Nexus between Financial Development and Sustainable Development Goals: Evidence from Emerging Economy

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Abstract. This study investigates the long-term relationship between Financial Development Index (FDIX) and Sustainable Development Goals (SDGs) in India, along with the causality analysis of the impact so observed. The study employs time series data from 2005-2021 on FDIX and comprehensive SDG scores along with individual SDG scores. It applies the Augmented Dickey Fuller test to check the stationarity of the time series data, followed by cointegration test to study the long run relationship between the two variables (FDIX and SDGs) and the application of vector autoregression (VAR) model. Linear granger causality tests were conducted to study the causal relationship between the two variables. Jarque-Bera tests and eigenvalue stability condition were tested for each VAR model. The findings reveal unidirectional impact of composite SDG score on FDIX after two years, but bidirectional relationship between most of the individual SDGs (except SDG 2, SDG 5 and SDG 16) and FDIX. By pointing out the relationship between FDIX and SDGs, as well as the direction of causality, the findings open scope for exploring various policy-crafting that specifically caters to the requirements of India. This is a seminal paper that employs FDIX data to study the relationship between financial growth and sustainable development in the Indian context. The outcomes are of utmost significance for policymakers, scholars, and financial institution professionals, both domestically and globally.

Keywords: Financial Development Index, Sustainable Development Goals, Environmental Disclosure, Financial Inclusion, Environmental Issues.

1 INTRODUCTION

Sustainable development, defined as development that fulfils current demand without tampering with the needs of coming generations (Ozili, 2022a) has gained traction once again after the announcement of Sustainable Development Goals (SDGs) by United Nations (UN) which are to be achieved by 2030 along with 169 targets effective from 1st January 2016 (United Nations, 2015). For an economy to grow sustainably, it is important to focus on three important pillars: Environmental, Social, and Economic (WCED, 1987). The essential role of financial institutions in achieving these targets as well as SDGs has been emphasized multiple times (Peeters, 2005; Weber, 2014), since

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these institutions can channelize funds towards sustained development (King and Levine, 1993; Rajan and Zingales, 2003). Access to financial services enhances the mobilization of resources and promotes investment with a positive impact on socio-economic development (Park and Mercado, 2015; Nanda and Kaur, 2016). Infact, financial services, including providing credit enhances the efficiency of small enterprises (Mehrotra and Yetman, 2015). The robustness of a financial system depends on two strong legs: developed financial institutions and an efficient financial market which further depends on usage, accessibility, and availability.

Financial development positively impacts sustainable economic development the most in middle to low-income countries (Hunjra et al., 2022). As a result, developing economies are working on strategies for financial development. Khatun and Bist (2019) pointed out that developing countries stress financial development policies to achieve higher economic growth. Building on this, the current study strives to explore the long-term nexus between financial development and sustainable development by utilizing the Financial Development Index (FDIX) and SDGs index in the context of an emerging economy, India.

This paper is the first to examine this relationship. Though few studies have been conducted in a similar direction, their scope is narrow. For instance, Pandey et al. (2022) studied the impact of financial inclusion drivers in achieving sustainable growth in north India, which is a small segment of the Indian geography. Further, this study employs FDIX and SDGs for conducting the empirical analysis. Though prior studies have examined sustainable economic development, they are marred with certain limitations. For instance, Machdar (2020) used gross domestic product (GDP) to measure sustainable economic growth, which though is an indicator of economic growth in monetary terms, ignores the social and environmental aspects. Lastly, this study focusses on studying the long-term relationship between the two given aspects, becoming the first one to do so. Studying long-run relationships is crucial to framing long-term policies, which, when aligned towards the objectives, can achieve long-term goals.

1.1 The case of India

India, as a country, offers some unique reasons to become the focal point of this study. First, India is one of the fastest growing emerging economies. According to the World Economic Outlook Report (2024), the five largest emerging economies are Brazil, China, India, Indonesia, and Russia. The global economic growth driven by these nations highlight India's significance. Second, it offers promising projected economic growth of 6.5% by 2025, driven by increasing domestic demand, a rising working-age population, and rapid growth in manufacturing production (Press Information Bureau, 2024). Studying this robust growth trajectory is crucial for understanding emerging market dynamics. The third reason is its humongous size and global economic impact. As of 2024, India, with a population of over 1.4 billion, ranks as the 7th largest country and the 3rd largest economy globally in terms of purchasing power parity (PPP). Achieving its economic targets is crucial for meeting global targets (SDG India Index Baseline Report, 2018). Fourth is the commitment of the Indian government to achieve the goal with its proactive initiatives such as the Swachh Bharat Mission, Beti Bachao

Beti Padhao, etc., which align closely with SDGs and significantly impact the economy and financial system. Fifth, the Reserve Bank of India (RBI) has made notable strides in promoting financial inclusion and providing access to banking services as well as enhance savings products. The RBI Financial Inclusion Index for India stood at an impressive 60.1% for the financial year ending March 2023, a notable increase from 56.4% in 2022 (Finance Industry Development Council, 2023). As per IMF's Financial Development Index (Svirydzenka, 2016), the China's (mainland) FDIX stood at 63% in 2021, while that of Brazil was 66%, that of Indonesia was 36.4% and that of Russia was 52.9 %. Table A1a (in annexure) outlines the top 10 performing states in India in terms of financial inclusion and SDG. The sixth strong reason to choose India is its impressive and promising SDG score (NITI Aayog, 2020). India's SDG index score for 2020 was an impressive 66%, reflecting significant progress in achieving socio-economic targets and highlighting the country's potential for greater efficiency. Table A1b (annexure) outlines the detailed performance of India in individual SDGs. These reasons make India an ideal case for studying development impacts.

