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Article

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Macroeconomic Determinants of Renewable Energy Production in Jordan

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ABSTRACT

Using the years 1970-2022, this research looks at the macroeconomic variables that have an impact on Jordan's renewable energy production. To assess the main factors impacting Jordan's renewable energy scenario, the study employed the dynamic autoregressive distributed lag (DARDL) tool. Several important aspects affecting renewable energy production are highlighted in the study. A multitude of factors that statistically and positively impact the attainment of renewable energy are diverse economic activities as measured by the GDP. The contribution of a fair economy in speeding up and maintaining promotion of renewable energy projects in Jordan is noticeable. Moreover, FDI is one of the factors in fostering renewable energy production and its role is very significant and positive, thus, it is affecting renewable energy production in a great extent. In a nutshell, overseas funding should be meant to yield a great harvest in planting and constructing Jordanian renewable energy plants and equipments. The study also indicates that finance is not just fundamental for renewable energy movement but for the evolution of the renewable energy industry as well. While the tried and true fact of the positively and statistically significant case of link between renewable energy production and financial development underline the vital role of a financially prosperous area in redirecting investments from traditional resources to renewable energy and therefore contribute to its further expansion. However, that idea needed some modification due to the disagreement that the CO2 emissions also have significant role in reducing renewable energy production. The study has identified that there is a negative correlation between the carbon emissions and renewable energy production if it is computed statistically. The implementation of more effective policies and initiatives that will result in reduced carbon emissions becomes possible with all sectors working together to form a better environment for the establishment of renewable energy infrastructures.

Keywords: Dynamic Autoregressive Distributed Lag, Jordan, Macroeconomic Determinants, Renewable Energy Production
JEL Classifications: B23, N15, O11, Q2

1. INTRODUCTION

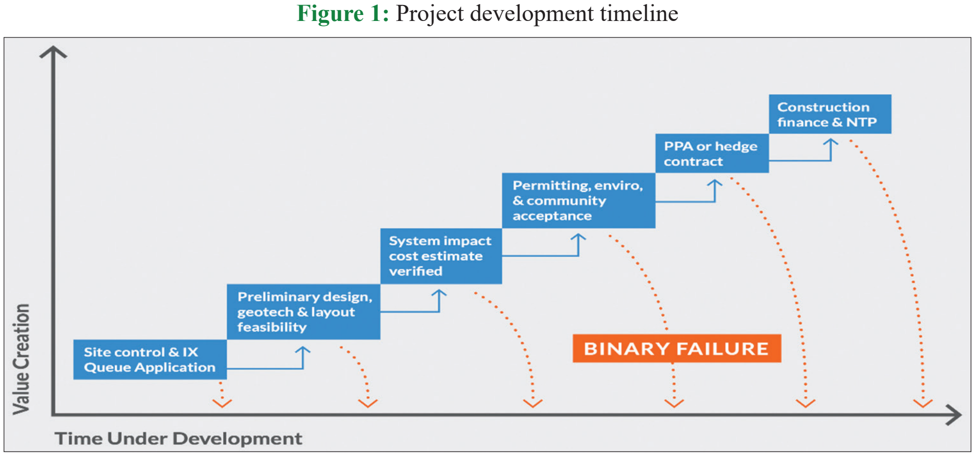
The current energy picture of the world is altering dramatically as the worldwide energy systems are urgently changing in respect to climate change and insufficient amounts of fossil fuels. For the oil import dependent Jordan countries, the critical shift from fossil fuels to renewable resources presents on the one hand, a basket of issues and on the other, a potent arena for new economic prospects. One of the most crucial issues with the Jordanian renewable energy development is numerous challenges the country has to go through even though it has large solar and wind resources to exploit. If Jordan sees the transition, from fossil fuels to renewable energy leader, with untapped opportunities, the main economic factor remains the understanding and importance for the leaders of the microeconomics factors. The Jordanian energy sector holds all the cards since it is heavily dependent on fossil fuels importation which in turn makes the country vulnerable to fluctuations in energy prices and political uncertainties. The Energy Commission of Jordan assesses that the increase tariffs of imported energy might bring extra financial burden upon the country's economy and augment the existing monstrous debt (Tan, et al., 2022; Alhawamdeh, et al., 2023a). In addition to greenhouse gases, on-going fossil fuel consumption will bring high cost on environment both in the short run and the long run. Water sources, agricultural output, public health in Jordan are all threatened severely by the emissions that intensify global warming; this is true to both Alkhawaldeh et al. (2022b) and Albatayneh (2023). Renewable energy can be considered as an appealing and strong answer to these issues. Unlike the rival nonrenewable energy sources, renewable energy sources, they are environmentally friendly, sustainable, no external interference, and local (endogenous) to their respective areas of application. Renewable energy sources of Jordan enable it to get less dependent on foreign energy, increase its national sovereignty in the energy sphere and be more resilient against any uncertainties and disturbances taking place on the international level (International Renewable Energy Agency, 2021). Additionally, renewable energy's production can guarantee growth in economy as by creating new jobs, attract foreign investments and strengthen research and development (Alkhawaldeh, & Mahmood, 2021; Alkhawaldeh, et al., 2020; Huang, 2023). Moreover, using renewables as the source of energy on a large scale can bring down the rate of global warming. This can be a huge relief and maintainer of the natural resource as well as conducive conditions for future humans to enjoy comfortable living. The macro development of Jordan's green energy sector is highly driven by intricate balance of numerous interrelated factors. In that case, there are all of these getting up to speed, and the way of how fast or steadily the industry develops is an indication to the need for Jordan to achieve its clean energy goals. These sub-factors provide better clarity to showcase the importance of macroeconomic factors for sustainable development of renewable energy in Jordan. Such characteristics are essential for the increase of investment, the drop of barriers to market-entry, and the enhancement of technology development rates. Macroeconomic environment (part of which renewable energy does not counterpart) should be supportive towards Jordan's renewable energy industry. Otherwise, it's gonna stand the risk to the countries's energy security, economy, and environment.

