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FINANCIAL DEVELOPMENT AND ENVIRONMENTAL PERFORMANCE: EVIDENCE FROM BRICS-T

Finansal Gelişme ve Çevresel Performans: BRICS-T Ülkelerinden Kanıtlar

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ABSTRACT

The development process is a whole that encompasses economic growth as well as social welfare, environmental sustainability and quality of life. The financial system plays an important role in this development process. The financial system plays an important role in the efficient allocation of resources, promotion of investments and creation of an environment of trust among economic actors. The financial system serves as the cornerstone of development, and improvements in its size, efficiency and stability lead to increased welfare. Especially when financial inclusion gains importance, access to financial services by low-income groups becomes easier, thus contributing to reducing income inequality and increasing social welfare. On the other hand, improving national welfare can also lead to better access to clean water and sanitation. This study investigates panel data from BRICS-T countries (Brazil, Russia, India, China, South Africa, and Türkiye) covering the period 2000 to 2022. The findings reveal that financial development positively and significantly affects access to clean water and sanitation. This suggests that in countries with high financial development, allocating resources for infrastructure projects is more efficient and effective. Conversely, the substantial impact of environmental policies on access to clean water and sanitation underscores the pivotal role of environment-oriented regulations in achieving sustainable development goals. On the other hand, the finding that public expenditures do not significantly affect access to sanitation indicates that these expenditures need to be directed more effectively.

Yazar Bilgileri

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Sanitasyona Erişim.

ÖZ

Kalkınma süreci ekonomik büyümenin yanı sıra sosyal refah, çevresel sürdürülebilirlik ve yaşam kalitesini kapsayan bir bütündür. Bu kalkınma sürecinde finansal sisteme önemli roller düşmektedir. Finansal sistem burada kaynakların verimli tahsisi, yatırımların teşviki ve ekonomik aktörler arasında güven ortamının oluşturulması açısından önemli bir işlev görmektedir. Finansal sistem kalkınmanın temel taşı olarak hizmet etmekte olup, büyüklüğü, verimliliği ve istikrarındaki gelişmeler refahın artmasına yol açmaktadır. Özellikle finansal kapsayıcılık önem kazandığında düşük gelirli grupların finansal hizmetlere erişimi kolaylaşmakta ve böylece gelir eşitsizliğinin azaltılmasına ve sosyal refahın artırmasına katkı sağlamaktadır. Diğer yandan, ulusal refahın iyileştirilmesi temiz suya ve sanitasyona daha iyi erişimin sağlanmasına da yol açabilmektedir.Bu ilişkiyi araştırmak amacıyla, 2000-2022 dönemi için BRICS-T (Brezilya, Rusya, Hindistan, Çin, Güney Afrika, Türkiye) ülkelerine ait panel veriler kullanılarak bir çalışma yapılmıştır. Bulgular, finansal gelişmenin temiz su ve sanitasyona erişim üzerinde pozitif ve anlamlı bir etkisi olduğunu ortaya koymaktadır. Bu durum, finansal gelişmişliğin yüksek olduğu ülkelerde altyapı projeleri için kaynak tahsisinin daha verimli ve etkili olduğunu göstermektedir. Buna karşılık, çevre politikalarının temiz su ve sanitasyona erişim üzerindeki önemli etkisi, çevre odaklı düzenlemelerin sürdürülebilir kalkınma hedeflerine ulaşmadaki önemli rolünün altını çizmektedir. Diğer taraftan, kamu harcamalarının sanitasyona erişimi önemli ölçüde etkilemediği bulgusu ise bu harcamaların daha etkin bir şekilde kanalize edilmesi gerektiğine işaret etmektedir.

