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Environmental and Macroeconomic Determinants of Financial Market Development: A Workforce-Centered Analysis for Pakistan

[*1]Sadia Mustafa
[2]Quratulain Benish
[3]Umme Farwa
[4]Hadia Batool

[*1]*Department of Economics, University of Southern Punjab, Multan*
[2]*Bahauddin Zakariya University, Multan*
[3]*School of Business, University of Southern Punjab, Multan*
[4]*Bahauddin Zakariya University, Multan*

[*1]sadiamustafa@usp.edu.pk, [2]Quratulainbenish@bzu.edu.pk, [3]umefarwa@usp.edu.pk
[4]Hadiahussain49@gmail.com

Abstract

Environmental quality and core macroeconomic fundamentals have long been recognized as important determinants of financial market performance, particularly in emerging economies such as Pakistan. However, despite this recognition, these factors have often been studied in isolation, failing to capture their integrated and long-run dynamics within the financial development process. To fill this knowledge gap, the study considers the long- and short-run impacts of environmental degradation (proxied by CO2 emissions), exchange rate dynamics, GDP per capita growth, and external debt on the financial market development in Pakistan (proxied by market capitalization) over the period 19802024. Through a unified framework created using the Autoregressive Distributed Lag (ARDL) method resourcing to the endogenous growth and financial development theories, this research weaves the environmental and macroeconomic realms that interactively complement each other. Empirical evidence establishes that there is a constant long-run equilibrium between the variables, with a highly significant negative effect of CO 2 emissions, exchange rate depreciation, and external debt on market capitalization, and a positive impact of GDP per capita growth. The rapid short-run adjustment toward the equilibrium of the error correction model elucidates this aspect. The effectiveness of the model is validated through thorough diagnostic and case tests of stability. This study provides a policy-relevant contribution to fostering workforce-oriented and environmentally sensitive financial market activities in Pakistan by merging macroeconomic stability with environmental sustainability.

Keywords: CO_2 emissions, exchange rate, GDP per capita growth, external debt, ARDL, financial market development, Pakistan

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Corresponding Authors*:
Sadia Mustafa

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INTRODUCTION

Financial market development is central to mobilization of savings, optimal allocation of resources and sustainable economic growth. Capitalization in the stock markets in a developing country like Pakistan does not only indicates the depth of the financial sector but also indicator of investor confidence and macroeconomic stability. Financial market development has gained a more and more complex relationship with other socio-economic parameters, such as the environmental sustainability and productive power of the labour force. These interdependencies are especially pertinent in the 21 st century when economies are faced with the competing objectives of economic growth, financial inclusion, and environmental protection.

The financial market in Pakistan, though it has witnessed some major reforms in the last 20 years, is susceptible to externalities as well as domestic adjustments. Rapid growth experienced by Karachi Stock Exchange (now Pakistan Stock Exchange) has been accompanied by periods of sharp declines, attributed in many cases by macroeconomic imbalances, exchange rate volatility, and political turmoil. Environmental degradation, expressed in the form of increasing CO 2 emissions since the expansion of industrial production, fossil-fuel reliance, and expenditure of vitality, has turned lately into a working however covert determinant of financial business sector dynamics. Environmental mismanagement will cause poor environment to destroy employees efficiency, raise operations expenses, and weaken environmentally concerned investors hence wasting market asset value.

Financial market development is affected both directly and indirectly by macroeconomic factors. Currency fluctuations affect portfolio flows abroad, corporate profits, and investor confidence, and GDP per capita has a positive impact on the economic foundation of capital market activity. External debt, if excessive, can divert resources from productive investment and heighten default risk, dampening investor confidence. In the context of workforce-driven development, these macroeconomic levers also shape the labor market's capacity to contribute to sustained financial expansion.

While literature has recognized the role of macroeconomic stability in fostering financial development, the integration of environmental performance into this framework is still nascent, especially for Pakistan. Most studies examine either the impact of macroeconomic factors on financial markets or the consequences of environmental degradation on economic growth, rarely uniting the two within a single empirical framework. Moreover, workforce productivity—although often discussed in labor economics—has not been adequately linked to environmental conditions and financial sector outcomes.