As shown in the Figure 1, factors such as the scale of economic movement affect each phase of the renewable project energetic generation. Investment is viewed favourably in the market where the economic climate is considered advantageous this subsequently limits the risks and cost implication. Finance accounting is simply enabled by access to financial resources. ICT is leading to more projects and are innovatively done and effective, whilst institutions are ensuring that regulatory framework is strong, and the projects are well implemented. The future of the renewable energy sector in Jordan of course is not likely to be bright until its current issues are successfully tackled especially the macroeconomic state of the country. Jordan could implement easy regulatory practices, provide regionalized fiscal incentives and promote the growth of an economically viable environment for investment and development of renewable energy. A vast area of impact could be felt by the energy security, economic development and the environmental sustainability as the study will help identity the best renewable energy resource for the Jordanian sector. Through the incorporation of a special macro-economic analysis of the factors at play and the policymaking being discussed in this report, such expert opinions will serve as a great facilitator to the Kingdom's progressive movement towards a sustainable energy future. One of the objectives of the study is to identify the microeconomic variables that contribute to the production of renewable energy in Jordan.

2. LITERATURE REVIEW

According to Ibragimov et al. (2019), environmental performance is just as important as more traditional factors like a country's institutions, infrastructure, and stability when it comes to determining its economic competitiveness. Instead of considering only environmental trends and economic stability, the Cobb-Douglas production function has been adjusted by modifying it to this end. The information that drove these conclusions was acquired from many sources such as the World Data Bank, the Global Competitiveness Report, the Global Environmental Performance Index ranging from 2000 to 2017. As expected from the input data, the model's outerities yielded higher and also

Figure 1: Project development timeline



statistically significant. Bamati and Raoofi (2020) highlighted elements that influence the use of renewable energy by developed and developing countries. What could be defined as a resulting factor in technologically-oriented nations, not developing countries was found. In addition, whereas GDP had a favorable impact on the production of renewable energy in both groups, the effects on CO_2 emissions varied across the two groups. Bourcet (2020) presents a comprehensive review of the varied body of literature concerning the factors that determine the adoption of renewable energy (RE). The author highlights the absence of agreement regarding the economic, environmental, and energy-related factors that drive this adoption. The contradictions arise due to variations in methodology and scales employed for renewable energy. The recommendations propose the standardization of renewable energy indicators and the examination of additional factors to attain policy implications that are more reliable.

Przychodzen and Przychodzen (2020) provide fresh perspectives on post-socialist economies, demonstrating that the adoption of renewable energy is affected by economic growth, unemployment, and public debt. The implementation of the Kyoto Protocol significantly increased the use of renewable energy, while factors such as rising CO_2 emissions and market competitiveness constrained its production, based on data from 27 transition countries in the period 1990-2014. Bayale et al. (2021) pioneer a regional perspective on the determinants of renewable energy by applying Bayesian model averaging to panel data of West African countries (1990-2017). Socio-economic and financial factors as well as internal environmental indicators were found to be important determinants of renewable energy production. FMOLS and DOLS estimators showed that renewable energy consumption, GDP per capita, energy investment, urbanisation and unemployment promote renewable energy, while CO_2 emissions and energy imports inhibit it. Murshed and Alam (2021) analyse Bangladesh's energy demand (1980-2014) for renewable and non-renewable energy at primary energy and electricity levels. Their results illustrate the positive impact of economic growth, household consumption, and technological innovation on energy demand, especially for renewable energy. Income inequality has the opposite effect. Oil price shocks have only a minimal effect on the demand for renewable energy but reduce the demand for non-renewable energy. The causality estimates reflect the feedback hypothesis and illustrate the complicated relationship between economic growth and energy demand in Bangladesh. Chishti and Dogan (2022) address the determinants of renewable energy, highlighting technology and macroeconomic uncertainty among other variables in the countries that consume the most renewable energy. Novel empirical tests show that ICT has a significant influence on renewable energy consumption (REC). Conversely, uncertainty has a dampening effect on RECs. Human development, natural resources, globalisation, and economic growth further boost REC. Based on these findings; this study recommends a policy oriented towards the Sustainable Development Goals.

