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Do Clean Energy and Financial Innovation Induce SME Performance? Clarifying the Nexus between Financial Innovation, Technological Innovation, Clean Energy, Environmental Degradation, and SMEs Performance in Bangladesh

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ABSTRACT

The economic contribution of small and medium enterprises (SMEs) has been well appreciated and documented in the literature. On the other hand, another domain of studies has concentrated on discovering the key determinants of SMEs' growth and survival. The motivation of the study is to gauge the nexus between financial innovation, technological innovation, clean energy, environmental degradation, and SME performance in Bangladesh for the period 1991-2019. The study has implemented Autoregressive Distributed Lagged (ARDL), Nonlinear ARDL, and the Toda-Yamamoto causality test. Referring to output derived with ARDL, a study has exposed a positive and statistically significant link between explanatory variables, that is, financial innovation, technological innovation, and clean energy consumption and SMEs' contribution to GDP both in the long-run and short-run. At the same time, environmental degradation has been revealed to be adversely connected to SME performance. The results of the standard Wald test have established an asymmetric association between explained and explanatory variables in the long-run and short run. In terms of the directional causality test, the study disclosed bidirectional causal effects running between clean energy and SMEs performance [CE←→SME], foreign direct investment, and SMEs performance [FDI←→SME]. Based on the study findings, the policy suggestions have been introduced in light of future development in SMEs in Bangladesh.

Keywords: Financial Innovation, Technological Innovation, Clean Energy, Environmental Degradation, SME
JEL Classifications: G29; O33; O13; L16

1. BACKGROUND OF THE STUDY

Forming small and medium-sized enterprises (SMEs) is commonly believed to be vital for attaining sustainable growth via industrialization. The contributions of SMEs to GDP growth and employment opportunities are generally recognized. Small and medium-sized enterprises (SMEs) are widely acknowledged to contribute to sustainable economic growth in both developed and developing countries. According to World Bank, small and medium-sized enterprises (SMEs) make up more than half of the world's workforce in 2022. SMEs are a major economic force in emerging nations, contributing 40% of GDP. 1 It is estimated that SMEs in several Asian countries are responsible for more than 90% of industrial output and employ 60% of the labor force (Shi and Qamruzzaman, 2022).

There is speculation that the fast expansion of Bangladesh's SMEs is the primary factor behind the country's improving economic situation. While crucial to the economy, this area has not yet reached its full potential because of limitations. According to some research, there seems to be a robust correlation between GDP expansion and SME production (Alauddin, 2015; Zamir and

Mujahid, 2022). The output of small and medium-sized enterprises increased by more than 100% after 1992, from BDT 67.56 billion in 1994 to BDT 94.33 billion in 2000 and then BDT 194.85 billion in 2005. It reached $200.40 billion (BDT) after another decade and $437.8 billion (USD) by 2020. (BDT). Small and medium-sized companies (SMEs') contribution to the nation's gross domestic product (GDP) has increased dramatically over the last two decades, from 2.55% in 1994 to 3.44% in 2015. It is anticipated to reach 3.74% by 2020.

Regarding SMEs' growth and contribution, many researchers have been engrossed in digging into the key macro fundamentals that could affect the SMEs' full potential utilization, eventually leading to sustainable economic growth. For example, in the case of SMEs contribution in Bangladesh, Wei and quamruzzaman investigated the effects of financial innovation on SMEs' performance by employing ARDL and exposed a beneficial connection between them. The study suggested that the financing constraints can be minimized with the adaptation of financial innovation. (Prasanna et al., 2019) Advocated technological challenges subdue SMEs' performance. Thus, the inclusion of technological innovation has an angular rule in SMEs performance alleviation. The study of (Rusu and Roman, 2016) revealed that domestic capital formation significantly influences SMEs' performance in the EU. Furthermore, the availability of skilled human resources expedited the overall SMEs growth, especially in the long run (Rusu and Roman, 2016; Moscarini and Postel-Vinay, 2012).

The present study has considered financial Innovation, renewable energy, environmental degradation, foreign direct investment, and gross capital formation in the quality of SME contribution to the aggregated economy. Adopting technology by small and medium-sized enterprises (SMEs) is becoming an increasingly hot topic in emerging nations. The field of technology adoption has produced ideas that have been widely used in a Western setting. There has been little implementation of several of these ideas in the setting of developing nations. The same holds for the private sector: Embracing technology is essential to its continued success (Pu et al., 2021). To obtain and retain a competitive edge and expand into new areas, businesses must constantly innovate their technologies (Qamruzzaman, 2020). Achieving economic autonomy requires countries to plan, manage change in the context of globalization, and concentrate on S&T intervention to boost economic activity inside the nation. The SME's contribution to industrial development is indispensable as a critical source of input suppliers in the economy. This suggests that finished, from SMEs to large corporations, actively foster industrial growth, leading to economic outperformance. Environmental consequences are directly attributed to economic sustainability due to excessive carbon emissions in the ecosystem. According to the literature, adverse environmental degradation has been well-documented with great concern, especially for the key macro fundamentals such as trade openness, economic growth, environmental protection cost, and industrial development. However, the effects of carbon emissions on small scaled enterprises have yet to explode critically in the literature. Considering the literature focusing on environmental degradation-led economic growth, it is anticipated that possible adverse effects might be explored, indicating that SMEs' performance has dwindled due to environmental degradation.

The contribution of the present study in extending the present literature is as follows. First, the nexus between financial Innovation and economic growth has been investigated in literature and exposed to the beneficial effects. It is suggested that expanding financial services and offering in the financial system allows the greater extension of economic activities, which positively uplifts economic sustainability through the contribution of other macro agents. Here noteworthy to mention that the empirical nexus between financial Innovation and SMEs contribution has yet to investigate extensively. In line with the existing research gap, the present study has investigated the financial innovation effects on SMEs under linear and nonlinear environments. Second, the present study has investigated the target nexus with the assumption of both symmetric and asymmetric framework, indicating that nonlinear assessment has offered more compelling findings through the assessment of positive and negative innovation in explanatory variables both in the long-run and short-run horizon.

The remaining structure of the study is as follows section II deals with the literaturature survey and hypothesis development following the targeted nexus. The data and methodology of the study have been explained in Section III. Section IV exhibits the empirical model estimation and interpretation. A discussion of the study findings is available in Section V. Finally, the conclusion and suggestions are reported in Section VI.