Against this backdrop, the present study aims to systematically analyze the long-run and short-run impacts of CO_2 emissions, exchange rate movements, GDP per capita growth, and external debt on financial market development in Pakistan over the period 1980–2024. Using the Autoregressive Distributed Lag (ARDL) methodology, this research captures both equilibrium relationships and dynamic adjustments, offering a nuanced understanding of how environmental and macroeconomic forces interact to shape market capitalization.

The contributions of this study are threefold. First, it provides an integrated analytical framework that combines environmental sustainability, macroeconomic stability, and workforce productivity within the financial development literature. Second, it delivers Pakistan-specific empirical evidence over a four-decade span, addressing the scarcity of

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country-focused, long-horizon studies. Third, it offers policy-relevant insights for achieving sustainable, workforce-driven financial market growth in an environmentally constrained global economy.

LITERATURE REVIEW

Financial markets channel savings into productive investments, reduce transaction costs, and improve resource allocation efficiency. The stock market, in particular, serves as a mechanism for price discovery and risk diversification. According to Vardari and Vardari (2024), deep and liquid markets are associated with higher economic growth rates, while Badwan et al. (2023) find that well-functioning markets enable firms to raise long-term capital more efficiently.

Macroeconomic stability is a prerequisite for financial market development. Exchange rate stability reduces uncertainty for foreign and domestic investors alike. Persistent currency depreciation can discourage portfolio investment by increasing foreign investors' risk exposure. GDP per capita growth is another crucial determinant, signaling expanding market opportunities and a larger base for corporate profitability. Conversely, excessive external debt can crowd out private investment, elevate sovereign risk premiums, and depress stock market valuations (Mustafa et al.,2024).

Environmental degradation , particularly rising CO_2 emissions has emerged as a significant factor influencing financial market performance. Empirical evidence shows that poor environmental quality can reduce labor productivity (Khanna et al., 2021), increase firm-level costs through compliance or health-related absenteeism and deter environmentally conscious institutional investors (Rettl et al., 2022). In developed markets, green investment trends have pushed firms and economies toward cleaner production, and stock exchanges with stronger environmental governance attract more stable capital flows (Yahya et al., 2024).

For emerging economies, the relationship is more complex. On the one hand, rapid industrialization drives both market capitalization and CO_2 emissions. On the other, prolonged environmental degradation undermines long-term investor confidence. (Li et al.,2024) finds that in China, unchecked emissions eventually erode economic competitiveness and market stability. Similar dynamics may apply to Pakistan, where energy-intensive industries dominate and environmental policy enforcement remains weak. Pakistan's financial market has been shaped by episodes of macroeconomic turbulence, structural reforms, and integration into global capital markets. Studies such as Mustafa et al.(2024) and Thahara et al. (2021) highlight GDP growth and trade openness as positive drivers of market capitalization, while exchange rate volatility and inflation exert negative effects. External debt has been identified as a long-term constraint on private sector investment (Musah, 2023).

On the environmental front, Pakistan's CO_2 emissions have risen steadily due to urbanization, industrial expansion, and heavy reliance on fossil fuels (Ali et al., 2022). Few studies, however, have empirically linked environmental performance to financial market outcomes. A rare exception is Younis et al. (2021), who show that environmental degradation indirectly affects stock returns through reduced economic productivity and investor confidence.

Four main gaps emerge from the literature. First, there is a lack of integrated models combining environmental quality and macroeconomic fundamentals in explaining financial market development. Second, country-specific studies for Pakistan that cover multiple decades are rare, despite the country's unique economic and environmental

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trajectory. Third, the role of environmental degradation in influencing workforce-driven market development has been underexplored. Fourth, methodological gaps persist, as many prior studies rely on static models that fail to capture both long-run equilibrium and short-run dynamics.

This research addresses these gaps by developing an integrated framework based on endogenous growth and financial development theories, applying ARDL methodology to Pakistan's 1980–2024 data. The approach captures both equilibrium relationships and dynamic adjustments, providing actionable insights for balancing environmental sustainability with macroeconomic stability to promote financial market growth.