In his study, Foye (2023) analyzes the patterns of renewable energy usage in the BRICS nations, with a particular focus on the uneven influence of financial institutions and ICT trade. When there are positive disruptions to financial institutions, renewable energy usage increases, and when there are negative disruptions, it decreases. And just as good impacts in ICT commerce boost consumption, bad impacts dampen it. South Africa, Brazil, Russia, China, and India are among the countries where these effects are seen. Positive and negative shocks affect renewable energy use differently, according to the asymmetrical results. This highlights the significance of renewable energy certificates (RECs) and environmental sustainability as policy concerns. An asymmetrical analysis of renewable energy production in Pakistan from 1980 to 2019 is carried out by Iqbal et al. (2023). Renewable energy production is significantly enhanced by gains in GDP, CO_2 emissions, and financial development over the long run, according to their NARDL approach. However, unfavorable changes to these factors do not significantly impact the outcome. On the other hand, according to the ARDL method, renewable energy production is positively affected only by GDP over the long run. In their study covering a period of half a century, Mohamed Yusoff et al. (2023) analyze how various macroeconomic variables in Malaysia affected renewable energy. Greater carbon emissions, trade openness, and foreign investment have the ability to reduce the usage of renewable energy, but economic expansion and urbanization enhance its utilization. This report offers policy recommendations to support Malaysia's goal of utilizing renewable energy sources in a low-carbon manner.

3. RESEARCH METHODOLOGY AND DATA

Iqbal et al. (2023) have shown various ways that the transition to renewable energy sources might help achieve the goals of a green economy, all in line with the concept of green growth. Renewable energy production is impacted by macroeconomic issues, according to the authors. They also stressed that technology progress, environmental concerns, and economic development drive the transition to sustainable green energy. Advocates of green growth highlight the significance of conserving natural resources and maintaining living standards, saying that environmental sustainability is essential for fostering green economic development. This study, conducted under the framework of green growth theory, analyzed the primary factors—namely GDP, CO_2 emissions, financial development, and foreign direct investment—that impact the production of renewable energy. Iqbal et al. (2023) conducted a study with a similar focus on economies that have transitioned from socialism. The formulation of our model was derived from this research.

$$RE_t = f\,(GDP_t, FDI_t, CO_{2t}, FD_t) \qquad (1)$$

The model is re-written in eq (2) below:

$$lnRE_t = \alpha_0 + \phi_1\, lnGDP_{t-1} + \phi_2\, lnFDI_{t-1} + \phi_3\, lnCO_{2t-1} + \phi_4\, lnFD_{t-1} + \mu_t \qquad (2)$$

To ascertain the order of integration of the variables, the dataset is initially examined for stationarity. The initial step of this investigation involved the application of the unit root tests developed by Kapetanios and Shin (KSUR) and Clemente-Montanes Reyes (CMR). Analyzed in the study was the enduring correlation between the variables, employing a cointegration test often known as the F-statistic. Both models utilize the following two hypotheses to elucidate the cointegration relationship between the dependent and independent variables:

$$H_0: \propto_1 = \propto_2 = \propto_3 = \propto_4 = 0 \quad (3)$$

$$H_1: \propto_1 \neq \propto_2 \neq \propto_3 \neq \propto_4 \neq 0 \quad (4)$$

Equation (2) demonstrates the correlation between the output of renewable energy in Jordan and four factors: GDP per capita (GDP), carbon emissions (CO_2), financial development (FD), and foreign direct investment (FDI). The anticipated projections of the GDP elasticity, CO_2 emissions, and financial development within the framework of the renewable energy model are predicted to exhibit favorable connections. The coefficients in equation (2) offer valuable insights into the enduring dynamics. We modify equation (2) by analyzing the long-term and short-term changes in GDP, CO_2 emissions, and FD using the dynamic ARDL simulation model established by Jordan and Philips (2018).

$$\begin{aligned}\Delta lnRE_t &= \omega_0 lnRE_{t-1} + \tau_1 lnGDP_t + \omega_2 \Delta lnGDP_{t-1} + \tau_2 lnFDI_t \\ &+\omega_2 \Delta lnFD_{t-1} + \tau_3 lnCO_{2t} + \omega_3 \Delta lnCO_{2t-1} + \tau_4 lnFD_t \\ &+\omega_4 \Delta lnFD_{t-1} + +\sigma ECT_{t-1} + \varepsilon_t \quad (5)\end{aligned}$$