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1.INTRODUCTION

The Sustainable Development Goals (SDGs) are global goals adopted by the United Nations in 2015 to prevent poverty, improve the environment, and establish peace and prosperity in the world by 2030 (United Nations Development Programme, 2025). Sustainable Development Goal 6.1 calls for universal and equitable access to safe and affordable drinking water. In addition, the objective is to enable access to improved clean water when required and to undertake actions to increase these opportunities, i.e., to ensure the effective management of drinking water services (World Health Organization, 2019, p. 5). According to the World Health Organization (2019, p. 6), the proportion of households in Africa with access to clean water was only 9 percent in 2019. However, this figure increases to 27 percent in Southeast Asia and 36 percent in the Eastern Mediterranean. The rate of essential water services in the Western Pacific is 56 percent higher than in Africa, Southeast Asia, and the Eastern Mediterranean. The Americas and Europe demonstrate similar access levels, with 59 percent and 62 percent of households accessing basic water services. However, the overall access to clean water at the household level in low- and middle-income countries is only 38 percent. The report published by the World Bank Group (2024, p. 41) emphasizes that to achieve the Sustainable Development Goals for access to safely managed water supply and sanitation by 2030, countries must allocate an additional $131.4 billion to $140.8 billion. Similarly, Sustainable Development Goal 6.2 also addresses access to equitable and adequate sanitation and hygiene for all. The objective is to promote the adoption of improved sanitation facilities customized to individual needs. In essence, this objective entails the provision of sanitation services that are both safe and managed effectively (WHO, 2019, p. 9). According to the WHO (2019, p. 9), the African region exhibits the lowest access rate to basic sanitation with sewerage, at a mere 7 percent. This figure rises to 9 percent in Southeast Asia and 32 percent in the Eastern Mediterranean. The Western Pacific region demonstrates higher access to essential sanitation services (49 percent) than other regions. The highest access rates to essential sewerage-related services are observed in Europe and the Americas, at 59 percent. Sanitation remains a critical issue in low- and middle-income countries. Here, it is essential to note that access to basic sanitation-related services in low- and middle-income countries remains a challenge, with only 30% of the population having access to such services. Despite the progress witnessed in the last two decades, approximately 40 percent of the global population (3.5 billion) still lacks access to essential sanitation services, as outlined in Sustainable Development Goal 6.2. Furthermore, as urbanization accelerates, cities and towns are expected to face increasing sanitation challenges (World Bank Group, 2024, p. 44).

The United Nations recognizes access to adequate water as a fundamental human right. Nevertheless, this continues to be a challenging objective for institutions and organizations. Conversely, the Sustainable Development Goal asserts that access to safe water is inextricably linked to socio-economic advancement, and its absence exerts a detrimental influence on the economic and social welfare of individuals and communities (Dangui & Jia, 2022). While the impact of finance may appear relatively modest when viewed in the context of more significant factors such as health and the environment, it is crucial to recognize the role that financial dynamics play in shaping the attainability of these fundamental rights. However, when the financial system functions efficiently, it can indirectly contribute to economic growth and poverty alleviation. However, a problem in this system can lead to increased poverty, especially increased poverty, and destabilization in society (World Bank Group, 2013, p. 17). Numerous

studies have demonstrated the pivotal role of financial sector development in economic advancement (World Bank, n.d.). The process of financial development can be defined as the acquisition of information, the implementation of contracts, and a reduction in transaction costs. From this perspective, it is acknowledged that direct measurement of financial development is challenging. Nevertheless, fundamental dynamics exist that can comprehensively reveal such financial development and reflect the characteristics of the financial market. These dynamics are categorized into fundamental factors such as depth, access, efficiency, and stability (World Bank Group, 2013, p. 132). As Hlophe (2018, pp. 121–122) emphasizes, financial development is characterized by improvements in the financial system's size, efficiency, and stability. However, financial development also depends on the financial system concept. The financial system performs fundamental functions, including the provision of information regarding potential investment opportunities, the allocation of capital, the monitoring of investments post-financing, the implementation of corporate governance principles, the facilitation of trade, the establishment of a risk management framework, the assurance of effective savings functionality, and the facilitation of the exchange of goods and services (World Bank, n.d.).

In their study on 106 developing countries, Tadadjeu, Kamguia, and Djeunankan (2023) found that financial development improves access to drinking water and sanitation for urban and rural populations. The same study also found that financial development reduces the gap between urban and rural populations regarding access to drinking water and sanitation. Adams, Boateng, and Amoyaw (2016) emphasized that public investments in water and sanitation should be accompanied by interventions to reduce education and income poverty. Their study found that wealthier and better-educated households have better access to safe water and better sanitation facilities. Moreover, they stated that investing in water infrastructure and providing credit to the private sector is an essential component of economic growth. Zhou et al. (2018) show that sanitation is a comprehensive field linked to multiple categories, and the increasing number of publications reflects the strong interest in this research area. Sanitation issues are also a serious problem in developing countries. In this sense, the regulatory effect of financial development on public health and environmental policies is not very common in the literature, especially in BRICS-T countries. The studies in the literature mainly investigate Sub-Saharan African countries and the relationship between financial inclusion and WASH. At this point, examining the relationship between a sustainable environment and financial development in BRICS-T countries is considered essential for the literature. The Sustainable Development Goal emphasizes that access to well-managed and safe water and sanitation is fundamental to a fair and equal life in many countries worldwide. For this purpose, the impact of the financial development index, public investments, and effectiveness of environmental policies on the rate of access to clean water and sanitation services is analyzed for BRICS-T (Brazil, Russia, India, China, South Africa, Türkiye) using 2000-2022 data.

