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Impact of oil rents, oil prices, and investment taxes on renewable energy consumption and investment: An investigation

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ABSTRACT

The aim of this paper is to explore the relationship between oil rents and renewable energy consumption and to provide evidence on the significance of the effects of oil prices and investment taxes on renewable energy investment. Two different panel data samples were used: six variables for 44 countries were utilized to prove that oil rents' are an independent variable causing renewable energy consumption, and five variables for 10 countries were utilized to prove that higher oil prices and higher investment taxes lead to higher levels of renewable energy investment. For both samples, the Granger causality test, unit root test, correlation matrix, fixed and random multiple regressions, Hausman test, and panel cointegration test were performed. The paper adds to the narrow literature on the determinants of renewable energy consumption, mainly oil rents. It also provides further evidence on how higher investment taxes can lead to higher renewable energy investment. The findings confirm that "oil rents" directly affect the variations in renewable energy consumption and that investment taxes directly affect renewable energy investment as they lead to a higher selling price of oil-dependent products. However, no correlation was found between renewable energy investment and oil prices. Taxes are an effective instrument for changing people's and businesses' behaviour. Given the numerous advantages of renewable energy consumption and investment, governments must make plans and create regulations and laws to compel a gradual transition from non-renewable to renewable energy using consumption and investment taxes and other behavioral incentives.

Contribution/Originality: This work adds to the limited literature review on the factors that affect renewable energy consumption and investment, with a focus on the role of oil rents. It also provides further evidence that higher investment taxes can lead to more investment in renewable energy.

1. INTRODUCTION

The global economy is characterized by its intricate nature and susceptibility to unexpected disruptions (Kaletsky, 2009). Ozone depletion, global warming, and biodiversity loss have arisen as major topics of discussion at international conferences, joining the repercussions of recent financial, political, and economic upheavals. Governments in major economies have been forced to rethink their production and consumption techniques as a result. Humans are highly dependent on non-renewable resources, which has led to global warming and air and water pollution. The future of humanity will collapse if anthropogenic ecosystems are not preserved (Gale & Cordray, 1994). Intensive use of limited

fossil energy and raw material resources, pollution poisoning, increasing illiteracy, and frightening hunger linked to destructive political conflicts are leading to serious problems affecting the health conditions of humans and their environment.

The concept of sustainability has changed over time to accommodate the needs of a complex, unpredictable world. It underlines the difficulties humanity faces in achieving not only sustainable growth but also survival on Earth. A key component for achieving sustainable economic development is renewable energy (Sebri, 2015).

- This paper's overarching goal is to answer the following two research questions on the factors that influence both renewable energy consumption and investment: Do oil rents positively affect renewable energy consumption?
- Do oil prices and investment taxes directly affect renewable energy investments?

Several tests were performed on two different panel data samples to provide answers to the question raised. Both samples were exposed to the unit root test, the Granger causality test, the fixed and random effects multiple regression analysis, the Hausman test, and the panel cointegration test. The findings support the idea that taxes on non-renewable goods and services have an inverse relationship with renewable energy consumption and a positive relationship with oil rents. Even though it is impossible to measure the money supply variable's coefficient, it has a direct impact on the consumption of renewable energy. However, the sample results were unable to confirm any relationship between renewable energy investment and oil prices. Instead, the paper's findings show that renewable energy investment is favorably associated with investment taxes that mostly rely on non-renewable energy. The subsequent sections of this paper present a comprehensive literature review to establish the theoretical foundation that supports the claims being examined. Additionally, the research methodology employed to assess these claims is elucidated. Furthermore, the research findings and results, along with the subsequent conclusions and recommendations, are thoroughly discussed.

2. LITERATURE REVIEW

Renewable energy sources are clean, limitless, and increasingly concentrated sources of energy. Their diversity, richness, and potential for application anywhere on the earth set them apart from non-renewable energy sources. In theory, their use can aid in achieving environmental sustainability because they do not produce toxic effluents or poisonous gases. The use of renewable energy sources such as hydropower, solar photovoltaic (PV), wind, geothermal, and biomass power has a significant impact on sustainable economic growth (Chen et al., 2022). Environmental concerns and rising energy prices threaten the expansion of the economy and its ability to remain sustainable. Renewable energy, on the other hand, is produced through the regeneration of natural resources in an effort to enhance energy security, counteract climate change, and deal with the problems associated with global warming (Yikun et al., 2021).