This production variable is the primary focus of the research, which aims to investigate the dynamic factors influencing renewable energy output in Jordan. Renewable energy production, measured in Quad Btu and including both renewable and non-renewable sources, is the dependent variable under investigation in this study, which builds on the work of Iqbal et al. (2023). Growth in the economy, FDI, carbon dioxide emissions, and financial development are some of the measures used to measure renewable energy output. Kilotonnes of carbon dioxide gas discharged into the air is abbreviated as CO_2. GDP represents the gross domestic product per person, adjusted for inflation and stated in constant 2015 US dollars. Financial development is quantified by the proportion of domestic credit provided to the private sector relative to the GDP. FDI is measured as the net inflow of foreign direct investment, expressed in current US dollars. The analysis incorporates time series data spanning from 1970 to 2022 sourced from the World Bank. In order to simplify the analysis, the variables GDP, CO_2, and FDI were subjected to logarithmic transformation.

4. EMPIRICAL RESULTS

Table 1 contains the descriptive statistics for five variables relevant to the study. The table provides information on the central tendency, the dispersion, and the shape of the data distribution for each variable. The mean of lnRE (0.447828) is slightly higher than the median (0.338319), indicating a right-skewed distribution. The variability of the data is moderate (SD = 0.273197), with a range of 0.129852-0.988908. The positive skewness (0.917108) indicates a tendency towards higher values, while the kurtosis (2.570863) indicates stronger tails than in a normal distribution, suggesting occasional extreme values. lnGDP, both the mean (8.236115) and median (8.271101) are close to each other, indicating a relatively symmetrical distribution. The standard deviation (0.206643) is low and indicates limited variability. The negative skewness (−0.96625) indicates a slight left skew, and the kurtosis (3.629524) indicates strong tails or extreme values. The lnFDI mean (18.75187) is close to the median (18.76427), indicating a symmetrical distribution. There is a wider range from 13.23569 to 21.98739, with a higher standard deviation (2.222268). The skewness (−0.25147) is slightly negatively skewed, and the kurtosis (2.076938) indicates moderate tail-heaviness. The skewness (0.252354) and kurtosis (1.43855) of $lnCO_2$ both indicate a slight deviation from a perfectly symmetrical and normal distribution. There is moderate variability (SD = 0.374785) ranging from 9.188217 to 10.16669. The lnFD mean (4.035749) is slightly lower than the median (4.1991), indicating a slight left skew. There is considerable variability (SD = 0.442979) with a wider range of 2.833777-4.517461. The significant negative skewness (−1.54091) and kurtosis (4.292867) indicate significant deviations from normality and stronger spurs, possibly indicating extreme values.

Table 2 shows the results of the correlation matrix. lnRE has a moderately positive correlation with lnFDI (0.674) and $lnCO_2$ (0.719), which indicates a correlation between higher production of renewable energy and an increase in FDI and CO_2 emissions. lnFDI_t has a strong positive correlation with $lnCO_2$ (0.659) and lnFD (0.707), indicating an interdependence between FDI, CO_2 emissions, and financial development. lnGDP shows a weak positive correlation with other variables. All correlations are statistically significant ($P < 0.05$), which confirms their reliability.

Table 3 shows the results of the KSUR and CMR unit root tests. When two structural breaks at the level are considered for Jordan, all variables exhibit non-stationarity, indicating a unit root problem. However, upon differencing the variables once, they show stationarity. Accordingly, all model variables reach stationarity after the first difference when two structural breaks are present. Consequently, the study concludes that these series are integrated into the same order, which is labelled I(1).

Cointegration between the dependent and independent variables is shown in Table 4, which presents the results of the boundaries method for renewable energy production. Results showing

Table 1: Descriptive statistics

Variables	Mean	Median	Maximum	Minimum	SD	Skewness	Kurtosis
$lnRE_t$	0.447828	0.338319	0.988908	0.129852	0.273197	0.917108	2.570863
$lnGDP_t$	8.236115	8.271101	8.513586	7.647138	0.206643	−0.96625	3.629524
$lnFDI_t$	18.75187	18.76427	21.98739	13.23569	2.222268	−0.25147	2.076938
$lnCO_{2t}$	9.578143	9.537361	10.16669	9.188217	0.374785	0.252354	1.43855
$lnFD_t$	4.035749	4.1991	4.517461	2.833777	0.442979	−1.54091	4.292867

Table 2: Correlation matrix

Variables	$lnRE_t$	$lnGDP_t$	$lnFDI_t$	$lnCO_{2t}$	$lnFD_t$
$lnRE_t$	1.000				
$lnGDP_t$	0.334 (0.014)	1.000			
$lnFDI_t$	0.674 (0.000)	0.620 (0.000)	1.000		
$lnCO_{2t}$	0.719 (0.000)	0.447 (0.000)	0.659 (0.000)	1.000	
$lnFD_t$	0.626 (0.000)	0.461 (0.000)	0.707 (0.000)	0.660 (0.000)	1.000