2 REVIEW OF LITERATURE AND DEVELOPMENT OF HYPOTHESES

2.1 Sustainable development and financial development

Schumpeter (1911) explains how finance promotes growth. The supply-side theory, as also observed by Knack and Keefer (1995), suggests that a financial system facilitates the mobilization of funds required for investment, innovation, and entrepreneurship. This mobilization is necessary for investment and hence boosts economic growth. A sound financial system comprises effective financial institutions and efficient financial markets. Demetriades and Hook (2006) found that financial development impacts GDP significantly when the building of financial system is guided by a robust institutional framework. An efficient financial market helps in hedging risk and pooling investments, leading to economic development. For instance, in the absence of sound institutional framework, financial development might not be completely reflected in economic growth due to credit diversion into unproductive activities. Likewise, transaction and information costs come down with increased availability of financial instruments. An enhanced financial market boosts confidence and expands the investment pool contributing to the growth of the economy (Goodhart, 2004). In other words, several researchers have affirmed that greater financial inclusion positively affects the socioeconomic development of numerous developing countries (Jima and Makoni, 2023; Hussain et al., 2024; Afonso and Blanco-Arana, 2022; Asante et al., 2023). Hence, the first hypothesis is:

H1: Financial development impacts sustainable development.

Patrick (1966) and Robinson (1979) prominently pointed out that economic growth significantly facilitates increased financial inclusion as it creates new demand from individuals and organizations for financial services, emphasizing on demand side theory. This theory explains that as the enterprise sector advances in terms of technology and delivery, it generates more demand of financial services. The expansion of the financial sector, in turn, is influenced by the economic cycle. As the economy progresses from an intermediate to a mature stage, the rate of financial development accelerates. Research has also studied that financial inclusion and economic development affect each other, demonstrated by a bidirectional causality. Hence, the second hypothesis is:

H2: Sustainable development impacts financial development.

Some scholars argue for an independent hypothesis suggesting that change in one variable doesn't affect the other (Lucas, 1988; Stern, 1989). This theory explains that every economy reaches a stagnant point where growth cannot be stimulated with increased capital in the financial sector. The bidirectional hypothesis suggests that changes in one variable impacts other which in turn affect the first variable and so on (Demetriades and Hussein, 1996; Harrison et al., 1999; Greenwood and Smith, 1997). Also known as feedback effect, this theory explains that economic growth increases banks' activities, which in turn leads to more banks coming into the economy. This leads to greater specialization in banking services, which in turn result in higher bank profits. However, Ozili (2023) and Guang-Wen et al. (2023) affirmed that financial development and its inclusion contribute to sustainable development with a significant role in sustainable social and economic development.

2.2 Individual SDG and Financial development

Some researchers have explored the nexus between financial development and individual SDGs. The World Bank's Global Findex Database highlights financial inclusion as a key factor in poverty reduction, by providing underbanked population the financial freedom and shared prosperity (Mishra et al., 2024; Sahay et al., 2015). In the context of Africa, studies have shown that financial inclusion can reduce gender inequality and improve socioeconomic outcomes (O'Toole and Nayak, 2023; Demirguc-Kunt and Klapper, 2013). Specifically, financial access has been linked to better educational enrollment and income levels, which are critical for sustainable economic growth. When financially marginalized women gain access to financial services, they acquire greater control over their finances and economic choices. This empowerment enhances the wholistic development of families promoting gender equality. The OECD (2023) has released reports highlighting the influence of financial literacy on socio-economic development. Additionally, the International Labor Organization has found a positive correlation between financial inclusion and job creation (Sykes et al., 2016).

Vo (2024) suggests that better institutional quality is linked to improved lending practices and more efficient resource mobilization, which fosters economic growth and greater financial inclusion in those countries that have high to middle range of income.

Countries falling in the range of low income may not experience the same level of benefit from institutional reforms (Zafar et al., 2019). Good institutional quality has a broad dimension that covers strong legal principles, safeguarding of individual's rights, and effective government regulation (Van et al., 2022). Not only financial institutions, but other quality institutions also improve financial inclusion and balanced growth of economy, society and environment. Pata et al. (2023a) emphasize the importance of clean energy technology in supporting sustainable environmental quality catalyzed by institution quality and effective policies. Information and communication technology (ICT) emergence gave new ways of improving financial inclusion. ICT-enabled financial platforms have been found to significantly reduce wealth gaps in developing regions by improving access to financial services. Integration of technology and financial inclusion possess positive effects on economics, society and environment (Hussain et al., 2023).

Access to finance can lead to access to investment in resources that improves the climate and environment (Klapper et al., 2016; Kara et al., 2021). However, Wang et al. (2023) pointed out that increasing financial development affects the environment negatively. Table A1c (annexure) provides a comprehensive analysis of how financial development relates to individual SDGs, supported by relevant literature and logical arguments. The analysis indicates that financial development influences specific SDGs, though the issue of causality is still under investigation. Hence, this paper studies the long-term nexus between financial development and individual SDGs specifically in the context of India.