Oil rents, "the difference between the value of crude oil production at regional prices and total costs of production" (World Bank, 2019), prices of oil, taxes on non-renewable energy sources, investments and production, interest rates, foreign direct investment (FDI), and growth rates all have an impact on the consumption and investment of renewable energy. While taxes on non-renewable energy investments, products, and resources encourage consumers to switch their demand away from non-renewable energy-dependent products in favor of investing in renewable energy sources, the consumption of renewable energy will increase as oil rents decline (Harrison, 2015; Olanrewaju, Olubusoye, Adenikinju, & Akintande, 2019). The increase in FDIs, on the other hand, makes it easier for capital to flow across borders, which benefits sustainable, social, and environmental projects (Sun, 2002), and the decline in interest rates significantly facilitates the financing of creative renewable energy projects (Johnson, 2014; Keeley, 2018; Monnin, 2015; Nelson & Shrimali, 2014; Paul, Rosid, & Biswas, 2021). In addition, faster growth promotes the usage of and investment in renewable energy (Twine, Kiiza, & Bashaasha, 2015).

Spending on renewable energy, whether in the form of consumption or investment, would contribute to reducing capital depletion and would fall under the heading of sustainable development, especially when different types of capital can be substituted for each other. In this section, the literature on the variables considered for each sample is provided to build up a solid foundation to answer the paper's claims.

2.1. Shifting to Renewable Energy

Over the past few decades, the renewable energy sector has effectively grown to compete with the non-renewable energy sector (Ahuja & Tatsutani, 2009). Coal and fossil fuels are two examples of non-renewable energy sources, while renewable energy sources include hydrogen, solar, geothermal, wind, and biomass. This shift shows how we are moving away from finite resources that can only be used once and towards resources that can be used over and over again (Skinner & Murck, 2011).

Efficiency Vermont, the leading energy efficiency utility in the United States, commissioned a study showing that for every million dollars spent on efficiency projects, 43 new jobs are created each year (Optimal Energy & Synapse Energy Economics, 2011). According to a report by the International Renewable Energy Agency, transitioning to renewable energy sources now will boost economic growth, provide new job opportunities, improve human well-being, and help ensure a sustainable future. According to the report's calculations, increased investment in renewable energy will result in a global GDP increase of between $700 million and $1.3 billion. If investment in renewable energy is doubled by 2030, it will increase global welfare by 2.7% and create 24.4 million new jobs. Furthermore, trade in renewable energy-related items and services will increase, while trade in traditional energy-related products will decrease (IRENA, 2016).

Investment in renewable energy projects opens new markets and shifts demand towards other goods. For instance, raw materials are required to build the infrastructure for a wind farm, so various economic sources will be involved in supplying these materials, which in turn will involve other sources to help generate the inputs, and so on. The main obstacle to the expansion of renewable energy sources like solar and wind is the fact that their production costs are higher than those of conventional sources. Governments must play a key role in creating policies that can effectively implement innovations that will lower costs; "a variety of policy tools, such as feed-in tariffs, tradable certificates, renewable portfolio standards, tax incentives, and production quotas, have a crucial role in promoting innovation in renewable energy technologies" (Shokri & Heo, 2012).

While the available literature provides numerous studies relating renewable energy investment to several control variables such as interest rate, money supply, exchange rate, foreign direct investment, taxes, and economic growth, the available literature on renewable energy consumption concerning other control variables in general and oil rents in particular is limited, if not non-existent.

2.2. Renewable Energy Consumption, Renewable Energy Investment, and Related Variables

Renewable energy consumption is defined as the percentage of annual gross domestic energy consumption that comes from renewable energy sources (EEA, 2015). The gap between the selling price of crude oil and its production expenses is commonly referred to as "oil rent" (World Bank, 2019). Therefore, it is the production activity's pre-tax profit from exploration. The state's portion of the oil rent includes taxes paid to the state where the production taxes are levied.