Table 3: Unit root tests

Variables	KSUR	CMR	
	Intercept and trend	Intercept and trend	Break-year
$lnRE_t$	−1.683	0.005 and 0.059	1997 and 2016
$lnGDP_t$	−2.322	−0.006 and−0.010	1982 and 2006
$lnFDI_t$	−2.437	0.481 and−0.495	1995 and 2007
$lnCO_{2t}$	−2.712	0.003 and−0.025	1989 and 2016
$lnFD_t$	−2.059	−0.005 and−0.007	1981 and 2003
$\Delta lnRE_t$	−4.908**	0.301* and 0.422*	1988 and 2013
$\Delta lnGDP_t$	−3.689**	0.203* and 0.111**	1979 and 1987
$\Delta lnFDI_t$	−4.502**	2.815* and 1.348**	1998 and 2004
$\Delta lnCO_{2t}$	−4.828**	0.464* and 0.368*	1993 and 2006
$\Delta lnFD_t$	−4.114**	0.851* and 0.246*	1979 and 1996

* and ** signify 1% and 5% significant level

Table 4: Cointegration test result

Cointegration bounds testing (k=4)		
Estimated models		***F*-statistics**
$lnRE_t=f(lnGDP_t, lnFDI_t, lnCO_{2t}, lnFD_t)$		4.920**
Level of significant	**I (0)**	**I (1)**
1% level	4.244	5.726
5% level	3.068	4.334
10% level	2.578	3.710

* and ** signify 1% and 5% significant level

Table 5: DARDL estimates results

Dependent variable: $LNRE_t$		
Variables	**Coefficients**	**P-value**
$lnGDP_t$	0.591* (6.16)	0.000
$\Delta lnGDP_t$	0.326** (3.09)	0.005
$lnFDI_t$	0.199* (4.75)	0.000
$\Delta lnFDI_t$	0.105** (2.32)	0.032
$lnCO_{2t}$	−0.151* (−7.43)	0.000
$\Delta lnCO_{2t}$	−0.590* (−6.26)	0.000
$lnFD_t$	0.173* (4.71)	0.000
$\Delta lnFD_t$	0.122* (3.46)	0.000
ECT_{t-1}	−0.334** (−2.87)	0.006
R^2	0.606	
Adj-R^2	0.463	
Simulation	5000	
γ_{ser}	0.432 (0.875)	
γ_{Hetr}	1.518 (0.679)	
γ_{Nor}	0.827 (0.176)	

* and ** signify 1% and 5% significant level

F-statistics that are statistically significant at the 5% level lend credence to this (Enders and Granger, 2015). A good conclusion to this is that Jordan and Phillips (2018) should go ahead and establish the dynamic ARDL model based on the outcomes of the analysis undertaken Consistent of systems and inquiries into several dependent and independent variables that make dependent is most appropriate application of the paradigm. With the help of this technique, these additional elements are taken into account therefore giving more information on how every variable besides the independent ones, can affect the production of renewable energy (Pesaran et al., 2001).

Table 5 shows the results of the dynamic ARDL (DARDL) estimation with LNREt as the dependent variable. The coefficients show the impact of different factors on renewable energy production in Jordan. LNGDP shows a significant positive relationship in both the long run (0.591) and the short run (0.326), indicating that GDP has a positive impact on renewable energy production. LNFDI shows a positive influence in both the long run (0.199) and the short run (0.105), indicating that foreign direct investment contributes positively to renewable energy production. lnCO_2 shows a negative relationship in both the long run (−0.151) and the short run (−0.590*), indicating that CO_2 emissions have a negative impact on renewable energy production. lnFD shows a positive impact in both the long run (0.173) and the short run (0.122), indicating that financial development has a positive impact on renewable energy production. The lagged error correction term shows a negative effect (−0.334), indicating that all deviations from the long-term equilibrium are corrected in the following period. The R2 value of 0.606 and the adjusted R2 value of 0.463 indicate that around 60.6% of the fluctuations in renewable energy production are explained by the variables in the model. The significance level of the F-statistic confirms the general significance of the model. Γ_ser, γ_Hetr, and γ_Nor test the stability of the coefficients over time, with their values showing no signs of serial correlation, heteroscedasticity, or normality problems.

Therefore, dynamic ARDL simulation diagrams were used to visualise the hypothetical effects of individual variables on renewable energy production. These graphical representations showed several lines in light and dark blue, each marked by a central dot representing the mean value, and coloured lines denoting confidence intervals at the 70%, 90%, and 95% levels. Figures 2-5 show both positive and negative shocks of 10% to FD, FDI, GDP, and CO_2.

