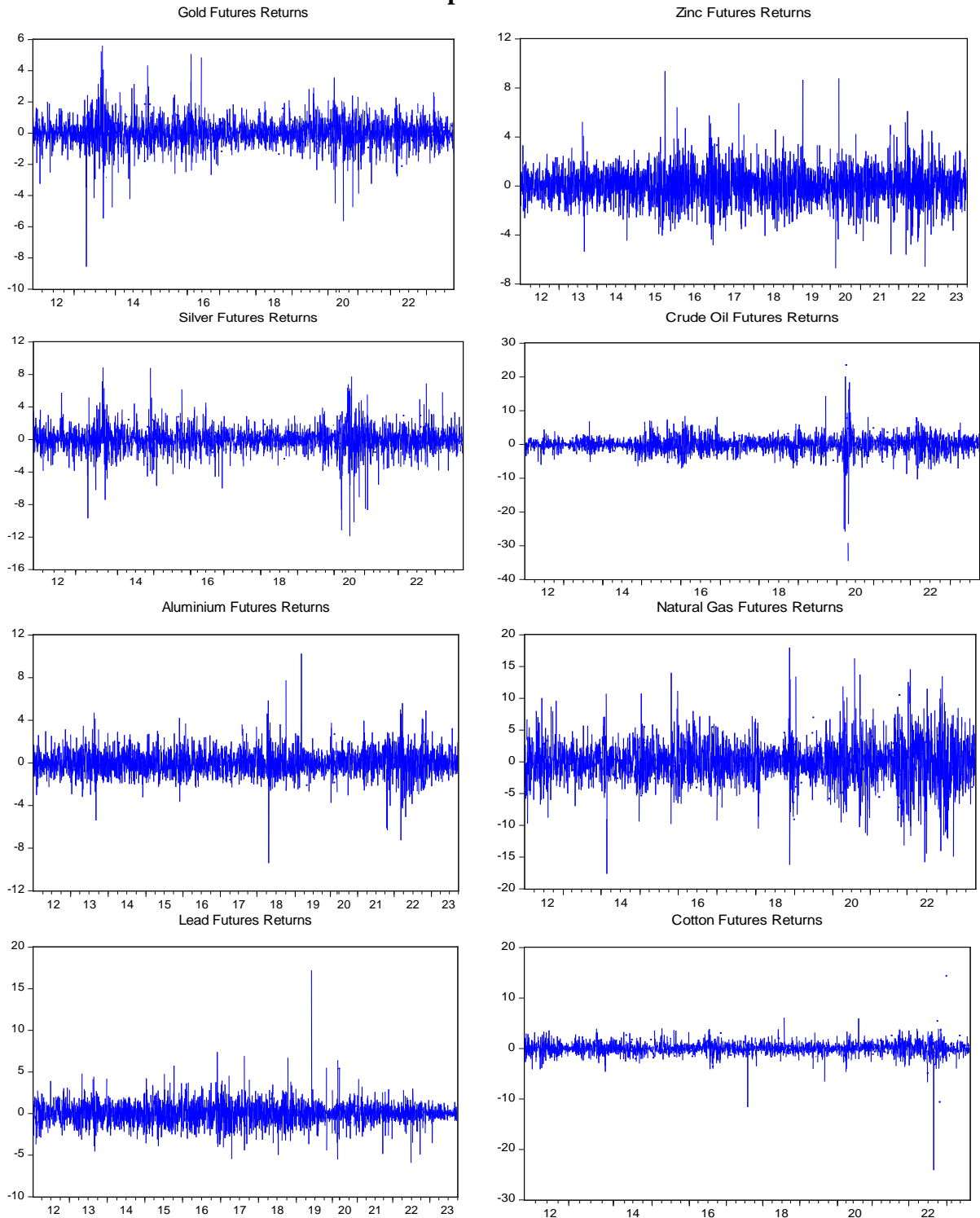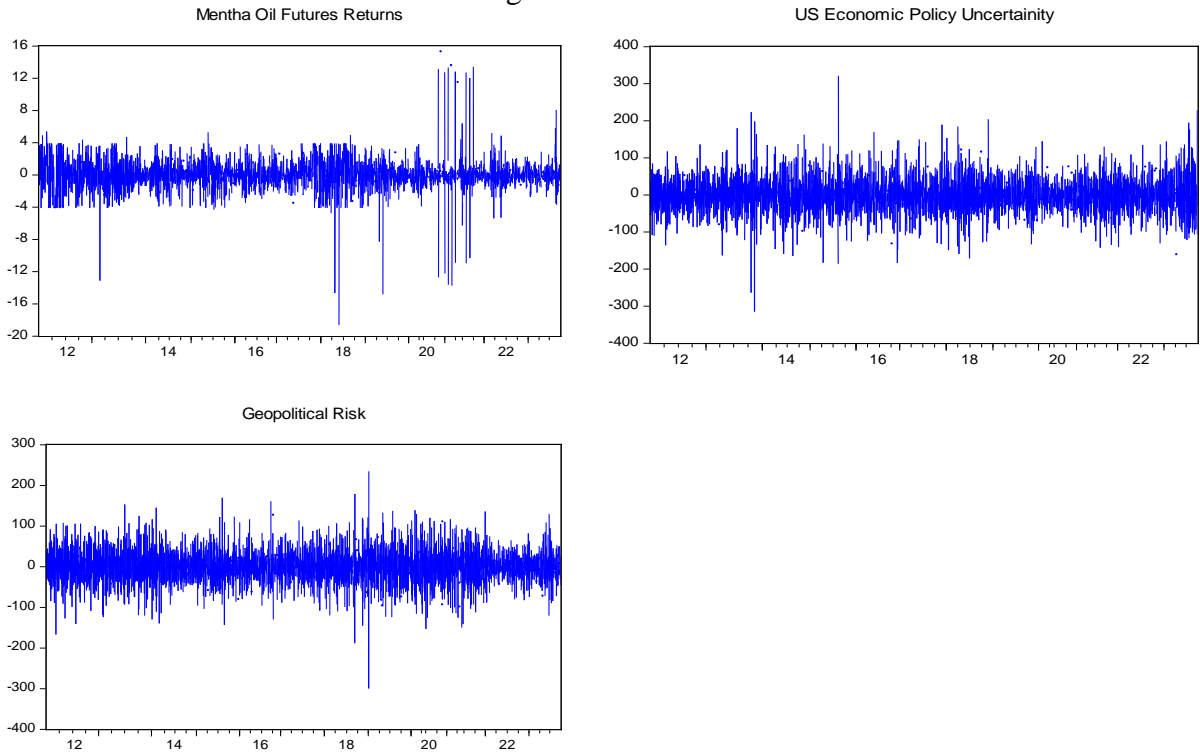
Wavelet analysis

Figure 2 Wavelet power spectrum plots for the commodity futures return, EPU, and GPR

