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Trade Openness, Energy Consumption, and Financial Development Influence on Jordan's Economy: Evidence from ARDL and Non-Granger Causality Test Approach

Baha Aldeen Mohammad Fraihat[1], Asma'a Al-Amarneh[2], Hadeel Yaseen[3], Miral R. Samarah[4], Bashar Younis Alkhawaldeh[5]*, Ola Buraik[6]

[1]Department of Administrative Sciences, Faculty of Business, Jerash University, Jordan, [2]Department of Financial and Accounting Sciences Faculty of Business, Middle East University (MEU), Amman, Jordan, [3]Department of Finance, Faculty of Business, Applied Science Private University, Jordan, [4]Department of Finance and Banking, Faculty of Business, Applied Science Private University, Jordan, [5]Department of Administrative Sciences, Faculty of Business, Jerash University, Jordan, [6]Department of Accounting, Faculty of Business, Jerash University, Jordan. *Email: basharyounes@yahoo.com

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ABSTRACT

The purpose of this study is to analyze the effect of trade openness, energy consumption, and financial development on Jordan's economic development using the Autoregressive Distributed Lag (ARDL) method. By looking at data from 1970 through 2022, the study reveals a short-and long-term impact. Short-term economic development was found to be positively influenced by energy consumption but negatively influenced by trade openness and financial development. However, financial development has a favourable effect on economic development in the long run, whereas trade openness and energy consumption have a negative effect. Furthermore, evidence of a nonlinear bidirectional causal relationship between trade openness and economic development, and evidence of a one-way causal relationship between energy consumption and economic development, were found by the results of Diks and Panchenko's Granger causality test. The development of the economy and the financial sector also demonstrated a reciprocal causal relationship. These findings have important implications for policy and strategic planning for Jordan's economic growth and underscore the need to carefully weigh the potential costs and gains of trade liberalization, financial sector development, and energy consumption.

Keywords: ARDL, Jordan, Economic Development, Energy Consumption, Financial Development, Trade Openness
JEL Classifications: B23, N15, O11, Q43, D53, P33

1. INTRODUCTION

Trade liberalization, consumption of energy, and the development of the financial sector are all factors that contribute to economic development (Fayyad and Daly, 2021). In order to formulate policies, organize the economy, and foster long-term growth in Jordan's developing market, a thorough comprehension of these interconnections is required. Economic development refers to the process by which a nation improves the material, political, and social conditions of its population. Improvements in income and living standards, infrastructure and technological advancements, and the quality of education and health services are just a few of the many facets of economic development, which touches on virtually every sector of the economy. Economic development is a complicated concept that is closely intertwined with a number of other macroeconomic factors. For example, trade openness-the extent to which a country participates in international trade-can promote economic development by facilitating the exchange of goods, services, and information. Economic growth and development are enhanced by greater trade openness because

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it allows economies to specialize in areas where they have comparative advantage and to access a broader market (Fayyad and Daly, 2021). Trade openness is believed to spur economic growth by facilitating access to markets and promoting competition and innovation (Zhang and Freestone, 2022).

Empirical data, particularly from developing countries, support the theoretical premise underlying this perspective (Nduka et al., 2021). However, the literature has not really addressed the context-specific impact of trade openness on Jordan's economic growth. Energy consumption is a critical component of economic growth. It is closely related to urbanization, industrialization, and a generally higher standard of living (Adedoyin et al., 2021). Understanding the relationship between energy consumption and economic development is essential to developing effective energy policies that support sustainable development in a country like Jordan, which is one of the largest energy importers in the world (Al-mulali et al., 2021). The ability to mobilize funds and allocate resources efficiently is enabled by financial development, which is supported by the effectiveness and maturity of financial institutions (Svirydzenka, 2021; Ismaeel et al., 2023). Although a link between financial development and economic growth is known, the impact varies across economies. Understanding this relationship in the context of Jordan therefore remains essential for implementing meaningful financial policies to promote economic growth.

