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ANALYZING THE DYNAMIC RELATIONSHIPS BETWEEN FINANCIAL DEVELOPMENT, RENEWABLE ENERGY CONSUMPTION, AND ECONOMIC GROWTH: EVIDENCE FROM TANZANIA

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ABSTRACT

This paper analyzing the dynamic relationships between financial development, renewable energy consumption, and economic growth of Tanzania. Given the complex and multifaceted nature of these relationships, a robust econometric approach is employed to capture both short-term and long-term effects. The methodology is structured using data from World Bank indicators from (1990-2021) to assess how financial development facilitates renewable energy adoption, and in turn, how both financial development and renewable energy consumption influence economic growth.

Findings indicated that in the long run the net financial flow shows a significant negative relationship with economic growth since a 1% increase in net financial flow decreases the economic growth but the renewable energy consumption has a positive relationship with growth statistically significant positive relationship between renewable energy consumption and economic growth in the region. In case of short run shown that net financial flow increases economic growth however, renewable energy consumption is not significance and has a negative relationship with economic growth.

The study will contributes to existing literature and by prioritizing renewable energy investments, good financial system and supportive policies, Tanzania country can harness the economic potential of renewable energy while advancing environmental sustainability goals.

KEYWORDS: - Net Financial Flow, Renewable Energy Consumption and Economic Growth.

INTRODUCTION

The most modern challenge in the global economy of today is sustainable development. It is a challenge policy makers world over are putting in place to balance economic growth against sustainability in the environment. Most developing economies find it very hard to grow without depleting resources or aggravating climate change. This balance is very critical in Tanzania, an East African country blessed with abundant natural resources, to emphasize the link between financial development, the use of renewable energy, and economic growth. The experience of Tanzania gives very important lessons for other developing countries looking forward to sustainable development.

The link between financial development, energy use, and economic growth is a widely studied topic, especially in SSA. Financial development drives growth by supplying capital for infrastructure, boosting market efficiency, and supporting economic activities (Diby&Kassi, 2021). Energy consumption, especially from renewable, is very critical to sustainable growth. As Li et al. (2021) note, renewable energy consumption exerts a positive impact on economic growth and also helps environmental sustainability and resilience. This change is very important for those countries which are to abandon fossil fuels in favor of sustainable energy sources.

The interaction of these variables in SSA is very complex and asymmetric with different short- and long-run effects. Diby and Kassi (2021) used the NARDL model to examine the relationship between energy consumption and financial development on economic growth. Their study observed that positive financial shocks stimulate growth in certain countries, while negative energy consumption shocks may surprisingly have a positive effect on growth in the short term. This means that context-specific energy and financial policies are needed to support sustainable growth in SSA.

Development Challenges of Tanzania and its Energy Context

Tanzania confronts huge challenges in increasing economic growth while looking for sustainable energy solutions. Historically, the economy of Tanzania has been based on three main sectors: agriculture, mining, and fossil fuels. Now, it is shifting towards renewable energy sources such as solar, wind, and hydroelectric power to meet increasing energy demands (Diby&Kassi, 2021). This is in line with the country's Vision 2025, aimed at transforming it into a middle-income economy through sustainable energy practices in the long run. Understanding how financial development interacts with the use of renewable energy to affect economic growth is what lies at the heart of this transition. Financial development mobilizes capital for infrastructure and innovation, central to the transition towards renewable energies. The relationship between renewable energy use and economic growth is multidirectional, especially among developing countries like Tanzania. Now seen as an integral factor in solving both environmental and economic problems, renewable energies were once looked at as being expensive.

Renewable Energy and Its Benefits to the Economy of Tanzania.

Energy consumption has played a big role in growing the economy. Non-renewable energy sources—oil and coal—drove industrialization, but their environmental negatives—pollution and resource depletion—have driven global change to renewable. Renewable energy comes from sources such as sunlight, wind, and water and provides a cleaner alternative to fossil fuels. For Tanzania, it affords benefits including energy security, reduced reliance on imports, and better electricity access in rural areas (Li et al., 2021).

Energy access is a great challenge, as in most developing countries, especially rural areas. The gap can be bridged by renewable energy technologies, especially solar panels and micro grids. These technologies have brought sustainable energy to remote locations, increasing access to electricity, and therefore bettering the livelihood of small businesses and improving the overall quality of life with better education, health, and communication. Inclusive economic growth and combating climate change require a countrywide transition toward renewable energy.

Financial Development as an Enabler of Renewable Energy Transition.

The greatest hindrance to the adoption of renewable energy technologies in Tanzania is financial constraints. Initial investment in projects is high, which poses a big challenge in developing economies. Most of the potential projects cannot start without adequate capital. Expanding financial institutions and creating new financing mechanisms is therefore very essential in overcoming these barriers.

The financial sector in Tanzania is young and at very early stages of development. While credit for large renewable energy projects might be available, it would generally be offered only for established industries. Huge growth is there, however, in the finance sector, which could encourage adoption of renewable. Green bonds, public-private partnerships, and international funding could be the way to fund renewable energy projects. On their part, these have been seen to accelerate the deployment of renewable energy and increase economic growth and energy security (Amarachi et al., 2022).