5. DISCUSSION

The finding that economic growth has a positive and significant effect on renewable energy production in Jordan is consistent with several important theoretical perspectives and empirical findings. The Environmental Kuznets Curve (EKC) concept posits that as economies grow, environmental degradation initially rises but subsequently declines once a certain level of development is reached. The decrease in environmental degradation can be attributed to the rise in environmental consciousness, advancements in technology, and the implementation of more stringent environmental legislation, which are closely linked to increasing levels of income (Grossman and Krueger, 1991). Similarly, the richer a country is, the closer it comes to the stage of the ¨ Environmental Kuznets Curve (EKC), the economy is able

Figure 2: LNGDP and LNRE

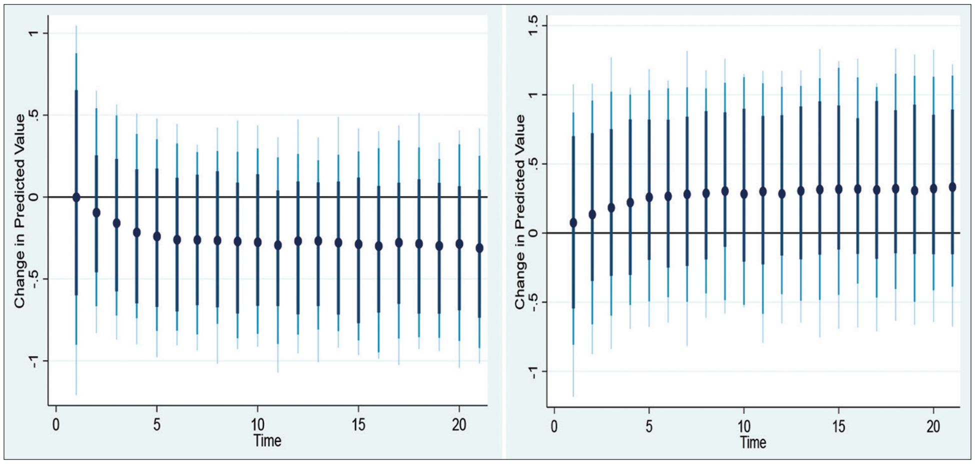


Figure 3: LNFDI and LNRE

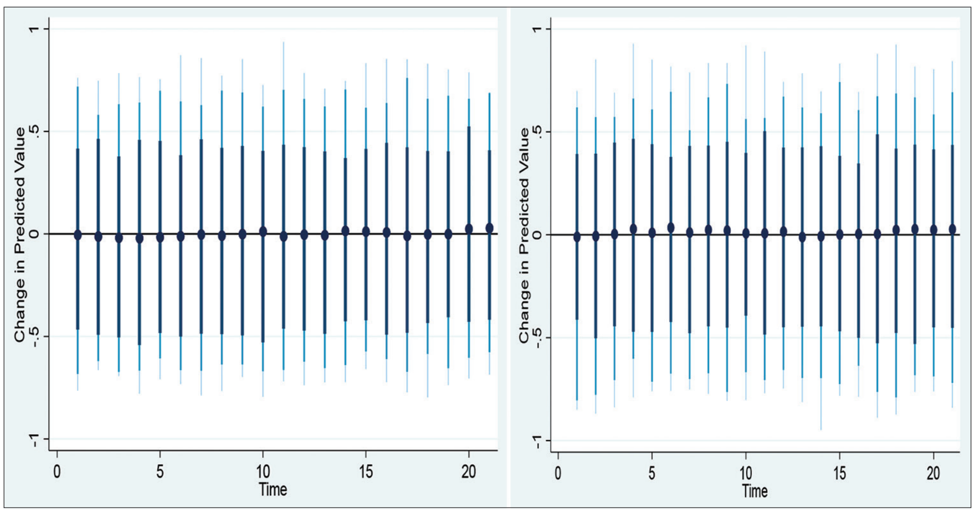
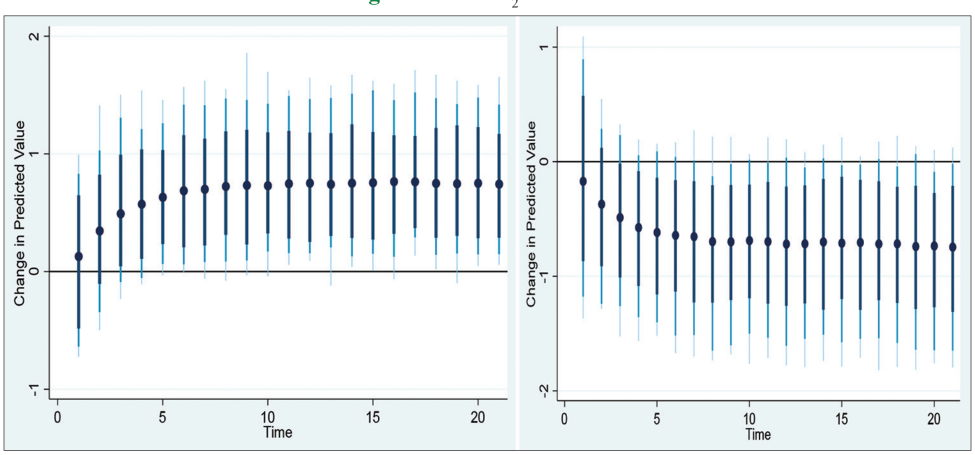
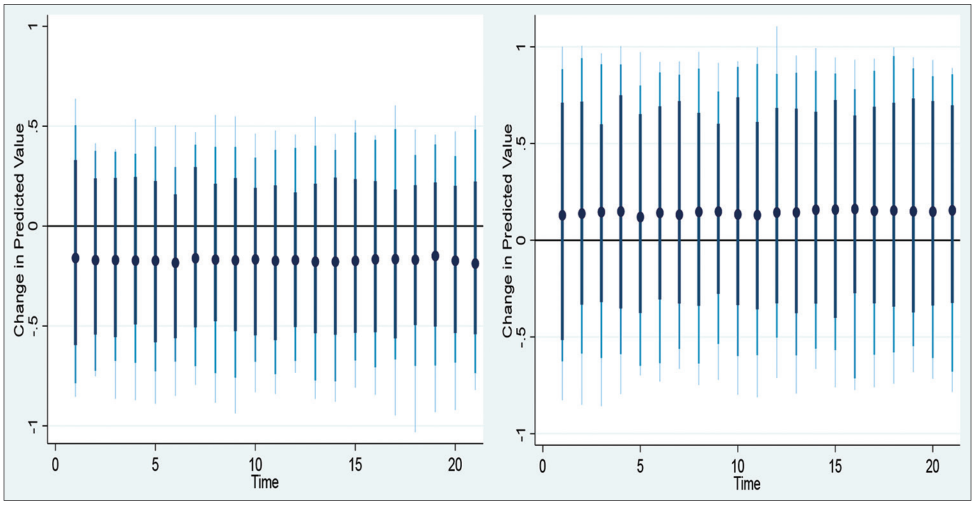