Gold futures return

Silver futures return

Aluminium futures return

Lead futures return

Zinc futures return

Crude Oil futures return

Natural Gas futures return

Cotton futures return

Mentha Oil futures return

US Economic Policy Uncertainty

Geopolitical risk

The study examines the dynamic comovement between daily commodity futures return, US economic policy uncertainty, and GPR employing wavelet power spectrum and wavelet coherence analysis. We use the R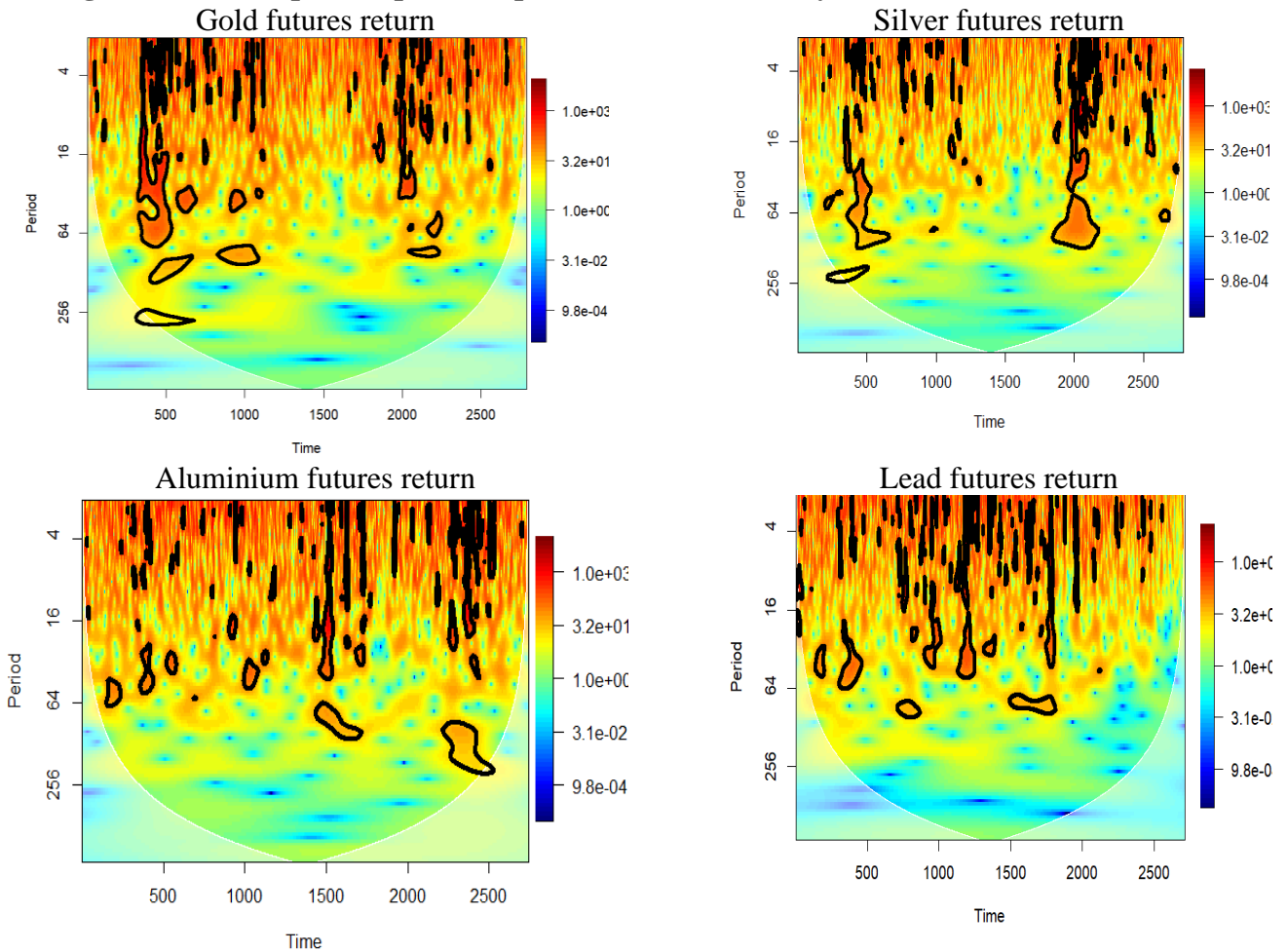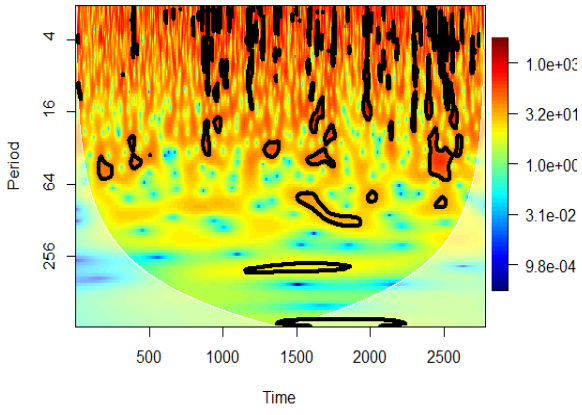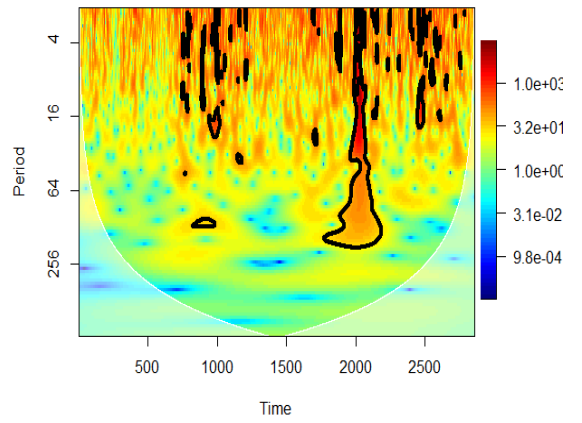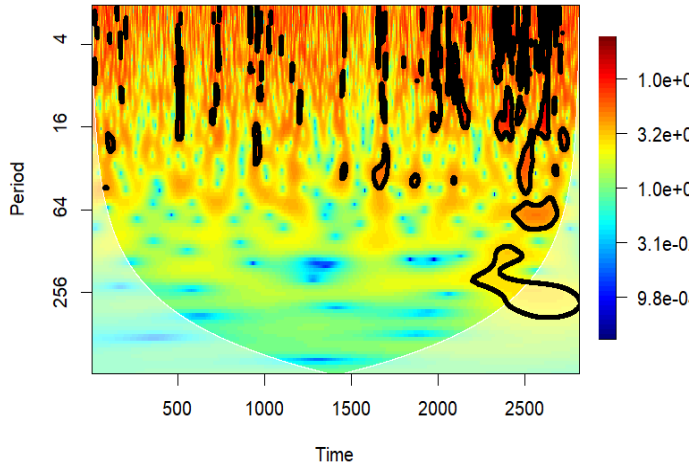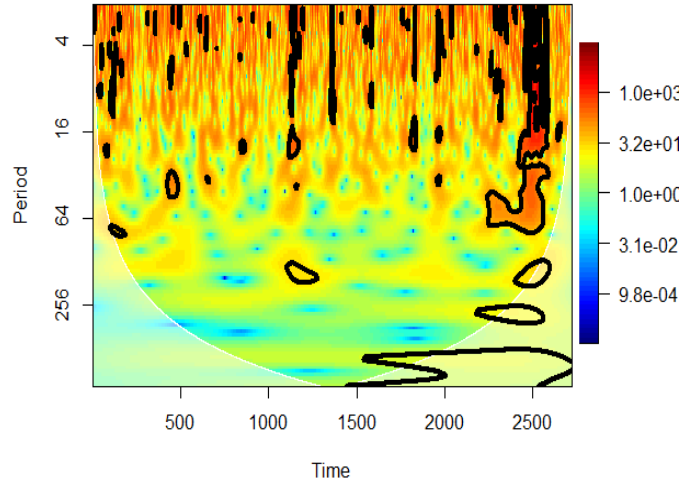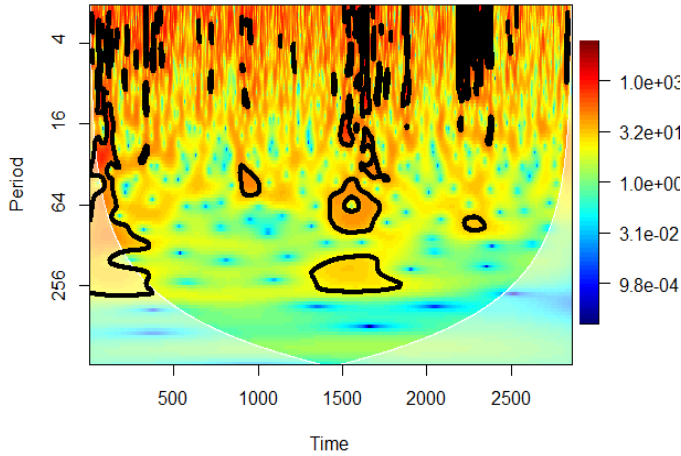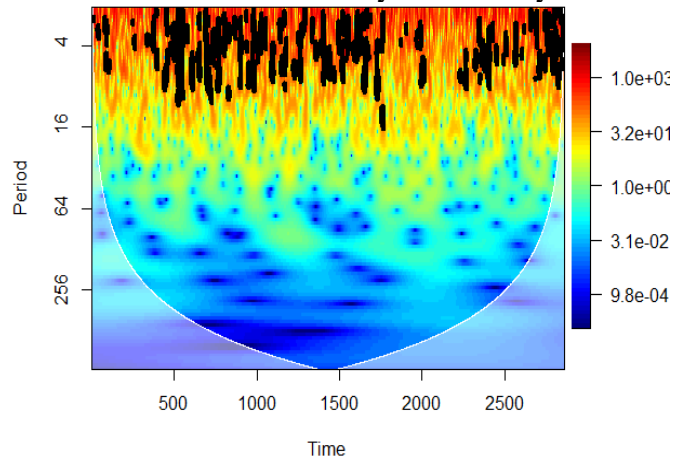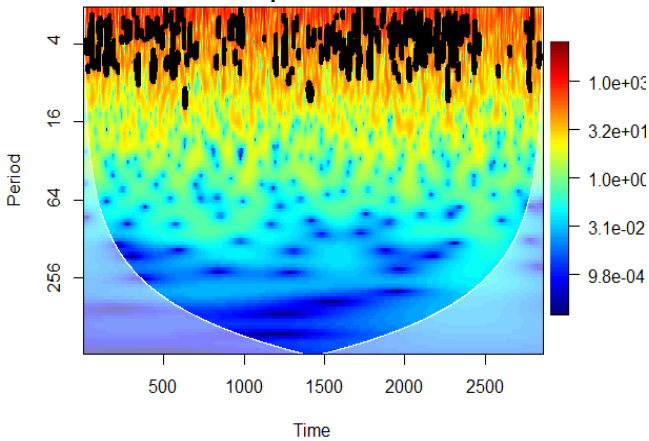 software (biwavelet package) developed by Gouhier, et al., (2022) to undertake wavelet analysis. Figure 2 presents the wavelet power spectrum plots for the daily commodity futures return, economic policy uncertainty, and GPR. However, the study considers the time series data of more than 2500 observations and the scale of 256 periods has been used. The vertical and horizontal axis refers to the time in days (frequencies) and study periods. However, the white curve links to the cone of influence, indicating an edge where the wavelet power is at the end, and it becomes difficult to infer. Further, the black outline marks indicate the wavelet power spectrum, which is significant at 5%. Additionally, the means of Monte Carlo simulation are employed to obtain significant test results. The power spectrum color bar shows the magnitude of the power level, and the colors indicate that red expresses a strong correlation, and blue denotes a weak correlation. Next, the study classifies the frequency range into three time periods: short-term frequencies, which range from 2 to 64 days; medium-term frequencies, which range from 64 to 128 days; and long-term frequencies, which range from 128 to 256 days respectively. The power spectrum results of all commodities futures return reveal a high power (see red zones) throughout the study period from January 2012 to September 2023, on a scale ranging from 16 to 64 days and 128 to 256 days. Further, all commodity futures return shows some similarities among them. In addition, all commodity futures return exhibits high power in the short term from January 2012 to July 2015 and the middle of June 2017 to June 2019, besides, low frequency (256 period) over the study period. On the contrary, the wavelet power spectrum exhibits a low scale at upper frequencies over the full sample period.

Wavelet coherence analysis

Wavelet coherence analysis is used to find out pairwise comovements between the commodity futures return, US economic policy uncertainty (EPU), and geopolitical risk. The vertical and horizontal axis refer to the time in days (frequency) and study period, respectively. However, the white curve links to the cone of influence, indicating an edge where the wavelet power is at the end, and it becomes difficult to infer. The main advantage of wavelet coherence analysis is to identify the regions in the time-frequency domain. The red colors denote that the commodity futures return shows strong comovement with EPU and GPR, whereas the blue color indicates that the commodity futures return exhibits weak comovement with EPU and GPR. Moreover, the wavelet coherence is indicated by the black outline marks, which are significant at 5%. Additionally, the means of Monte Carlo simulation is employed to obtain significant test results. Next, the arrow marks in the wavelet coherence show the lead-lag relationship between the commodity futures return, EPU, and GPR. Certainly, the arrow marks indicate the phase difference directions of the two-time series. In particular, the two-time series variables will move together in the same direction, treated as zero phase difference, while the arrow marks travel towards the right direction. It is called time series are in phase (positive comovement). The arrow marks traveling towards the left direction are considered anti-phase (opposite direction and negative comovement), and when the arrow marks move left up or right down, it denotes that the first time series variable leads the second variable. The arrow marks move left down and right up, indicating that the second variable leads to the first variable. However, the present study considers commodity futures return as the first variable, and the second variables are EPU and GPR.

Figure 3 (a) shows the coherence between gold futures return and US economic policy uncertainty (EPU) as well as geopolitical risk. The study finds a strong interrelationship between gold futures return and EPU from August 2013 to November 2013 and is statistically significant at close to 264 days scale. Further, the arrow shows the right and down direction, confirming that both variables are in phase and implying that the gold futures return leads the EPU. Similarly, it shows a strong correlation from the middle of May 2017 to June 2017. On the other hand, the return on gold futures and geopolitical risk pair exhibited a little red zone with 64 64-day scale in 2014.

The coherence between the silver futures returns and EPU and geopolitical risk is represented in Figure 3 (b). The silver futures return shows weak comovement with EPU. Besides, the study finds that from November 2013 to December 2013 and the middle of August 2023 to September 2023, silver futures return shows a strong correlation with geopolitical risk and is statistically significant at close to 64 scale. The rightward arrows point out that both the variables are in phase.

Figure 3 (c) represents the comovement between aluminium futures return and EPU as well as geopolitical risk. Thus, the study shows a strong correlation from August 2023 to September 2023 and is statistically significant at 64 scale. The arrows move towards a right and upward direction. It implies that aluminium futures return leads to US economic policy uncertainty (EPU). However, the aluminium futures return reveals a strong correlation with geopolitical risk from July 2023 to September 2023 and is statistically significant at close to 256 scales. The arrow marks move towards the right and upward direction. It indicates that the aluminium futures return leads to geopolitical risk.

The coherence between the lead futures returns and EPU and geopolitical risk is represented in Figure 3 (d). The lead futures return shows weak comovement with EPU and GPR.

Concerning Figure 3 (e), we show the wavelet coherence between the zinc futures return and EPU and geopolitical risk. The zinc futures return reveals a strong correlation between US economic policy uncertainty, especially from July 2015 to December 2016 and in the middle of June 2017 to June 2019, and statistically significant at a 64-day scale and 182-day scale. The arrow marks travel towards the right and upward direction. It shows that the zinc futures return is in the phase and zinc futures return leads to US economic policy uncertainty. Although, the zinc futures return exhibits a weak correlation with geopolitical risk.