The research will benefit Tanzania and act as a model for other developing nations aiming at sustainable development and environmental resilience through renewable energy integration. Current literature ties financial development, renewable energy consumption, and economic growth in various ways, particularly for developing countries like Tanzania. Most studies on Sub-Saharan Africa are scant, and the socio-economic challenges in the region demand more research (Amarachi et al., 2022). Few studies have explored asymmetric effects relating to financial development and energy consumption with nonlinear models (Diby&Kassi, 2021). Financial inclusion's role in boosting renewable energy adoption and security is underexplored (Lianbiao Cui et al., 2022). This study seeks to address these gaps and offer evidence-based recommendations for policymakers in Tanzania and other developing nations pursuing sustainable growth through renewable energy.

LITERATURE REVIEW

There is an extensive literature which investigate the relationship between financial development, renewable energy consumption and economic growth. Their impact varies from one country to another and from one panel to another depending on the level of development of the selected sample and the estimated techniques applied.

Although the results of previous studies vary by country, and model most studies find that financial development positively influences renewable energy consumption.

Hassan, Qudrat-Ullah., Chinedu, Miracle, Nevo. (2022). The study at hand has given more insight into the dynamics relating renewable energy, economic growth, financial development, and CO2 emissions. While the short-run effects do not appear, the long-run relations suggest that increased consumption of renewable energy and financially sound systems may lead to lower CO2 emissions. Besides, the positive relation of economic growth to emissions supports the hypothesis of the EKC, which postulates that with economic development, although pollution increases in the initial stages, it gets cleaner as the economy advances. Results again point out the long-term strategies in respect to attainment of sustainable development in energy transitions and improvement in financial sector.

Lianbiao Cui, Shimei Weng and Malin Song, (2022) "Financial inclusion, renewable energy consumption and inclusive growth: cross-country evidence" examine show financial inclusion and renewable energy consumption affect the inclusive economic growth. Financial inclusions thus have a positive significant effect on inclusive growth, with the implication that a higher level of access to financial services develops economic growth that benefits larger sections of the population. Contrasting trend several the positive impact of renewable energy consumption on inclusive growth via promotion of sustainable and equitable economic development. The study has pointed out the role of industrial structure upgrading in enhancing inclusive growth, while it suggested that government loans may affect negatively inclusive growth due to the financial burdens created. Finally, a spatial spillover effect was observed; it showed that improvement in financial inclusion and renewable energy consumption in one country could positively influence neighboring countries and vice versa, hence promoting regional economic development.

Specifically, Amarachietal. (2022) investigate the dynamic relationships of renewable energy production, financial development, and real per capita growth in African countries. The authors investigate how each factor contributes to economic growth and present some valuable findings on the interaction of energy consumption, financial infrastructure, and development at different levels of income and resource endowments. The contributions are pegged on the literature extending the understanding of renewable energy and financial development as the determinants of growth for various economies, especially the African case.

Anh and Nguyen, 2021, examine the effect of financial development, trade openness, and renewable energy consumption on economic growth. Economic growth is highly influenced by financial development because it may provide capital for investment and trade. Nevertheless, trade openness and renewable energy consumption exhibit more complicated behaviors; for instance, trade openness might hamper long-term growth, while renewable energy does not contribute to economic performance directly. The study, therefore, calls for a balancing act in policies that promote financial development, trade liberalization, and the adoption of renewable energy in pursuit of sustainable economic growth.

Li etal.(2021) presents critical data, entitled "The Positive Influences of Renewable Energy Consumption on Financial Development and Economic Growth," for delineating the contribution of renewable energies toward economic and financial developments. With increased consumption in renewable energy sources, countries show a significantly higher level of positive impact on the causality of economic growth; likewise, the general performance was considerably improved. It also illustrates that the utilization of renewable energies is complementary to financial development and thus supports each other. Through the application of the VAR, the analysis has been proven to show that renewable energy consumption positively affects financial development and economic growth processes. Therefore, renewable energy investments have to been hence dif policy makers are to achieve this state of long-term growth in sustainability.

In an earlier study, Diby and Kassi (2021) investigated the financial development and energy consumption-economic growth nexus using the NARDL framework in a panel of 21 Sub-Saharan African countries between 1990 and 2014. The authors find that the impact of both financial development and energy consumption on growth is a symmetric. While positive shocks to financial development favor growth in the short run, negative shocks to energy consumption boost growth for most countries. It has suggested that this can be achieved by providing energy-saving policies and effective credit allocation for regional development.

Anton and Nucu (2020) analyzed the relationship between financial development and renewable energy consumption in 28 European Union countries and found that financial development positively affects renewable energy consumption.
Pham (2019) investigated the impact of financial development on renewable energy innovation in 22 OECD countries and found that financial development has a positive impact on renewable energy innovation.

Paramati et al (2016) investigated the relationship between renewable energy consumption and financial development in 20 developing countries and revealed that that foreign Direct Investment and stock market development increase investment in energy market economy resulting in the growing of renewable energy consumption.