2. LITERATURE SURVEY AND HYPOTHESIS DEVELOPMENT OF THE STUDY

In terms of Innovation led to SMEs, existing literature has posited two strands of evidence. The first domain of literature has focused on the nexus between financial Innovation as a means of access to finance by SMEs and SMEs' contribution and survival. For the case of Nigeria, Effiom and Edet (2022) investigated the nexus of financial innovation-led SME performance, which is measured by SMEs' contribution to GDP by employing the ARDL bound testing approach. According to study findings, financial innovation in the financial system expands the financial depth and efficient financial intermediation, offering easy access to credit facilities in the long and short run. Financial Innovation, as defined by Henderson and Pearson (2011), entails the introduction of new financial instruments that seem safe to market participants but are susceptible to risks that might have been mitigated. Financial Innovation encourages and facilitates the creation of new products by financial institutions that capitalize on customers' lack of understanding of the underlying mechanisms of financial markets. According to Houston et al. (2010), financial innovation-induced arbitrage is weakened, cannot ensure the appropriate allocation of resources to facilitate development, and instead encourages financial instability. This position is supported by Brunnermeier and Pedersen (2008), who argue that the extraordinary increase in credit creation that resulted in the subprime mortgage crises in the United States was caused by financial Innovation. The crisis in the

subprime mortgage industry in the United States began when the number of loans being made rose sharply. As of 2007, this crisis has spread across the worldwide financial system.

The second vine of studies focusing on technological innovation effects on SMEs documented a positive linkage that IT fosters the survival and growth of SMEs in the economy (Inyang and Enuoh, 2009; Anis and Kassim, 2016; Oyeku et al., 2014). Instance, in the stud of Rahman et al. (2016) has exposed the beneficial role of technological Innovation in the process of SMEs survivals. The study postulated that TI amplifies the SME's survival instinct through operational efficiency and optimization of economic resources. Furthermore, SMEs with the TI adoption offer competitive market advantages and ensure sustainability in their financial performance. Additionally, technological advancements were cited as a means to encourage Innovation in the workplace. Varis and Littunen (2010) studies identify four main types of Innovation: product, process, market, and organization. Each relies significantly on technical resources, whether online groups, free access to information, or certain equipment. Constant Innovation is essential to any firm's growth, prosperity, and existence, and the author agreed with this assessment. Research into the issue of small and medium-sized enterprises (SME) survival is uncommon, although it has been explored sometimes. For emerging economies, (Hanadi and Aruna, 2013; Mia et al., 2014) exploded the availability and inclusion of technological Innovation in the economy, offering incubation facilities for SMEs, especially in designing and transferring their production possibilities in the economic progress. The study further advocated that technology-based SMEs augment operational contribution through new technology and benefits of R&D investment by the government.

Due to the rapidity and magnitude of environmental damage caused by economic activity, corporations, governments, and civil society have begun to react responsibly. Consequently, companies in all regions of the globe are implementing sustainable practices and publishing their outcomes. The great majority of these operations, however, occur inside the borders of the firms themselves. Large companies shirk their environmental duties when outsourcing manufacturing and service to smaller and medium-sized businesses. Most developing nations have inadequate environmental regulations and lax enforcement, enabling small and medium-sized enterprises (SMEs) to improve their environmental practices independently. However, they generally lack the financial and organizational resources to implement sustainability-promoting measures.

FDI contributes significantly to the integration of economies throughout the globe. Foreign direct investment (FDI) creates direct and durable linkages between economies. It enables the host nation to promote its products on international markets and encourages the global dissemination of breakthrough technology and information. Foreign direct investment (FDI) is an alternative funding source for projects. A regulatory environment conducive to their development may be a key factor in expanding small and medium-sized businesses (SMEs). Increasing a nation's inflow of foreign direct investment (FDI) may offer several advantages. Foreign direct investment (FDI) may influence various economic factors, including but not limited to labor and capital markets, trade patterns, and GDP growth. The study of Tülüce and Doğan (2014) revealed the positive effects of FDI on SMEs' success in the channel of technological transfer and operational efficiency, which is documented especially for SMEs' targeted inflows of FDI.

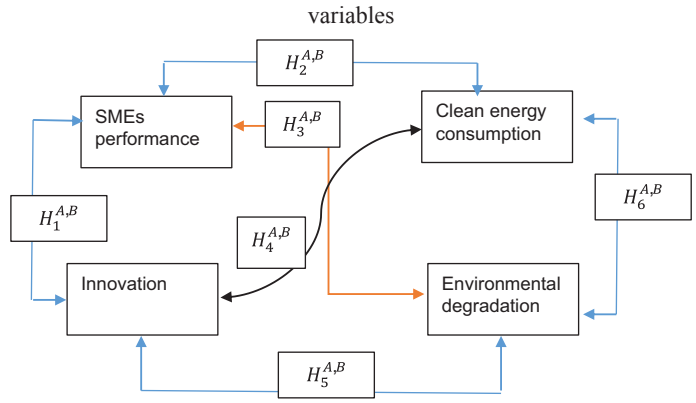
According to neoclassical economic theory, the inflows of FDI have the domestic firm's capacity in terms of technical acceptability and business process efficiency with advanced know-how amply. Additionally, Economic theory suggests that FDI, or foreign direct investment, may benefit businesses in the nation that receives it. Multinational companies (MNCs) are a major contributor to foreign currency and technology; consequently, their entry into a market may enable the transfer of technical and commercial know-how, boosting the productivity and competitiveness of certain small and medium-sized enterprises (SMEs). Knowledge transfer occurs when successful methods are shared with other businesses, when relationships are forged between domestic and international companies that lead to the latter two groups acting as suppliers or customers, and when skilled workers move from international companies to domestic companies. An increase in rivalry is possible with the emergence of foreign corporations, which might encourage domestic firms to follow suit (Aldaba et al., 2010; Aldaba, 2010).

2.1. Conceptual Model and Proposed Hypothesis of the Study

As a determinant of SME performance, a growing number of studies have implemented empirical nexus with the consideration of macro fundamentals and found several factors have positive and few variables revealed adversely associated. However, the underlying motivation of the study is to gauge the impact of Innovation, clean energy, and environmental degradation on SMEs' performance with the application of symmetric and asymmetric frameworks. Furthermore, the following causal association between explained and explanatory variables will be investigated through the non-granger causality test familiarized by Toda and Yamamoto (1995) and the framework displayed in Figure 1. The study proposed the following hypothesis:

$H_1^{A,B}$: Innovation granges cause SMEs' Performance and Vice-versa

Figure 1: Proposed hypothesis between explained and explanatory variables



$H_2^{A,B}$: Clean energy consumption granges causes SMEs' Performance and Vice-versa

$H_3^{A,B}$: Innovation positively granges causes SMEs' Performance and Vice-versa

$H_4^{A,B}$: Environmental Degradation granges cause SMEs' Performance and Vice-versa

$H_5^{A,B}$: Environmental Degradation granges cause Innovation and Vice-versa

$H_6^{A,B}$: Environmental Degradation granges cause Clean Energy Consumption and Vice-versa.

3. DATA AND METHODOLOGY

3.1. Variables of the Study

The present study utilized annual time series data for the period 1991-2019, and all the relevant data has been extracted from publically published sources, including the annual report published by Bangladesh Bank, the Statistical Year Book published by BBS, the Bangladesh economic review published by the Ministry of Commerce, World development indicator (WDI) published by World bank, respectively. The measures of explained and explanatory variables and their data sources are displayed in Table 1.