With reference to Figure 3 (f), we represent the wavelet coherence among crude oil futures return and US economic policy uncertainty and geopolitical risk. Further, the crude oil futures return is strongly correlated with US economic policy uncertainty (EPU), especially from June 2017 to December 2020, and statistically significant at a 256-day scale. Next, the arrow marks move toward the right and downward direction. It implies that the EPU leads to crude oil futures return. On the other hand, the crude oil futures return shows a weak correlation with geopolitical risk from June 2017 to September 2017 and is statistically significant at 256-day frequency. The arrow marks also move towards the right and downward direction. It reveals that the geopolitical risk leads to crude oil futures return.

Figure 3 (g) shows the wavelet coherence of natural gas futures return with EPU and GPR. The study finds that natural gas futures return is substantially correlated with EPU during June 2016 to July 2016 and statistically significant at 64-day scale frequency. The arrow marks a turn towards the right and upward direction, and it indicates that the natural gas futures return is in phase. Further, it exhibits that natural gas futures return leads EPU. Whereas the natural gas futures return shows a weak correlation with geopolitical risk.

Concerning Figure 3 (h) we present our wavelet coherence among cotton futures return and EPU and GPR. However, the study results reveal a strong correlation between cotton futures returns and EPU, especially from January 2014 to March 2914 and in the middle of June 2017 to September 2017. It is statistically significant at 64-day scale to 256-day scale frequencies. Further, the arrow marks move toward the left and downward direction. It infers that the EPU leads cotton futures return. Similarly, the cotton futures return exhibits a correlation with geopolitical risk from March 2020 to June 2020 and is statistically significant at a 256-day scale. The arrow marks move towards the right and upward direction. It indicates that the cotton futures return leads to geopolitical risk.
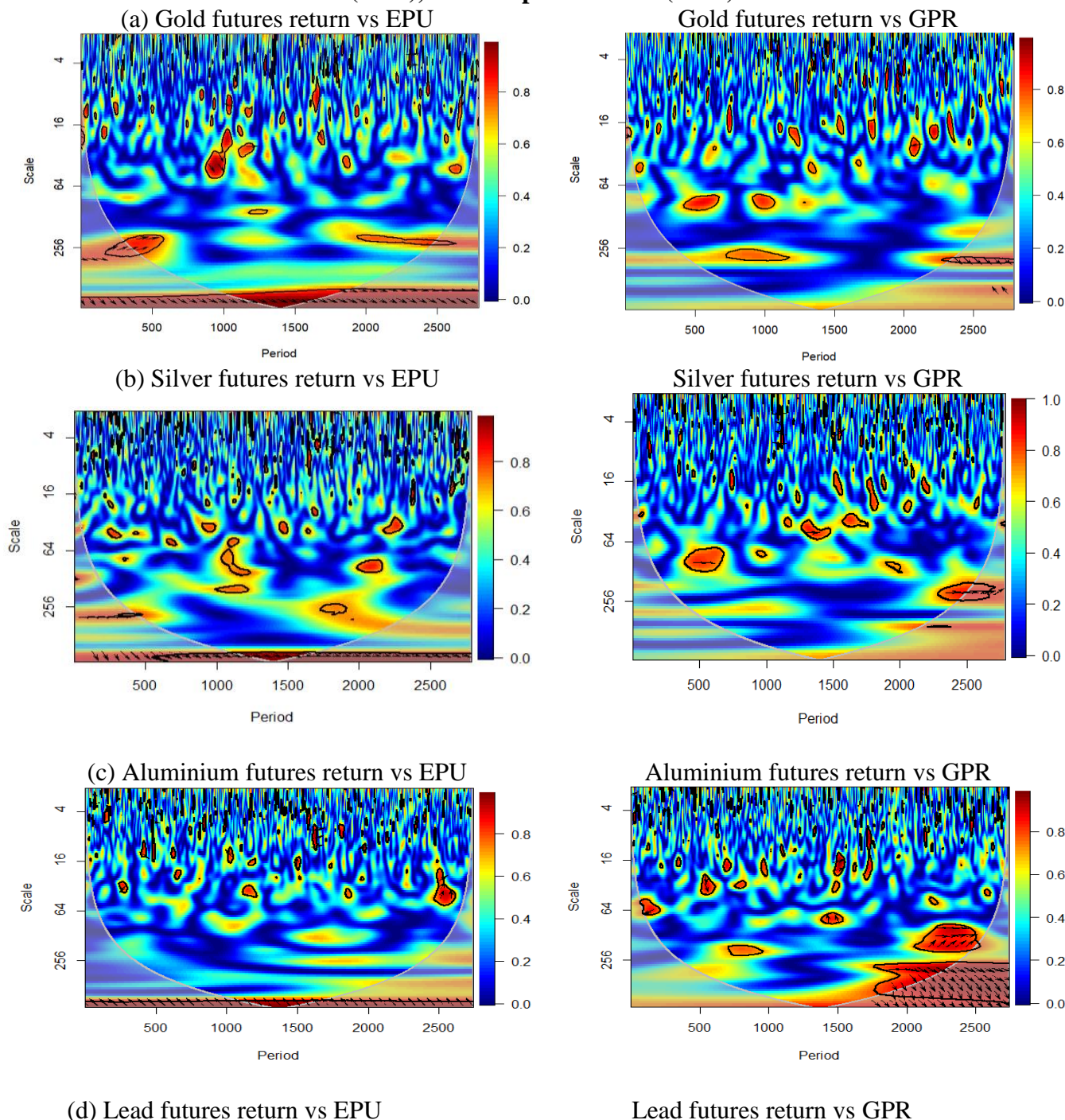
Lastly, Figure 3 (i) shows coherence results between mentha oil futures return, EPU, and GPR. The study results reveal a weak correlation between return on mentha oil futures and EPU. On the other hand, it shows a strong correlation with GPR from June 2017 to August 2017 and is statistically significant on a 256-day scale. The arrow marks a move towards the left and upward trend. It implies that the GPR leads mentha oil futures return.

To examine the causal relationship between commodity futures returns and EPU as well as GPR across different time scales, we employ a wavelet-based Granger causality test by using the different time scales. The study employs the maximal overlap discrete wavelet approach (MODWT) to decompose the original time series data into various time scales (Hung, 2020). Although the scales D_1, D_2, D_3, D_4, D_5, D_6, and S_6 are classified into four different time horizons, we consider (D_1 - D_2) as short term, (D_3 - D_4) as the medium term, (D_5 - D_6) as the long term, and (S_6) as the very long term (see Athari and Hung, 2022; Hung, 2020). The scales resemble the time horizon of 2-4, 4-8, 8-16, 16-32, 32-64-, and 64-128-day horizons. Whereas scale (S_6) represents more than 128 days' time horizon. Table 2 shows the empirical results between return on commodity futures and EPU, which are based on the wavelet Granger causality test for different scales. The study results indicate that the aluminium and zinc futures return significantly causes EPU at a 5% all-time horizon, that is, short, medium, long, and very long terms. It implies that an increase in the commodity market uncertainty could impact its economic policy at all time horizons. However, the study infers that both base metals are essential commodities, which may increase the

commodities market's stability. Hence, any volatility in these two commodities has significantly affected the commodities market in India.

Further, a few unidirectional causality relationships exist at a 5% significant level. Gold shows unidirectional relations with EPU in the short and very long-term time horizon. On the other hand, cotton futures return exhibits unidirectional causality with EPU. Followed by natural gas shows a similar direction in the medium and very long-term time horizon. Lastly, the mentha oil shows unidirectional causality with EPU in the long term.

Figure 3 Wavelet Coherence in pairs of commodity futures returns, US economic policy uncertainty (EPU), and Geopolitical risk (GPR)

(a) Gold futures return vs EPU

Gold futures return vs GPR

(b) Silver futures return vs EPU

Silver futures return vs GPR

(c) Aluminium futures return vs EPU

Aluminium futures return vs GPR

(d) Lead futures return vs EPU

Lead futures return vs GPR
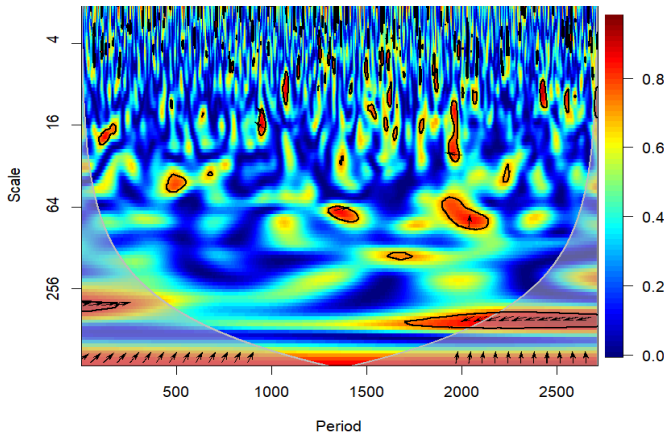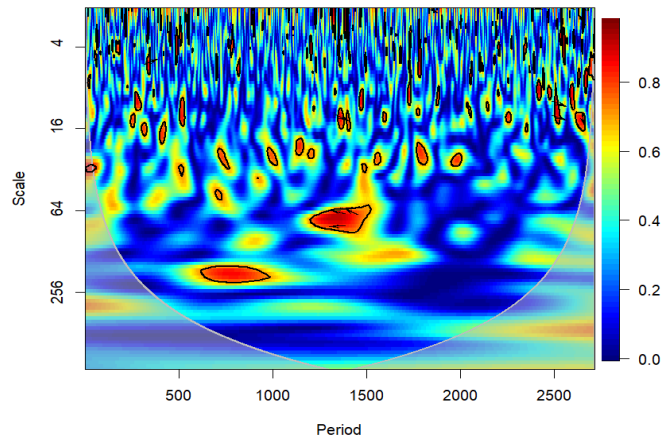
(e) Zinc futures return vs EPU   Zinc futures return vs GPR
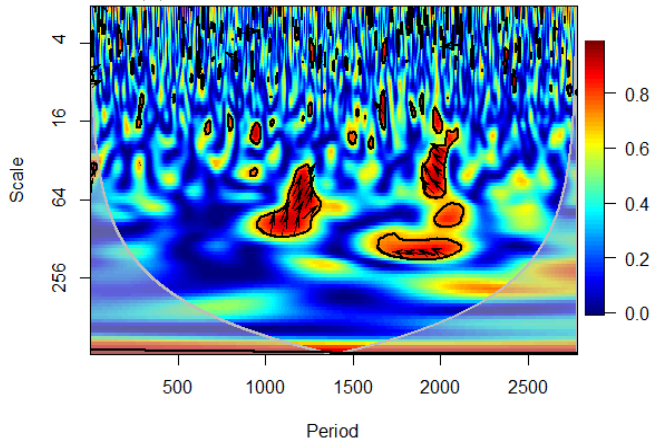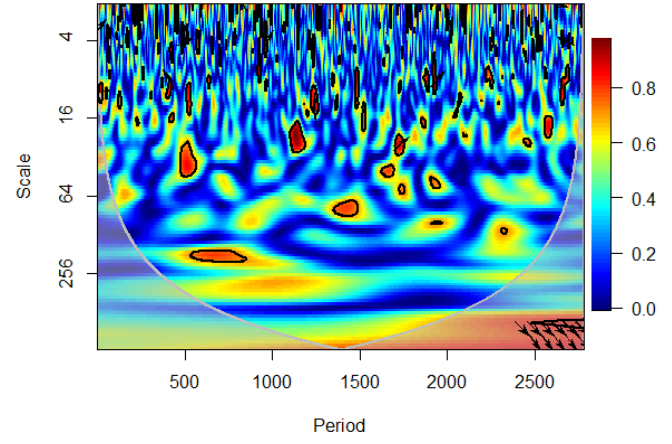
(f) Crude Oil futures return vs EPU   Crude Oil futures return vs GPR
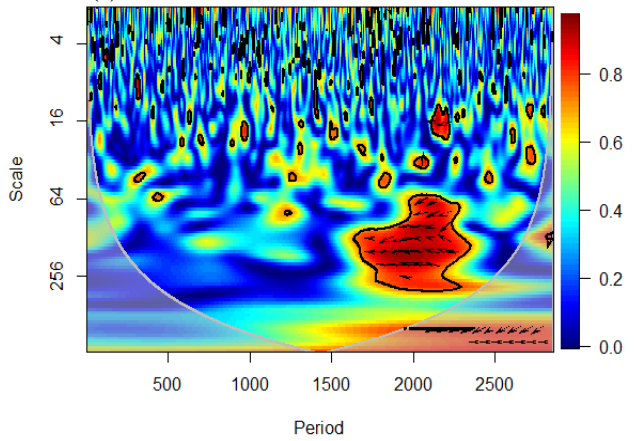
(g) Natural Gas futures return vs EPU   Natural Gas futures return vs GPR