Alsagr and Van Hemmen (2021) analyzed the impact of financial development on renewable energy consumption for 19 emerging countries and found that financial development has a long term and positive impact on renewable energy consumption.

Some studies examined a specific country rather than group of countries. Eren et al (2019) found that financial development has a positive effect on renewable energy consumption in India.

Ji and Zhang (2019) estimated contributions of the stock market, banking sector and international investment to renewable energy and found that Chines financial market contributed 42.2% to renewable energy consumption.

Juan Wang et al (2021) examined the long run and short run impacts of economic growth and financial development and renewable energy based on the panel data at national and regional level of China. The long run relationship show that economic growth stimulate renewable energy consumption, while financial development impact it negatively, however the short run relationship show that economic growth and financial development influence renewable energy consumption negatively and positively respectively.

BertacSakir and SemilYilmazer (2021) discussed the nexus between financial development and renewable energy consumption, showing a positive and statistically significant relationship between domestic credit to the private sector and renewable energy consumption.

Methodology and Econometric Model Specification

This study aims to analyze the dynamic relationships between financial development, renewable energy consumption, and economic growth, with a specific focus on Tanzania. Given the complex and multifaceted nature of these relationships, a robust econometric approach is employed to capture both short-term and long-term effects. The methodology is structured using data from World bank indicators, International Monetary Fund, Tanzania Bureau of Statistic (1990-2021) to assess how financial development facilitates renewable energy adoption, and in turn, how both financial development and renewable energy consumption influence economic growth. The key econometric techniques used in this study include unit root tests, co integration tests, Error Correction Model (ECM) for long run and short run and other tests.

Model Specification

To examine the interrelationship between financial development, renewable energy consumption, and economic growth, the study employs the following general equation:

$$(GDP_t) = \beta_0 + \beta_1(NFF_t) + \beta_2(REC_t) + \beta_3(NR_t) + \beta_4(GCF_t) + \beta_5(FCE_t) + \beta_6(TR_t) + \epsilon_t$$

All variables are transformed into their natural logarithms (ln) to facilitate interpretation and reduce skewness.

$$\ln(GDP_t) = \beta_0 + \beta_1 ln(NFF_t) + \beta_2 \ln(REC_t) + \beta_3 ln(NR_t) + \beta_4 ln(GCF_t) + \beta_5 ln\text{FCE}) + \beta_6 \ln(TR_t) + \epsilon_t$$

Where $lnGDP_t$ is natural logarithm of economic growth (current US$), $ln(NFF_t)$is natural logarithm of net financial flow (current US$), $\ln(REC_t)$ is natural logarithm of renewable energy consumption as (% of total final energy consumption), $lnNR)$ is natural logarithm of total natural resources rents (% of GDP), $ln(GCF_t)$is natural logarithm of Gross capital formation (% of GDP),

$ln(FCE_t)$ is natural logarithm of Final consumption expenditure (current US$), $ln(TR_t)$ is natural logarithm of Trade (% of GDP) and ϵ_t is error term.

Stationary and Unit Root Tests

Before proceeding with the analysis, it is crucial to ensure that the time-series data is stationary. The **Augmented Dickey-Fuller (ADF)** test is used to check for unit roots in the variables. The general form of the ADF test equation is:

$$\Delta y_t = \alpha\beta_t + \gamma y_{t-1} + \sum_{i=1}^{p} \delta_i \,\Delta y_{t-1} + \epsilon_t$$

Where y_t represents the time-series data, Δ is the first difference operator, $\epsilon_t$is the error term and The null hypothesis H_o is that the series contains a unit root (i.e., it is non-stationary). If the null is rejected, the variable is considered stationary.

Co integration Tests

Since the study focuses on the long-term relationship between financial development, renewable energy consumption, and economic growth, it is essential to determine whether these variables are cointegrated. Cointegration tests allow us to assess if a long-run equilibrium relationship exists among the variables. If the variables are found to be integrated of the same order (e.g., I(1)), we test for cointegration using the **Johansen Cointegration Test**. The cointegration equation is as follows:-

$$\Delta y_t = \alpha + \sum_{i=1}^{p} \beta_i \,\Delta y_{t-1} + \prod y_{t-1} + \epsilon_t$$

Where:
$y_t = (\ln(GDP_t), \ln(NFF_t), \ln(REC_t), ln(NR_t), ln(GCF_t), \ln(FCE_t), \ln(TR_t))'$is the vector of variables and $\prod$ represents the matrix of co integration relationships.

The presence of co integration implies a long-run relationship between the variables, and this is followed by the estimation of an **Error Correction Model (ECM)**.