DATA AND VARIABLES

Robust empirical results are achieved by using consistent and reliable data. The present analysis employs a time-series study of Pakistan spanning the period 1980 to 2024, a time frame sufficiently long to capture structural long-run dynamics while short enough to incorporate relevant short-run fluctuations. The selection of variables is grounded in strong theoretical relevance and well-documented empirical evidence from previous research, aligning with the integrated environmental–macroeconomic perspective of the study. Data have been sourced from credible and recognized national and international databases, including the World Bank's World Development Indicators (WDI), International Financial Statistics (IFS), and the State Bank of Pakistan (SBP), ensuring accuracy, consistency, and comparability.

In this study, the dependent variable is market capitalization (MCAP) as a proxy indicator of financial market development, whereas the independent variables (carbon dioxide emissions (CO 2), exchange rate (ER), GDP per capita growth (GDP), and external debt (ED)) are used. Such variables have been selected to reflect the environmental aspect and fundamental macroeconomic drivers of financial market performance.

TABLE 1: DESCRIPTION OF VARIABLES

Variable	Description	Measurement/Unit	Source	Expected Impact on MCAP
MCAP	Financial market development (Market capitalization)	% of GDP	(WDI)	Dependent variable
CO_2	Carbon dioxide emissions	Metric tons per capita	(WDI)	Negative: higher emissions undermine sustainability and investor confidence
ER	Exchange rate (PKR per USD)	Annual average	(SBP)	Negative: depreciation reduces foreign investor participation
GDP	GDP per capita growth	Annual % growth	(WDI)	Positive: reflects economic expansion and market opportunities
ED	External debt	% of GDP	(WDI)	Negative: excessive debt increases fiscal vulnerability

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The addition of the CO 2 emissions reflects the environmental aspect of financial market growth, due to the fact that the environment could impact the productivity of the workforce around, the attitudes of the investors, and the sustainability of the market in the long term. Exchange rate (ER) is taken into consideration because it has direct impacts on capital flows, trade competitiveness, and prices of foreign-denominated assets. The growth in GDP per capita (GDP) reflects the wider macroeconomic growth that normally leads to increases in market capitalization due to increased corporate profits and spending. External debt (ED) is a measure of macroeconomic constraint because high debt levels can crowd out the private investment, increase the risk of default, and reduce confidence among investors.

This study attempts to comprehensively demonstrate the determinants of workforce-led financial market development in Pakistan by synthesizing environmental and macroeconomic variables within the same scope of analysis.

MODEL SPECIFICATION

The model specification of the study is designed to empirically test the connection between financial market development (MCAP) and its major environmental and macroeconomic drivers in the theoretical frameworks of endogenous growth theory and financial development theory. The model also enables simultaneous estimation of the short-run adjustments and the long-run equilibrium relationships between the variables based on the Autoregressive Distributed Lag (ARDL) technique. This approach is especially appropriate where the sample size is relatively small, and when on the data there are a mix of orders of integration of the variables involved, thus providing a strong application and a diverse methodology.

The functional nature of the model involves including carbon dioxide emissions (CO 2), exchange rate (ER), GDP per capita growth (GDP), and external debt (ED) as the explanatory variables. These determinants combine the environmental sustainability and macroeconomic stability perspectives of the financial market development differences.

Formally, the functional representation of the model is:

$$MCAP=f(CO_2,ER,GDP,ED)$$

The linear econometric form of the model is expressed as:

$$MCAP= \beta_0 + \beta_1 CO_2 + \beta_2 ER + \beta_3 GDP + \beta_4 ED + \mu_i$$

ECONOMETRIC METHODOLOGY

The data analysis used three methods: Autoregressive Distributed Lag approach, Phillips Perron (PP) unit root test and Augmented Dickey-Fuller test.

UNIT ROOT

Order of integration of the variables used necessitates the determination prior to the use of the ARDL bounds testing procedure as it would be a pre-condition for utilizing a procedure of ARDL in that none of the variables should be integrated of order I(2) and above. In that regard, the research uses two common tests of stationarity: the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. Each variable at level, and above a first difference is tested, under specifications that include an intercept, and, where applicable, a deterministic trend.