(h) Cotton futures return vs EPU

Cotton futures return vs GPR

(i) Mentha Oil futures return vs EPU
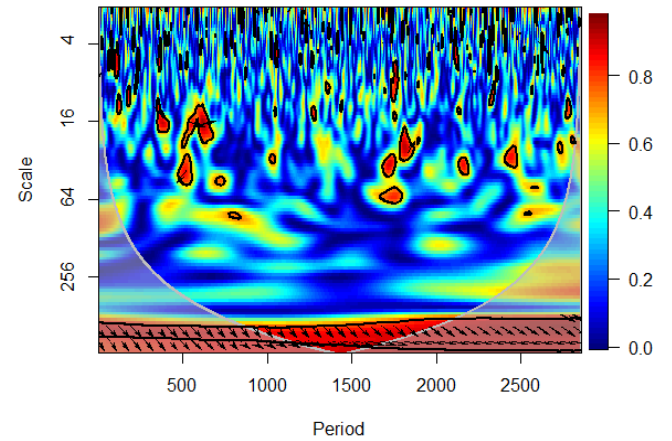
Mentha Oil futures return vs GPR
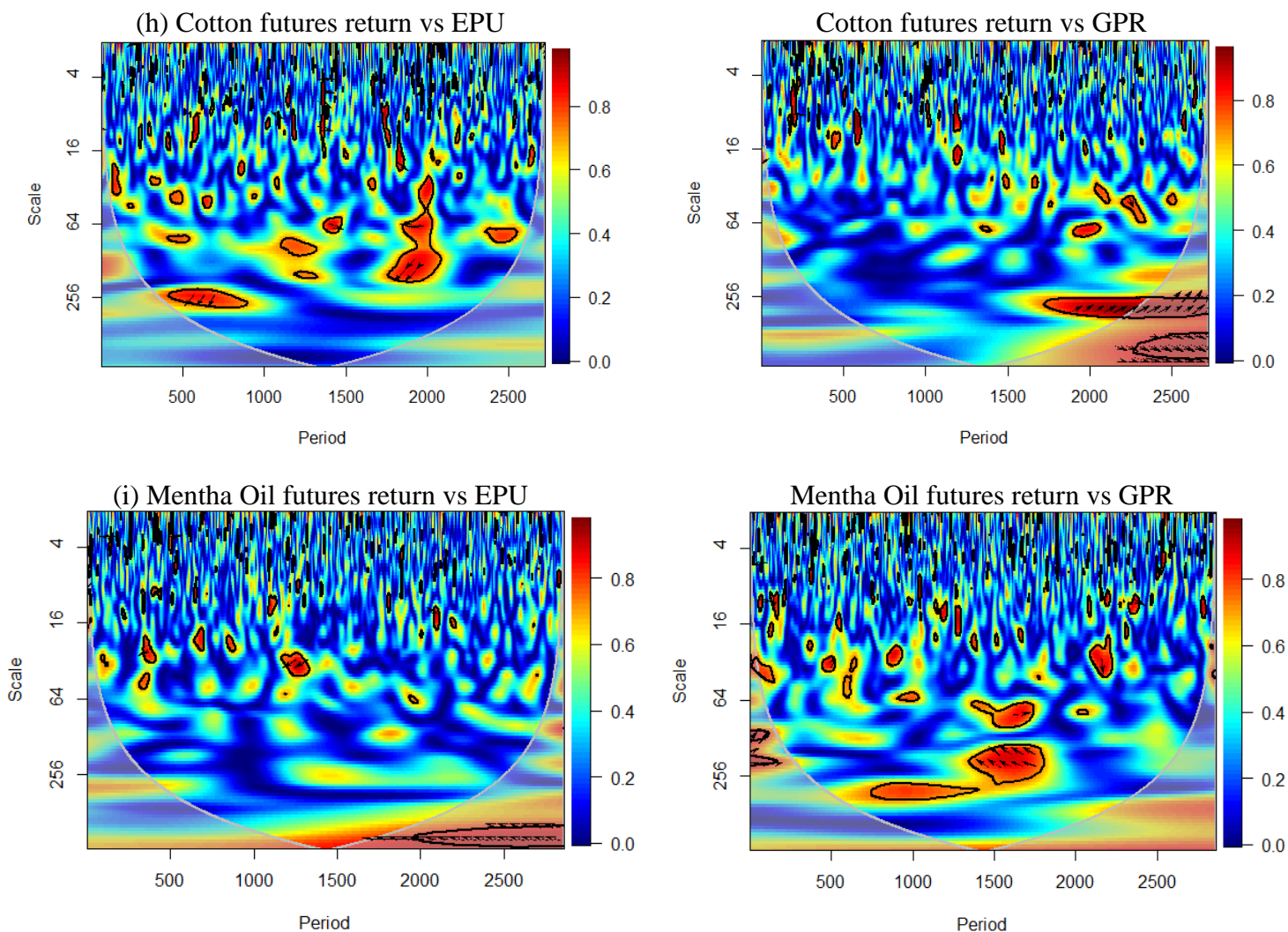
Next, the findings show some bidirectional relationship between commodity futures return and EPU. Silver and natural gas register bidirectional causality with EPU in the long and very long term, respectively. However, the lead exhibits a similar relationship with EPU in the short and long term. Finally, crude oil shows bidirectional causality in the long term and very long term. It implies that commodities futures return being influenced by US economic policy uncertainty indicates that tend to invest in commodities to hedge against uncertainties.

Table 2: Wavelet Granger causality test between Commodities futures return and EPU

Time domain	Result	H0: Commodity futures return does not cause EPU		H0: EPU does not cause Commodity futures return	
		F stat	P value	F stat	P value
Gold - EPU					
D_1	GOLD → EPU	2.646	0.047**	2.142	0.093*
D_2	No Causality	0.733	0.533	1.429	0.232
D_3	No Causality	0.639	0.590	0.787	0.501
D_4	No Causality	2.108	0.097*	0.765	0.514
D_5	Gold ← EPU	0.748	0.523	3.303	0.019**
D_6	No Causality	2.280	0.077*	0.188	0.905
S_6	GOLD → EPU	4.532	0.003***	1.489	0.216
Silver - EPU					

D_1	No Causality	0.740	0.527	0.612	0.606
D_2	No Causality	0.240	0.868	1.825	0.140
D_3	No Causality	0.341	0.795	0.757	0.517
D_4	Silver → EPU	4.338	0.004***	1.872	0.132
D_5	No Causality	0.091	0.964	0.415	0.742
D_6	No Causality	0.598	0.615	0.234	0.872
S_6	Silver ↔ EPU	4.846	0.002***	5.797	0.000***
Aluminium - EPU					
D_1	Aluminium → EPU	3.099	0.025**	1.651	0.175
D_2	No Causality	0.997	0.393	0.684	0.561
D_3	Aluminium ↔ EPU	3.374	0.017**	3.450	0.015**
D_4	EPU → Aluminium	2.390	0.066*	2.716	0.043**
D_5	No Causality	0.418	0.739	2.196	0.086*
D_6	Aluminium ↔ EPU	3.086	0.026**	3.027	0.028**
S_6	Aluminium → EPU	4.857	0.002***	0.664	0.573
Lead - EPU					
D_1	Lead ↔ EPU	3.144	0.024**	3.622	0.012**
D_2	Lead ↔ EPU	6.440	0.000***	8.628	0.000***
D_3	No Causality	1.353	0.255	1.358	0.253
D_4	No Causality	2.025	0.108	4.008	0.007***
D_5	Lead → EPU	3.639	0.012**	2.015	0.109
D_6	Lead ↔ EPU	2.978	0.030**	3.996	0.007***
S_6	No Causality	1.749	0.154	1.307	0.270
Zinc - EPU					
D_1	No Causality	1.593	0.188	1.156	0.324
D_2	Zinc ← EPU	1.803	0.144	2.773	0.040**
D_3	No Causality	1.834	0.138	2.287	0.076*
D_4	Zinc ← EPU	0.987	0.397	3.104	0.025**
D_5	Zinc ← EPU	2.037	0.106	3.018	0.028**
D_6	Zinc ← EPU	2.596	0.050*	3.967	0.007***
S_6	Zinc → EPU	6.031	0.000***	2.463	0.060*
Crude Oil - EPU					
D_1	No Causality	0.395	0.756	0.216	0.884
D_2	No Causality	1.643	0.177	1.755	0.153
D_3	No Causality	1.398	0.241	0.925	0.427
D_4	No Causality	0.875	0.452	2.171	0.089*
D_5	Crude Oil ← EPU	0.939	0.420	4.622	0.003***
D_6	Crude Oil ↔ EPU	5.108	0.001***	9.189	0.000***
S_6	Crude Oil ↔ EPU	3.237	0.021**	17.211	0.000***
Natural Gas - EPU					
D_1	No Causality	0.712	0.544	0.031	0.992
D_2	No Causality	1.181	0.315	0.983	0.399
D_3	No Causality	2.307	0.074*	0.361	0.780
D_4	Natural Gas → EPU	4.424	0.004***	0.896	0.442
D_5	No Causality	1.847	0.136	2.081	0.100
D_6	Natural Gas ↔ EPU	2.836	0.036**	3.082	0.026**

S_6	Natural Gas $\rightarrow$ EPU	3.298	0.019**	0.805	0.490

Cotton - EPU

D_1	Cotton $\rightarrow$ EPU	3.337	0.018**	0.641	0.588
D_2	Cotton $\rightarrow$ EPU	3.093	0.025**	1.732	0.158
D_3	No Causality	1.930	0.122	0.490	0.688
D_4	Cotton $\rightarrow$ EPU	2.681	0.045**	1.769	0.150
D_5	Cotton $\rightarrow$ EPU	10.267	0.000***	1.280	0.279
D_6	No Causality	0.793	0.497	0.663	0.574
S_6	No Causality	0.201	0.895	0.392	0.758

Mentha Oil - EPU

D_1	No Causality	1.589	0.189	2.193	0.086*
D_2	No Causality	0.694	0.555	1.357	0.254
D_3	No Causality	1.844	0.136	0.059	0.980
D_4	No Causality	0.752	0.521	1.536	0.202
D_5	Mentha Oil $\rightarrow$ EPU	2.713	0.043**	1.362	0.252
D_6	Mentha Oil $\leftarrow$ EPU	1.783	0.148	2.636	0.048**
S_6	No Causality	2.392	0.066*	1.521	0.206

Source: Author's calculations, Note: "$\leftrightarrow$", "$\leftarrow$" and "$\rightarrow$" indicate a bidirectional relationship between commodity futures return and EPU, a unidirectional relationship between EPU and commodity futures return and a unidirectional relationship between commodity futures return and EPU at 5% significant level. ***, **, and * significant at 1%, 5%, and 10%, respectively.