Dynamic Error Correction Model (ECM):

If co integration is found between the variables, an **Error Correction Model (ECM)** is used to model both the short-run dynamics and the long-run equilibrium relationship between the variables. The ECM equation is specified as:

$$\Delta\ln(GDP_t) = \beta_0 + \beta_1\Delta\ln(NFF_t) + \beta_2\Delta\ln(REC_t) + \beta_3\Delta ln(NR_t) + \beta_4\Delta ln(GCF_t) + \beta_5\Delta\ln(FCE_t) + \beta_6\Delta\ln(TR_t) + \gamma EC_{t-1} + \epsilon_t$$

Where:$\Delta\ln(GDP_t), \Delta\ln(NFF_t), \Delta\ln(REC_t), \Delta ln(NR_t), \Delta ln(GCF_t), \Delta\ln(FCE_t), \Delta\ln(TR_t)$ are the first differences of the natural logarithms of economic growth, financial development, and renewable energy consumption, γEC_{t-1} is the error correction term that represents the lagged deviation from the long-run equilibrium, γ captures the speed of adjustment to the long-term equilibrium.

To capture short-run dynamics and any potential deviations from long-term equilibrium, the **Error Correction Model (ECM)** will be employed following the cointegration tests. The ECM allows the model to adjust for short-term imbalances while maintaining long-term equilibrium relationships.

Granger Causality Test:
To examine the direction of causality between the variables, the **Granger causality test** is performed. The null hypothesis in the Granger causality test is that there is no causal relationship between the variables. The alternative hypothesis is that one variable does "Granger cause" another variable.

CONCLUSION

The inclusion of these control variables ensures that the analysis accounts for a broad range of factors that could potentially influence economic growth, financial development, and renewable energy consumption in Tanzania. By controlling for investment, trade openness, inflation, and other relevant factors, the model provides a more accurate and comprehensive understanding of the dynamic relationships among these variables.

RESULTS AND DISCUSSION

This part includes results and discussion of findings on analyzing the Dynamic Relationships between Financial Development, Renewable Energy Consumption, and Economic Growth of Tanzania. The analysis is based on the objectives of the study, the presentation and the interpretation done with the help of tables, charts and narrative text as follows.

Table 1: Descriptive Statistics of Variables

	LNGDP	LNNFF	LNREC	LNNR	LNGCF	LNFCE	LNTR
Mean	23.75179	19.66572	4.487328	1.829320	3.215943	23.43850	3.596569
Median	23.64143	19.89612	4.508657	1.720564	3.361166	23.36179	3.570769
Maximum	24.98108	20.64438	4.555980	2.642385	3.682016	24.50373	4.028314
Minimum	22.54505	18.47934	4.360548	1.261709	2.328290	22.17784	3.177600
Std. Dev.	0.797822	0.765043	0.058339	0.390855	0.395390	0.789427	0.238449
Skewness	-0.017220	-0.275587	-0.756316	0.494557	-0.506220	-0.217130	0.051870
Kurtosis	1.670088	1.466554	2.114385	2.234916	2.105416	1.717248	1.873069
Jarque-Bera	2.359802	3.540331	4.096493	2.084932	2.433755	2.445379	1.707647
Probability	0.307309	0.170305	0.128961	0.352584	0.296153	0.294437	0.425784
Sum	760.0572	629.3030	143.5945	58.53826	102.9102	750.0319	115.0902
Sum Sq. Dev.	19.73213	18.14402	0.105507	4.735785	4.846326	19.31903	1.762595
Observations	32	32	32	32	32	32	32

Source: Author's computation using Eviews 13

Table 1 show the summary of the descriptive statistics of the seven variables employed in the model in term of mean, median, maximum, minimum, standard deviation and so on as the results shown on **Table 1** above. The descriptive statistics is carried out to further give insight on the trend, normality and stability of the variables used in the research analysis. The standard deviation, skewness, kurtosis, Jarque-Bera and probability confirmed that the variables are stable and normal. However, Gross Domestic Product, Net financial flows, Gross Capital Formation, Final Consumption Expenditure and Trade are not far from normal or do have a slight deviation from normality. While there is minor right-skewness of the Renewable Energy Consumption and Natural Resource, which shows a slightly higher concentration in both ends. The overall variability is moderate; Renewable Energy Consumption and Trade, are very low. The variables do not deviate from normality except that Renewable Energy is a little left-skewed with some deviating from normality.

ADF Unit Root Test Result

Table 2: ADF Unit Root Test Result

Variables	Model specification	ADF AT LEVEL		ADF FIRST DIFFERENCE		Order of integration lag
		t-stat	Results	t-stat	Results	
LNGDP	Intercept	-0.757101 (-2.967767)	Non stationary	-4.768932 (-2.967767)	Stationary	I(1)
LNNFF	Intercept	-0.771664 (-2.967767)	Non Stationary	-5.587959 (-2.967767)	Stationary	I(1)
LNREC	Intercept	1.514721 (-2.960411)	Non Stationary	-4.340520 (-2.963972)	Stationary	I(1)
LNNR	Intercept	-2.387632 (-2.963972)	Non stationary	-3.336303 (-2.963972)	Stationary	I(1)
LNGCF	Intercept	-0.967502 (-2.960411)	Non stationary	-5.807954 (-2.963972)	Stationary	I(1)
LNFCE	Intercept	-0.636368 (-2.963972)	Non stationary	-3.897737 (-2.963972)	Stationary	I(1)
LNTR	Intercept	-2.214188 (-2.963972)	Non stationary	-3.722652 (-2.963972)	Stationary	I(1)

Source: Author's computation using E views 13

NB: Figures in parentheses represent the critical values at 5% level of significance.