With this in mind, the objective of this study is to examine how Jordan's economic development is influenced by trade openness, energy consumption, and financial development. The goal is to provide policymakers in Jordan with a comprehensive understanding of these relationships in their specific context to complement the information they already know and help them make informed decisions.

2. LITERATURE REVIEW

The economic literature strongly emphasizes the link between trade openness and economic growth. Balassa (2022) supports globalization and claims that economies that are more open to trade tend to have faster growth rates. Zhang and Freestone's (2022) suggestion that trade openness promotes efficiency in resource allocation, stimulates creativity, and drives technological improvements, leading to better economic development, is consistent with this position. However, these studies also suggest that the effects of trade openness can vary dramatically across countries and industries. Nduka et al. (2021) emphasized the need to contextualize the benefits of trade openness, as these benefits can vary by sector and country. The relationship between energy consumption and economic growth has been a recurring theme in many research papers. For example, Adedoyin et al. (2021) assert that the quantity and effectiveness of energy consumption strongly influence economic development. They argue that in order to promote economic growth, energy, which plays a critical role in virtually all forms of economic activity, must be used efficiently. A study by Al-Mulali et al. (2021) proposed a bidirectional causality between renewable energy consumption and GDP growth, which added another layer to this relationship. According to their results, economic growth can increase energy consumption, but the reverse is also possible. However, they warn that over-reliance on non-renewable energy sources can have a negative impact on the environment and even hinder the growth of a sustainable economy.

The literature widely recognizes the contribution of financial development to accelerating economic development. Svirydzenka (2021) argues that a developed financial system has the potential to boost economic growth through better resource mobilization, increased investment, and mitigated credit risk. Financial progress, according to Fayyad and Daly (2021), can boost GDP expansion by making resource allocation more effective and bolstering economic security. They argue, however, that the pace of economic development can be slowed down by the lack of robust regulatory structures to protect against the possibility of financial crises. Although characteristics like trade openness, energy consumption, and financial development have been shown to significantly affect economic growth in the literature, it is crucial to keep in mind that this is not always the case. The extent and nature of these effects might vary considerably from nation to country as a result of the various socioeconomic and geopolitical forces at play in each situation. Therefore, a more in-depth analysis of the current situation in Jordan would yield more accurate and actionable results.

3. RESEARCH METHODOLOGY

3.1. Data

The secondary time series data used in this study span 1970-2022. Economic development is measured by gross domestic product (GDP) in current U.S. dollars, while energy consumption (EC) is calculated as energy use (kg of oil equivalent per capita). Principal component analysis is used to measure financial development (FD), which also includes market capitalization, lending rates, domestic bank and private sector credit, and broad money supply. The main source of data for this study is the World Development Indicators (2023).

3.2. Unit root

It is essential to ensure that the time series data used for the analysis are stationary before estimating the extended autoregressive distributed lag (ARDL) model. Since non-stationary data can lead to erroneous regression results and invalid conclusions, stationarity is an essential assumption in many econometric models (Ryan et al., 2023). Several unit roots tests have been conducted to test for stationarity, including the Augmented Dickey-Fuller test (ADF) and the Phillips-Perron test (PP). By determining whether a time series has a unit root (a root of the characteristic equation equal to 1), these tests determine whether a time series is nonstationary (Gianfreda et al., 2023). The ADF test determines whether a time series follows a random walk process with or without drift (Sjösten, 2022; Alkhawaldeh, et al., 2022; Fraihat, et al., 2023). It is a popular unit root test. The null hypothesis for the ADF test is that the time series has a unit root, indicating non-stationarity. The time series may also be stationary, which is an alternative theory (Alkhawaldeh, et al., 2023a; Wang et al., 2023). To test for stationarity, the test compares the coefficient of the lagged difference term of the autoregressive model to a crucial value (Ahmad et al., 2015a).