2.LITERATURE REVIEW

2.1. Theoretical Framework

In this study, in which we examine the relationship between financial development and environmental sustainability for BRICS-T countries, we can mention three concepts that we think are theoretically relevant. These are: agency theory, shareholder theory and financial markets theory. Firstly, if we start with the agency theory, the

agency theory focuses on the problems that will arise due to the separation of the owners and managers of the company. This theory helps to develop various management systems to monitor and control the actions of those who represent the company (Hendrastuti & Harahap, 2023, p. 85). The second is the shareholder theory. This theory argues that the main objective of a company is to maximise shareholders' profits. The funds used by managers should be channelled into projects that maximise value for investors (Tse, 2011, p. 52). The third is the modern financial markets theory. This theory represents the efficient hypothesis, rational expectations theory and modern portfolio theory and has a great impact on analysing the capital market. The theory is widely used in financial markets to explain the price formation of assets such as stocks, bonds and foreign exchange and to estimate the cost of capital (Polleit, 2021, p. 448).

2.2.Literature Review

Zhou et al. (2018) conducted an analysis using bibliometric analysis method to evaluate sanitation research. In this context, articles were analysed using Science Citation Index EXPANDED (SCI-EXPANDED) and Social Sciences Citation Index (SSCI) databases between 1992-2016. According to the findings, it was suggested that the increasing number of publications reflects the strong interest in the field of sanitation and that innovations in sanitation techniques can prevent susceptible populations from contracting diseases caused by various pollutants and microorganisms. In this context, the literature is categorized based on the intensity of studies. First, studies focus on African countries, followed by low-income and middle-income countries, and finally, studies involving various countries, including those from Asia. These are in the following order:

When we look at the studies on Africa, the following studies stand out. Immurana et al. (2024) used logistic regression to investigate the impact of financial inclusion on the use of improved water for drinking and general use among households in Ghana using data from 2016-2017. Key variables such as water sources (for drinking and general use), financial inclusion, and total household income were used in the study. According to the findings, households in Ghana that are involved in financial inclusion are more likely to use improved water sources than those that are not. Dangui and Jia (2023) investigated the relationship between household access to drinking water and the multidimensional financial inclusion index, as well as the relationship between two aspects of financial inclusion (formal and informal) and access to drinking water in Sub-Saharan Africa between 2018 and 2019. The findings show that financially included households are more likely to access improved water sources with less traveling time than financially excluded households. On the other hand, improving households' access to formal financial inclusion was found to potentially increase access to water and reduce travel time to the water source compared to informal financial inclusion. Immurana, Iddrisu, Mohammed, and Mathew (2022) analysed the impact of financial inclusion on access to basic drinking water and sanitation in Africa using a sample of 33 countries for the period 2004-2018 and the basic estimates of random effects and fixed-effects regressions. The findings show financial inclusion increases access to basic drinking water and sanitation services. In other words, expanding financial inclusion can be an effective strategy to improve access to basic drinking water and sanitation services in Africa. Chireshe and Ocran (2020) investigated the relationship between financial development and health expenditures for 46 Sub-Saharan African countries between 1995 and 2014. The findings emphasise that financial development leads to an increase in health expenditures and that financial development should be encouraged in Sub-Saharan African economies to help

local resource mobilisation to finance health expenditures. Adams et al. (2016) analyzed how investment in water infrastructure affects economic growth in 31 Sub-Saharan Africa (SSA) countries. The findings show that a 1 percent increase in per capita income growth and trade openness leads to a 0.2 and 0.03 percent increase in water infrastructure performance, respectively. In comparison, a 1 percent increase in population density leads to a 0.76 percent reduction in water infrastructure performance. This effect is primarily due to per capita income growth and population density in low- and middle-income countries. On the other hand, it was found that an additional increase in water infrastructure investment leads to a higher impact on economic growth. Hopewell and Graham (2014) analyzed household access to water and sanitation using data from Demographic and Health Surveys (DHS) for thirty-one cities in Sub-Saharan Africa (SSA) between 2000 and 2012. The findings revealed that national-level GDP or GDP growth does not directly increase access to water and sanitation in large cities.