Figure 4: $LNCO_2$ and LNRE



to pay and be motivated to substitute conventional energy sources to renewable sources. Opportunities and requirements of economy as well as market conditions may be viewed as the primary reason for appearing of new inventions argued by the theory of inspired innovation. Of the entire modernized planet ecosystem cleaner and more efficient energy sources become one of the most crucial things due to the continuous scale of economic growth. I thus suggest that such a policy, as Acemoglu and his companions argue in (2012), motivates renewable sector innovations with an end of producing cleaner and more efficient technologies that ensures renewable energy for all societies. The economic growth and modernization of cultures, based on the modernization theory principle, are highly probable to result in having sustainable behaviors and technologies. Thus, the rising concern about environmental degradation, and the

Figure 5: LNFD and LNRE



desire to strip the country of reliance on conventional fossil fuels, led to a shift towards renewables energy and other environmentally friendly forms of electricity. Study results give further evidence that renewable energy production is positively connected with national GDP growth. The results of Apergis and Payne's study, which focused on countries of OECD, demonstrate the balanced relationship between renewable usage and economic development. In particular, in countries of the Middle East, for instance, such as Jordan, Omri and Kahouli (2014) demonstrated that the relation between the renewable energy production and the economic performance is positive and significant.

Undoubtedly the most remarkable aspect of the result that FDI is associated with a rise and growth in the amount of renewable energy production in Jordan is the fact that this has contributed positively to promoting sustainable development by saving the limited non-renewable sources. An advanced examination of the multidimensional and constraining aspects of the case is needed so as to better comprehend this outcome, however. Studies of Borensztein et al. (1998) and Asiedu (2002) present the view that the countries (the recipient ones) which import the renewable energy technology and which have a specialized knowledge through the foreign direct investment (FDI) often benefit as well. This cannot just help the governments to use the resources more effectively, but also assist in speeding up the advancement and operation of similar policies. Capacity of host countries to join global resources for renewable energy products and services is given a name "market access and" it can be executed by FDI which is foreign direct investment. They can do that in order to enter in the world-wide market of renewable energy and to get the benefit of economies of scale if that is relevant (UNCTAD, 2023). According to Coe and Helpman (1995), the sort of spillovers that multinational corporations can bring into play with their involvement by sharing the expertise to local firms can lead to capacity building and technological advancements in the renewable energy sector. The name of this phenomenon is 'spillover effects' which means that it affects all the neighboring cities. Despite the fact that this relationship between FDI and environmentally friendly energy investment has a complex and context-dependent nature, the research outcomes accord with the Jordanian study findings. Research conducted by the team of Al-Mulali (2016) illustrated that investors in Jordan can benefit indirectly from MENA's energy market by the use of renewable energy sources such as solar toفـقوتت. Summarily, the same result is proved by Shahriyar Mukhtarov et al. (2019), i.e. that FDI in the public export performance in Jordan can be considered. On that account, such exchanges may facilitate a continuous flow of the renewable energy technologies across the globe.