We reject the null hypothesis of nonstationarity and conclude that the time series is stationary if the ADF test statistic is less than the critical value (and the associated P-value is less than the specified significance level, e.g., 0.05). Another unit root test similar to the ADF test is the PP test. It too tests whether a time series contains a unit root (Ahmad et al., 2015b). However, the PP test differs from the ADF test in the underlying assumptions and estimation methods. Like the ADF test, the PP test checks whether the coefficient of the lag difference term is significantly different from zero. We reject the null hypothesis of nonstationarity and find that the time series is stationary if the test statistic is less than the critical value and the corresponding P-value is below the chosen significance threshold. The extended ARDL model can be estimated when stationarity has been established for all variables used in the analysis. The extended ARDL model is an effective econometric tool for analyzing long-run linkages and short-run dynamics between variables when they are stationary and non-stationary.

3.3. The Autoregressive Distributed Lag (ARDL) Approach

The autoregressive distributed lag (ARDL) bounds testing strategy is a technique for determining whether the variables in a time series have a long-run relationship (Pesaran and Pesaran, 2009). Regardless of whether the underlying regressors are pure I(0), pure I(1), or partially cointegrated, the ARDL technique of Pesaran et al. (2001) provides reliable results. Using an F-test, determine whether the coefficients of the lagged levels of the variables (ϕ and γ) are jointly significant. The alternative is that cointegration exists (i.e., $\phi = \gamma = 0$), while the null hypothesis is that no cointegration exists (i.e., $\phi \neq 0, \gamma \neq 0$). Apply the F-test or Wald test to the null hypothesis that there is no long-run relationship because the coefficients of the long-run variables are zero. The test provides two critical value cutoffs, one assuming all variables are I(0) and the other assuming all variables are I(1). The null hypothesis is rejected if the calculated F-statistic exceeds the upper bound, indicating the presence of a long-run relationship. If it falls below the lower bound, the null hypothesis-that there is no long-term relationship-is not rejected. The test is inconclusive if the value falls within the bounds. Estimate the long-run and short-run coefficients of the model if cointegration is found. The model could be expressed as follows:

$$\Delta lnGDP_t = \omega_0 + \sum_{i=1}^{r} \omega_1 lnGDP_{t-1} \sum_{i=1}^{s} + \omega_2 \Delta lnTOP_{t-1} + \sum_{i=1}^{q} \omega_3 \Delta FD_{t-1} + \sum_{i=1}^{w} \omega_4 \Delta lnEC_{t-1} + \tau_1 lnGDP_t + \tau_2 lnTOP_t + \tau_3 lnFD_t + \tau_4 lnEC_t + \varepsilon_t \quad (1)$$

Where, *lnED* is the natural logarithm of Economic Development, *lnTOP* is the natural logarithm of trade Openness, *lnFD* is the natural logarithm of Financial Development, *lnEC* is the natural logarithm of Energy Consumption, ε_t is the error term, and t is the time series.

3.4. Granger Non-causality Test

In order to investigate the non-linear cause-and-effect relationship between trade openness, energy consumption, financial development, and economic development in Jordan, the authors utilized the Diks and Panchenko non-parametric Granger causality test. The primary goal was to ascertain if there is a nonlinear causal relationship between changes in these variables. Diks and Panchenko's nonparametric Granger causality test is a statistical method for identifying correlations between variables without assuming anything about their underlying distribution (Almassri et al., 2023). It excels in situations when the connection between causes and effects is not necessarily linear. This test of causation begins with the assumption that the observed relationships are coincidental. In other words, the null hypothesis assumes that there is no correlation between the variables and that changing one variable does not affect the others (Fadol, 2020). The researchers tested the hypothesis that there is no significant causal relationship between trade openness, energy consumption, financial development, and economic development in Jordan using the Diks and Panchenko nonparametric Granger causality test. The test's findings can help clarify the intricate interplay between these factors and their effect on Jordan's economic development.