The results above shown all the series are non stationary at the level but become stationary after first differencing. This infers that all the variables Gross Domestic Product, Net financial flows, Renewable Energy Consumption, Natural Resource, Gross Capital Formation, Final Consumption Expenditure and Trade are all I(1) series, implying they have to be differenced once to attainstationarity. This then implies that you can utilize a co integration approach, for instance, an ECM model, in investigating any long-run relationship that exists between these variables, since they are integrated of the same order, I(1).

Johansen Co integration Results

Table 3 Johansen Test for Cointegration for Unrestricted Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05	Prob.**
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Critical Value

None *	0.998837	445.0186	125.6154	0.0000
At most 1 *	0.975961	249.0663	95.75366	0.0000
At most 2 *	0.930037	140.9518	69.81889	0.0000
At most 3 *	0.648980	63.81812	47.85613	0.0008
At most 4 *	0.563902	33.45767	29.79707	0.0181
At most 5	0.276617	9.390922	15.49471	0.3305
At most 6	9.03E-06	0.000262	3.841465	0.9891

Trace test indicates 5 co integrating eqn(s) at the 0.05 level

*Denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Source: Generated from E view 13.

The study used vector error correction mechanism to estimate both and long run relationship. However the Johansen co integration test for long run relationship is conducted to check the steady nature of the variables. This can only be possible when the variables have been assigned through ADF test as shown in **Table2**. When the this pre-condition for running co integration test is met, then such test is to be done and when variables integrated of the same order, I(1) and become stationary. This test is done in order to assess whether to use restricted Vector Error Correction Model (VECM) for long-run causality and short-run causality or Vector autoregressive (VAR) as well the ECM.

The Johansen test shows that there is five co integration which allows us to use ECM because there is long-run relationship among our variable therefore, all variable are moving together or co integrated. The **Table 3** shows that there is five co integrated variables because at Null Hypothesis the Trace statistic is (9.390922) less than critical value (15.49471) at 0.05 (5%) level. This implies that our variables such that Gross Domestic Product, Net financial flows, Renewable Energy Consumption, Natural Resource, Gross Capital Formation, Final Consumption Expenditure and Trade, are co integrated together or moving toward equilibrium. Therefore, we used ECM to estimate our results.

Table 4 Johansen Test for Co integration for Unrestricted Co integration Rank Test (Maximum Eigen value).

Hypothesized		Max-Eigen	0.05	Prob.**
No. of CE(s)	Eigen value	Statistic	Critical Value	Critical Value
None *	0.998837	195.9523	46.23142	0.0000
At most 1 *	0.975961	108.1145	40.07757	0.0000
At most 2 *	0.930037	77.13367	33.87687	0.0000
At most 3 *	0.648980	30.36044	27.58434	0.0214
At most 4 *	0.563902	24.06675	21.13162	0.0187
At most 5	0.276617	9.390660	14.26460	0.2551

At most 6	9.03E-06	0.000262	3.841465	0.9891

Max-Eigen value test indicates 5 co integrating eqn(s) at the 0.05 level

*Denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Source: Generated from E view 13.

As it has been seen in **Table 3** for trace statistics test, **Table 4** also indicates as the results for co integration for unrestricted Co integration Rank Test (Maximum Eigen value). Maximum Eigen value is another statistics test that normally provides the same result as trace statistic. For max-Eigen value statistic, the result shows an existence of five co integrated variables. This means that all variables such as Gross Domestic Product, Net financial flows, Renewable Energy Consumption, Natural Resource, Gross Capital Formation, Final Consumption Expenditure and Trade are co integrated together. Maxi-Eigen value (9.390660) is less than critical value (14.26460) at 0.05 (5%) level together. However, both co integration tests Trace statistic and Max-Eigen statistics show the same result of co integration. So we can decode to choose either trace statistics or Max-Eigen statistics for further analysis since they yield the same number of co integration. When the variables are co integrated, this means that there is long-run relationship associated in our variables.