3.2. Model Specification

The purpose of the study is to scrutinize the effects of financial Innovation, Technological Innovation, clean energy, environmental degradation, and FDI on SMEs' contribution to GDP in Bangladesh for the period 1990-2020. Taking into account the explained and explanatory variables, the generalized empirical equation is as follows:

$$Y_{SME} = \int FI, TI, CE, ED, GCF, \& FDI \quad (1)$$

Above equation (1) further reproduce the following regression equation in documenting the magnfititutes of explanatory variables.

$$Y_{SME,t} = \alpha_0 + \beta_1 FI_t + \beta_2 TI_t + \beta_3 CE_t + \beta_4 ED_t + \beta_5 FDI_t + \epsilon_t \quad (2)$$

Where FI, TI, CE, ED, and FDI stand for Financial Innovation, Technological Innovation, clean energy, environmental degradation, and foreign direct investment, respectively. The coefficients of $\beta_1 \beta_5$ explain the magnitudes of explanatory and control variables' effects on SMEs' performance in Bangladesh.

3.3. Estimation Strategy

3.3.1. Unit root test

Variables order of integration has placed an apes importance in targeting the appropriate estimation. On the ground, we have implemented test for unit root test following the framework offered by Dickey and Fuller (1979), Phillips and Perron (1988), and Elliott et al. (1996) with the null hypothesis of "non-stationary: And Kwiatkowski et al. (1992) with the null of stationery. The study performed the Ng-Perron unit root test Ng and Perron (2001).

3.3.2. Bayer-Hacked combined and Maki cointegration test

For long-run assessment, the present study implemented the novel combined cointegration test, familiarized by Bayer and Hanck (2013), with the null hypothesis of a no-cointegration test, the following Fishers' equation is considered in deriving the test statistics for detecting long-run association.

$$EG - JOH = -2[LN(PEG) + LN(PJOH)]$$

$$EG - JOH - BO - BD = -2[LN(PEG) - \ln(PJPH) + \ln(PBO) + \ln(PBDM)]$$

Furthermore, the Maki (2012) cointegration test has deployed with an unknown structural break, and the test statistics for long-run assessment has tested by executing the following equation.

3.3.3. Autoregressive Distributed Lagged (ARDL)

The ARDL approach has grown in popularity among empirical researchers studying long-term connections since then (Qamruzzaman and Jianguo, 2020; Qamruzzaman and Jianguo, 2018; Karim et al., 2022; Pu et al., 2021; Yang et al., 2021; Nawaz et al., 2021). One advantage of ARDL estimation over standard cointegration testing is that it produces a consistent estimate regardless of sample size (Ghatak and Siddiki, 2001). (2) Capable of handling mixed-order variable integration with delayed requirements for improved model stability and efficiency (Pesaran et al., 2001). Finally, long-term and short-term elasticity tests should be conducted objectively based on Banerjee et al. (1993). Following Pesaran et al. (2001), the generalized ADRL model for the study was considered for detecting both long-run and short-run coefficients by performing the following equation. The

Table 1: Variables proxies and sources

Variables	Notation	Measures	Units	Data sources
SMEs growth	SME	SMEs' contribution to GDP	Percentage	BB annual reports, statistical yearbook-BBS; BER-MoC
Financial innovation	FI	SMEs financing as a percentage of total credit		
Technological innovation	TI	No patent application from residential residence	No	
Clean energy	CE	Renewable energy consumption as a percentage of total energy	Percentage	WDI
Environmental degradation	ED	Carbon emission	Ket	WDI
Foreign direct investment	FDI	Net inflows of FDI percentage of GDP	Percentage	WDI
Gross capital formation	GCF	Gross capital formation as a percentage of GDP	Percentage	WDI

SMEs: Small and medium-sized enterprises, GDP: Gross domestic product, FDI: Foreign direct investment, WDI: World development indicator, FI: Financial innovation, TI: Technological innovation, CE: Clean energy, ED: Environmental degradation

details Null and alternative hypothesis for long-run cointegration displayed in Table 2.

Where Innovation measured by Financial Innovation (FI)

$$\begin{aligned}\Delta lnSME_t &= \alpha_0 + \sum_{i=1}^{n}\mu_1 \Delta lnSME_{t-i} + \sum_{i=0}^{n}\mu_2 \Delta lnFI_{t-i} + \sum_{i=0}^{n}\mu_3 \Delta lnCE_{t-i} \\ &+ \sum_{i=0}^{n}\mu_4 \Delta lnED_t + \sum_{i=0}^{n}\mu_5 \Delta lnFDI_{t-i} + \sum_{i=0}^{n}\mu_6 \Delta lnGCF_{t-i} \\ &+ \gamma_1 lnSME_{t-i} + \gamma_2 lnFI_{t-1} + \gamma_3 lnCE_{t-1} + \gamma_4 lnED_{t-1} \\ &+ \gamma_5 lnFDI_{t-1} + \gamma_5 lnGCF_{t-1} + \omega_{1t}\end{aligned} \tag{3}$$

Where Innovation measured by technological Innovation (TI)

$$\begin{aligned}\Delta lnSME_t &= \alpha_0 + \sum_{i=1}^{n}\mu_1 \Delta lnSME_{t-i} + \sum_{i=0}^{n}\mu_2 \Delta lnTI_{t-i} + \sum_{i=0}^{n}\mu_3 \Delta lnCE_{t-i} \\ &+ \sum_{i=0}^{n}\mu_4 \Delta lnED_t + \sum_{i=0}^{n}\mu_5 \Delta lnFDI_{t-i} + \sum_{i=0}^{n}\mu_6 \Delta lnGCF_{t-i} \\ &+ \gamma_1 lnSME_{t-i} + \gamma_2 lnTI_{t-1} + \gamma_3 lnCE_{t-1} + \gamma_4 lnED_{t-1} \\ &+ \gamma_5 lnFDI_{t-1} + \gamma_5 lnGCF_{t-1} + \omega_{1t}\end{aligned} \tag{4}$$

Where Innovation measured by Financial Innovation and Technological Innovation

$$\begin{aligned}\Delta lnSME_t &= \alpha_0 + \sum_{i=1}^{n}\mu_1 \Delta lnSME_{t-i} + \sum_{i=0}^{n}\mu_2 \Delta lnFI_{t-i} + \sum_{i=0}^{n}\mu_3 \Delta lnTI_{t-i} \\ &+ \sum_{i=0}^{n}\mu_4 \Delta lnCE_{t-i} + \sum_{i=0}^{n}\mu_5 \Delta lnED_t + \sum_{i=0}^{n}\mu_6 \Delta lnFDI_{t-i} \\ &+ \sum_{i=0}^{n}\mu_7 \Delta lnGCF_{t-i} + \gamma_1 lnSME_{t-i} + \gamma_2 lnFI_{t-1} \\ &+ \gamma_3 lnTI_{t-1} + \gamma_4 lnCE_{t-1} + \gamma_5 lnED_{t-1} + \gamma_6 lnFDI_{t-1} \\ &+ \gamma_7 lnGCF_{t-1} + \omega_{1t}\end{aligned} \tag{5}$$