Ω_t on the $\varnothing_{t-1}\ldots, \varnothing_{t-lx}$, assumed the $\Omega_{t-1}\ldots, \Omega_{t-ly}$; Hence,

$$H_0: \ \Omega_{t+1} \left| \left(\varnothing_t^{\ell_\varnothing}; \Omega_t^{\ell_\varnothing} \right) \sim \Omega_{t+1} \right| \Omega_t^{\ell_x}, \quad (2)$$

It must comply with its marginal:

$$\frac{f_{\varnothing,\Omega,\infty}(\varnothing,\Omega,\infty)}{f_\Omega(\Omega)} = \frac{f_{\varnothing,\Omega,\infty}(\varnothing,\Omega)}{f_\Omega(\Omega)} \cdot \frac{f_{\Omega,\infty}(\Omega,\infty)}{f_\Omega(\Omega)} \quad (3)$$

The vector for each ($\varnothing$, Ω, ∞) in the provision of ($\varnothing$, Ω, ∞) Diks and Panchenko additionally show that the null hypothesis indicates:

$$r \equiv Q\left[f_{\varnothing,\Omega,\infty}(\varnothing,\Omega,\infty) f_\Omega(\Omega) - f_{\varnothing,\Omega}(\varnothing,\Omega) f_{\Omega,\infty}(\Omega,\infty) \right] = 0 \quad (4)$$

$$T_n(\pi_n) = \frac{n-1}{n(n-2)} \sum_i (f'_{\varnothing,\Omega,\infty}(\varnothing_i,\Omega_i,\infty_i) f'_\Omega(\Omega_i) - f'_{\varnothing,\Omega}(\varnothing_i,\Omega_i) f'_{\Omega,\infty}(\Omega_i,\infty_i)) \quad (5)$$

4. RESULTS AND DISCUSSION

4.1. Lag Selection Criteria

The ideal length of delay in a model that best fits the data is determined by delay selection criteria. These criteria include the Hannan-Quinn criterion (HQC), the Akaike information criterion (AIC), and the Bayesian information criterion (BIC) (Ahmad et al., 2015c). In this situation, a delay of 1 is the most appropriate value with respect to all factors listed in Table 1.

4.2. Descriptive Statistics and Correlation Analysis

Economic time series data often exhibit a non-normal (skewed) distribution due to the occurrence of outliers and trends. To assess the normality of the variables in the model, the Jarque-Bera test is used, as shown in Table 2. To determine normality, the test

Table 1: Lag selection results

Lag	LogL	LR	FPE	AIC	SC	HQ
0	−73.05148	NA	0.000273	3.144959	3.299393	3.203551
1	150.8099	402.0368*	5.66e-08*	−5.339180*	−4.567008*	−5.046219*
2	166.2149	25.15103	5.88e-08	−5.314894	−3.924985	−4.787565
3	172.6485	9.453454	9.00e-08	−4.924429	−2.916783	−4.162731
4	183.9701	14.78738	1.17e-07	−4.733473	−2.108090	−3.737407

AIC: Akaike information criterion

Table 2: Descriptive statistics

Variables	Mean	Median	Standard deviation	Skewness	Kurtosis
LNGDP	22.80136	22.65877	1.197755	−0.24482	2.351616
LNTOP	0.243813	0.164743	0.404159	2.102358	1.04715
LNFD	−1.89E-08	0.476263	1.719489	−0.7745	2.7896
LNEC	6.721196	6.86559	0.375729	−1.71743	1.582783

calculates the skewness and kurtosis coefficients using the mean. A measure of the asymmetry of the distribution is skewness. Its value should be between 0 and +3 under typical circumstances. In contrast, the kurtosis measures how "peaked" or tapered the distribution is, and it should be between 0 and +3 for a normal distribution. The alternative hypothesis for the normality test suggests that the series does not have a normal distribution, while the null hypothesis assumes that it does. The series is considered not normally distributed if the probability value is below the 5% significance level. The series in Table 1 deviates significantly from the normal distribution, as shown by the mean Jarque-Bera coefficients and the standard deviation in the frequency distributions. The considerable volatility of the variables lnED, lnTOP, lnFD, and lnEC relative to interest rates is reflected in their standard deviation values. The results of the Pearson correlation matrix for the series are also shown in Table 3.