Vector Error Correction Estimates

Table 5 Cointegrating Eq: CointEq1

LNGDP(-1)	LNNFI(-1)	LNREC(-1)	LNNR(-1)	LNGCF(-1)	LNFCE(-1)	LNTR(-1)	C
1.000000	-0.36022	2.612247	-0.32923	1.063394	-1.2232	0.235390	-3.3827
	(0.08977)	(1.24607)	(0.19644)	(0.19764)	(0.15545)	(0.22835)	
	[-4.01257]	[2.09638]	[-1.67597]	[5.38048]	[-7.86859]	[1.03083]	
Error Correction:	D(LNGDP)	D(LNNFI)	D(LNREC)	D(LNNR)	D(LNGCF)	D(LNFCE)	D(LNTR)
COINTEQ1	-0.03432	0.814309	0.009155	0.853485	-0.70014	-0.19752	0.122254
	(0.10018)	(0.50911)	(0.01734)	(0.25356)	(0.20000)	(0.11914)	(0.15659)
	[-0.34257]	[1.59949]	[0.52786]	[3.36600]	[-3.50067]	[-1.65790]	[0.78074]
D(LNGDP(-1))	0.201616	1.428191	-0.0201	0.243365	0.999406	0.255647	-0.33433
	(0.34980)	(1.77769)	(0.06056)	(0.88538)	(0.69836)	(0.41601)	(0.54677)
	[0.57637]	[0.80340]	[-0.33191]	[0.27487]	[1.43108]	[0.61452]	[-0.61146]
D(LNNFI(-1))	0.010455	-0.04335	0.004036	0.098475	-0.01728	-0.02919	0.113455
	(0.04712)	(0.23944)	(0.00816)	(0.11925)	(0.09406)	(0.05603)	(0.07364)
	[0.22190]	[-0.18106]	[0.49472]	[0.82576]	[-0.18373]	[-0.52090]	[1.54056]
D(LNREC(-1))	-0.58069	-10.8628	-0.06642	-4.92657	5.628404	2.093559	1.478211

	(1.60095)	(8.13599)	(0.27718)	(4.05215)	(3.19621)	(1.90397)	(2.50240)
	[-0.36272]	[-1.33515]	[-0.23961]	[-1.21579]	[1.76096]	[1.09958]	[0.59072]
D(LNNR(-1))	0.106832	0.192382	-0.02235	0.119766	-0.09118	0.090515	0.091314
	(0.08576)	(0.43582)	(0.01485)	(0.21706)	(0.17121)	(0.10199)	(0.13405)
	[1.24573]	[0.44142]	[-1.50541]	[0.55176]	[-0.53258]	[0.88748]	[0.68121]
D(LNGCF(-1))	-0.12129	0.802976	0.003127	0.029409	0.112619	-0.21812	0.194015
	(0.12595)	(0.64006)	(0.02181)	(0.31878)	(0.25144)	(0.14978)	(0.19686)
	[-0.96303]	[1.25454]	[0.14338]	[0.09226]	[0.44789]	[-1.45619]	[0.98553]
D(LNFCE(-1))	0.321334	-0.76751	0.016462	-1.52958	-0.43867	0.559940	-0.16101
	(0.33438)	(1.69931)	(0.05789)	(0.84634)	(0.66757)	(0.39767)	(0.52266)
	[0.96098]	[-0.45166]	[0.28435]	[-1.80728]	[-0.65711]	[1.40805]	[-0.30806]
D(LNTR(-1))	0.165222	-0.78754	0.006964	-0.8527	0.719627	0.266086	0.113773
	(0.16581)	(0.84266)	(0.02871)	(0.41969)	(0.33104)	(0.19720)	(0.25918)
	[0.99644]	[-0.93459]	[0.24258]	[-2.03176]	[2.17387]	[1.34934]	[0.43898]

Source: Generated from E view 13.

The result Table 5 of error correction term from the co integration equation shown that has coefficient of-0.03432, meaning 3.4% adjustment towards the long-run equilibrium value per period. However, the t-statistic of this term is -0.34257, which is in significant and hence is an unreliable speed of adjustment in the short run. In the long run, Gross Domestic Product in period 1 is the reference variable, hence its coefficient is equal to 1. The Net Financial Flow shows a significant negative relationship with Gross Domestic Product since a 1% increase in Net Financial Flow decreases the Gross Domestic Product. The Renewable Energy Consumption has a positive relationship with Gross Domestic Product similar results of Juan Wang et al (2021), though it is not statistically significant. The coefficients of Natural Resource have a significant negative effect, indicating that an increase in Natural Resources decreases Gross Domestic Product. The Gross Capital Formation is statistically significant and positively affects Gross Domestic Product, while Final Consumption Expenditure though statistically insignificant, still shows a negative influence. Lastly, Trade is statistically significant and positively related to Gross Domestic Product.

Results of Short Run Estimates and Error Correction Mechanism (ECM).

Table 6 Results of Short Run Estimates and Error Correction Mechanism (ECM).

Dependent Variable: D(LNGDP)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.010995	0.010491	1.048049	0.3055
D(LNNFI)	0.013033	0.020444	0.637507	0.5301
D(LNREC)	-0.515592	0.673222	-0.765858	0.4515
D(LNNR)	0.060003	0.042032	1.427552	0.1669
D(LNGCF)	-0.209703	0.054905	-3.819360	0.0009

D(LNFCE)	0.931208	0.112212	8.298642	0.0000
D(LNTR)	-0.026599	0.069120	-0.384818	0.7039
ECM(-1)	-0.510095	0.168908	-3.019956	0.0061
R-squared	0.808053	Mean dependent var		0.078574
Adjusted R-squared	0.749634	S.D. dependent var		0.072750
S.E. of regression	0.036402	Akaike info criterion		-3.570757
Sum squared resid	0.030477	Schwarz criterion		-3.200695
Log likelihood	63.34673	Hannan-Quinn criter.		-3.450126
F-statistic	13.83207	Durbin-Watson stat		1.413976
Prob(F-statistic)	0.000001			

Source: Generated from E view 13

The Table 6 presented of short-run (ECM). We see that estimated equation of error correction mechanism (ECM) value is -0.510095which implies that the speed of adjustment is approximately 51% per year. This negative and significant coefficient is an indication of an existence of co-integrating relationship among the variables.