3 RESEARCH METHODOLOGY

This study examines the causal link between SDGs (both composite goals and individual goals) and financial development in India using indexes of both SDGs and financial development. The Financial Development Index (FDIX) is a composite index of the Financial Institution Index (FIIX) and the Financial Market Index (FMIX) (Svirydzenka, 2016). We conducted the augmented dicky-fuller (ADF) tests on the stationarity of FDIX and SDG index data (composite SDG index and individual SDG index) of India. Further, we used the co-integration test suggested by Johansen (1991, 1995) using the appropriate lag length. As we did not find any cointegration among the variables, we estimated Vector Auto Regression (VAR) models to investigate the dynamic association between FDIX and SDG Index (overall and for each SDG) for the sample study period. The VAR model of the two variables given below shows that the dependent variable is a function of its lagged values and the lagged values of other variables, while all the variables have equal lags. We determined the optimal lag length based on the Akaike information criterion (AIC) before estimating the VAR models.

$$FDIX_t = \alpha + \delta_i * FDIX_{t-i} + \rho_j * SDG_{t-j} + \mu_{1t}$$
$$SDG_t = \sigma + \beta_i * SDG_{t-i} + \lambda_j * FDIX_{t-j} + \mu_{2t}$$

In order to determine the causal link between FDIX and SDGs, we used linear Granger causality test (Granger, 1969). The bivariate model used to conduct the linear Granger causality test is:

$$FDIX_t = \beta_1 * SDG_{t-i} + \beta_2 * FDIX_{t-j} + \mu_{1t}$$
$$SDG_t = \beta_3 * FDIX_{t-i} + \beta_4 * SDG_{t-j} + \mu_{2t}$$

In order to ensure the robustness of our results, we conducted Jarque-Bera test to assess whether the residuals of the VAR models are normally distributed. Finally, we checked the eigenvalue stability condition after estimating the parameters of all the VAR models.

3.1 Variables and Data Sources

The Financial Development Index (FDIX), provided by the International Monetary Fund (IMF), measures financial development by ranking countries based on the depth, accessibility, and efficiency of their financial institutions and markets. The detailed calculation of the index is outlined in Svirydzenka (2016). SDG index, indicator and other assumptions are outlined by Sach et al. (2023). The reference year for the SDG data is the 2018 SDG Index and Dashboards report. Selection of the indicators was based on global relevance and applicability, statistical adequacy, timeliness, data quality, and data availability for at least 80% of the 149 UN member states with population over 1 million. A total of 109 indicators are used, including those from the OECD, with an average of 5 indicators per goal, 14 indicators for SDG 3, and 1 indicator for SDG 10. The calculation used 65% of official data (more than half of which is from OECD, WHO, and UNICEF) and 35% non-official data (Lafortune et al., 2018).

4 RESULTS AND ANALYSIS

Table 1 presents the descriptive statistics for FDIX and both composite and individual SDGs.

Table 1. Descriptive Statistics

	Mean	Max	Min	Std. Dev.	Skewness	Kurtosis
FDIX	.41	.46	.34	.03	-.03	2.51
SDG	56.95	62.8	52.3	3.67	.36	1.70
SDG_1	62.31	81.10	45.90	14.10	-.05	1.41
SDG_2	51.57	54.20	46.60	2.42	-.66	2.21
SDG_3	55.16	64.30	44.40	7.28	-.18	1.52
SDG_4	77.45	86.00	64.00	5.68	-.83	3.12
SDG_5	36.04	46.10	28.40	6.41	.37	1.72

SDG_6	52.54	58.10	46.60	3.84	.01	1.71
SDG_7	54.27	66.20	45.40	7.54	.39	1.66
SDG_8	68.53	74.70	65.80	3.52	.83	1.86
SDG_9	31.06	50.60	23.00	10.60	.93	2.06
SDG_10	39.19	40.30	38.20	.82	.35	1.35
SDG_11	47.06	52.10	43.00	2.01	.54	4.03
SDG_12	95.21	95.7	94.8	.27	-.04	2.16
SDG_13	95.23	96.5	94.30	.74	.34	1.84
SDG_14	55.28	62.40	51.60	3.51	1.29	3.27
SDG_15	46.53	47.50	45.70	.53	.21	1.97
SDG_16	51.18	54.3	48.10	1.68	-.01	2.26
SDG_17	49.68	55.00	47.30	2.01	1.27	4.10

Source: The Authors

The results of the analysis, presented in Table 2, indicate that the composite SDG score has a significant positive effect on FDIX after two years. The relationship between individual SDG scores and FDIX reveals that SDG 1 (no poverty) has a significant positive impact after three, four, and five years, while SDG 2 (zero hunger) shows a significant negative impact after one year but a positive impact after two and three years. SDG 3 (good health and wellbeing) positively impacts FDIX after five years, and SDG 4 (quality education) has a positive impact on FDIX after two years. SDG 5 (gender equality) shows positive impacts after one, two, and four years, and SDG 6 (clean water and sanitation) has a negative impact after one year but a positive impact after two and four years. SDG 7 (affordable and clean energy) positively impacts FDIX after one, two, three, and four years, while SDG 8 (decent work and economic growth) shows negative impacts after one and four years but a positive impact after two years. SDG 9 (industry, innovation, and infrastructure) has a negative impact after one and four years and a positive impact after two years. SDG 10 (reduced inequalities) shows a positive impact after one year, and SDG 11 (sustainable cities and communities) has a negative impact after one and two years but a positive impact after three years. SDG 12 (responsible consumption and production) shows a negative impact after two years, while SDG 13 (climate action) has a positive impact after one and three years but a negative impact after two and four years. SDG 14 (life below water) has a significant negative impact after four years, and SDG 15 (life on land) shows a positive impact after four years. SDG 16 (peace, justice, and strong institutions) has no impact on FDIX, while SDG 17 (partnerships for the goals) shows negative impact after one, two, and five years but a positive impact after three and four years.