It was established that the CO2 emissions were detrimental and statistically significant factors that impact the usage of renewable energy in Jordan. This is significant and important to explore further the connection between pollution and the use of clean energy. Public opinion about the environment and climate change is becoming a problem, and might lead politicians and firms build wider support for renewable energy in order to cut carbon dioxide emissions and ease the effects of global warming (Stern, 2006). To limit CO2 emissions, governments can levy carbon taxes and tradeable permits as well in policy-making, which imply higher costs for utilizing fossil fuels and hence supports renewable energy use instead (IPCC, 2021). The production renewable energy could become more and more cost-effective and efficient as scientists go ahead making these sources of energy more advanced. Yet, as Foye (2023) empirical essay investigated, this can promote a decrease of CO2 emissions and then make renewable energy sources even more competitive with fossil fuels. According to multiple empirical studies, CO2 emissions are inversely proportional to the share of renewable energy, what means - the greater the part of renewable sources the lower is carbon intensity level. On the contrary, the OECD nations which were known as the pioneer nations of renewable energy apparently preferred to use fossil fuels such as coal and natural gas instead of renewable energy which was mentioned by Apergis and Payne (2010). The research work of Shahbaz et al. (2013) revealed that renewable energy applications are also associated with a negative impact on CO2 emissions; moreover, it is true for Jordan, as well as MENA countries.

On one hand, there is a high quantity of theoretical forecasts and empirical evidence gathered in Jordan, so there is a hint that higher financial outlays cause a boost in renewable energy resources utility. The outcomes demonstrate a very high potential of creating a well-functioning financial system that will not be any making the energy transition to renewables a problem at all. Investors in the renewables sector draw funds from savers in market smooth environments that are tradable. Beck et al. (2000) argue that in this way, renewable energy projects would get funds easily under their budgets. To make up for the risks that renewable energy project might could bring, banks and other financial institutions can have these risk management tools and green bonds (green bonds is one of the financial instruments) (World Bank, 2021). A good functioning financial system, offering a variety of information in an efficient way and where there is sufficient disclosure of market data is important if investors in the renewable energy sector are to be able to make the right decisions on where and on which activities the capital should be used (Levine, 2005). An array of experiments has been proved that it is additional of the efficient systems for finances that makes traditional energy sources more acceptable and available. According to Apergis and Payne (2011), across a sample of OECD countries, it was shown that the employment of renewable energy resources depends on the degree of their financial development (or vice versa). Speaking of middle eastern and northern African countries, including Jordan, favorable effect on financial attractiveness looks very possible through the development of renewable energy.

6. CONCLUSION

Investigating the macroeconomic factors impacting renewable energy production in Jordan from 1970 to 2022 has produced important and useful results. The DARDL method, which is a dynamic autoregressive distributed lag model, will be rused to find out the most revalent factors that explain renewable energy production in the country. It is a fact that growth in the GDP promotes the output of renewable energy. It is rather obvious from this correlation that the general trend is that intensive economic activity results in an improvement of the environment for renewable energy exploitations. Developed countries are directing their FDI into renewable energy sources which are playing a significant role in building up of renewable energy production. The impact of international assistance for renewable energy schemes and infrastructure supypportation in Jordan is shown in this. Participation of financial community emerges as a defined aspect that sits at the heart of the emergence of renewable energies while the outcomes are understood. A smooth financing system should be a significant objective so that funds can be channeled into renewable energy initiatives and, consequently, more development will be fostered which are highly positive. On the other hand, the study highlights a worrying aspect: the reduction of the performance of the renewable energy system by carbon dioxide emissions.

Along with the negative correlation, the increased call for better laws and regulations related to lowering carbon footprints and increasing the development of renewable energy sources is also brought to light. The scientific revelations of the past have brought with them complicated issues that go further into depths of the implications. With reference to managerial position, key actors and policymakers in Jordan's energy section can certainly use these results for developing and implementing purposes deliberated initiatives. The foundation of an energy-sustaining and resilient renewable energy industry can cause economic benefits which consist of exporting and transporting green technology, as well reducing CO2 emissions. It concludes that a comprehensive policy approach is required with the core framework supporting sustainable development and economic growth. To ensure the long-term success of Jordan's renewable energy projects, it is crucial to implement policies that encourage investment, improve financial systems, and reduce carbon emissions. The importance of public awareness and commitment to sustainable energy measures is highlighted by these findings. Community engagement programs and awareness campaigns can amplify efforts to reduce carbon emissions and promote renewable energy.

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