The size of coefficient on the error correction model denotes that 51% speed of correct or adjustment of the disequilibrium caused by previous shock converges back to the long run equilibrium in the current year. For the specific case of Net Financial Flow, it shows an insignificance effect. The positive value of 0.013033 shows that an increase in Net Financial Flow increases economic growth show the similar results of Lianbiao Cui, ShimeiWeng and Malin Song, (2022) and Amarachietal. (2022). Renewable Energy Consumption is not significance and has a negative relationship with economic growth differ from result of Hassan, Qudrat-Ullah., Chinedu, Miracle, Nevo. (2022), Anh and Nguyen,(2021) and Li etal.(2021). The and Natural resource also is statistical insignificance but has positive relationship on Economic Growth, while Gross Capital formation is statistical significance and has negative relationship with Economic Growth, but Final Consumptions has statistical significance and positive relationship on Economic growth and total Trade are not statically significant at 5% level but has positive relationship with Economic Growth.

Short run causality

Table 7 VEC Granger Causality/Block Exogeneity Wald Tests

Dependent variable: D(LNGDP)			
Excluded	Chi-sq	df	Prob.
D(LNNFI)	0.049238	1	0.8244
D(LNREC)	0.131564	1	0.7168
D(LNNR)	1.551835	1	0.2129
D(LNGCF)	0.927418	1	0.3355
D(LNFCE)	0.923492	1	0.3366
D(LNTR)	0.992890	1	0.3190
All	5.938787	6	0.4301

Source: Generated from E view 13.

The Granger causality test results show that individual variables and overall variables in the set are not able to Granger-cause Economic Growth- in the short run with a set of variables: Net financial flows, Renewable Energy Consumption, Natural Resource, Gross Capital Formation, Final

Consumption Expenditure and Trade. This evidence presents that disturbances in these variables do not directly hit the economic growth in the very short-run period. These results are similar as Hassan, Qudrat-Ullah., Chinedu, Miracle, Nevo. (2022) but opposite from results of Juan Wang et al (2021).These are indeed variables that might exert effects in the long run; however, they are insignificant in explaining the short-run dynamics, which suggests a time lag for their eventual impact.

Evaluation of the Model

Table 8 VEC Residual Normality Tests

Component	Jarque-Bera	df	Prob.	
1	2.015499	2	0.3650	
2	1.691512	2	0.4292	
3	1.689188	2	0.4297	
4	4.977333	2	0.0830	
5	6.472084	2	0.0393	
6	2.278794	2	0.3200	
7	1.125560	2	0.5696	
Joint	20.24997	14	0.1225	

Source: Generated from E view 13

Table8 shown VEC Residual Normality Tests The normality of the residuals for each component and the overall model are shown in the following table. Most components have a probability of being greater than 0.05, which would suggest normality. However, Component 5 has a Jarque-Bera statistic of 6.472084 and a probability of 0.0393, indicating non-normality. Finally, the joint Jarque-Bera statistic of 20.24997 with a probability of 0.1225 indicates that residuals from all combined components are insignificantly deviated from normality. In general, most of the components are normally distributed, except for Component 5. The joint test confirms that the residuals do not have any significant deviation from normality.

Table 9 VEC Residual Serial Correlation LM Test

Null hypothesis: No serial correlation at lag h						
Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	44.96313	49	0.6375	0.852164	(49, 45.0)	0.7087
2	29.68105	49	0.9868	0.498145	(49, 45.0)	0.9910
Null hypothesis: No serial correlation at lags 1 to h						
Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	44.96313	49	0.6375	0.852164	(49, 45.0)	0.7087
2	102.5495	98	0.3566	0.631667	(98, 15.2)	0.9088

Source: Generated from Eview 13

Serial correlation tests do not indicate significant serial correlation at lags 1 and 2. At lag 1, the LRE* statistic is 44.96313 with a p-value of 0.6375,whilethe Rao F-statistic is 0.852164 with a p-value of 0.7087. At lag 2, the LRE* statistic is 29.68105 with a p-value of 0.9868,whilethe Rao F-statistic is 0.498145 with a p-value of 0.9910. The results are consistent when testing from lags 1 to h. In general, all probabilities are above the 5% significance level, which justifies no serial correlation at these lags.

Table 10VEC Residual Heteroskedasticity Tests

VEC Residual Heteroskedasticity Tests (Levels and Squares)					
Joint test:					
Chi-sq	df	Prob.			
458.7862	448	0.3521			

Source: Generated from E view 13

The results of the VEC Residual Heteroskedasticity Test are that the joint test statistic is 458.7862 with 448 df and a probability of 0.3521. Since the probability is greater than the 5 percent significance level, we fail to reject the null hypothesis of homoskedasticity. This means there is no significant evidence in the heteroskedasticity of the residuals, indicating that the variance of the errors is constant for all observations.