The relationship between oil rents and the consumption of renewable energy has been the subject of numerous studies, each with its own methodology. In the five most populous and developed economies in Africa—Nigeria (West), Ethiopia (East), Egypt (North), the Democratic Republic of the Congo (Central), and South Africa (South)—there has been a significant and negative correlation between oil rent and consumption of renewable energy from 1990 to 2015. This means that as oil prices fall, renewable energy sources will become more widely used (Olanrewaju et al., 2019). On the other hand, the consumption of renewable energy in Balkan countries is unaffected by the oil

price (Akar, 2016). Another viewpoint indicates that, for instance, in Canada, changes in oil prices have a direct effect on investment and consumption of durable goods (Boyer & Filion, 2007).

The literature offers several examples of how oil prices and renewable energy utilization are related to one another. Rising oil prices have an advantage over renewable energy sources since they encourage more investment in those sources (Slav, 2018). However, this only applies to nations that rely solely on imported energy, particularly oil. In Europe, governments have reduced their reliance on oil by switching their largest oil consumer, the electricity sector, to a nuclear-dependent sector (Deane, 2018); in a similar vein, rising prices have compelled them to look for other more advanced and efficient energy sources, including renewable ones (Deane, 2018). Following the conflict in Ukraine and the reduced oil supply, they are actively looking for other energy sources and restarting nuclear units that had been suspended (France 24, 2022). High oil prices help generate much-needed money, but they also make alternative energy sources like renewables more economically viable than oil (Deane, 2018). As a result, rising oil prices are encouraging customers to use renewable energy. The rise in crude oil costs has made customers more aware of oil substitutes, such as renewable energy sources that compete with oil (Le, 2015). Egypt, Jordan, Mauritania, Morocco, Tunisia, Turkey, and Yemen are among the oil-importing nations that have built their renewable energy industries to lessen their reliance on oil supplies and relieve the strain on their governments' finances (Menichettti, El Gharras, & Karbuz, 2017).

While oil-importing countries like the United States benefit from the steady flow of revenue, exporting nations like Saudi Arabia are becoming weary of their competitive disadvantage. However, the funds from oil sales are essential for this transformation, making giving up oil a challenge (Slav, 2018). Therefore, for oil-importing countries, there is a positive correlation between the price of oil and the use of renewable energy; higher oil costs lead to increased consumption of renewable energy (Deniz, 2017). On the other hand, oil exporters have little incentive to switch to renewable energy for their energy production or consumption. It might be claimed that these economies won't be motivated to develop their renewable energy resources unless their oil reserves decrease, renewable energy conversion costs decrease, or a policy change is imposed at the national or international level (Deniz, 2017). Because taxes lower investment returns and disposable income, they have a negative influence on both consumption and investment (Talpos & Vancu, 2009). Taxes are designed to deter people from consuming particular commodities because of potential negative effects on their health, the environment, or other factors (Donastorg, Renukappa, & Suresh, 2017). Taxes on products that rely on nonrenewable energy sources cause consumers and investors to shift demand and supply away from polluting products and towards cleaner alternatives (Liobikienė, Butkus, & Matuzevičiūtė, 2019). Investment in renewable energy sources is stimulated by taxes on non-renewable energy, and investors are helped to rely less on these sources in the course of their regular financial dealings (Harrison, 2015). For instance, the introduction of the carbon tax seeks to increase the cost of carbon emissions in order to decrease them (Aflaki & Netessine, 2018).

Renewable resources are a significant investment sector. Renewable energy projects have been one of the most active investment industries for a while now (Antonich, 2019). The cost of renewable energy investments must be taken into account while making financial decisions. Renewable energy installations don't require any fuel, but developing their underlying technologies does require a sizable investment and is subject to market interest rates (O'Boyle, 2018). Reduced interest rates are a powerful tool in supporting the financing of cutting-edge renewable energy projects (Johnson, 2014; Monnin, 2015; Nelson & Shrimali, 2014). Investments in renewable energy can be financed through several means (Donastorg et al., 2017). One of the key methods for funding these initiatives was borrowing from financial institutions in the form of a bank loan.