The study implemented the following equation with error correction terms to capture the short-run dynamics.

$$\begin{aligned}\Delta lnSME_t &= \alpha_0 + \sum_{i=1}^{n}\mu_1 \Delta lnSME_{t-i} + \sum_{i=0}^{n}\mu_2 \Delta lnFI_{t-i} + \sum_{i=0}^{n}\mu_3 \Delta lnTI_{t-i} \\ &+ \sum_{i=0}^{n}\mu_4 \Delta lnCE_{t-i} + \sum_{i=0}^{n}\mu_5 \Delta lnED_t + \sum_{i=0}^{n}\mu_6 \Delta lnFDI_{t-i} \\ &+ \sum_{i=0}^{n}\mu_7 \Delta lnGCF_{t-i} + \rho ECT_{t-1} + \omega_{1t}\end{aligned} \tag{6}$$

We used several approaches to narrow down the potential diagnoses. The Harvey test was first used to determine whether the residuals from the refined ARDL model were heteroscedastic. Following this, we used the Breusch-Godfrey Serial Correlation LM test to look for serial correlation in the residuals. We then used the Ramsey RESET test to ensure our model parameters were correct. The Jarque-Bera normality test was then used to check whether the model residuals were normally distributed. In conclusion, the CUSUM and CUSUM of squares tests were used to demonstrate the stability of the model.

3.3.4. Nonlinear ARDL (NARDL)

The following nonlinear equation to be implemented for exploring the asymmetric elasticities of government debt, globalization, foreign direct investment, and financial development on institutional quality which is derived by following the asymmetric framework introduced by Shin et al. (2014); (Md, 2021).

$$\begin{aligned}SME_t &= (\pi^+ FI_{1,t}^+ + \pi^- FI_{1,t}^-) + (\beta^+ CE_{1,t}^+ + \beta^- CE_{1,t}^-) \\ &+ (\gamma^+ ED_{1,t}^+ + \gamma^- ED_{1,t}^-) + \varepsilon_t\end{aligned} \tag{7}$$

$$\begin{aligned}SME_t &= (\pi^+ TI_{1,t}^+ + \pi^- TI_{1,t}^-) + (\beta^+ CE_{1,t}^+ + \beta^- CE_{1,t}^-) + \\ &(\gamma^+ ED_{1,t}^+ + \gamma^- ED_{1,t}^-) + \varepsilon_t\end{aligned} \tag{8}$$

$$\begin{aligned}SME_t &= (\pi^+ FI_{1,t}^+ + \pi^- FI_{1,t}^-) + (\rho^+ TI_{1,t}^+ + \rho^- TI_{1,t}^-) \\ &+ (\beta^+ CE_{1,t}^+ + \beta^- CE_{1,t}^-) + (\gamma^+ ED_{1,t}^+ + \gamma^- ED_{1,t}^-) + \varepsilon_t\end{aligned} \tag{9}$$

Where $\pi^+, \pi^-, \beta^+, \beta^-\ \rho^+, \rho^-\ and\ \gamma^+, \gamma^-$ Stands for the long-run asymmetric coefficient of Financial Innovation, Technological Innovation, Clean Energy Consumption, and Environmental Degradation. The asymmetric shock of Financial Innovation (FI^+; FI^-), Technological Innovation (TI^+; TI^-), Clean Energy (CE^+; CE^-), and Environmental Degradation (ED^+; ED^-) can be derived from the following manner.

$$\begin{cases} POS(FI)_{1,t} = \sum_{k=1}^{t} lnFI_k^+ = \sum_{K=1}^{T} MAX(\Delta lnFI_k, 0) \\ NEG(FI)_t = \sum_{k=1}^{t} lnFI_k^- = \sum_{K=1}^{T} MIN(\Delta lnFI_k, 0) \\ POS(TI)_{1,t} = \sum_{k=1}^{t} lnTI_k^+ = \sum_{K=1}^{T} MAX(\Delta lnTI_k, 0) \\ NEG(TI)_t = \sum_{k=1}^{t} lnTI_k^- = \sum_{K=1}^{T} MIN(\Delta lnTI_k, 0) \end{cases}$$

$$\begin{aligned} POS(CE)_{1,t} &= \sum_{k=1}^{t} lnCE_k^+ = \sum_{K=1}^{T} MAX(\Delta lnCE_k, 0) \\ NEG(CE)_t &= \sum_{k=1}^{t} lnCE_k^- = \sum_{K=1}^{T} MIN(\Delta lnCE_k, 0) \end{aligned}$$

$$\begin{aligned} POS(ED)_{1,t} &= \sum_{k=1}^{t} lnED_k^+ = \sum_{K=1}^{T} MAX(\Delta lnED_k, 0) \\ NEG(ED)_t &= \sum_{k=1}^{t} lnEI_k^- = \sum_{K=1}^{T} MIN(\Delta lnED_k, 0) \end{aligned}$$

The following equation documents the asymmetric coefficients in the long-and short-run assessments.

$$\Delta SME_t = \partial U_{t-1} + (\pi^+ FI^+_{1,t-1} + \pi^- FI^-_{1,t-1}) + (\beta^+ TI^+_{1,t-1} + \beta^- TI^-_{1,t-1})$$
$$+(\gamma^+ CE^+_{1,t-1} + \gamma^- CE^-_{1,t-1}) + (\gamma^+ ED^+_{1,t-1} + \gamma^- ED^-_{1,t-1}) + \sum_{j=1}^{m-1} \lambda_j \Delta SME_{t-j0}$$
$$+\sum_{j=1}^{n-1}(\pi^+ \Delta FI^+_{1,t-1} + \pi^- \Delta FI^-_{1,t-1}) + \sum_{j=1}^{n-1}(\mu^+ \Delta TI^+_{1,t-1} + \mu^- \Delta TI^-_{1,t-1})$$
$$++\sum_{j=0}^{m-1}(\beta^+ \Delta CE^+_{1,t-1} + \beta^- \Delta CE^-_{1,t-1})$$
$$+\sum_{j=0}^{m-1}(\beta^+ \Delta ED^+_{1,t-1} + \beta^- \Delta ED^-_{1,t-1}) + \varepsilon_t \quad (10)$$

The error correction term of the above equation is as follows

$$\Delta \mathrm{SME}_t = \partial e_{t-1} + \sum_{j=1}^{m-1} \lambda_j \Delta SME_{t-j0} + \sum_{j=1}^{n-1}(\pi^+ \Delta FI^+_{1,t-1} + \pi^- \Delta FI^-_{1,t-1})$$
$$+\sum_{j=1}^{n-1}(\mu^+ \Delta TI^+_{1,t-1} + \mu^- \Delta TI^-_{1,t-1}) + +\sum_{j=0}^{m-1}(\beta^+ \Delta CE^+_{1,t-1} + \beta^- \Delta CE^-_{1,t-1})$$
$$+\sum_{j=0}^{m-1}(\beta^+ \Delta ED^+_{1,t-1} + \beta^- \Delta ED^-_{1,t-1}) + \varepsilon_t + \varepsilon_t \quad (11)$$