Table 3: Correlation analysis

Variables	LNED	LNTOP	LNFD	LNEC
LNGDP	1.000			
LNTOP	−0.430	1.000		
LNFD	0.262	−0.532	1.000	
LNEC	0.620	−0.471	0.318	1.000

4.3. Unit Roots Results

The results of the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are shown in Table 4. According to these tests, LNEC and LNTOP are both integrated at I(1) and I(0), but LNGDP and LNFD are integrated only at I(1). This suggests that the variables have different degrees of stationarity. This shows the importance of the Autoregressive Distributed Lag (ARDL) method for this study.

4.4. ARDL Bound Test Result

The results of the cointegration limits test are shown in Table 5. At a 1% significance level, it is noteworthy that the F-statistics for both I(0) and I(1) are higher than the critical values. This result is significant for econometric analysis because it shows that the variables under consideration-trade openness, energy consumption, financial development, and economic developmen-exhibit an equilibrium relationship in the long run. In other words, changes in one of these variables lead to changes in the others in the long run, indicating some degree of interdependence among them. Consequently, we can safely assert that these variables are cointegrated.

4.5. Long Run and Short Run Results

The results show interesting relationships between financial development (LNFD), trade openness (LNTOP), energy consumption (LNEC), and economic development (LNGDP), which are summarized in Table 6. In particular, the short-term study shows that LNFD and LNTOP have significant, negative impacts on LNED. Accordingly, a 1% increase in LNFD and LNTOP leads to a proportional decrease in LNGDP of 0.482 and 0.359, respectively, which can be seen as a short-term manifestation of trade-offs where gains in financial development and trade openness may drain resources or lead to temporary difficulties that slow down economic development (Nazar et al., 2022). On the other hand, LNECs appear to act as a catalyst for LNGDP in the short run, as evidenced by a sizable and beneficial effect. LNGDP increases by 0.277 when LNEC increases by 1%, showing the critical role of energy in boosting economic activity in the short run. This supports the idea that energy consumption is a critical driver of industry, economic growth, and global development (Chen et al., 2020; Doğan et al., 2020). Looking at things from a long-term perspective, the dynamics change noticeably. This suggests that, despite short-term trade-offs, financial development is essential for sustainable economic growth in the long run. The LNGDP has a significant and positive impact on the LNGDP. The financial sector is expected to boost economic development through better capital allocation and risk management as its ages and becomes more efficient (Wang et al., 2022). On the other hand, both LNTOP and LNEC show significant long-term negative effects on LNGDP. This result may reflect the notion that energy consumption and trade openness may promote economic growth in the short run, but may also create vulnerabilities in the long run, such as dependence on foreign markets or unsustainable energy consumption. Importantly, the error correction term (ECT) is negative and statistically significant, supporting the conclusion of the limit test that there is a cointegration relationship between these variables. The ECT value indicates a rapid rate of adjustment: Any short-term deviation from long-term equilibrium is expected to self-correct by about 54%. This indicates that despite short-term changes, there is a stable long-term relationship to which the system tends to return over time.

Table 4: ADF, and PP unit root test

Variables	ADF				PP			
	Level		1st Diff.		Level		1st Diff.	
	t stats	P-values	t stats	P-values	t stats	P-values	t stats	P-values
LNEC	−3.859**	0.004	−5.916*	0.000	−3.689**	0.007	−6.217*	0.000
LNED	−2.180	0.215	−3.936**	0.003	−2.097	0.246	−4.007**	0.002
LNFD	−2.079	0.253	−6.115*	0.000	−2.164	0.221	−6.119*	0.000
LNTOP	−4.652*	0.000	−4.757*	0.000	−4.652*	0.000	−4.715*	0.000

ADF: Augmented Dickey-Fuller, PP: Phillips-Perron test

Table 5: Bound test result

Estimated models						F-statistics
$lnGDP_t$=f ($lnTOP_t$, $lnFD_t$, $lnEC_t$)						5.345*
	Bound criteria value					
	10%		5%		1%	
Sample Size	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)
50	2.538	3.398	3.048	4.002	4.188	5.328
55	2.508	3.356	2.982	3.942	4.118	5.200