These tests are aimed to determine whether the time series data contain unit roots meaning that they are not stationary or they are stationary when differences are made. The requirement of stationarity in econometric modeling is of particular importance, since non-stationarity in variables may cause spurious regression. The ARDL methodology

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becomes validated as a suitable method of estimation in this case because of the confirmation of the variable being I (0) or I (1).

COINTEGRATION TEST

After ensuring the order of integration properties of the variables, it is important to determine whether there exists a long-run equilibrium relationship between the variables. The cointegration analysis is critical in finding out whether two variables that are not individually stationary can co-move over time in a stable and economically meaningful relationship.

In the present study, the ARDL bounds testing procedure of Pesaran et al. (2001) will be used to reflect cointegration. This procedure is ideal when dealing with models that contain variables that are either integrated of different orders, I(0) or I(1) and will also work well on small-sample estimation. Contrary to traditional cointegration methods like the Engle-Granger or the Johansen, the test of bounds procedure does not place a limitation excessive all variables to be integrated of the same order, thereby making it more flexible and robust (Mustafa et al., 2024).

Using this method, the article assesses the combined urge of lagged level variables utilizing an F-statistic. When the calculated F-statistic is greater than its upper critical value, then the null hypothesis of no cointegration will be rejected which implies the existence of a stable long-run relationship. Then the statistic on the lower bound, however, it will inevitably be under it and in this case, the null hypothesis will not pass the test, whereas the values within the scopes will simply be unconfirmed and thus will need additional investigation.

ARDL

The research utilizes the autoregressive distributed lag (ARDL) modelling framework, elaborated by Pesaran and Shin (1995, 1999), Pesaran et al. (1996) and Pesaran (1997), to examine the long-run and short-run dynamics of the relationships between the variables of interest. The ARDL bounds testing method has a number of econometric benefits compared to the traditional Johansen and Juselius (1990) maximum likelihood cointegration. In contrast to the conventional system-based methods that necessitate estimation of a complete vector autoregressive (VAR) or vector error correction model (VECM), the ARDL approach estimates just one reduced-form equation, minimizing the chance of over-parameterization as well as small-sample bias (Pesaran & Shin, 1995).

An important aspect of the ARDL approach is that there is no need to pre-test the exogenous regressor integration order, so long as none of the independent variables is of order two or greater. This would enable incorporating a combination of I(0) and I(1) variables in the same model without a loss in the validity of the inference, especially when unit root tests result in marginal power or in the presence of structural breaks (Mustafa et al., 2025). In addition, the ARDL model effectively encompasses both the short-run dynamics and the long-run equilibrium relationships in a single specification which renders it particularly suitable in analysing macroeconomic time-series that have cyclical property and restricted sample sizes. Considering these econometric characteristics, the ARDL method is methodologically highly appropriate in the given current analysis since it guarantees strong estimation and error-free inference.Furthermore, ARDL method avoids requirements other than the standard cointegration test.

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General ARDL equation, which establishes a relationship between "Environmental ,Macroeconomic Determinants and Financial Market Development" is as follows:

$$\Delta(MCAP) = \alpha + \beta_1(MCAP)_{t-1} + \beta_2(CO2)_{t-1} + \beta_3(ER)_{t-1} + \beta_4(GDP)_{t-1} + \beta_5(ED)_{t-1} + \sum_{i=1}^{\alpha 1} \delta_1\Delta(MCAP)_{t-i} + \sum_{i=0}^{\alpha 2} \delta_2\Delta(CO2)_{t-i} + \sum_{i=0}^{\alpha 3} \delta_3\Delta(ER)_{t-i} + \sum_{i=0}^{\alpha 4} \delta_4\Delta(GDP)_{t-i} + \sum_{i=0}^{\alpha 5} \delta_5\Delta(ED)_{t-i\ i} + +\varepsilon_t$$

In ARDL model, parameters represent the long-run multipliers, while symbols Δ and white noise error term represent the short-run dynamic coefficients and variables' initial differences.

Following equation can be used to determine the long-run parameters of the model on (cointegration test.