CONCLUSION AND RECOMMENDATIONS

The relationship between financial development, renewable energy consumption, and economic growth is intricate. At the initial stages, financial development may not help much in the adoption of renewable energy because of the high up-front costs. However, as financial development progresses, it can significantly boost the transition toward renewable energy by ensuring access to investment capital. This can spur economic growth through new industries and job creation as well as increases in productivity. The quality of institutions and regulations in Tanzania would be important for financial development that will support renewable energy adoption. Good governance and stable policies are important in attracting investments in renewable technologies. Institutional setups can nurture the positive impacts of renewable energy on economic growth. On the other hand, weak governance will always stand in the way of a financial sector that is conducive to supporting renewable energy and economic development.

Tanzania is not exceptional in the challenges that are commonly linked with the adoption of renewable energy. One of the crucial barriers is the initial high costs of renewable energy technologies. The long-term advantages, including sustainability and energy security, are obviously there, but this factor turns out to be a significant barrier to investing in these technologies. Some of the obstacles that stand in the way of the energy transition for Tanzania include limited access to capital, poor infrastructure, and the lack of renewable financing. However, rising global interest in green financing and new instruments in the form of green bonds have opened large opportunities for major funding of these projects. In addition, international financial support in the form of aid and development loans is important for the promotion of renewable energy in Tanzania. Moreover, with improved regulation, investments could be attracted by public-private partnerships. This study is very important because it explores the link between financial development, renewable energy, and economic growth in Tanzania. These findings may provide policymakers with evidence-based recommendations on how financial systems and energy policies should be structured to encourage the adoption of renewable energies and sustainable economic growth.

Appendix 1

Explanation of variables

GDP	Gross Domestic Product
NFF	Net financial Flows
REC	Renewable Energy Consumption
NR	Natural Resources
GCF	Gross Capital Formation

FCE	Final Consumption Expenditure
TR	Trade

Appendix 2

YEAR	LNGDP	LNNFI	LNREC	LNNR	LNGCF	LNFCE	LNTR
1990	22.54529	18.8591	4.53582	2.442324	2.889339	22.17784	3.540484
1991	22.69704	18.90098	4.53903	2.304222	2.897856	22.33002	3.408888
1992	22.62268	19.12947	4.540098	2.434545	2.931331	22.27296	3.574248
1993	22.54505	18.52307	4.544358	2.372711	2.850824	22.20301	3.811904
1994	22.6028	18.80545	4.55598	2.452137	2.831705	22.24126	3.789556
1995	22.75554	18.50664	4.53582	2.642385	2.612113	22.33516	3.810254
1996	22.96754	18.61096	4.522875	2.424716	2.438611	22.53931	3.575893
1997	23.13544	19.02503	4.529368	2.183049	2.32829	22.68604	3.362414
1998	23.22247	18.63409	4.533674	1.745653	3.046134	23.06816	3.263606
1999	23.26521	19.12621	4.54542	1.326599	2.902428	23.12023	3.219758
2000	23.31641	18.88622	4.53903	1.323178	2.860073	23.15313	3.1776
2001	23.33068	18.47934	4.533674	1.397265	2.907818	23.13313	3.33328
2002	23.37154	19.01408	4.526127	1.580518	2.895254	23.15937	3.314158
2003	23.44532	19.91476	4.526127	1.926106	3.029379	23.21732	3.416048
2004	23.53706	19.80349	4.514151	1.677899	3.198411	23.27647	3.514817
2005	23.63537	19.87748	4.503137	1.608155	3.310393	23.35561	3.609817
2006	23.64749	19.96256	4.498698	1.708734	3.411938	23.36797	3.755794
2007	23.80794	20.24312	4.506454	1.825533	3.485882	23.53016	3.872417
2008	24.05361	20.07167	4.503137	1.624641	3.624061	23.73351	3.892362
2009	24.10428	20.5959	4.51086	1.711319	3.536767	23.78667	3.77351
2010	24.1894	20.56737	4.493121	1.715501	3.466275	23.92032	3.863682
2011	24.26877	19.87337	4.472781	1.992857	3.547778	24.02238	4.028314
2012	24.40337	20.34857	4.445001	1.921694	3.550913	24.15968	3.995793
2013	24.54424	20.64438	4.436752	1.752193	3.623557	24.2825	3.884274
2014	24.63502	20.49861	4.439116	1.618775	3.628438	24.3529	3.814543
2015	24.58218	20.50481	4.416428	1.668073	3.489168	24.27822	3.707644
2016	24.63077	20.09606	4.403054	1.725626	3.471183	24.25959	3.56729
2017	24.69873	20.42232	4.406719	1.636307	3.476742	24.31878	3.499914
2018	24.76638	20.38703	4.398146	1.28415	3.647447	24.38058	3.485618
2019	24.83458	20.43394	4.387014	1.261709	3.682016	24.42573	3.497071
2020	24.91396	20.41892	4.391977	1.348513	3.65704	24.44011	3.330883
2021	24.98108	20.13797	4.360548	1.901168	3.681016	24.50373	3.398366

Source: World Bank Data

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