Looking at low- and middle-income countries, Cavoli, Gopalan, Onur, and Xenarios (2023) investigated whether traditional and digital financial inclusion can affect access to sanitation services in 84 low—and middle-income countries from 2000 to 17. The findings revealed that traditional and digital financial inclusion have a strong and positive impact on access to sanitation services, especially in rural areas. Khan, Yaseen, and Ali (2018) investigated the long-term relationship between greenhouse gases (GHG), financial development, forest area, improved sanitation, renewable energy, urbanization, and trade in 24 lower-middle-income countries from Asia, Europe, Africa, and the Americas (South and North) using panel data between 1990 and 2015. Bidirectional causality is established between financial development and forest (Asia), improved sanitation and forest (Asia, Africa, and America), and improved sanitation and economic development (Europe). GHG emissions also show that unidirectional causality runs from financial development to GHG (Americas) and from GHG to financial development (Europe).

Finally, the scope of various countries and studies carried out in the Asian context are mentioned. These studies are as follows. Acheampong, Opoku, and Tetteh (2024) investigated the impact of income inequality on safe drinking water, sanitation, and hygiene regarding financial inclusion using data from 119 countries between 2004 and 2020. The first finding is that income inequality is associated with decreased adoption and implementation of WASH (safe drinking water, sanitation, and hygiene). The second finding is that financial inclusion significantly facilitates WASH adoption and practices, i.e., the role of financial inclusion in improving WASH adoption and practices is more pronounced in rural than urban areas, as financial inclusion promotes WASH among rural and urban populations. Third, it highlights heterogeneity across income groups in the impact of income inequality and financial inclusion on WASH. The fourth finding is that the effect of income inequality and financial inclusion differs across regions. Tadadjeu et al. (2023) investigated the impact of financial development on access to water and sanitation through panel analysis using data from 106 developing countries between 2000 and 2019. The findings show that financial development improves access to drinking water and sanitation for the total population and both urban and rural populations, and financial development reduces the gap between urban and rural populations in terms of access to drinking water and sanitation. Further analyses also show that the financial market and financial institutions, and their sub-indices (financial depth, financial access, and financial efficiency), also improve access to water and sanitation. Al, Khan, and Khan (2018) examined the relationship between total reserves, financial development index,

improved sanitation, renewable energy, trade openness, and tourism in 19 Asian Cooperation Dialogue member countries using panel data for 1995-2015. The findings show that long-run causality is observed for total reserves, financial development index, and improved sanitation access in high-income countries; total reserves and financial development index in developed and developing countries; and economic development index and improved sanitation access in low- and middle-income countries. On the other hand, the increase in total reserves associated with an increase in improved sanitation was the most critical finding of the study, and the impact of a 1% increase in improved sanitation on total reserves was 4.7% in upper middle-income countries and 2.9% in lower middle-income countries. As Asian Cooperation Dialogue-high-income countries have already achieved the target of 100% access to improved sanitation, there is a need to further increase access there is a need to further increase access there is a need to further increase access to improved sanitation in these countries.

3. METHODOLOGY AND DATA

3.1.Data

This study examines the impact of the Financial Development Index, public investments, and the effectiveness of environmental policies on the access rate to clean water and sanitation services using two separate models. This panel data analysis utilizes annual data for BRICS-T countries (Brazil, Russia, India, China, South Africa, and Türkiye) from 2000 to 2022. The data were obtained from the databases of international organizations such as the World Bank and the United Nations. The variables used in this study and the related literature are as follows:

- Financial Development Index (Tadadjeu et al., 2023)
- Access to Clean Water (Acheampong et al., 2024; Dangui & Jia, 2023; Immurana et al., 2024)
- Access to Sanitation (Acheampong et al., 2024; Immurana et al., 2022; Tadadjeu et al., 2023)
- Public Expenditure (Acheampong et al., 2024; Cavoli et al., 2023)

3.2.Methodology

Since our study involves multiple countries and years, it is classified as a panel data analysis in terms of data type. In general, the panel data model is:

$$\gamma_{i,t} = \alpha_{i,t} + \beta_{i,t} X_{i,t} + u_{i,t} \quad i = 1, \dots\dots, N ; t = 1, \dots\dots, T \tag{1}$$

It can be expressed as follows: Y: dependent variable, X: independent variable, α\alphaα: constant parameter, β\betaβ: slope parameter, and u: error term. The subscript i represents the units (individuals, firms, cities, or countries), while t represents time (such as days, months, or years). The fact that the variables, parameters, and error terms have subscripts i and t indicates that they belong to a panel dataset. In this model, the constant and slope parameters take values depending on the units and time.