Table 3 presents the empirical results between return on commodity futures and GPR, which are based on the wavelet Granger causality test for different scales. The study results indicate that the natural gas futures return significantly causes GPR at 5% in all time horizons, that is, short, medium, long, and very long terms. However, the study reports a few unidirectional causality relationships exist at a 5% significant level. Especially, gold, lead and zinc show unidirectional relations with GPR in the medium, long-term and very long-term time horizons. However, silver futures return exhibits unidirectional causality with GPR. This is followed by aluminium, which shows a similar direction in the long and very long-term time horizons. Cotton futures return shows unidirectional causality with GPR in the short, long, and very long-term horizons. The study results show some bidirectional relationship between commodity futures return and GPR. Aluminium and crude oil register bidirectional causality with GPR in the long term. On the other hand, silver exhibits a similar relationship with GPR in the long and very long terms, respectively. Followed by natural gas shows bidirectional causality in the short and long term. Finally, the lead and mentha oil exhibit bidirectional causality during medium and short terms.

Table 3: Wavelet Granger causality test between Commodities futures return and GPR

Time domain	Result	H0: Commodity futures return does not cause GPR		H0: GPR does not cause Commodity futures return	
		F stat	P value	F stat	P value

Gold - GPR

D_1	No Causality	1.089	0.353	1.469	0.220
D_2	No Causality	0.404	0.750	2.503	0.057*
D_3	Gold $\leftarrow$ GPR	1.034	0.376	4.130	0.006***
D_4	No Causality	2.232	0.082	1.994	0.112
D_5	Gold $\leftarrow$ GPR	0.338	0.798	12.318	0.000***
D_6	No Causality	0.903	0.439	2.450	0.061*
S_6	Gold $\rightarrow$ GPR	5.463	0.000***	0.826	0.479

Silver - GPR					
D_1	No Causality	2.493	0.058*	1.263	0.285
D_2	No Causality	0.569	0.635	0.533	0.659
D_3	No Causality	2.325	0.072*	0.895	0.442
D_4	Silver → GPR	4.346	0.004***	0.825	0.479
D_5	Silver ↔ GPR	5.074	0.001***	2.680	0.045**
D_6	Silver ↔ GPR	2.915	0.033**	2.839	0.036**
S_6	Silver ↔ GPR	6.811	0.000***	8.525	0.000***
Aluminium - GPR					
D_1	No Causality	1.966	0.116	1.698	0.165
D_2	No Causality	2.573	0.052*	1.576	0.193
D_3	No Causality	1.512	0.209	0.388	0.761
D_4	No Causality	2.096	0.098*	0.917	0.431
D_5	Aluminium ↔ GPR	5.705	0.000***	2.929	0.032**
D_6	Aluminium → GPR	3.549	0.013**	0.372	0.773
S_6	Aluminium ← GPR	1.080	0.355	10.544	0.000***
Lead - GPR					
D_1	No Causality	0.060	0.980	0.117	0.950
D_2	No Causality	0.447	0.719	0.508	0.676
D_3	Lead ← GPR	0.428	0.732	4.106	0.006***
D_4	Lead ↔ GPR	3.414	0.017**	5.222	0.001***
D_5	No Causality	1.693	0.166	0.404	0.749
D_6	Lead ← GPR	1.862	0.133	5.565	0.000***
S_6	Lead → GPR	5.663	0.000***	0.480	0.695
Zinc - GPR					
D_1	No Causality	0.174	0.913	0.404	0.750
D_2	No Causality	1.904	0.126	1.032	0.377
D_3	No Causality	0.290	0.832	0.309	0.818
D_4	Zinc ← GPR	1.400	0.240	2.837	0.036**
D_5	No Causality	0.597	0.616	1.820	0.141
D_6	Zinc ← GPR	0.212	0.887	6.798	0.000***
S_6	Zinc → GPR	4.008	0.007***	1.129	0.335
Crude Oil - GPR					
D_1	No Causality	0.461	0.708	1.451	0.226
D_2	No Causality	1.481	0.217	1.534	0.203
D_3	No Causality	0.350	0.789	0.842	0.470
D_4	No Causality	1.551	0.199	2.457	0.061*
D_5	Crude Oil ↔ GPR	2.625	0.048**	3.728	0.010**
D_6	No Causality	2.454	0.061*	1.991	0.113
S_6	No Causality	0.886	0.447	0.506	0.677
Natural Gas – GPR					
D_1	No Causality	0.694	0.555	1.460	0.223
D_2	Natural Gas ↔ GPR	3.938	0.008***	2.776	0.039**
D_3	Natural Gas ← GPR	1.687	0.167	3.884	0.008***
D_4	Natural Gas → GPR	3.436	0.016**	1.924	0.123
D_5	Natural Gas → GPR	5.528	0.000***	2.381	0.067*

D_6	Natural Gas $\leftrightarrow$ GPR	6.033	0.000***	3.466	0.015**
S_6	Natural Gas $\leftarrow$ GPR	0.033	0.991	22.680	0.000***

Cotton – GPR

D_1	Cotton $\rightarrow$ GPR	3.483	0.015**	0.663	0.574
D_2	No Causality	0.585	0.624	0.887	0.447
D_3	No Causality	1.572	0.194	1.145	0.329
D_4	No Causality	0.114	0.951	1.854	0.135
D_5	No Causality	1.864	0.133	1.865	0.133
D_6	Cotton $\leftarrow$ GPR	1.369	0.250	3.565	0.013**
S_6	Cotton $\leftarrow$ GPR	1.483	0.217	5.806	0.000***

Mentha Oil – GPR

D_1	No Causality	1.597	0.187	0.167	0.918
D_2	Mentha Oil $\leftrightarrow$ GPR	4.322	0.004***	3.709	0.011**
D_3	No Causality	2.603	0.050*	0.937	0.421
D_4	No Causality	2.540	0.054*	1.712	0.162
D_5	No Causality	1.439	0.229	1.577	0.192
D_6	Mentha Oil $\leftarrow$ GPR	2.441	0.062*	4.262	0.005***
S_6	No Causality	1.111	0.343	1.942	0.120

Source: Author's calculations

Note: "$\leftrightarrow$", "$\leftarrow$" and "$\rightarrow$" indicate a bidirectional relationship between commodity futures return and GPR, a unidirectional relationship between GPR and commodity futures return and a unidirectional relationship between commodity futures return and GPR at a 5% significant level. ***, **, and * significant at 1%, 5%, and 10%, level respectively.

The overall findings of the study provide evidence that the time frequencies in which the causal relationship between the global risk factors and commodity futures returns manifests itself. The wavelet-based Granger causality test helps us to examine the influence of global risk factors and commodity futures returns in the short, medium, and long term. Finally, the results show that causality between the variables strongly exists. The findings align with previous studies (Soni et al, 2022).

Conclusion

The present study examines the dynamic comovement between Indian commodity futures return and global risk factors such as economic policy uncertainty and geopolitical risk. We consider the daily futures price of nine commodities spanning from 4th January 2012 to 29th September 2023. We employ Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) tests to check the stationarity of the variables used in the study. Next, the study employs wavelet analysis and the Granger causality test to examine the dynamic comovement and causality effects between commodity futures return and global risk factors. The wavelet power spectrum results show that commodities futures return reveal a high power (see red zones) throughout the study period on a scale ranging from 16 to 64 days and 128 to 256 days. Further, all commodity futures return shows some similarities among them. In addition, all commodity futures return exhibits high power in the short term from January 2012 to July 2015 and the middle of June 2017 to June 2019, besides, low frequency (256 period) over the study period. On the contrary, the wavelet power spectrum exhibits a low scale at upper frequencies over the full sample period. However, the wavelet coherence results show a strong comovement between the US economic policy uncertainty (EPU) and commodity futures return except for silver and mentha oil. On the contrary, the geopolitical risk (GPR) exhibits a weak relationship with gold, lead, zinc, and energy commodities across all-time frequencies. Further, the wavelet Granger causality test results provide strong evidence that commodities futures return cause the EPU in all the time horizons. Followed by the geopolitical risk reports substantial evidence that commodities futures return causes GPR in all time horizons. The study results provide significant implications for investors, market practitioners, policymakers, fund managers, and other stakeholders

dealing with the commodities market. The impact of US economic policy uncertainty and geopolitical risk significantly affect the commodity futures return. Further, the combined use of these two risk factors allows us to shed further light on the dynamic interrelations with commodity futures return. The present study considered only the Indian commodity derivatives market, particularly MCX. This study gives the scope for upcoming researchers in several ways for better understanding, a study can be conducted to include other indices. Further, comparative analysis can be undertaken by incorporating other stock exchanges of India as well as of foreign countries.

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Impact of Celebrity Face Value on Purchase Intention of Consumers-An Empirical Study from Delhi-NCR

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Abstract

Social media platforms has played a key role in influencing consumers' purchase intentions. They help marketers understand the various factors affecting the purchase intention of consumers. The study attempts to measure how celebrity face value affects the consumers' purchase intention. An online questionnaire was sent to 350 consumers of Delhi NCR of which 240 responses were received. Simple Random sampling method is used to collect data from 240 consumers. Data analysis and validation were carried out using PLS-SEM Software. The findings advocate that trust in celebrities and their credibility has positive impact on purchase intention. Moreover, celebrity face value also affects the purchase intention of consumers significantly. Findings also suggest that personal experience and social media influence is less significant in affecting the purchase intention. Based on the research findings, the importance of the face value of celebrities, their trust, and the credibility of social media influence for influencing purchase decisions have been highlighted. This study also provides valuable insights into social media platforms and online shopping portals to develop effective marketing strategies. Most previous studies analysed the relationship between celebrity endorsement (Paid) and purchase intentions. Few studies have provided insight into the relation between the face value of a celebrity and purchase intention. The study studies that relationship. The face value of a celebrity refers to the innate attractiveness, popularity, and recognition of a celebrity in the public eye. It is the value that a celebrity adds merely by being associated with a brand or product, owing to their popularity, appearance, or personality independent of active promotion or participation. Companies may use a celebrity's face value to draw attention, generate trust, or establish prestige, even if the celebrity does not explicitly support the product. For example, using their picture on packaging or in marketing. Celebrity Endorsement means a formal and active association in which a celebrity promotes a product, service, or brand through ads, public appearances, or direct referrals. It frequently entails a contractual arrangement through the celebrity's active engagement in marketing the product, adding credibility and influence through personal endorsement or relationship.

Keywords: Celebrity Face value, purchase intention, social media, trust, credibility

JEL Classification: D12, L67

Introduction

Celebrity endorsements have evolved as a potent marketing tactic in today's competitive economy. A brand's relationship with a celebrity who represents particular characteristics or ideals can have a substantial impact on customer behavior. When used correctly, a celebrity's face value may increase brand

awareness, build emotional connections, and, ultimately, influence purchase decisions. Purchase intention, defined as a consumer's desire to purchase a product or service, is often influenced by both rational and emotional factors (Fishbein & Ajzen, 1975). Celebrities are aspirational characters, and their endorsements frequently function as indications of trust, quality, or social standing, influencing customer sentiments (Erdogan, 1999). For example, (Spry et al., 2011) found that a celebrity's credibility—defined as trustworthiness, knowledge, and attractiveness—significantly increases customers' impressions of a brand, driving purchase intention.