3.3.5. Toda-yamamoto causality test

Following the non-granger framework offered by Toda and Yamamoto (1995), the study has implemented the following causal equation in documenting the directional association between SMEs performance, Financial Innovation, Technological Innovation, Clean Energy and Environmental Degradation, FDI, and Gross Capital Formation. The following equation is to be executed for a causal association.

$$SME_t = \alpha_0 + \sum_{i=1}^{k} \beta_{1i} SME_{t-i} + \sum_{j=k+1}^{d_{max}} \beta_{2j} SME_{t-j} + \sum_{i=1}^{k} \gamma_{1i} FI_{t-i}$$
$$+\sum_{j=k+1}^{d_{max}} \gamma_{1j} FI_{t-j} + \sum_{i=1}^{k} \pi_{1i} TI_{t-i} + \sum_{j=k+1}^{d_{max}} \pi_{1j} TI_{t-j} + \sum_{i=1}^{k} \tau_{1i} CE_{t-i}$$
$$+\sum_{j=k+1}^{d_{max}} \tau_{1j} CE_{t-j} + \sum_{i=1}^{k} \varphi_{1i} ED_{t-i} + \sum_{j=k+1}^{d_{max}} \varphi_{1j} ED_{t-j} + \sum_{i=1}^{k} \delta_{1i} FDI_{t-i}$$
$$+\sum_{j=k+1}^{d_{max}} \delta_{2j} FDI_{t-j} + \sum_{i=1}^{k} \theta_{1i} GCF_{t-i} + \sum_{j=k+1}^{d_{max}} \theta_{2j} GCF_{t-j} + \varepsilon_{1t} \quad (12)$$

4. ESTIMATION AND INTERPRETATION

4.1. Unit Root Test

The study implemented a static test for assessing the variables' order of integration with the null hypothesis of a unit root. Referring to the test statistics, all the variables have exposed stationary after the first difference; see the results displayed in Table 3.

4.2. Bayer-hancked and Maki Cointegration

For documenting the long-run cointegration between Innovation, environmental degradation, clean energy, and SME development, the study implemented the long-run cointegration framework following Bayer and Hanck (2013) and Maki (2012). The results of the cointegration test are displayed in the Table 4. In terms of the test statistics, it is apparent that all the test statistics are statistically significant at a 5% level, suggesting the long-run association between explained and explanatory variables in the empirical nexus.

4.3. Symmetric and Asymmetric Cointegration Assessment

Next, the study has implemented a bound testing approach that includes symmetric and asymmetric shocks of explanatory variables in assessing the cointegration under the framework of symmetric and asymmetric. Table 4 reports the results of the cointegration test. The study exposed the long-run association between Innovation, environmental degradation, clean energy, and SME development which is valid in symmetric and asymmetric frameworks.

4.4. Long-run and Short-run Coefficients Under the Symmetric Framework

Once the long-run association has been revealed, we proceed to document the elasticity of financial Innovation, Technological Innovation, clean energy, and environmental degradation on SMEs' contribution both in the long-run and short-run horizon. The results of long-run and short-run coefficients are displayed in Table 5, including column [1], Innovation measured in terms of financial Innovation; column [2], considered technological Innovation; and column [3], both financial and technological Innovation, incorporated into the equation. It is noted that for discussion, we considered the output displayed in column [3].

In terms of the association between financial Innovation and SMEs contribution, the study revealed a positive and statistically significant linkage between them, which is valid for the long-run and short-run assessment. Especially, a 10% progress in financial Innovation, that is, mitigation of financing constraints of SMEs, will increase SMEs' contribution by 1.036% in the long run and by 0.601% in the short run. Study findings suggest that innovative financing expands the credit facilities in the economy, which eternally increases the possibilities for capitalization and optimization of SME growth potential, especially in the long run.

The coefficients of technological Innovation, see col [3], revealed positive and statistically significant in the long run (coefficients of 0.1036) and short-run (a coefficient of 0.029). Study findings suggest the contributory effects of technological Innovation on

Table 2: The null hypotheses for all three tests are defined as follows

Cointegration test	Null hypothesis	Alternative hypothesis
F-bound test	$\gamma_1=\gamma_2=\gamma_3=\gamma_4=\gamma_5=\gamma_6=0$	Any, $\gamma_1,\gamma_2,\gamma_3,\gamma_4,\gamma_5,\gamma_6\neq0$
A *t*-test on lagged dependent variable	$\gamma_1=0$	$\gamma_1\neq0$
F-test on the lagged independent variable	$\gamma_2=\gamma_3=\gamma_4=\gamma_5=\gamma_6=0$	Any, $\gamma_2,\gamma_3,\gamma_4,\gamma_5,\gamma_6\neq0$

Table 3: Results of unit root test

Variables	At level				After first difference			
	ADF	GF-DLS	PP	KPSS	ADF	GF-DLS	PP	KPSS
SME	−1.6438	−1.2999	−0.2941	0.8829***	−5.8615***	−5.5146***	−5.5482***	0.0185
FI	−1.7233	−2.0781	−2.0201	0.6664***	−6.3119***	−6.5524***	−8.3204***	0.0194
TI	−0.8437	−2.155	−1.1474	0.7993***	−8.3328***	−5.7565***	−6.8071***	0.0193
ED	−1.9773	−0.4397	−2.3332	0.7944***	−8.4442***	−9.2586***	−5.5424***	0.0205
CE	−0.8634	−0.4328	−0.403	0.6777***	−8.3005***	−5.5932***	−6.1503***	0.0204
GCF	−1.4043	−2.532	−1.3318	0.8007***	−6.3402***	−6.404***	−8.4314***	0.019
FDI	−2.0732	−0.924	−2.0478	0.738***	−6.4381***	−8.1979***	−8.326***	0.021
Panel-B: Ng-Perron unit root test								
Variables	**At level**				**At first difference**			
	MZa	MZt	MSB	MPT	MZa	MZt	MSB	MPT
SME	−2.4887	−1.4115	0.2532	7.6006	−22.112	−5.2208	0.1328	4.9132
FI	−2.5816	−0.9489	0.3088	8.3035	−19.86	−4.4656	0.1327	4.5584
TI	−2.4697	−1.628	0.3613	8.1053	−24.211	−4.516	0.1257	3.8684
ED	−2.739	−1.3386	0.3197	8.8866	−18.043	−4.3746	0.132	4.4242
CE	−2.1586	−1.3299	0.3384	9.0128	−19.367	−5.1032	0.1727	5.0178
GCF	−1.73	−1.5658	0.2664	7.494	−24.28	−5.4415	0.1474	4.9605
FDI	−2.1891	−1.4252	0.3146	8.4417	−24.912	−4.9135	0.1783	4.453

SME: Small and medium-sized enterprise, FDI: Foreign direct investment, FI: Financial innovation, TI: Technological innovation, CE: Clean energy, ED: Environmental degradation, The superscript *** denotes the significance at a 1% level.