General ARDL equation, which establishes a relationship between "Environmental Macroeconomic Determinants and Financial Market Development".

$$\Delta(MCAP) = \alpha + \sum_{i=1}^{\alpha 1} \eta_1(MCAP)_{t-i} + \sum_{i=0}^{\alpha 2} \eta_2(CO2)_{t-i} + \sum_{i=0}^{\alpha 3} \eta_3(ER)_{t-i} + \sum_{i=0}^{\alpha 4} \eta_4(GDP)_{t-i} + \sum_{i=0}^{\alpha 5} \eta_5(ER)_{t-i} + \varepsilon_t$$

Following can be used to estimate the short-term dynamics of the model.

$$\boldsymbol{\Delta(MCAP) = \alpha + \sum_{i=1}^{\alpha 1} \lambda_1\Delta(MCAP)_{t-i} + \sum_{i=0}^{\alpha 2} \lambda_2\Delta(CO2)_{t-i} + \sum_{i=0}^{\alpha 3} \lambda_3\Delta(ER)_{t-i} + \sum_{i=0}^{\alpha 4} \lambda_4\Delta(GDP)_{t-i} + \sum_{i=0}^{\alpha 5} \lambda_5\Delta(ED)_{t-i} + \omega ECM_{t-1} + \varepsilon_t}$$

DIAGNOSTIC AND STABILITY TESTS

A series of diagnostic and stability tests needs to be carried out to guarantee the accuracy, reliability and robustness of the estimated ARDL model. Such tests can be used to test the adequacy of a model specification and the integrity of model residuals. In particular, heteroscedasticity, serial correlation, and model stability tests are used to identify any possible misspecification or bias. Provided that the model has passed through these diagnostic checks, then the estimates can be considered statistically acceptable and can be used in further analysis.

RESULTS AND DISCUSSION

This section presents the empirical results derived from ARDL model, , unit root tests, bounds testing for cointegration. Diagnostic and stability tests are also performed to ensure the reliability and validity of the model.

6.1 Unit Root Tests

Augmented Dickey-Fuller and Phillips-Perron tests were applied to confirm the stationarity of all selected variables.

TABLE 2: UNIT ROOT TEST RESULTS (ADF AND PP TESTS)

Variable	ADF Level (Stat, p)	ADF 1st Diff. (Stat, p)	PP Level (Stat, p)	PP 1st Diff. (Stat, p)	Order
MCAP	-2.103 (0.217)	-6.781*** (0.000)	-2.024 (0.242)	-6.802*** (0.000)	I(1)
CO_2	-3.019* (0.053)	-6.931*** (0.000)	-2.959* (0.061)	-6.928*** (0.000)	I(1)
ER	-2.243 (0.198)	-6.842*** (0.000)	-2.178 (0.210)	-6.851*** (0.000)	I(1)
GDP	-4.412*** (0.004)	–	-4.286*** (0.006)	–	I(0)
ED	-7.362***	–	-7.425***	–	I(0)

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(0.000)	(0.000)

*Note: ***, *, and * indicate significance at the 1%, 5%, and 10% levels, respectively. No variable is integrated of order two, validating the use of the ARDL bounds testing approach.*

These results confirm that none of the variables are integrated of order I(2), which justifies the use of the ARDL bounds testing approach.

BOUNDS TEST FOR COINTEGRATION

ARDL bounds test was applied to examine the presence of a long-run equilibrium relationship among the variables.

TABLE 3: BOUNDS TEST RESULTS

Test Statistic	Value	I(0)	I(1)	Decision
F-Statistic	10.3089	3.17	4.21	Cointegration confirmed

The F-statistic exceeds the upper bound at the 1% level, indicating the existence of a stable long-run relationship between MCAP and all other selected variables.