Celebrity endorsements have a strong impact in areas such as fashion, cosmetics, and sports, where customer purchases are frequently impacted by lifestyle expectations and social conformity(Choi & Rifon, 2012). However, the efficiency of this method is determined by aspects such as the celebrity's alignment with the brand, the consumer's identification with the celebrity, and cultural concerns (Till & Busler, 2000). This dynamic interaction between consumer behavior and celebrity endorsements highlights the importance of investigating the relationship between celebrity face value and purchase intentions.

Following a celebrity and adopting their habits and preferences in your life is no rocket science. In the past few years, the effect of celebrity influence has been hyped with the emergence of social media platforms like Facebook, Instagram, and WhatsApp. This hype is not about celebrity endorsement but about an attempt to imitate the patterns and lifestyles of an influential person. Doing so develops a sense of being the hero of one's own life. This brings out the importance of the face value of an influential person (or a celebrity) on the purchase intention of consumers. Consumers are highly influenced by what a celebrity is consuming in their day-to-day lives. The face value of a celebrity refers to their public image, reputation, and the traits they are known for. This doesn't mean celebrity endorsements. As a follower, we attach value to the celebrity's emotion, activity, or trait. Buying decisions influenced by such factors are the outcome of customers' desire to imitate the celebrity rather than the celebrity's purpose to promote.

Celebrity Endorsement is a marketing strategy that involves using well-known personalities, such as actors, athletes, musicians, or public figures, to promote products or services. The impact of celebrity endorsement on consumer buying behavior can be significant and can influence various aspects of consumer decision-making. The familiarity and popularity of the celebrity can create a strong initial impression. Most of the times Celebrities have established credibility and trust with their fan base. When a celebrity endorses a product, their credibility can transfer to the product, making consumers more likely to trust the quality and benefits claimed. Consumers may feel a personal connection with their favorite celebrities. This emotional bond can extend to the endorsed product, creating a stronger attachment and loyalty. Consumers are more likely to remember and recall an advertisement featuring a celebrity, increasing the chances that the product will stay in their minds. These factors may cause an effective impact and immediate purchase. On the other hand, one may create a long-lasting impact and produce a delayed purchase when the consumer's need arises.

Consumer behavior is the study of how people, groups, or organizations choose, buy, utilize, or discard products, services, ideas, or experiences to meet their needs and desires.One may be an Analytical Buyer who makes conscious decisions before making a purchase, or one may be an Impulsive Buyer who makes buying decisions impetuously. Consumer Buying Behaviour is a schema that involves all the decisions taken by a consumer in the process of need fulfillment through a product or service. The consumer decision process includes five stages, namely, problem recognition, information search, alternatives evaluation, purchase decision, and post-purchase evaluation. Consumer Buying Behaviour involves every action taken by a consumer throughout these five stages. This process includes answering various questions like- 'What is needed?' 'How important it is?' 'Which brand or quality of product should be chosen?' and many more. Answers to these questions are affected by various factors like awareness of competitive products, the income of the buyer, cultural beliefs, personal beliefs, etc.

In the context of consumer buying behavior, the face value of a celebrity plays a crucial role in influencing how consumers perceive and respond to products or services consumed by their favorite celebrity. Celebrities who embody qualities that consumers aspire to have, have been more likely to influence buying behavior. Consumers may identify themselves with a celebrity's values, lifestyle, or interests. If a celebrity aligns with a consumer's self-concept, the endorsement can reinforce that identification and lead to purchase decisions.

This study seeks to investigate the effect of celebrity face value on consumer purchase intentions, with an emphasis on how various elements of celebrity appeal influence decision-making processes. By combining current theoretical frameworks and empirical data, this study aims to give practical insights for marketers looking to optimize endorsement tactics.

The study attempts to evaluate the impact of the face value of a celebrity on consumer buying behavior. In previous literature, the impact of celebrity endorsement on consumer buying intentions has been well discussed. In this era of influential purchasing decisions, the face value of celebrity and imitation of trends is the paradigm shifter in the decision-making process of a consumer. Because of that, there is a need to study the overall impact of the face value of the celebrities on purchase intention of consumers.

Theoretical Framework

Source Credibility Theory states that a source's credibility, including expertise, trustworthiness, and attractiveness, influences how persuasive the message is. Celebrities seen as trustworthy sources can boost consumers' intentions to make a purchase (Hovland & Weiss, 1951). Match-Up Hypothesis proposes that how well a celebrity endorsement works is based on how well the celebrity's image fits with the product. According to Kamins (1990), a positive match can improve how consumers view the product.(Kamins, 1990)

Meaning Transfer Model, introduced by McCracken in 1989, elucidates how celebrities convey their meanings (such as values, lifestyle, personality) to the products they promote, subsequently impacting consumers' intent to purchase.

The study also spports the Theory of Planned Behavior, which holds that a person's desire to engage in a particular behavior influences that person's decision to engage in it. Attitude, subjective norms, and perceived behavioral control all impact one's intention to engage in a certain behaviour. (Ajzen, 1991) Among other things, a customer's intention determines whether or not he will allow himself to be persuaded by a celebrity. What a customer thinks about a celebrity, how friends and family view the celebrity, and how much control they feel over their own behavior all influence what they decide to buy. Subjective norms are the perceptions that an individual has for the society, family and friends. If a consumer is affected by what others think of his/her social media presence, he would feel more pressurized and this will positively affect his purchase intention and decision. Perceived behavioral control explains how an individual feels while deciding to perform a particular action. If congenial external environment is available, time and resources are available, then a consumer is more likely to make a purchase decision.

For this study, celebrities include sportspersons, YouTubers, social media influencers, actors, and politicians.

Literature Review

(Suhartanto et al., 2020) predicts consumer behavior in the tourism industry using a comparison between structural equation modelling (SEM) and multiple regression and finds that the model of tourist behavior using SEM shows more reliable results as compared to the multiple regression. (Chaudhary, 2018)examines the green buying behavior among young consumers and uses SEM analysis to test the research model. They study finds that green buying behavior is significantly influenced by green purchase intentions. (Zhao et al., 2021) uses confirmatory factor analysis, path analysis and discriminant validity in SEM to study the impact of product pricing and packaging as independent variables on consumer buying behavior, the dependent variable with the moderating role of consumer satisfaction and reveals that both pricing and packaging have a significant relationship with the buying behavior of consumers.

"Consumer behavior is the behaviour that consumers demonstrate when looking for,, purchasing, using, evaluating and disposing of the products and services that they expect will satisfy their needs (*Consumer Behaviour - Leon Schiffman, Aron O'Cass, Angela Paladino, Jamie Carlson - Google Books*, n.d.). The process of consumer behavior involves three stages, pre consumption, consumption and post consumption. Any marketer or a researcher must analyze these three stages since all three phases are crucial for influencing consumers' thoughts, feelings, and behavior. (Solomon & Russel Bennett, 2012) Many

academics examine consumer behavior to ascertain the consumer's thoughts, intentions, and emotions when making a particular purchase. "Consumer behaviour analysis is the use of behaviour principles, usually gained experimentally, to interpret human economic consumption. It stands academically at the intersection of economic psychology on one hand, and marketing science – the study of the behaviour of consumers and marketers, especially as they interact – on the other." (Foxall, 2001)There are various methods, models and tools through which consumer behavior may be analyzed. The Behavioral Perspective Model of Purchase and Consumption (BPM) (Foxall, 1992) is also used in studies, in which consumer actions occur at different rates depending on the relative openness of the environment in which they take place and the informational and hedonic reinforcement that the environment offers or promises. (Nicholson & Xiao, 2011)uses the BPM to understand three major areas of behavioral intervention: neighborhood crime, environmental preservation, and public health.

(Hani et al., 2018) takes the case of Lebanese jewelry industry and examines the effect of celebrity endorsement on customer buying behavior. The study uses structural equation modeling and to test the reliability and validity of the constructs, the confirmatory factor analysis (CFA) was used. The study finds that the celebrity endorser attractiveness has positive impact on the consumers' tendency to recall the advertisement but has no significant effect on the purchase intentions of the consumers while the celebrity endorser credibility has a positive impact on both consumer ad recall as well the purchase intention. (Adam and Hussain, 2017) also supports that credibility and the meaning transferred to the product by the celebrity have a positive influence on consumer's buying intentions while attractiveness of celebrity has no relationship with the purchase intention of the consumers. The study has been conducted in cosmetics industry. In the telecommunications industry, factors such as celebrity attractiveness, likeability and trustworthiness do have a positive influence on the brand reputation, (Zakari et al., 2019)and affects the purchase intentions of the consumers especially female consumers. (Abbas, A., Afshan, G., Aslam, I., & Ewaz, L. (2018)

(Bush et al., 2004) analysis to examine the effect of celebrity endorsement on consumer behavior and concludes that advertisements endorsed by celebrity are more attractive than non-endorsed advertisements and there is a significant influence of celebrity endorsement on consumer buying behavior. (krishna, n.d.)conducts the research on multiple brands of face care products with a sample size of 200 male and female of diverse age, occupation and preferences in Karachi city and finds that the celebrity endorsed advertisements do have an influence on the consumers purchase decision.

(Min et al., 2019)applies the S-O-R Model and the balance theory to examine the effects of celebrity brand congruence and publicity on consumer's attitude towards the brand and the celebrity and consumer's buying behavior. The results showcase a positive effect of celebrity brand congruence and publicity on consumer's attitude and buying behavior. (Osei-Frimpong et al., 2019) investigates the impact of celebrity endorsement and the moderating effect of negative publicity on consumer purchase intention with 500 respondents. The study finds a positive influence of attractiveness, trustworthiness, and familiarity of the celebrity endorser on consumer's perception of brand, purchase intentions, and quality. (Ifeanyichukwu, 2016) conducts the study on 200 young adults to know the impact of variables trustworthiness, expertise, attractive and respect of celebrities endorsing a product on its buying behavior and finds a positive relationship between celebrity endorsement and purchase decision of the consumers. However, one hypothesis i.e. trustworthiness is not significant while the other three hypothesis have shown positive and significant results.

The use of Social media platforms such as Instagram has also grown in the recent years. Social media contributes to influence the behavior of the consumers (Ioană, 2014)(*(PDF) Social Media and Its Impact on Consumers Behavior*, n.d.). Consumers buying behavior is also affected by what celebrities and influencers post or say on such platforms. Consumers feel a sense of belongingness with the celebrities. Despite not knowing them personally, the consumers with high affiliation needs feel a personal connection with the celebrities. In these situations, media users build parasocial connections with distant media personas, which gives the impression of closeness or intimacy. (Escalas & Bettman, 2017) In these situations, media users build parasocial connections with distant media personas, which gives the impression of closeness or intimacy. Electronic word of mouth (e-WOM) also influences the purchase intentions. (Sa'ait et al., 2016)shows the impact of four variables of e-WOM which are relevance, accuracy, timeliness and comprehensiveness and finds that all the four variables have a significant influence on

consumer purchase intention. Celebrities' post authenticity also has a direct effect on consumers' urge to buy impulsively(Zafar et al., 2021). Studies show that celebrity attributes have an impact on the buying intentions of consumers because of trust and that electronic word of mouth also influences the purchase intentions through mediating of trust variables (Firman et al., 2021)

Customers, especially women, aspire to the lifestyles of some celebrities; they imitate their choices of restaurants and vacation spots, their makeup and fashion looks, and the kinds of postings they make. (Djafarova & Rushworth, 2017) conducts an in depth interview of 18 female Instagram users and finds that celebrities on instagram and influential when it comes to influencing the buying behavior of the customers. (Hameed et al., 2023) studies the impact of brand awareness on purchase intention in the digital era with the insights of moderated mediation role of celebrity endorsement and consumer attitude. Research discovers that when celebrities endorse a brand, people acquire a good attitude and their intention to buy is positively impacted.