Table 4: Results of the combined cointegration test

Panel-A: Bayer-Hancked cointegration test					
Model	**1**	**2**	**3**	**4**	**5**
EG-JOH	14.97	11.149	11.264	10.898	10.608
Critical values @ 5%	11.229	10.895	10.637	10.576	10.419
EG-JOH-BO-BDM	26.854	28.366	24.455	21.358	20.951
Critical values @ 5%	21.931	21.106	20.486	20.143	19.888

Panel-B: Maki cointegration test			
Number of breaks points Tb <5	**Test statistics**	**Critical values @ 5%**	**Break points**
0	−8.586	−6.306	2017, 1994, 1998, 2004, 2014
1	−7.2754	−6.494	2018, 2011, 2017, 2009, 2007
2	−7.6777	−8.869	1995, 1998, 2011, 1990, 2019
3	−7.3004	−9.482	1999, 1988, 2015, 1991, 2010

Table 5: Results of long-run cointegration: Symmetric and asymmetric framework

Approach	$F_{overall}$	t_{DV}	F_{IDV}
ARDL	8.19***	−7.137***	7.589***
NARDL	7.247***	−5.611***	7.513***

Note: the superscript *** denotes the level of significance at a1% level; ARDL: Autoregressive distributed lagged, NARDL: Nonlinear ARDL

SMEs' preformation amplification. In particular, a 10% positive IT change will increase SMEs' performance in the long run by 1.036% and the short run by 0.29%, respectively.

As stated by the documented coefficient of clean energy, there is a positive and statistically significant linkage to SMEs' performance, indicating that the inclusion of clean energy in the production process increases the SMEs' cost-effectiveness. More precisely, a 10% development in clean energy inclusion in the economy fosters SMEs' contribution in the long run by 1.425% and 0.517% in the short run. Literature has revealed that conventional energy used in the operational process incurred additional costs for the firm and dwindled the potential contribution. Regarding cost efficiency, clean energy inclusion should be promoted in economic activities specially targeted in SME development.

Environmental degradation revealed a negative association with SMEs performance, implying negative and statistically significant magnitudes in the long run (a coefficient of –0.1411) and short run (a coefficient of –0.0126). Study findings suggest that environmental quality benefits SMEs' progress and that controlled carbon emission will strengthen performances in the long run by 1.411% and in the short run by 0.126%, respectively.

Regarding how to control variables influence SMEs performance, the study documented positive assistance from foreign direct investment and gross capital formation both in the long-run and short-run assessment. In the long run, a 10% change in FDI and gross capital formation will change the SME's performance by 0.415% and 0.926%, respectively. While the short-run effects of FDI and GCF can be observed on SMEs by 0.991% and 0.235% with 10% changes. The study advocated the critical role of FID and domestic capital adequacy for SMEs' performance, suggesting that capital assistance for SMEs in the economy will generate a greater scope for economic resources estimation and efficient reallocation.

The coefficients of error correction term revealed negative and statistically significant in all three models, which explains the speed of disequilibrium adjustment towards long-run. In terms of ECT elasticity, the state of disequilibrium is to be corrected

with 3.32 years at a speed of 34.41%. Regarding empirical model robustness and internal consistency, the study has passed several residual diagnostic tests, namely autocorrelation, heteroskadacity, normality, and the Ramsey test. The study disclosed that all the test statistics had been found statistically insignificant, suggesting that the empirical nexus has consistency and efficiency in explaining the targeted relationship (Ma and Qamruzzaman, 2022).

4.5. Nonlinear Assessment

The study implemented a standard Wald test in assessing the presence of an asymmetric association between explanatory variables and explained variables with a null hypothesis of symmetry in the long and short run. The results of the symmetry test are displayed in Panel –C see Table 6, following the test statistics, it is apparent that the null hypothesis has been rejected; alternatively disclosed, the asymmetric tie is valid both in the long and short run. Furthermore, the study passes several residual diagnostic tests to ascertain the empirical nexus consistency and efficiency in estimation. The results of the residual diagnostic test are displayed in Panel –D. Referring to the test statistics, it is unveiled that the econometric model is free from autocorrelation, the residuals are normally distributed, and there is no heteroskadacity and internal consistency. Additionally, the CUSUM and CUSUM of square test exposed the robustness of our estimation.

Referring to the asymmetric coefficients of financial Innovation reported in column [3], the study disclosed a positive and statistical linkage with SME contribution in the long run (coefficients of $FI^{+} = 0.1886; FI^{-} = 0.0769$) and short-run (coefficients of $FI^{+} = 0.0999; FI^{-} = 0.0332$). More precisely, a 10% positive (negative) change in financial Innovation can amplify (demises) the SME's contribution to the economy by 1.886% (0.769%) in the long run and 0.999% (0.332%) in the short run (Table 7). The study advocated the adoption and diffusion of innovative financial products and services in the financial system, progressively contributing to SMEs' contribution by eliminating the financial limitation and allowing their expansion of production possibilities. The asymmetric shocks of technological Innovation have exposed positive and statistically significant in the long-run and short-run estimations, indicating the contributory role of technological advancement in the process of SMEs' progress in the economy. In terms of long-run (short-run) asymmetric elasticity, the study suggested a 10% positive change in technological Innovation might augment the SME's performance by 1.544% (0.64%). At the same time, negative technological innovation shocks could decrease the SME's contribution to the economy by 0.731% (0.335%) respectively. The study postulated that TI expands the scope for capacity enlargement through advanced technological integration by allowing economic resource optimization and efficient reallocation. Clean energy, precisely renewable energy consumption, has positively connected to SMEs' performance which is valid for both positive and negative shocks. Study findings advocate that expanding renewable energy sources in the economy offers energy security and energy cost efficiency in the industrial output. In particular, a 10% innovation in clean energy will increase SMEs' performance by 0.831% in the long run and 0.395% in the short run. In terms of adverse shock in clean energy consumption, the study detailed the contraction effects on SMEs performance; precisely a 10% reduction in clean energy will result in SMEs performance degradation in the long run by 0.527% and a short run by 0.741%, respectively. The study findings revealed that the asymmetric coefficients of environmental degradation are negatively connected with the explained variables in the long and short run, suggesting that environmental quality benefits SMEs' progress. More precisely, a 10% asymmetric carbon emission shock will result in the acceleration (diminution) of SMEs' contribution to the national economy by 1.885% (1.178%). Additionally, the short-run elasticities have exposed a similar line of connection.