LONG-RUN ARDL RESULTS

TABLE 4: LONG-RUN ARDL COEFFICIENTS

Variable	Coefficient	Std. Error	t-Statistic	p-Value
CO_2	-74.5181	13.5956	-5.4811	0.0001
ER	-0.1371	0.0615	-2.2297	0.0415
GDP	2.6206	0.8840	2.9646	0.0096
ED	-0.6189	0.1287	-4.8084	0.0002
C	100.3311	12.7902	7.8444	0.0000

The long-run ARDL results indicate that CO_2 emissions, exchange rate, GDP per capita growth, and external debt significantly determine Pakistan's financial market development (proxied by market capitalization). The coefficient for CO_2 emissions is –74.5181 ($p < 0.01$), suggesting that a one-unit increase in CO_2 emissions per capita leads to a 74.5 percentage point decrease in market capitalization as a percentage of GDP. This large negative effect implies that environmental degradation erodes investor confidence, increases regulatory and operational risks, and undermines workforce productivity. Similar results were found by Omri et al. (2015), who concluded that environmental degradation negatively affects financial development in emerging markets by reducing the attractiveness of investment projects and increasing long-term uncertainty.

The exchange rate coefficient is –0.1371 ($p < 0.05$), meaning that a 1% depreciation in the domestic currency against the U.S. dollar reduces market capitalization by 0.137 percentage points. This aligns with the theoretical framework of the portfolio balance model (Bhattacharyya and Deb, 2024) which suggests that exchange rate instability increases foreign investment risk and reduces cross-border capital flows, thereby shrinking financial markets. Similar evidence was reported by (Hina and Najeeb, 2022), who found that exchange rate volatility significantly depresses stock market development in emerging economies.

GDP per capita growth shows a positive and significant coefficient of 2.6206 ($p < 0.01$), implying that a 1% increase in economic growth increases market capitalization by approximately 2.62 percentage points. This supports the endogenous growth theory (Jones, 2019), which posits that sustained economic growth fosters capital accumulation, improves labor productivity, and stimulates demand for financial services. Empirically, (Işık et

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al.,2024) found a similar positive relationship between economic growth and financial market development across a panel of countries.

External debt has a negative coefficient of –0.6189 ($p < 0.01$), indicating that a 1% increase in the external debt-to-GDP ratio reduces market capitalization by 0.619 percentage points. This result reflects the debt overhang hypothesis (Sala and Trivin, 2024), which suggests that excessive debt burdens reduce investor confidence, crowd out productive investment, and increase the perceived sovereign risk premium. This finding is consistent with (Tung and Nguyen, 2024), who observed that high public debt levels constrain financial development in emerging economies.

The constant term (100.3311) indicates that in the absence of changes in the explanatory variables, Pakistan's financial market capitalization would be about 100% of GDP, reflecting the base structural capacity of the economy to support financial markets under stable conditions.

Environmental degradation (CO_2) acts as a primary constraint by directly lowering investor confidence and increasing costs for firms, which reduces market capitalization. Exchange rate depreciation amplifies this effect by discouraging foreign portfolio inflows and reducing liquidity in the financial market (Arzova and Şahin, 2024). Meanwhile, economic growth (GDP) counterbalances these negative forces by increasing investment demand and expanding market activity. However, excessive external debt limits this positive momentum by increasing sovereign risk and reducing fiscal space for productive investments. The net outcome for financial market development depends on whether GDP growth can outpace the combined negative impacts of environmental degradation, currency depreciation, and rising debt levels.

SHORT-RUN ECM RESULTS

TABLE 5: SHORT-RUN ARDL–ECM RESULTS

Variable	Coefficient	Std. Error	t-Statistic	p-Value
D(MCAP(-1))	0.2541	0.0925	2.7465	0.0150
D(MCAP(-3))	0.4736	0.0862	5.4970	0.0001
D(CO_2(-1))	77.1537	24.1059	3.2006	0.0060
D(ER)	0.1185	0.0531	2.2307	0.0414
D(ER(-1))	0.3162	0.0716	4.4192	0.0005
D(ER(-3))	0.4552	0.1419	3.2089	0.0059
D(GDP)	0.9785	0.3129	3.1269	0.0069
D(GDP(-1))	-0.8688	0.3204	-2.7119	0.0161
D(ED)	0.5264	0.1447	3.6389	0.0024
D(ED(-1))	0.9877	0.1874	5.2691	0.0001
D(ED(-3))	1.0376	0.1482	7.0037	0.0000
CointEq(-1)	**-1.2514**	**0.1340**	**-9.3387**	**0.0000**