*I (0) and I (1) are respectively the stationary and non-stationary bounds

Table 6: Long run and short run results

Short run coefficients				
Variable	Coefficient	Std. error	t-statistic	Prob.
D (LNTOP)	−0.359**	0.120	−2.992	0.005
D (LNFD)	−0.482*	0.034	−14.015	0.000
D (LNEC)	0.277*	0.023	11.837	0.000
CointEq(−1)	−0.540*	0.026	−20.769	0.000
Long run coefficients				
Variable	Coefficient	Std. Error	t−Statistic	Prob.
LNTOP	−0.805*	0.060	−13.417	0.000
LNFD	0.927*	0.040	23.175	0.000
LNEC	−0.274*	0.034	−8.059	0.000
Constant	0.423*	0.067	6.313	0.000
Diagnostic test				
Serial correlation	0.353			0.377
Heteroskedasticity	1.883			0.115
Normality	2.414			0.298

Finally, the diagnostic tests in Table 6 and the analysis of Figures 1 and 2 provide convincing evidence of the reliability and validity of the model. The computed model effectively reproduces the relationships among the variables, as evidenced by the absence of serial correlation, heteroskedasticity, and normality problems in the residuals. In addition, the stability of the model, as demonstrated by the cusum tests, ensures that its predictions hold true over time, increasing its applicability in real-world applications. Overall, these diagnostic tests increase confidence in the model's ability to provide insightful information and support wise decisions based on study results.

4.6. Causality Test Results

The nonparametric causality test developed by Diks and Panchenko (2005) was used in the study to examine the nature of causal associations among the variables in the model. Selected ℓx = ℓy values were used for the nonparametric causality test based on the Akaike information criterion, as shown in Table 7. The range (-value) was maintained at 0.5 throughout the series. The study found evidence of a nonlinear bidirectional causal relationship between economic development and trade openness

Table 7: Diks and panchenko causality test

lnGDP –/→lnTOP	lnTOP –/→ lnGDP	Direction
3.765* (0.000)	4.776* (0.000)	Bidirectional
lnGDP –/→lnEC	lnEC –/→ lnGDP	
0.418 (0.337)	7.876* (0.000)	Unidirectional
lnFD –/→lnGDP	lnFD –/→lnGDP	
3.134* (0.000)	5.330* (0.000)	Bidirectional

Figure 1: Cusum test

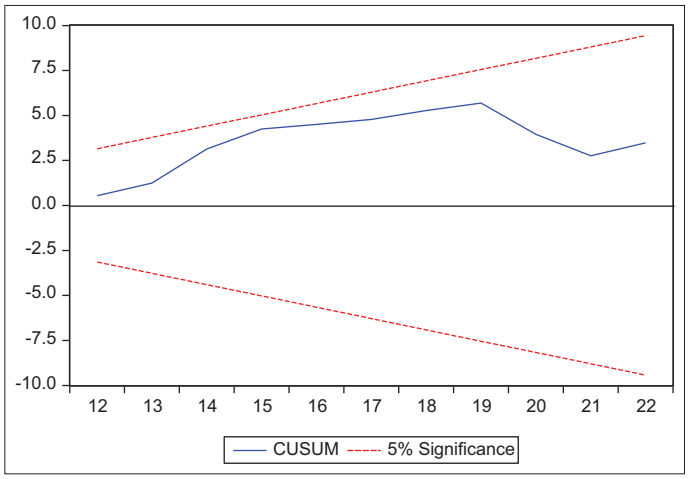
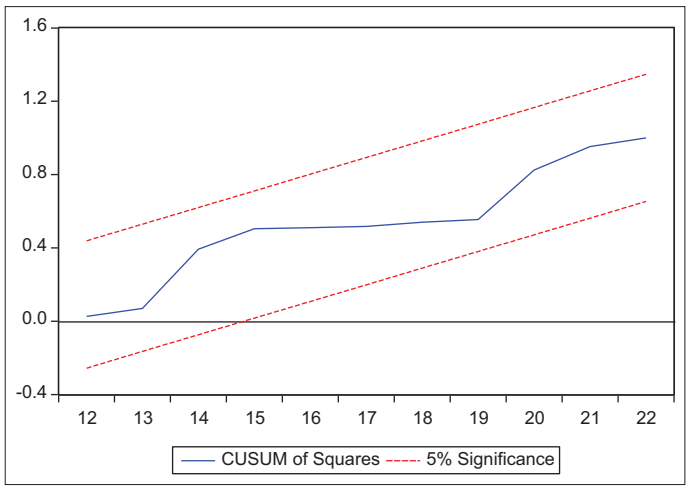