Using panel data in econometric research offers numerous advantages in addition to the benefits of using cross-sectional and time series data. Since it combines time series and cross-sectional observations simultaneously, panel data allows researchers to work with a larger dataset. This, in turn, increases the number of observations and degrees of freedom. Consequently, the degree of multicollinearity among explanatory variables decreases, enhancing the efficiency and reliability of econometric estimates. Furthermore, using panel data enables the analysis of economic

problems that cannot be addressed solely with cross-sectional or time-series data (Güriş, Çağlayan Akay, and Güriş, 2020, p. 230).

To determine which approach to use, the first step is to test whether the model can be pooled using the Breusch-Pagan (B-P) test. If pooling is not appropriate, the decision on whether to use the fixed-effects or random-effects approach is made based on the results of the Hausman test (Hausman, 1979; Hausman, Jerry, and William Taylor 1981).

The Regression Models to be estimated are shown below;

MODEL1=$RACW_{i,t}=\alpha_0+\alpha_1 FDI_{i,t}+\alpha_2 SPE_{i,t}+\alpha_3 EP_{i,t}+\alpha_4 UR_{li,t}+\varepsilon_{i,t}$ (2)

MODEL2=$RASS_{i,t}= \alpha_0+\alpha_1 FDI_{i,t}+\alpha_2 SPE_{i,t}+\alpha_3 EP_{i,t}+\alpha_4 URl_{i,t}+ \varepsilon_{i,t}$ (3)

Model 1 and Model 2 examine the impact of financial and environmental factors on access to clean water and sanitation services. In Model 1, the dependent variable is defined as RACW (Ratio of Access to Clean Water) and in Model 2 as RASS (Ratio of Access to Sanitation Services). In both models, the independent variables are FDI (Financial Development Index), SPE (Share of Public Expenditures in GNP), EP (Environmental Policy) and UR (Urban/Rural). These models aim to assess the impact of financial development, public expenditure, environmental policies and urban-rural segregation on access to clean water and sanitation services. The results will reveal which factors have a stronger impact and whether these relationships are statistically significant.

4.RESEARCH FINDINGS

Descriptive statistics of the variables used in the analysis are presented in Table 1. Descriptive statistics include the mean, median, standard deviation, minimum and maximum values of the variables. These statistics are important for understanding the general characteristics of the data set. In particular, they provide preliminary information about the distribution of independent variables, the presence of outliers and potential relationships between variables. Analysis of descriptive statistics is a critical step in assessing the appropriateness of variables and identifying potential data problems before model estimation.

Table 1. Descriptive Statistics

Variables	Number of Observations	Mean	Standard Deviation	Minimum	Maksimum
RACW	138	86.1524	7.4087	74.7430	97.6469
RASS	138	48.0944	16.8510	6.0963	78.6854
FDI	130	50.3872	7.7103	33.4942	67.4299
SPE	138	2.3620	1.7078	0.3824	7.0353
EP	126	1.2361	0.8530	0.1666	3.1388
KK	138	2.3620	1.7078	0.3824	7.0353

Note: RACW=Ratio of Access to Clean Water, RASS=Ratio of Access to Sanitation Services, FDI= Financial Development Index, SPE= Share of Public Expenditures in GNP, EP= Environmental Policy, UR= Urban/Rural

The descriptive statistics in Table 1 show the main characteristics of the variables used in the study. Rate of Access to Clean Water (RACW) is generally high with an average of 86.15 and ranges from 74.74 to 97.64. The Rate of Access to Sanitation Services (RASS) is moderate, with an average of 48.09, and has a wide range of variation. The Financial Development Index (FDI) shows a relatively balanced distribution with an average of 50.38. The share of public expenditures in GDP (SPE) and the Urban/Rural indicator (UR) have the same values and show a low

concentration level with an average of 2.36. The Environmental Policy (EP) variable indicates a low level with a mean of 1.23, ranging from a minimum of 0.16 to a maximum of 3.13. These data give a general idea about the distribution of the variables in the study. No strong multicollinearity was observed.