Short-run ARDL–ECM results show that past values of MCAP, lagged CO_2 emissions, exchange rate, GDP growth, and external debt significantly affect Pakistan's financial market development. Positive coefficients for MCAP lags indicate market momentum, while lagged CO_2 suggests short-term industrial activity boosts market performance despite its long-run harm. Exchange rate movements and GDP growth have immediate positive effects, though GDP turns negative after one lag, reflecting adjustment pressures. External debt positively influences MCAP in the short run, likely due to temporary liquidity from borrowing. The negative and highly significant error correction term (–1.25) confirms rapid adjustment to long-run equilibrium, correcting over 100% of disequilibrium

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within a year. These findings highlight that short-term market gains often stem from temporary macroeconomic and environmental shocks, but sustained growth requires environmental control, macroeconomic stability, and prudent debt management.

DIAGNOSTIC AND STABILITY TESTS

TABLE 6: DIAGNOSTIC TESTS

Test	p-Value	Result
Breusch–Godfrey LM	0.610	No serial correlation
Breusch–Pagan–Godfrey	0.431	No heteroscedasticity
Ramsey RESET	0.216	Model correctly specified
Jarque–Bera	0.864	Residuals are normal
CUSUM & CUSUMSQ	Stable	Model stable

Diagnostic tests confirm that the ARDL model satisfies all key econometric assumptions. Breusch–Godfrey LM test yields a p-value of 0.610, indicating no evidence of serial correlation in the residuals. The Breusch–Pagan–Godfrey test has a p-value of 0.431, suggesting homoscedastic residuals and the absence of heteroscedasticity. The Ramsey RESET test (p = 0.216) confirms that the functional form of the model is correctly specified. The Jarque–Bera test (p = 0.864) shows that the residuals are normally distributed, meeting the normality assumption. Furthermore, the CUSUM and CUSUMSQ plots lie within the critical bounds, confirming the structural stability of the model over the sample period. Collectively, these results validate the reliability and robustness of the estimated model for both inference and policy analysis.

CONCLUSION AND POLICY RECOMMENDATIONS

This study examined the environmental and macroeconomic determinants of workforce-driven financial market development in Pakistan over the period 1980–2024 using the ARDL bounds testing approach. The results provide robust evidence that CO_2 emissions, exchange rate, GDP per capita growth, and external debt significantly influence market capitalization both in the short and long run, albeit with differing directions and magnitudes. Long-run estimates show that CO_2 emissions, exchange rate depreciation, and external debt exert significant negative effects on financial market development, whereas GDP growth exerts a positive influence. Short-run dynamics imply that market activity can be stimulated by temporary changes in emissions, currency flows, and debt inflows into the market, but these stimulating effects prove to be unsustainable and do not have a permanent duration. This extreme and adverse error correction term supports the fast approach to the long-term balance. The reliability and the robustness of the model are also supported by diagnostic and stability tests. These results demonstrate the necessity of considering economic growth alongside environmental sustainability and macroeconomic stability in realizing sustainability in the financial market.

By increasing environmental regulation and providing green finance incentives, policymakers could restrain CO 2 emissions without adversely affecting industrial productivity, and the introduction of environmental social and governance (ESG) standards into capital market frameworks could drive the flow of sustainable investment. Stable exchange rates with proper monetary and fiscal coordination and synchronization will eliminate fear with both domestic and foreign investors. Investments in innovative ideas, infrastructure, and human capital can promote long-term GDP growth, which will in turn provide a favorable environment to expand the capital market. Intelligent debt management policies are needed to ensure that external debt is maintained at a sustainable level, to avoid crowding effects that might trigger the flight of investors. By linking the

development of the skills related to need in the market, the operation of workforce to maximize its productivity will actually be able to keep human capital as an essential source of the growth of the performance of financial market. A sustainable and stable financial market in Pakistan will thus require policymakers to have an integrated approach to environmental issues, macroeconomic risks, and workforce capacity.

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