Culture and contextual influence

The influence of famous people promoting products may differ greatly in various cultural and situational environments. For instance, according to Choi and Rifon (2007), cultural variances impact consumers' perceptions and reactions towards celebrity endorsements. In societies that prioritize group values, consumers may value the influence of endorsements from the group, whereas in societies that prioritize individuality, personal connection with celebrities may be more significant.

Digital Influence and Social Media

Celebrity endorsements have been changed by the emergence of social media. Famous people can now directly communicate with their fans, leading to more genuine and impactful endorsements. (Djafarova & Rushworth, 2017) emphasize that endorsements on social media platforms such as Instagram can greatly increase intentions to purchase because of the perceived authenticity and relatability.

While most of the previous research studies the impact of the products and services that are endorsed by various celebrities on the purchase intention of the consumer, very few talk about unpaid endorsements(Van Der Waldt,2007) or the face value of the celebrities and their impact on the buying behavior of the consumers. Do consumers get influenced by merely watching a particular celebrity wear or use a particular product? Are their purchase decisions and buying behavior impacted by the same? This study aims to fill the above mentioned research gap by analyzing the impact of celebrity face value on the buying behavior of the consumers.

Research Gap

While most of the previous research studies the impact of the products and services that are endorsed by various celebrities on the purchase intention of the consumer, very few talk about unpaid endorsements(Van der Waldt, Schleritzko, and Van Zyl, 2007) or the face value of the celebrities and their impact on the buying behavior of the consumers. Do consumers get influenced by merely watching a particular celebrity wear or use a particular product? Are their purchase decisions and buying behavior impacted by the same? The face value of a celebrity refers to the innate attractiveness, popularity, and recognition of a celebrity in the public eye. It is the value that a celebrity adds merely by being associated with a brand or product, owing to their popularity, appearance, or personality independent of active promotion or participation. Companies may use a celebrity's face value to draw attention, generate trust, or establish prestige, even if the celebrity does not explicitly support the product. For example, using their picture on packaging or in marketing. Celebrity Endorsement means a formal and active association in which a celebrity promotes a product, service, or brand through ads, public appearances, or direct referrals. It frequently entails a contractual arrangement through the celebrity's active engagement in marketing the product, adding credibility and influence through personal endorsement or relationship. This study seeks to fill the above-mentioned research gap by analyzing the impact of celebrity face value on the buying behavior of consumers.

Hypothesis

H1: Celebrity Face Value has a positive impact on the Purchase intention .
H2: Personal Experience of Customers positively or negatively affects their Purchase Intention.
H3: Trust and Credibility of celebrities directly influence the Purchase Intention of consumers.
H4: Social -Media and Celebrity Influence positively or negatively affect the Purchase Intention of consumers.

Research Methodology

The study uses a quantitative technique to examine the relationships between various factors in the context of impact of celebrity face value on purchase intention. Nowadays consumers are more influenced by watching celebrities using a product of their interest on social media platforms like Instagram, Facebook, YouTube, etc. and they strive to use those products in their daily lives because of the face value of that celebrity. This study was conducted on consumers of various age groups, income levels, professions, etc. Four variables- Celebrity Face value, Personal Experience of customer, trust, and credibility, and social media influence were used to analyze their impact on purchase intention. These variables were assessed using a five-point scale raging from Strongly Agree to Strongly Disagree. The questionnaire is designed to capture relevant information related to the research objectives through Google Forms and is used to interview 160 respondents. It includes Likert-scale questions. The validity and reliability of the constructs were measured using smart-PLS SEM software. Discriminant validity was also measured. Smart PLS-SEM is chosen as the analytical tool due to its suitability for handling complex structural equation models with latent variables and reflective indicators.

Data Analysis and Findings

Sample Descriptives
The respondent's profile is represented in Figure 1. 47.5% of the respondents were male and 52.5% were female. As far as age is concerned, the most of the respondents lie in the age group of 18-30 years (62% approx.) as this is the group that is mostly active on social media, approx. 25% lies in the age group 31-45 years, very less lies in the age group 46-60 years (10%) and only 2.5% are above 60 years. Similarly, in terms of occupation, most of them are employed in the private sector (36.25%) followed by 30% of students, 2.5% employed in the public sector, approx. 21% are self-employed and 10% have some other occupation. 62.5% of the respondents have an annual income of less than 5,00,000,18.75% have an income level between 5,00,000-10,00,000 and the rest of them lie in the category of above 10,00,000.

The validity and reliability of the constructs were measured using smart-PLS SEM software. Discriminant validity was also measured. Smart PLS-SEM is chosen as the analytical tool due to its suitability for handling complex structural equation models with latent variables and reflective indicators. The path model is developed to measure the impact of various constructs and various relationships among them.

Measurement Model
The measurement model is represented in Figure 2. This model is prepared using smart PLS where CF (Celebrity Face value), PE (Personal Experience), TC (Trust and Credibility), and SMCI (social media and Celebrity Influence) are independent variables and purchase intention (PI) is the dependent variable.

Table 1: Respondents' Profile

Variable	Category	Frequency	Percentage
Gender	Male	114	47.5
	Female	126	52.5
Age	18-30 years	150	62.5

	31-45 years	60	25
	46-60 years	24	10
	Above 60 years	6	2.5
Occupation	Student	72	30
	Employed in the private sector	87	36.25
	Employed in the public sector	6	2.5
	Self- Employed	51	21.25
	Others	24	10
Income Group	Less than 5,00,000	150	62.5
	5,00,000-10,00,000	45	18.75
	10,00,001-15,00,000	30	12.5
	Above 15,00,000	15	6.25

Source: Author's Own Data

Figure 1: Measurement Model of PLS-SEM
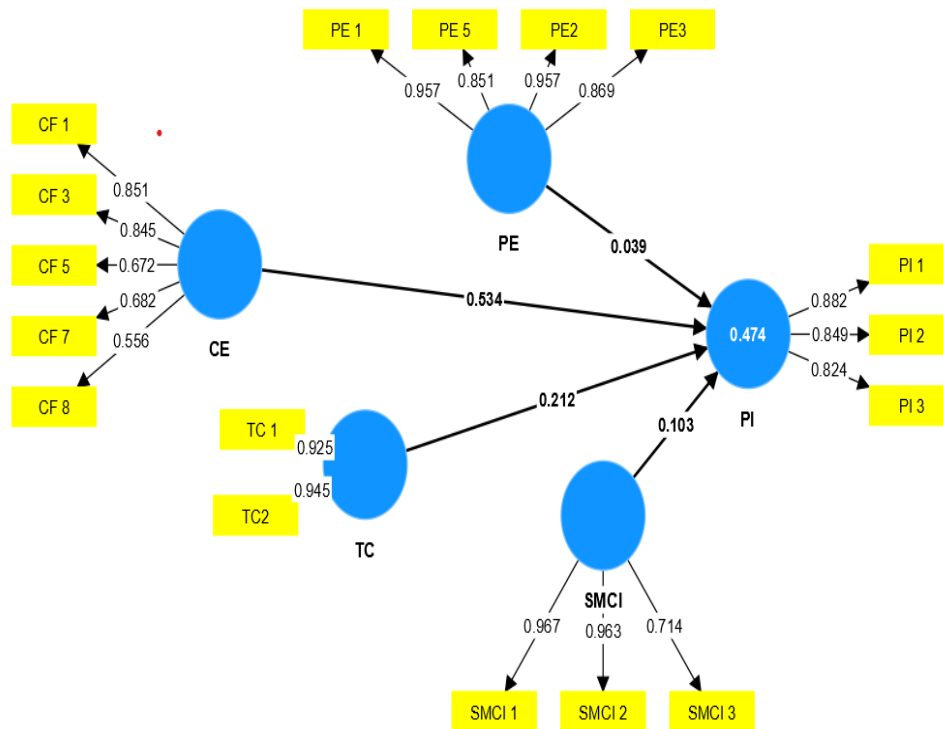
Source: Author's Own Data

Analysis of Measurement Model

First, the model is tested for reliability and validity.

Reliability and Validity

The reliability of the latent variables has been measured using Cronbach alpha and Composite Reliability. Overall Sample was analysed and variables having factor loadings less than 0.70 were rejected. The results of factor loading along with reliability and validity are presented in Table 2 for the sample. All the Cronbach alpha and CRs are greater than 0.70. High reliability indicates that the observed indicators (Face value, Personal experience, social media, Trust, and credibility) are measuring the purchase intention

consistently and that the constructs are internally consistent. This gives you confidence that the measurement model is reliable. Average variance extracted and Composite reliability is greater than equal to 0.5 and 0.7 repetitively indicating that the indicators are converging to measure the same construct. High validity ensures that the measurement model accurately captures the constructs we intend to study. Content validity ensures that the model is measuring the right things, while convergent and discriminant validity provide evidence that the measures behave as expected with other constructs.

Table 2: Reliability and Validity

	Outer Loadings	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Celebrity Face Value and Celebrity Influence (CF)		0.773	0.797	0.848	0.533
CF 1	0.851				
CF 3	0.845				
CF 5	0.672				
CF 7	0.682				
CF 8	0.556				
Personal Experience (PE)		0.934	0.987	0.95	0.828
PE 1	0.957				
PE 5	0.851				
PE2	0.957				
PE3	0.869				
Social Media and Celebrity Influence (SMCI)		0.865	0.942	0.918	0.791
SMCI 1	0.967				
SMCI 2	0.963				
SMCI 3	0.714				
Trust and Credibility (TC)		0.857	0.871	0.933	0.874
TC 1	0.925				
TC2	0.945				
Purchase Intention (PI)		0.812	0.831	0.888	0.726
PI 1	0.882				
PI 2	0.849				
PI 3	0.824				

Source: Author's Own Data

Discriminant Validity

Discriminant validity assesses whether the latent constructs are distinct from one another. To establish discriminant validity, the correlation matrix of latent constructs is analyzed to ensure that the square root of the AVE for each construct should be greater than the correlations between that construct and others (the Fornell-Larcker criterion). Discriminant validity is shown in Table 3 where the square root of the Average Variance Extracted of the variables as shown diagonally is more than the correlation of each variable with all other variables. This shows that all constructs are distinct from each other.