Table 6: Results of long-run and short-run coefficient: A Autoregressive distributed lagged estimation

	[1]	[2]	[3]
Panel-A: Long-run coefficients			
FI	0.1821 (0.0066) [27.5909]		0.1036 (0.0054) [19.1851]
TI		0.1218 (0.0088) [13.8409]	0.1652 (0.0118) [14.011]
ED	−0.1722 (0.0063) [−27.3333]	−0.1129 (0.0094) [−12.0106]	−0.1411 (0.0067) [−21.0597]
CE	0.0558 (0.011) [5.0727]	0.0719 (0.0086) [8.3604]	0.1425 (0.011) [12.9545]
FDI	0.1344 (0.0108) [12.4444]	0.151 (0.0211) [7.5549]	0.0415 (0.0059) [7.0338]
GCF	0.0594 (0.0034) [−17.4705]	0.1721 (0.0071) [−24.2394]	0.0926 (0.0066) [14.0303]
C	3.1206 (0.533) [5.8546]	3.5987 (0.4512) [7.9758]	2.734 (0.4512) [6.0593]
Panel-B: Short-run coefficients			
FI	0.0375 (0.0039) [9.6153]		0.0601 (0.0101) [5.9504]
TI		0.084 (0.0066) [12.7272]	0.029 (0.0087) [3.3333]
ED	−0.0744 (0.0061) [−12.1967]	−0.0139 (0.0022) [−6.3181]	−0.0126 (0.0112) [−1.125]
CE	0.0663 (0.0027) [24.5555]	0.0925 (0.006) [15.4166]	0.0517 (0.0056) [9.2321]
FDI	0.0692 (0.0083) [8.3373]	0.0736 (0.0117) [6.2905]	0.0991 (0.0069) [14.3623]
GCF	0.0192 (0.0025) [7.68]	0.025 (0.0089) [2.8089]	0.0235 (0.0064) [3.6718]
ECT (−1)	−0.3504 (0.0026) [−134.7984]	−0.2834 (0.0553) [−5.1247]	−0.3441 (0.0751) [−4.582]
Panel-C: Results of residual diagnostic tests			
Serial correlation	0.593	0.633	0.62
Normality test	0.637	0.781	0.829
ARCH test	0.85	0.732	0.598
Ramsey RESET test	0.549	0.858	0.659

That values in () and [] denote a *t*-statistic and SE. FDI: Foreign direct investment, FI: Financial innovation, TI: Technological innovation, CE: Clean energy, SE: Standard error, ED: Environmental degradation

Table 7: Results of long-run and short-run asymmetric coefficients

	[4]	[5]	[6]
Panel-A: Asymmetric long-run coefficients			
FI^+	0.1658 (0.0891) [1.8599]		0.1886 (0.0384) [4.9075]
FI^-	0.0551 (0.0265) [2.0728]		0.0769 (0.0467) [1.6468]
TI^+		0.1658 (0.0891) [1.8599]	0.1544 (0.0383) [4.0264]
FI^-		0.0551 (0.0265) [2.0728]	0.0731 (0.0016) [45.6901]
CE^+	0.0716 (0.0175) [4.0892]	0.1716 (0.0751) [2.2837]	0.0831 (0.0406) [2.0454]
CE^-	0.0651 (0.0293) [2.2157]	0.1651 (0.0893) [1.8471]	0.0527 (0.0197) [2.6721]
ED^+	−0.2253 (0.0787) [−2.8605]	−0.2253 (0.0787) [−2.8605]	−0.1885 (0.0414) [−4.5506]
ED^-	−0.0923 (0.0427) [−2.1615]	−0.0999 (0.0427) [−2.3401]	−0.1178 (0.0812) [−1.451]
FDI	0.2247 (0.0206) [10.8637]	0.0824 (0.0206) [3.9871]	0.0929 (0.0253) [3.6632]
GCF	0.1072 (0.05) [2.1434]	0.1072 (0.05) [2.1434]	0.079 (0.0329) [2.4005]
C	15.2656 (0.321) [47.5561]	15.2656 (0.321) [47.5561]	−8.5077 (0.3804) [−22.3634]
Panel-B: Short-run asymmetric coefficients			
ΔFI^+	0.0497 (0.0076) [6.4727]		0.0999 (0.033) [−3.0195]
ΔFI^-	0.0301 (0.6743) [−0.0446]		0.0332 (0.0194) [−1.7065]
ΔTI^+		0.0436 (0.0134) [3.2384]	0.064 (0.0465) [1.3775]
ΔFI^-		0.1026 (0.0751) [1.3647]	0.0335 (0.0518) [0.6465]
ΔCE^+	0.0417 (0.0075) [5.5013]	0.0497 (0.0479) [1.0375]	0.0395 (0.0421) [0.9371]
ΔCE^-	0.0042 (0.0012) [3.4653]	0.0343 (0.0051) [6.7257]	0.074 (0.0296) [2.4996]
ΔED^+	−0.04 (0.0196) [−2.0406]	−0.0497 (0.0168) [−2.9584]	−0.0195 (0.0013) [−14.3438]
ΔED^-	−0.0436 (0.0034) [−12.5882]	−0.043 (0.0074) [−5.7832]	−0.0992 (0.0045) [−21.9186]
ΔFDI	−0.026 (0.0027) [−9.452]	0.0744 (0.0275) [2.7001]	0.0436 (0.0346) [1.2588]
ΔGCF	0.1072 (0.0479) [2.2382]	−0.0206 (0.0634) [−0.3261]	−0.026 (0.0075) [−3.4597]
ECT	−0.343 (0.0605) [−5.6686]	−0.4105 (0.0449) [−9.1315]	−0.1497 (0.0479) [−3.1247]
Panel-D: Long-run and short-run symmetry test			
W_{LR}^{FI}	12.988		
W_{SR}^{FI}	7.888	6.802	7.584
W_{LR}^{TI}	11.255	3.375	5.43
W_{SR}^{TI}	3.573	13.009	7.185
W_{LR}^{CE}	4.915	3.629	5.923
W_{SR}^{CE}	10.928	11.27	6.557
W_{LR}^{ED}	11.117	6.475	9.58
W_{SR}^{ED}	8.825	3.775	13.696
Panel-D: Residual diagnostic test			
Serial correlation	0.649	0.622	0.631
Normality test	0.491	0.742	0.614
ARCH test	0.662	0.857	0.582
Ramsey RESET test	0.808	0.709	0.884
CUSUM	Stable	Stable	Stable
CUSUM of square	Stable	Stable	Stable

FDI: Foreign direct investment, FI: Financial innovation, TI: Technological innovation, CE: Clean energy, ED: Environmental degradation

Table 8: Results of the TY causality test

Variables	SOME	FI	CE	ED	FDI	GCF
Panel-A: Innovation indicates Financial Innovation						
SOME		6.588**	11.258**	3.479	6.922**	3.234
FI	2.108		1.647	1.651	4.637*	2.206
CE	6.611**	5.536*		1.205	0.34	7.062***
ED	6.986**	4.984*	4.779*		1.786	1.85
FDI	4.183*	5.71*	1.214	6.634**		1.592
GCF	3.208	2.279	0.448	2.529	6.283**	
Panel-B: Innovation indicates Technological Innovation						
SOME		13.475***	4.061*	2.494	6.901**	4.938*
TI	2.325		3.543	0.545	2.587	5.819*
CE	5.997*	0.492		1.94	5.585*	2.929
ED	5.73*	5.616*	4.343*		3.122	1.564
FDI	1.088	2.062	1.604	2.216		1.992
GCF	0.808	4.073*	5.964*	6.213**	5.946*	

The superscript of ***/**/*The significance level at 1%, 5%, and 10%, respectively. FDI: Foreign direct investment, FI: Financial innovation, TI: Technological innovation, CE: Clean energy, ED: Environmental degradation

In terms of control variables effects, foreign direct investment and gross capital formation on the explained variable. The study documented a positive and statistically significant long-term and short-run linkage.