Table 2. VAR Model Estimation of FDIX With Lags of SDG Index (Overall and for each SDG)

SDG (lag_1)	-.002 (.006)	SDG_1	.000 (.0004)	SDG_2	-.007**	SDG_3	.001 (.002)	SDG_4	-.009 (.007)	SDG_5	.008***

		(lag_1)		(lag_1)	(.003)	(lag_1)		(lag_1)		(lag_1)	(.001)
SDG (lag_2)	.013** (.006)	SDG_1 (lag_2)	.001 (.00006)	SDG_2 (lag_2)	.009** (.004)	SDG_3 (lag_2)	.001 (.003)	SDG_4 (lag_2)	.017* (.009)	SDG_5 (lag_2)	.003** (.001)
		SDG_1 (lag_3)	.001* (.0005)	SDG_2 (lag_3)	.010** (.004)	SDG_3 (lag_3)	-.001 (.003)	SDG_4 (lag_3)	-.005 (.006)	SDG_5 (lag_3)	-.005*** (.001)
		SDG_1 (lag_4)	.001*** (.0004)	SDG_2 (lag_4)	-.007* (.004)	SDG_3 (lag_4)	-.001 (.002)	SDG_4 (lag_4)	-.001 (.002)	SDG_5 (lag_4)	.005*** (.001)
		SDG_1 (lag_5)	.003*** (.0004)			SDG_3 (lag_5)	.004* (.002)	SDG_4 (lag_5)	-.004* (.003)		
SDG_6 (lag_1)	-.31*** (.06)	SDG_7 (lag_1)	.003*** (.001)	SDG_8 (lag_1)	-.002** (.001)	SDG_9 (lag_1)	-.003*** (.001)	SDG_10 (lag_1)	.018*** (.004)	SDG_11 (lag_1)	-.009*** (.003)
SDG_6 (lag_2)	.30*** (.11)	SDG_7 (lag_2)	.002** (.001)	SDG_8 (lag_2)	.007*** (.002)	SDG_9 (lag_2)	.001 (.001)	SDG_10 (lag_2)	.001 (.004)	SDG_11 (lag_2)	-.007*** (.003)
SDG_6 (lag_3)	-.17 (.12)	SDG_7 (lag_3)	.002*** (.001)	SDG_8 (lag_3)	.000 (.002)	SDG_9 (lag_3)	.002** (.001)	SDG_10 (lag_3)	-.007 (.004)	SDG_11 (lag_3)	.008*** (.003)
SDG_6 (lag_4)	.22*** (.08)	SDG_7 (lag_4)	.002*** (.001)	SDG_8 (lag_4)	-.006*** (.002)			SDG_10 (lag_4)	.000 (.006)	SDG_11 (lag_4)	.003 (.002)
		SDG_7 (lag_5)	-.009*** (.001)								

SDG_12 (lag_1)	.033 (.059)	SDG_13 (lag_1)	.06*** (.02)	SDG_14 (lag_1)	.00 (.00)	SDG_15 (lag_1)	.00 (.00)	SDG_16 (lag_1)	.00 (.00)	SDG_17 (lag_1)	-.02** (.01)
SDG_12 (lag_2)	-.103* (.053)	SDG_13 (lag_2)	-.06** (.02)	SDG_14 (lag_2)	.00 (.00)	SDG_15 (lag_2)	.00 (.00)	SDG_16 (lag_2)	.00 (.00)	SDG_17 (lag_2)	-.04** (.01)
SDG_12 (lag_3)	-.036 (.082)	SDG_13 (lag_3)	.04** (.02)	SDG_14 (lag_3)	.01 (.00)	SDG_15 (lag_3)	.00 (.00)	SDG_16 (lag_3)	.00 (.00)	SDG_17 (lag_3)	.01** (.00)
SDG_12 (lag_4)	.005 (.043)	SDG_13 (lag_4)	-.07** (.02)	SDG_14 (lag_4)	-.02** (.00)	SDG_15 (lag_4)	.02** (.00)			SDG_17 (lag_4)	.01** (.00)
						SDG_15 (lag_5)	-.01** (.01)			SDG_17 (lag_5)	-.01** (.01)

*, **, and *** represent significance at 10%, 5%, and 1%, respectively.

Source: The Authors

The results in Table 3 show that FDIX does not have a significant impact on the composite SDG score. The relationships between FDIX and individual SDG scores reveal that FDIX has a significant positive impact on SDG 1 after two years, but a significant negative impact after three years. Similar to the composite score, FDIX does not significantly impact SDG 2 or 5. FDIX has a significant negative impact on SDG 3 after two, three, four, and five years and on SDG after two, three, and five years, though it also has a significant positive impact after four years. FDIX positively affects SDG 6 after two, three, and four years and SDG 7 after one, three, and five years. Likewise, FDIX positively affects SDG 8 after two and three years and SDG 9 after one year. FDIX has a significant positive impact on SDG 10 after two years but a negative impact after four years. Similarly, FDIX positively impacts SDG 11 after one year but negatively affects it after four years. FDIX negatively affects SDG 12 after two and three years while positively affecting SDG 13 after one and three years. It has a negative impact on SDG 14 after one year but a positive impact after four years. Similarly, it negatively affects SDG 15 after two and three years but positively affects it after five years. FDIX has a positive impact on SDG 16 after two years while negatively affecting SDG 17 after one year but positively affecting it after two years.