Figure 2: Cusum square test



at both the 1% and 5% significance levels, for example, using the 0.5 bandwidth (μ-value) from Table 6. At the 1% significance level, the data also show that energy consumption and economic growth are not causally related. In addition, both economic and financial development showed evidence of bidirectional causality.

The study found a nonlinear bidirectional causal relationship between trade openness and economic growth. This means that nonlinear relationships exist between changes in trade openness and changes in economic development. This result means that as the economy grows, trade openness can increase, and conversely, greater trade openness can promote economic growth. This reciprocal causal relationship underscores the importance of international trade in promoting economic development and progress. The results show a one-way causal relationship between economic growth and energy consumption. This suggests that an increase in energy consumption can affect economic growth, but that the inverse relationship is not significantly correlated. Since energy is a necessary input for many different economic activities and businesses, higher energy consumption could lead to more economic growth and development. However, the study found no evidence to support the claim that energy consumption is highly influenced by economic progress. The study found a two-way causal relationship between financial and economic progress. This means that changes in economic development can affect changes in financial development and vice versa. Financial services are in greater demand when the economy expands, which encourages innovation in the sector. Similarly, a strong financial sector can support economic expansion by unlocking capital, encouraging investment and streamlining business operations.

5. CONCLUSION

Using the ARDL method, this study examined in detail the effects of trade openness, energy consumption, and financial development on economic development in Jordan from 1970 to 2022. The short-term results show that energy consumption has a positive impact on economic growth, while trade openness and financial development have a negative impact. However, long-term research shows that financial development has a positive impact on economic growth, while trade openness and energy consumption have the opposite impact. For Jordanian policymakers and business leaders, these findings offer important insights. The adverse short-term effects of trade openness and financial development on economic growth highlight the need for strategic trade-offs to manage potential trade-offs. To ensure near-term economic stability, policymakers should consider developing policies to reduce the transition costs associated with financial expansion and trade liberalization. Energy consumption has a favorable impact in the short term, suggesting that it is critical to boosting economic activity. This underscores the need for energy management and planning at the strategic level, as well as financial expenditures on energy-efficient technologies to optimize consumption. The long-term benefits of financial development suggest that promoting a successful and inclusive financial sector could make a significant contribution to long-term, sustainable economic growth. The fact that energy consumption has a positive impact on economic growth in the short term suggests to practitioners that businesses can benefit from efficient energy consumption, including the consumption of energy-saving methods and technologies. Since trade openness is detrimental in the long run, firms may need to improve their ability to withstand external shocks and changes in the world market.

Although this study provides insightful information, it also has a number of shortcomings. First, because it focuses primarily on Jordan, the results may not be generalizable to other economies. Second, the study assumes linear relationships among variables, although nonlinear or complicated relationships may exist. The geographic scope of future studies could be expanded to include international comparisons. It would also be interesting to investigate whether the results hold under different modeling assumptions, for example, considering nonlinear associations or mutual dependencies among variables. In addition, further research could be conducted, in particular a more thorough sectoral study, to understand the underlying mechanisms and pathways through which energy consumption, trade openness and financial growth affect economic development.

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