4.6. TY Causality Test

In the following, the study has implemented the causality test following the framework proposed by Toda and Yamamoto (1995). The results of the TY-causality test are displayed in Table 8, including panel –A with Innovation measured interim of Financial Innovation and panel –B innovation measured by Technological Innovation, respectively. Following the causality assessment, it appeared that bidirectional causal effects ran between clean energy and SMEs performance [CE←→SME], foreign direct investment, and SMEs performance [FDI←→SME]. Additionally, the study exposed a unidirectional association between Innovation and SMEs performance [FI→SME; TI→SME], SMEs performance and environmental degradation [SME→ED] and gross capital formation and SMEs performance [GCF→SME], respectively.

5. DISCUSSION

The present study has investigated the effects of Innovation, i.e., financial and technological, clean energy, and environmental degradation, on SMEs' contribution to Bangladesh's economy. Consistent with the symmetric and asymmetric assessment, a positive and statistically significant connection is found between financial Innovation and SMEs' contribution in the long and short run. Our finding is supported by the existing literature such as (Qamruzzaman and Jianguo, 2019; Effiom and Edet, 2022; Ahmed-Ishmel et al., 2018; Lee and Teo, 2015; Oyelola et al., 2013). According to Chou (2007), the efficiency of financial intermediation is improved when there is a proliferation of financial products and services made possible by technological advancements in the sector. As a direct result of financial innovation, there will always be a confluence between the requirements of investors and those attempting to save the production of new capital, which is the driving force behind economic expansion. Moreover, the relationships between technological Innovation and SMEs performance have revealed a positive tie with SMEs performance which is measured by the SME's contribution to GDP. Study findings suggest the adoption of technological changes in the economy insert and good ambiances for the SMEs in terms of production extension and recourses optimization with operational efficiency. Our findings align with the existing literature (Donbesuur et al., 2020). Technological innovation deals with the increment and enhancement of capacity development in the absorption of market demand through addressing customer expectations. Furthermore, technological Innovation offers a growth ambiance with competitive advantages that can contribute to fostering the SME's performances (Pla-Barber and Alegre, 2007; Castaño et al., 2016).

Access to energy profoundly affects SMEs, suggesting that energy availability supports capitalizing on the full potential and optimized economic resources. According to the study findings, clean energy sources positively motivate the SMEs' performance both in the long-run and short run, postulating that the inclusion of renewable energy sources ensures energy security and efficiency that lead to cost benefits in terms of production possibilities. The study documented the detrimental effects of environmental degradation on SMEs' performance under both symmetric and asymmetric frameworks, suggesting that quality environment had a prospective effect on SMEs' servile and economic growth. Our findings align with the existing literature (Cariola et al., 2020; Raharjo, 2019). Existing literature has offered green environment has a beneficial role in SMEs growth by elucidation of the potential effects of restoring the environmental degradation.

6. CONCLUSION AND POLICY SUGGESTIONS

The contribution of SMEs to economic sustainability is undeniable and is appropriately appreciated and acknowledged in the literature. On the other hand, many studies have been conducted to explore the key determinants of SME performance. The motivation of the study is to gauge the effects of Innovation, clean energy, environmental degradation, gross capital formation, and foreign direct investment in Bangladesh during 1990-2019. The study implemented the Bayer-Hancked and Maki cointegration test, ARDL and Nonlinear ARDL, and Non-granger causality test. The key findings are as follows:

First, the stationary test has been implemented in exploring the variable's order of integration by following the ADF test, GLS-ADF, P-P test, KPSS test, and Ng-Perrot test. Referring to the test statistics, all the variables become stationary after the first difference; most importantly, neither has revealed stationary after the second difference.

Second, the cointegration tests have been executed following the framework offered by Bayer and Hanck (2013) and Maki (2012). All the test statistics are statistically significant at a 5% level, suggesting the long-run association between explained and explanatory variables.

Third, ARDL bound test revealed Innovation, i.e., financial Innovation and technological Innovation, clean energy, gross capital formation, and FDI, positively connected to explained variables: SMEs' contribution to GDP. While an adverse association found.

Fourth, the standard Wald test results established an asymmetric association between explained and explanatory variables in the long and short run. In terms of the asymmetric coefficients, the study disclosed positive and statistically significant linkage between Innovation and SMEs performance in the long and short run. It confirms the proposition of innovation-led SMS performance that financial and technological Innovation has a contributory role in SMEs' progress. The positive and negative variations in clean energy unveil positively associated with SMEs' performance, suggesting that the inclusion and development of renewable energy sources offer a conducive ambiance for SMEs' growth and direct contribution to the economy. A study that exposed asymmetric shocks in environmental adversity disclosed a negative connection, indicating environmental quality has advantageous effects on

SMEs' performance. Controlling environmental degradation can be considered critical for SMEs' survival.

Fifth, the no granger casualty test following Toda and Yamamoto (1995), the study revealed bidirectional causal effects running between clean energy and SMEs performance [CE←→SME], foreign direct investment, and SMEs performance [FDI←→SME]. Additionally, the study exposed a unidirectional association between Innovation and SMEs performance [FI→ SME; TI→SME], SMEs performance and environmental degradation [SME→ED] and gross capital formation and SMEs performance [GCF→SME], respectively.

Based on the study findings, the following policy suggestions has established to foster the SME's growth and contribution by maximizing its full potential.

First, the study exposed credit facilities to SMEs through the innovative financing model positively connected, indicating that an appropriate level of credit facility might have assisted in the capitalization of the full potential of SMEs. This study advocated that financial institutions adopt financial innovation targeting SMEs in releasing easy access to financial support and target financing.

Second, clean energy positively affects SMEs' performance, suggesting that including renewable energy sources assists productivity and cost-effectiveness, which eventually leads to. Thus, the government of Bangladesh should extend the policy support by offering energy financing, especially in including renewable energy sources for SMEs.

A future study might be initiated with the full consideration of firms' specific data, even though the present study investigated empirical nexus with macro aggregated data, to understand the micro-management and SMEs growth in the perspective of micro performance.

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