Table 3. VAR Model Estimation of SDG Score (Composite and For Each SDG) With Lags of FDIX

SDG		SDG_1		SDG_2		SDG_3		SDG_4		SDG_5	
FDIX (lag_1)	.67 (10.56)	FDIX (lag_1)	-89.45 (62.89)	FDIX (lag_1)	-19.21 (16.79)	FDIX (lag_1)	-8.94 (8.18)	FDIX (lag_1)	-23.67 (16.43)	FDIX (lag_1)	-4.57 (33.76)
FDIX (lag_2)	10.36 (7.73)	FDIX (lag_2)	170.69*** (56.25)	FDIX (lag_2)	-8.31 (15.45)	FDIX (lag_2)	-57.16*** (7.43)	FDIX (lag_2)	-138.41*** (32.64)	FDIX (lag_2)	37.76 (31.83)
		FDIX (lag_3)	-195.12** (76.48)	FDIX (lag_3)	17.61 (13.98)	FDIX (lag_3)	-44.03*** (10.94)	FDIX (lag_3)	-107.30*** (20.46)	FDIX (lag_3)	31.49 (29.47)
		FDIX (lag_4)	4.36 (70.64)	FDIX (lag_4)	13.60 (12.29)	FDIX (lag_4)	-38.19*** (11.58)	FDIX (lag_4)	360.92*** (59.73)	FDIX (lag_4)	-18.61 (24.98)
		FDIX (lag_5)	55.03 (51.83)			FDIX (lag_5)	-31.64*** (8.38)	FDIX (lag_5)	-232.57*** (77.43)		
SDG_6		SDG_7		SDG_8		SDG_9		SDG_10		SDG_11	
FDIX (lag_1)	.98 (4.22)	FDIX (lag_1)	156.31*** (25.35)	FDIX (lag_1)	40.01 (46.12)	FDIX (lag_1)	217.76*** (62.25)	FDIX (lag_1)	-16.66 (19.17)	FDIX (lag_1)	254.20*** (59.06)
FDIX (lag_2)	9.57** (4.73)	FDIX (lag_2)	6.28 (16.64)	FDIX (lag_2)	108.34** (51.78)	FDIX (lag_2)	-33.45 (90.42)	FDIX (lag_2)	35.55** (14.90)	FDIX (lag_2)	-15.76 (49.17)
FDIX (lag_3)	16.97*** (4.44)	FDIX (lag_3)	208.75*** (26.81)	FDIX (lag_3)	110.32** (53.69)	FDIX (lag_3)	60.02 (46.23)	FDIX (lag_3)	3.88 (19.10)	FDIX (lag_3)	-.87 (33.31)
FDIX (lag_4)	.22*** (.08)	FDIX (lag_4)	-3.77 (28.61)	FDIX (lag_4)	-35.88 (27.20)			FDIX (lag_4)	-26.48** (13.44)	FDIX (lag_4)	-93.74*** (31.84)

		FDIX (lag_4)	109.80*** (14.44)								
SDG_12		SDG_13		SDG_14		SDG_15		SDG_16		SDG_17	
FDIX (lag_1)	-.21 (.77)	FDIX (lag_1)	.79*** (.26)	FDIX (lag_1)	-164.91*** (40.80)	FDIX (lag_1)	-4.33 (8.72)	FDIX (lag_1)	5.95 (24.70)	FDIX (lag_1)	-62.20*** (20.29)
FDIX (lag_2)	-5.25*** (.99)	FDIX (lag_2)	-.41 (.36)	FDIX (lag_2)	1208.08*** (39.69)	FDIX (lag_2)	-25.64*** (8.00)	FDIX (lag_2)	72.98** (30.68)	FDIX (lag_2)	36.51* (19.97)
FDIX (lag_3)	-5.71*** (.89)	FDIX (lag_3)	.69** (.30)	FDIX (lag_3)	1803.21*** (38.40)	FDIX (lag_3)	6.47 (6.89)	FDIX (lag_3)	-28.29 (22.13)	FDIX (lag_3)	-5.55 (14.69)
FDIX (lag_4)	-.45 (.98)	FDIX (lag_4)	-.29 (.31)	FDIX (lag_4)	23.22 (28.39)	FDIX (lag_4)	-32.61*** (9.41)			FDIX (lag_4)	-23.89 (22.85)
						FDIX (lag_5)	40.19*** (7.48)			FDIX (lag_5)	-33.86 (21.22)

*, **, and *** represent significance at 10%, 5%, and 1%, respectively.

Source: The Authors

The linear Granger causality test results (Table 4) indicate that composite SDG score, SDG 2 and 5 to FDIX, confirming that these scores significantly influence FDIX. Additionally, there is bidirectional causality between FDIX and several SDGs: SDG 1, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 and 17 indicating that these SDGs and FDIX significantly influence each other. There is also a unidirectional causality from FDIX to SDG 16, confirming that FDIX significantly impacts SDG 16. The results of the Granger causality tests show that the null hypothesis is rejected for all relationships between FDIX and the composite or individual SDG scores, suggesting that the composite and individual SDGs significantly affect FDIX, with the exception of SDG 16, where FDIX exerts a significant influence. However, most of the individual SDGs have bidirectional causality with FDIX.