Before proceeding with the model estimations, some preliminary tests are applied to check whether the basic econometric assumptions are violated. Table 2 presents the results of three main diagnostic tests: Pesaran CD test (to measure cross-sectional dependence), Modified Wald test (to detect variance variation) and Baltagi-Wu's Local Best Invariance (BW-LBI) test (to detect autocorrelation). The Pesaran CD test is used to assess whether there is cross-sectional dependence in the model. If there is cross-sectional dependence, conventional estimation methods may give misleading results. The modified Wald test examines the presence of heteroskedasticity (changing variance) by testing whether the error terms have constant variance. The BW-LBI test, additionally, helps to identify the autocorrelation problem by determining whether there is any interdependence between the error terms. The results of these tests contribute to the determination of appropriate methods for model estimation. If the test results indicate assumption violations, the reliability of the model is improved by applying appropriate correction methods. The test results for deviations from the basic assumptions are presented in Table 2.

Table 2. Testing for Deviations from Basic Assumptions

MODEL	Horizontal Cross-Section Dependence (Peseran Cd)	Test Changing Variance (Modified Wald Test)	Test Autocorrelation Test (Baltagi-Wu's Local Best Invariance Test (BW-LBI))
MODEL 1	0.278	94.65	547.833
	(0.1640)	(0.0000)	(0.0000)
MODEL 2	0.285	1342.61	496.580
	(0.1683)	(0.0000)	(0.0000)

For MODEL 1, the Pesaran CD test result (0.278, p = 0.1640) indicates no horizontal cross-section dependence at the 5% significance level. However, the result of the Variance Test (94.65, p = 0.0000) reveals a problem of varying variance in the model. The Autocorrelation Test result (547.833, p = 0.0000) indicates an autocorrelation problem in the model. For MODEL 2, the Pesaran CD test result (0.285, p = 0.1683) indicates no horizontal cross-section dependence. The result of the Variance Test (1342.61, p = 0.0000) indicates that the variances are not constant, and the result of the Autocorrelation Test (496.580, p = 0.0000) indicates an autocorrelation problem. These results suggest that both models have problems of heteroscedasticity and autocorrelation but no horizontal cross-sectional dependence.

The estimation results of model selection are presented in Table 3.

Table 3. Model Selection Estimation Results

Model	Random Effects - Pooled ERA	Fixed Effects - Pooled ERA	Fixed Effects - Random Effects
Model 1	920.93 (0.0000) **Conclusion: Random Effects**	329.92 (0.0000) **Conclusion: Fixed Effects**	1.20 (0.8779) **Conclusion: Random Effects**
Model 2	926.03 (0.0000)	291.70 (0.0000) **Conclusion: Fixed Effects**	1.61 (0.8365)

Conclusion: Random Effects	Conclusion: Random Effects

When Table 3 is analyzed, it is concluded that it would be more accurate to apply random effects in both models according to the selection methods. At this stage of the analysis, the impact of financial development on the rate of access to clean water and sanitation services was evaluated by focusing on the research question. In this context, how financial development shapes access to public services is analyzed and the findings are presented in Table 4. Due to autocorrelation and heteroskedasticity problems in our models, the Driscoll and Kraay (1998) estimator, one of the robust estimators widely used in the literature, was employed. In addition to Driscoll and Kraay, other robust estimators include Huber, Eicker, White, Arellano, Froot and Rogers, Wooldridge, Newey-West, Anselin Maximum Likelihood Estimator, Parks-Kmenta, and Beck-Katz estimators. Driscoll and Kraay (1998) proposed a non-parametric covariance matrix estimator. The selection of this estimator is based on its applicability in panel least squares and fixed effects models.

Considering that the time dimension T is large, Driscoll and Kraay (1998) demonstrated that standard non-parametric time-series covariance matrix estimators could be extended to be robust against all general forms of spatial and temporal correlation. Driscoll and Kraay's methodology applies a Newey-West type correction for the series of cross-sectional averages. The corrected standard error estimates ensure the consistency of covariance matrix estimators regardless of the cross-sectional dimension N ($N \rightarrow \infty$ or write out: "as N approaches infinity).