Table 3: Discriminant Validity of Latent Constructs

	CF	PE	PI	SMCI	TC
CF	**0.73**				
PE	0.218	**0.91**			
PI	0.637	0.23	**0.852**		
SMCI	0.266	0.47	0.339	**0.889**	
TC	0.316	0.123	0.423	0.357	**0.935**

Source: Author's Own Data

Table 4: R Square

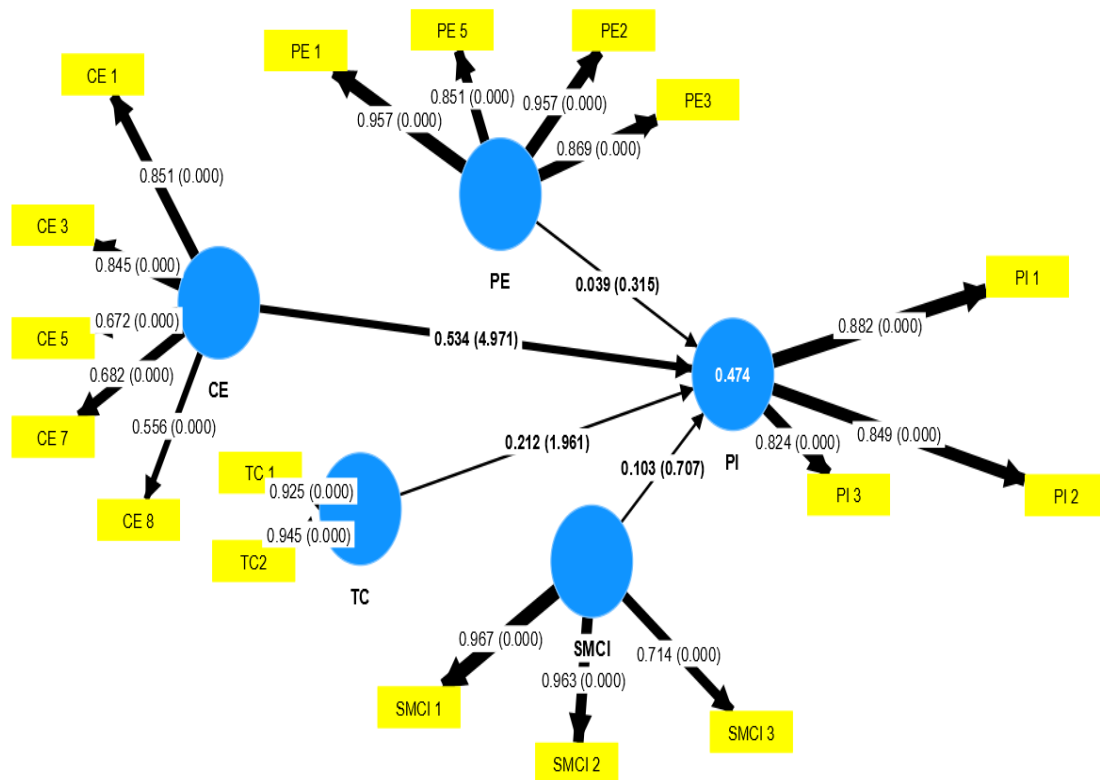|	**R-square**	**R-square adjusted**	
PI	0.474	0.448	

Source: Author's Own Data

R Square

In this study, R^2 is 0.474 which confirms that the 47.4% change in purchase intention is due to the independent variables considered for the study.

Analysis of the structural model

Figure 2: Structural Model of PLS-SEM

Source: Author's Own Data

Path coefficient along with T values are shown in the structural model as shown in Table 5 for the impact of celebrity value on purchase intention.

Table 5: Path Coefficient

	Path Coefficient	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Hypothesis Test
CF -> PI	0.534	0.533	0.107	4.971	0	Accepted
PE -> PI	0.039	0.049	0.124	0.315	0.753	Rejected
SMCI -> PI	0.103	0.089	0.146	0.707	0.48	Rejected
TC -> PI	0.212	0.22	0.108	1.961	0.05	Accepted

Source: Author's Own Data

As shown in Table 6, Celebrity Face value has a positive relationship with purchase intention as its p-value is 0 and it has the highest standardized beta value of 0.534, p-value of 0.00. In this case, the path coefficient is 0.534, indicating that a one-unit change in CF is associated with a 0.534-unit change in PI, assuming a linear relationship. Likewise, Trust and credibility also have a greater impact on purchase intention as indicated by a standardized beta value of 0.212., and a p-value of 0.05 which shows the level of significance. On the contrary, personal experience (beta value 0.039, p-value of 0.753) and social media (beta value of 0.103 and p-value of 0.48) do not significant impact on purchase intention. The p-values corresponding to each path coefficient evaluate whether the null hypothesis is true. A low p-value denotes the statistical significance of the association. Low p-values (0) in this instance show that the correlations between CF and PI are statistically significant. In contrast, the higher p-values for the associations between PE and PI (0.753 and 0.48, respectively) show that these relations are not statistically significant. This shows that H2: Personal Experience of Customers positively or negatively affects their Purchase Intention and H4: Social -Media and Celebrity Influence positively or negatively affects the Purchase Intention of consumers are rejected. On the other hand, H1: Celebrity Face Value has a positive impact on the Purchase intention of consumers, and H3: Trust and Credibility affect Purchase Intention.

Table 6: Outer Loading

	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
CF 1 <- CF	0.066	12.806	0
CF 3 <- CF	0.068	12.4	0
CF 5 <- CF	0.095	7.061	0
CF 7 <- CF	0.129	5.268	0
CF8 <- CF	0.107	5.194	0
PE 1 <- PE	0.168	5.683	0
PE 5 <- PE	0.212	4.014	0
PE2 <- PE	0.168	5.683	0
PE3 <- PE	0.154	5.635	0
PI 1 <- PI	0.028	31.844	0
PI 2 <- PI	0.047	17.964	0
PI 3 <- PI	0.061	13.531	0
SMCI 1 <- SMCI	0.077	12.513	0
SMCI 2 <- SMCI	0.078	12.288	0
SMCI 3 <- SMCI	0.14	5.103	0
TC 1 <- TC	0.03	30.516	0
TC2 <- TC	0.023	41.789	0

Source: Author's Own Data

As depicted by Table 7, all four independent variables are positively correlated with purchase intention. To be precise, celebrity endorsement has the highest correlation with purchase intention (r=

0.639) followed by trust and credibility (r= 0.422). Purchase intention is least affected by personal experience(r=0.230). This indicates that purchase intention is more influenced by the face value of their favorite celebrity and their trust and credibility of that celebrity than their personal experience.

Table 7: Correlation Matrix

	CF	PE	PI	SMCI	TC
CF	1.000				
PE	0.219	1.000			
PI	**0.639**	**0.230**	1.000		
SMCI	0.265	0.470	**0.339**	1.000	
TC	0.322	0.123	**0.422**	0.357	1.000

Source: Author's Own Data

Purchase intention is greatly influenced by celebrity endorsement trust and credibility and is least affected by social media influence and personal experience.

Discussion

This paper aimed to examine how celebrity face value affects consumers' purchase intention and purchase decisions. The research question is "Is the purchase intention affected by celebrity face value?" The answer is yes. For this personal experience of consumers, social media influence, trust and celebrity of celebrity seem to be the main factors affecting their decision to purchase after seeing a celebrity using a product not for endorsement but for their personal use.

One of our major findings is that trust in celebrities and their credibility has a positive impact on purchase intention. This is coherent with Adam and Hussain (2017) and Djafarova and Rushworth (2017) who have reported that celebrity endorser credibility has a positive impact on both consumer ad recall as well purchase intention. The products used by Sports athletes, Famous Personalities, Film stars, famous entrepreneurs, etc. are more likely to affect to decision to purchase the product which is consistent with Ahmed et al. (2015). People especially Gen Z are influenced by the Fame of the Celebrity, Trustworthiness of the Celebrity, Affection Towards the Celebrity, and Celebrity as a Role Model, to buy a product when endorsed/faced by a celebrity.

Nowadays people especially youngsters are more inclined toward social media. So social media plays an important role in affecting purchase intention. Celebrities post Instagram reels using different products like Alia Bhatt's beetroot raita, Virat Kohli's Rama Chole Bhature, and Candy Crush as MS Dhoni's famous leisure activity which creates a desire to use the product. This study is coherent with Erdogan (1999) which explains that Consumer buying behavior is also affected by what celebrities and influencers post or say on such platforms. Consumers feel a sense of belongingness with the celebrities. Despite not knowing them personally, consumers with high affiliations need to feel a personal connection with the celebrities. In these situations, media users build parasocial connections with distant media personas, which gives the impression of closeness or intimacy, and Bush et al. (2004) says that media users build parasocial connections with distant media personas, which gives the impression of closeness or intimacy. Nowadays people start following celebrities on social media when they are attracted to the product they are using. This ultimately creates a desire to use the product and affects purchase intention.

Another remarkable finding of the study was that the customers' personal experience after using the products endorsed by celebrities also plays some role in influencing the consumer's purchase decision.

Practical Implications

Not much research has been conducted in the past about the impact of celebrity face value on consumer's purchase intention. This research adds to the body of knowledge about the influence of celebrity face value on purchasing intention and decision. These can help researchers, businesses, and marketers better understand and capitalize on how social media and celebrities affect customer behavior. Research has consistently shown that celebrity endorsements can increase brand recall, awareness, and purchase

intent. For example, Erdogan (1999) found that celebrity endorsement increases brand equity and increases purchase intentions

Client referrals and celebrities are more likely to influence your recommendations. This sign can be based on values, lifestyles or aspirations (Escalas and Bettman, 2015).

Adverse Effects and Risks: Despite the potential benefits, celebrity endorsements come with risks. Bad behavior associated with celebrities can have a negative impact on the endorsed brand and decrease consumers' purchase intentions (Till and Shimp, 1998). Additionally, exposure to a celebrity through multiple endorsements can reduce their influence (Tripp, Jensen, & Carlson, 1994).

When selecting celebrities to endorse products, marketers should give careful thought to several variables, including the celebrity's fame as well as personal appeal, credibility, and dependability. Aligning the celebrity's image with the brand requires a thorough understanding of the target demographic and their preferences. Focus on strategies that increase the trustworthiness and credibility of celebrities in the eyes of consumers. This can entail showcasing a celebrity's own experience with a product and making sure that the product complements the celebrity's brand. Acknowledge social media's rising influence, especially among younger audiences. It is recommended that marketers allocate resources towards social media marketing tactics that feature celebrities using items on sites like Instagram, where short video content (such as reels) can create a desire among the audience to use the product.

Encourage and display user-generated reviews and content about products that celebrities have endorsed. Positive customer experiences can play a big role in influencing prospective customers and enhancing a brand's reputation. Marketers can gather and emphasize real-life stories and testimonials from consumers who have had positive experiences with the products used by celebrities, thereby reinforcing the product's worth. Segment the target market according to their media consumption patterns and inclinations. Marketing efforts can be more targeted if it is known which social media platforms and content work best for targeting particular consumer segments. Moreover it will help industries like FMCG, Luxury brands, fashion industry to make policies regarding pricing, advertising, decision to introduce new product line, entering into a new product line.

Conclusion

This research adds to the existing knowledge of celebrity endorsement by examining how celebrity face value affects consumers' purchase decisions. Moreover, the present study reports that purchase intention is influenced by celebrity face value. Consumers are enticed when they notice a celebrity using a product. Celebrity face value may become an important tool to influence consumer behavior.

This study also provides valuable insights into social media platforms and online shopping portals to develop effective marketing strategies. This study has been conducted using PLS-SEM. Using empirical data and analysis, this study shows that celebrity face value and their trust and credibility largely affect the purchase intention of consumers and their purchase intention. Secondly, it shows that personal experience and social media though valid and reliable factors for influencing consumer behaviour do not contribute much to influencing purchase intention. All four independent variables- Celebrity influence, Personal experience, trust and credibility, and social media influence are positively correlated to purchase intention as reflected by the model. Generally, consumers resist buying high-value items based on celebrity recommendations. Most of them are willing to spend less than Rs.20,000 to purchase such products. Most of the consumers attracted to these products are females who are willing to buy products like apparel, imitation jewelry, beauty products, etc.

The influence of a celebrity's image on buying decisions is complex, shaped by factors such as the celebrity's credibility, how well they match with the product, consumer connection, and cultural background. Although celebrity endorsements can greatly boost intentions to purchase, they also bring with them certain inherent dangers. Future studies should further investigate these interactions, especially in the changing digital environment.

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