Table 4. Granger casualty test results for linear models

Null Hypothesis	*Linear Granger Causality Stat*	*Null Hypothesis*	*Linear Granger Causality Stat*
SDG ↦ FDIX	27.33***	FDIX ↦ SDG	1.88
SDG_1 ↦ FDIX	158.43***	FDIX ↦ SDG_1	42.10***
SDG_2 ↦ FDIX	24.08***	FDIX ↦ SDG_2	4.85
SDG_3 ↦ FDIX	16.17***	FDIX ↦ SDG_3	150.98***
SDG_4 ↦ FDIX	38.92***	FDIX ↦ SDG_4	296.84***
SDG_5 ↦ FDIX	223.93***	FDIX ↦ SDG_5	3.80
SDG_6 ↦ FDIX	77.68***	FDIX ↦ SDG_6	18.84***
SDG_7 ↦ FDIX	280.04***	FDIX ↦ SDG_7	95.80***
SDG_8 ↦ FDIX	37.38***	FDIX ↦ SDG_8	28.81***
SDG_9 ↦ FDIX	11.18**	FDIX ↦ SDG_9	18.39***
SDG_10 ↦ FDIX	35.33***	FDIX ↦ SDG_10	13.37***
SDG_11 ↦ FDIX	21.18***	FDIX ↦ SDG_11	26.33***
SDG_12 ↦ FDIX	7.93*	FDIX ↦ SDG_12	102.83***
SDG_13 ↦ FDIX	36.65***	FDIX ↦ SDG_13	16.15***
SDG_14 ↦ FDIX	29.22***	FDIX ↦ SDG_14	31.46***
SDG_15 ↦ FDIX	52.58***	FDIX ↦ SDG_15	47.16***
SDG_16 ↦ FDIX	1.96	FDIX ↦ SDG_16	7.89**
SDG_17 ↦ FDIX	76.40***	FDIX ↦ SDG_17	20.43***

The symbol "↦" represents the null hypothesis of Granger non-causality. *, **, and *** represent significance at 10 %, 5 %, and 1 %, respectively.

Source: The Authors

We conducted Jarque-Bera tests of each VAR model between SDG (composite and individual scores) and FDIX. The null hypothesis of the test is that the disturbance of the VAR model follows a normal distribution, and the test statistics show that we cannot reject the null hypothesis at a 5% confidence level. We found that the disturbances of each VAR model equation follow a normal distribution.

The eigenvalue stability condition requires that all the eigenvalues of the VAR matrix are smaller than one (Lutkepohl, 2005; Hamilton, 1994). The eigenvalue stability in this study shows that in a few VAR models, each eigenvalue is less than one and the estimates satisfy the eigenvalue stability condition. However, in several other VAR models, at least one eigenvalue is more than one and the estimates do not satisfy the eigenvalue stability condition.

5 DISCUSSION

The objective of this paper was to study the composite and individual impact of sustainable development of India on its financial development and vice-versa. These were measured using SDG and FDIX. The findings indicate that while the composite SDG score positively influences FDIX after two years, the impact of individual SDGs on FDIX varies. SDGs 1(No Poverty), 3 (Good Health and Well-Being), 4 (Quality Education), 5 (Gender Equality), 7 (Affordable and Clean Energy), 10 (Reduced Inequalities), and 15 (Life on Land) consistently show positive effects. In contrast, SDGs like SDG 2 (Zero Hunger), 6 (Clean Water and Sanitation), 8 (Decent Work and Economic Growth), 9 (Industry, Innovation, and Infrastructure), 11 (Sustainable Cities and Communities), 13 (Climate Action), and 17 (Partnerships for the Goals) display both positive and negative impacts over time. SDG 12 (Responsible Consumption and Production) and 14 (Life Below Water) are associated with negative impacts. Additionally, FDIX shows varying effects on individual SDGs, with some experiencing positive impacts (SDG 6, 7, 8, 9, 13, 16), while others like SDG 3 and 12 facing negative impacts.

The findings indicate that the Financial Development Index (FDIX) has a negative effect on SDG 10, which aims to reduce inequalities. This adverse relationship arises from the notion that easier access to financial services encourages greater investment in financial assets, which often offer higher returns. However, this high investment habit leads to budget condensation on other matters like children's education, due to high interest rate on educational loans. This unhealthy short-term benefit jeopardizes the long-term return that human capital can generate, leading to increased inequality. Similarly, in a country like India where gender pay parity is still an issue, women are left with less money to invest in children's education, resulting in inequality. This also brings out the reason for negative impact observed in SDG 4. Even investing in the education of girl child extinguishes the return on the investment, which also leads to very little investment in the education of girl child, thereby broadening the gender inequality. This result is in consensus with Kling (2022).

Similarly, SDG 12 has a negative bidirectional relationship with FDIX, which emphasizes responsible consumption and production, indicating challenges in transitioning to sustainable consumption practices without disrupting financial markets. This could be due to the fact that higher economic growth induces more consumption that leads to unsustainable consumption. Additionally, SDG 13, 14 and 15, which focus on climate action, life below water and life on land respectively, present immediate challenges for financial development as also suggested by Wang et al. (2023), even though they are essential for long-term sustainability. Li et al. (2021) found out that financial

inclusion loans increase grazing intensity and decrease grassland ecosystem which directly affects the life on land.