Thus, Driscoll and Kraay (1998) approach was developed as an alternative to methodologies like the Parks-Kmenta or PCSE approaches, which produce consistent covariance matrix estimators only when T is large but are weak in cases of large cross-sectional dimensions often encountered in micro econometric panels. This estimator produces consistent and robust standard errors for heteroskedasticity and general spatial and temporal correlation forms, even in scenarios with large T and N.

In the panel data model below

$$\gamma_{i,t} = \beta X_{i,t} + u_{i,t} \quad (4)$$

Under the assumptions that the error term is heteroskedastic, autocorrelated, and correlated across units, the parameters can be consistently estimated using the Pooled Least Squares method:

$$\gamma_{i,t} = \beta X_{i,t} + u_{i,t} \quad (5)$$

The Driscoll and Kraay estimator will provide us with estimation results on the impact of Financial Development on the Rate of Access to Clean Water and Sanitation Services.

Table 4. Impact of Financial Development on Rate of Access to Clean Water and Rate of Access to Sanitation Services

Analysis Results	RACW	RASS
Constant	67.2527 (0.000)***	12.4769 (0.002)
FDI	0.1275 (0.000)***	0.3401 (0.008)***
SPE	0.2291 (0.000)***	-0.0717 (0.623)
EP	2.0776	9.1099

	(0.000)***	(0.000)***
UR	0.9317 (0.076)***	3.5590 (0.063)**
Observation Number of	126	126
R^2	0.1301	0.1777

Note: RACW=Ratio of Access to Clean Water, RASS=Ratio of Access to Sanitation Services, FDI= Financial Development Index, SPE= Share of Public Expenditures in GNP, EP= Environmental Policy, UR= Urban/Rural

Table 4 shows the effects of financial development, public expenditure, environmental policy, and urban/rural variables on the Clean Water Access Rate (RACW) and Sanitation Services Access Rate (RASS). For the TSI model, the Financial Development Index (FDI) and Environmental Policy (EP) variables show a positive and significant effect. In contrast, the impact of Public Expenditures (SPE) and Urban/Rural (UR) variables is statistically insignificant. In the RASS model, the FDI and EP variables again have a positive and significant effect, while the impact of the SPE variable is not statistically significant. The SPE variable has a positive but weakly significant effect on RASS. The R^2 value for the RACW model was calculated as 0.1301 and 0.1777 for the RASS model. These values indicate that the models explain a limited portion of the total variance in the dependent variables. That is, although the independent variables in the models have a certain explanatory power, there are other unobserved factors that affect access to clean water and sanitation services. This suggests that additional variables such as infrastructure quality, governance effectiveness such as infrastructure quality, governance effectiveness, and regional disparities may also play an important role in access to these services. These findings suggest that environmental policies strongly impact RACW and RASS, while financial development positively contributes.

5. CONCLUSION

This study analyzed the effects of financial development on the rate of access to clean water (RACW) and the rate of access to sanitation services (RASS) in BRICS-T countries. The findings reveal that financial development positively and significantly affects both variables. This finding supports the results of the study conducted by Tadadjeu et al. (2023) on 106 developing countries. Similarly, the result of Immurana et al. (2022) that financial inclusion increases access to basic drinking water and sanitation services also supports the findings of this study. This suggests that in countries with higher levels of economic development, it is easier and more effective to provide resources for infrastructure projects. Moreover, the strong impact of environmental policies on both RACW and RASS emphasizes the critical importance of environment-oriented regulations in achieving sustainable development goals. However, the fact that public expenditures do not significantly affect RASS indicates that these expenditures need to be directed more effectively.

Financial development contributes to expanding water and sanitation services by facilitating infrastructure project financing and increasing capital flows to related investments. For BRICS-T countries, financial development is critical for improving clean water and sanitation services. However, long-term sustainable development goals supported by financial mechanisms should be achieved by increasing the effectiveness of environmental policies and public expenditures. In this context, a holistic strategy should be adopted to allocate resources efficiently and reduce inequalities. Future studies may use micro-level household data or investigate the causal relationship between

financial development and access to water and sanitation. One of the study's limitations is that the indicators used to measure financial development focus on specific elements and do not encompass broader aspects such as financial inclusion, access to credit, or private sector investments. A more comprehensive financial development index could provide a detailed evaluation of the impact of various financial variables.

Declaration of Research and Publication Ethics

This study was prepared in accordance with the rules of scientific research and publication ethics.

Conflict of Interest

There is no conflict of interest for the authors or third parties arising from the study.

Ethics Committee Approval

This research does not require Ethics Committee Approval.

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