SDG 11 showed mixed bidirectional relationship with FDIX which could be due to the reason that sometimes, giving financial resources to city authorities is not enough to achieve the goal due to inherent limitations, like space crunch for road expansion (Bartniczak and Raszkowski, 2022). SDG 8 also impacts FDIX negatively in episodes on account of multiple banking crises, and soft budgetary restrictions due to which the loan growth is not always sustainable and are inefficiently used by private sector (Öncel et al, 2024). SDG 9 has a negative impact on FDIX episodically because financial development should exceed beyond the threshold discussed in Nkemgha et al. (2023) for electricity infrastructure to impact the SDG positively.

6 POLICY IMPLICATIONS

This study makes multiple contributions and provides implications for various stakeholders. For academicians, the study enriches academic literature by providing a robust framework for understanding how financial development interacts with various SDGs. It identifies gaps in existing research and suggests areas for future study, particularly the need for the granular analyses of the 2 variables. For financial institutions, the research highlights how their activities influence sustainable development, allowing them to align strategies and investments with positive SDG outcomes. This alignment can enhance their reputation, create new business opportunities, and help manage risks associated with unsustainable practices by identifying pros and cons of financial development on specific SDGs. For policymakers, the study underscores the importance of aligning economic policies with sustainability goals, guiding the formulation of strategies that promote balanced and inclusive growth while addressing the unique challenges posed by individual SDGs, such as inequality.

Overall, the study serves as a foundation for further research and practical applications, helping to advance sustainable development in emerging markets like India.

7 CONCLUSION

This study presents a comprehensive analysis of the long-term relationship between financial development and sustainable development goals in India using financial development index and sustainable development goal scores. Incorporating cointegration analysis on the data collected from 2005-2021, the study reveals a unidirectional positive correlation between composite SDGs and FDIX after 2 years and bidirectional relationship between individual SDGs and FDIX. Although few SDGs are positively or negatively related, most of the SDGs have mixed relationship with FDIX. The research can be further improved by including data from the recent two years. The study collected data from secondary sources, which is compiled based on few highly suggestive indicators, that always have a scope of improvement in terms of accuracy. Financial development and financial inclusion, although used interchangeably in the paper, have

a thin line of difference. Unavailability of detailed and condensed datasets from RBI on financial inclusion and NITI Ayog on SDGs is another limitation as these institutions work closely on these data and have better understanding of ground reality as compared to international organizations like IMF. As a result, their data can be reasonably concluded to be more accurate.

This research opens up several intriguing avenues for further exploration. SDG 3 is an interesting case where good health and well-being positively impact financial development, but financial development negatively impacts health and well-being. The negative relationship between FDIX and hunger, life below water, clean water and SDG 17 are also not explained properly in the literature. Strong research on the factors leading to negative relationship between the two variables, like inverse relation between SDG 12 and FDIX, SDG 14 and FDIX, FDIX and SDG 3, and FDIX and SDG 12 is required. Similarly, future research can be conducted on reasons of mixed relationship between SDG 2, 6, 8, 9, 11, 13, 17 with FDIX, and FDIX with SDG 1, 4, 10, 11, 14, 15 as well as 17. These studies can be done in the context of developing and developed countries to understand the ways to mitigate the effect of the same. Additionally, there is a need to explore what policies and regulations can be implemented to minimize the negative impact of these SDGs on financial development. Further research is required to understand why SDG 2 on FDIX and FDIX on SDG 16 do not show any relationship with financial development. On the positive side, researchers can work on identifying the factors that contribute positively to financial development for other SDGs and determine how these positive factors can be leveraged to speed up the financial development in rural areas of India.

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ANNEXURES

Table A1a: India's top 10 state-wise performance (Data is of the year 2020)

Rank	SDG	Financial Inclusion
1	Kerala	Goa
2	Himachal Pradesh	Delhi
3	Tamil Nadu	Tamil Nadu
4	Andhra Pradesh	Punjab
5	Goa	Telangana

6	Karnataka	Kerala
7	Sikkim	Haryana
8	Maharashtra	Karnataka
9	Gujrat	Maharashtra
10	Telangana	Himachal Pradesh

Sources: SDG: https://sdgindiaindex.niti.gov.in/#/ranking: Dhar and Barua (2020)

Table A1b: SDG goals and India's performance in each goal

Goal	Key Points	India's Performance
Goal 1	Requires actions on all other 16 goals to achieve this goal.	60 (up)
Goal 2	Needs attention to factors like local food production, mechanized farming, irrigation, wasteland regeneration, soil and water conservation, rain-fed farming, and food imports. Transitioning to nutrition security requires strategic techniques linking agriculture and nutrition in developing countries.	47 (up)
Goal 3	Requires access to quality and affordable healthcare. Aims to reduce mortality, morbidity, and malnutrition. India's current public health expenditure is low.	74 (up)
Goal 4	Focuses on inclusive education in primary and secondary schools, early childhood development, pre-primary, higher and tertiary education, vocational and technical training.	57 (Down)
Goal 5	Aims to improve gender equality index, equal educational opportunities, economic participation, political empowerment, and health access. Women constitute 48.20% of India's population.	48 (up)
Goal 6	Focuses on managing Indian rivers, addressing water pollution, revisiting the Ganga River Basin Management Plan.	83 (Down)
Goal 7	Emphasizes the importance of sustainable, reliable energy for development, reducing greenhouse gas emissions, and utilizing renewable energy sources.	92 (up)

Goal 8	Enhances manufacturing and service sectors, strategic employment opportunities, and aims for high GDP growth.	61 (Down)
Goal 9	Prioritizes infrastructure development, sustainable manufacturing practices, and innovation for economic growth	55 (Down)
Goal 10	Addresses inequalities in employment, education, access to resources, and social security.	67 (up)
Goal 11	Requires proper urban planning, housing for all, efficient transportation, and urban development.	79 (up)
Goal 12	Focuses on reducing ecological issues, managing toxic waste and pollutants, efficient resource utilization, recycling, and minimizing waste.	74 (up)
Goal 13	Emphasizes reducing CO2 emissions, strengthening national climate action plans.	54 (Down)
Goal 14	Interlinked with goals on infrastructure, sustainable consumption, combating climate change, and ecosystem use.	-
Goal 15	Focuses on protecting ecosystems, managing land degradation, and curtailing harmful human activities.	66 (No change)
Goal 16	Aims to build reliable, inclusive, effective, accountable, and corruption-free institutions.	74 (up)
Goal 17	Ensures implementation through financial and technological assistance, improving revenue generation, and building capacities.	-

Source: Haq et al. (2022) https://sdgindiaindex.niti.gov.in/#/ranking

Table A1c: Relationship between Financial Inclusion and Individual SDGs

Goal	Description	Relationship	Effect	Supporting literature

Goal 1	End poverty in all its forms everywhere.	Financial development provides access to credit, savings, and insurance, enabling investment and income generation. This also lowers the cost of financial services making it more accessible to the unbanked population.	Decreases poverty	Demirguc-Kunt and Klapper (2013)
Goal 2	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.	Access to finance allows farmers to invest in better tools, seeds, and technologies to increase agricultural productivity and local farming wages leading to improved consumption.	Decreases hunger and increases food security	Fink et al. (2014)
Goal 3	Ensure healthy lives and promote well-being for all at all ages.	Financial services can help manage health expenses and reduce the impact of health emergencies.	Increases access to healthcare and improves health outcomes	Klapper et al. (2016)
Goal 4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.	Saving products can help families plan education and related expenses. Also, small short-term loans help family to manage other related contingency expenditure.	Increases access to education	Ashraf et al. (2003); Morduch (2007)
Goal 5	Achieve gender equality and empower all women and girls.	Financial inclusion empowers women economically and increases their participation in financial decisions. This further leads to investment in	Decreases gender inequality	Demirguc-Kunt and Klapper (2013)

		the education of girl child thereby further filling the gap.		
Goal 6	Ensure availability and sustainable management of water and sanitation for all.	Financial inclusion increases the access to the resources that can enable investments in clean water and sanitation infrastructure.	Increases access to clean water and sanitation	Klapper et al. (2016)
Goal 7	Ensure access to affordable, reliable, sustainable, and modern energy for all.	Financing options can support investments in renewable energy sources and infrastructure.	Increases access to sustainable energy	Klapper et al. (2016)
Goal 8	Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all.	Financial inclusion stimulates entrepreneurship and business growth, leading to job creation. It also gives access to financial markets which gives greater return on investment leading to income growth.	Increases economic growth and employment	Beck et al. (2007); Banerjee et al. (2015)
Goal 9	Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.	Better access to credit leads to startup innovations creating jobs. Similarly, it helps existing firm to expand their capacity of operation. Both leads to industrialization.	Increases infrastructure and industrial growth	Park and Mercado (2015); Gimet and Lagoarde-Segot (2014)

Goal 10	Reduce inequality within and among countries.	Financial services reduce economic disparities by providing access to resources for marginalized groups. It also helps people get assistance during crisis.	Decreases income inequality	Demirguc-Kunt and Klapper (2013); Klapper and Singer (2015)
Goal 11	Make cities and human settlements inclusive, safe, resilient, and sustainable.	Financial inclusion facilitates investment in housing and urban development.	Increases sustainable urbanization	Klapper et al. (2016)
Goal 12	Ensure sustainable consumption and production patterns.	Access to credit can support investments in sustainable technologies and practices leading to sustainable consumption.	Increases sustainable consumption and production	El-Zoghbi et al. (2019)
Goal 13	Take urgent action to combat climate change and its impacts	Financial products like green bonds can fund climate change mitigation projects.	Supports climate action initiatives	Gimet et al. (2019), Saqib et al. (2024)
Goal 14	Conserve and sustainably use the oceans, seas, and marine resources for sustainable development.	Access to finance can support sustainable fisheries and marine conservation projects.	Increases ocean conservation	Kara et al. (2021)
Goal 15	Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt biodiversity loss.	Credit can fund reforestation and conservation initiatives.	Increases protection of terrestrial ecosystems	Beck et al. (2007)

Goal 16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels.	Financial inclusion can reduce economic disparities that lead to social unrest.	Increases social stability and inclusion	Claessens (2006)
Goal 17	Strengthen the means of implementation and revitalize the global partnership for sustainable development.	Collaborative financial inclusion efforts can mobilize resources for SDGs.	Increases support for global partnerships and resource mobilization	Kara et al. (2021)

Source: The authors.