Foreign direct investment and exchange rates also play a role in determining the volume of investment in renewable energy. Foreign direct investment (FDI) projects that rely on a stable exchange rate to support their operations face major challenges when exchange rates fluctuate. The growth of foreign direct investment (FDI) in the global economy is one of the most striking trends of recent years (Villaverde & Maza, 2012). For technological,

social, environmental, or other projects, FDI successfully facilitates the transfer of cash across borders (Sun, 2002), and many developing nations strive to increase foreign direct investment in renewable energy (Keeley, 2018).

Countries that prioritize the renewable energy industry and implement carbon pricing mechanisms, such as emissions trading and carbon taxes, attract more foreign direct investment (Wall, Grafakos, Gianoli, & Stavropoulos, 2019). Therefore, FDI is driving increased the usage of renewable energy in upper-middle-income countries (Doytch & Narayan, 2016). However, statistical proof of a connection between FDI and renewable energy consumption is still pending (Lee, 2013).

The rate of economic growth and spending on renewable energy are directly correlated (Pettinger, 2019). The rate of change in economic growth has an impact on investment, according to the gas pedal theory. Economic growth and investment are directly correlated, according to the gas pedal theory. Additionally, the idea contends that a drop in investment exerts downward pressure on the growth rate (Twine et al., 2015).

Increases in gross domestic product speed up economic expansion across 25 nations in Europe, leading to greater investment in and consumption of renewable energy (Ntanos et al., 2018). However, countries with lower GDP tend to use more fossil fuels. Particularly significant was the correlation between countries with high GDP and the use of renewable energy. G7 nations' consumption of renewable energy is also strongly correlated with their real GDP per capita, with higher GDP per capita leading to higher renewable energy consumption (Sadorsky, 2009). In contrast to the Balkan nations, there is a statistically significant inverse relationship between economic growth and the use of renewable energy (Akar, 2016).

3. RESEARCH METHODOLOGY

The study aims to illustrate that oil prices and investment taxes have a significant impact on renewable energy investment and to investigate the importance and direction of the relationship between the consumption of renewable energy and oil rents. This study aimed to ascertain private expenditure on renewable energy by aggregating the metrics of renewable energy consumption and investment. However, owing to limited data availability for both variables across the same countries and time period, we opted to analyze two distinct samples. The dataset comprises various variables, namely renewable energy consumption, oil rents, taxes on goods and services, interest payments, GDP growth, and broad money growth. The sample data were recorded over a 12-year interval, from 2004 to 2015, for 44 countries[1]. The paper claims that higher taxes on goods and services (not excluding renewable products) will increase product prices and reduce renewable energy consumption. Higher GDP growth reflects higher income and would lead to higher renewable energy consumption. As opposed to that, higher growth in broad money reflects an increase in the money supply and, in turn, a decrease in interest rates, which will lead to increased spending on renewable energy and, thus, an increase in renewable energy consumption. Similarly, a decrease in interest payments will lead to an increase in renewable energy consumption. Although the effect of oil rents is not clearly stated in the literature, we assume that higher oil rents signal higher pre-tax profits from exploration and production activity. To maintain high oil rents, the selling price of oil-dependent products is more likely to increase, making the products more expensive relative to any non-oil-dependent substitutes. This would directly affect the consumption of renewable energy, especially if renewable products are affordable relative to other products, given their many advantages.

Sample 2 data include observations on renewable energy investments, taxes on non-renewable energy investments, oil prices, foreign direct investment, and gross domestic product. The sample data were recorded over

[1] These countries are: Australia, Brazil, Japan, United States, United Kingdom, Lebanon, Egypt, Denmark, Sweden, Angola, Bahamas, Bangladesh, Belarus, Cambodia, Chile, Dominican Republic, El Salvador, Georgia, Guatemala, Honduras, Hungary, Iceland, Palestine, Jamaica, Korea, Lesotho, Malaysia, Mali, Mauritius, Moldova, Namibia, Nicaragua, Norway, Peru, Philippines, Poland, Russian Federation, Singapore, South Africa, Sri Lanka, Switzerland, Thailand, Ukraine and Uruguay.

a 12-year interval, from 2004 to 2015, for ten countries[2]. The paper assumes that higher investment taxes on non-renewables will increase investment in renewables since investment in other products will be more expensive. Similarly, higher oil prices reflecting higher production costs will reduce investment in non-renewables and favor investment in renewables. As GDP rises, so does income, and so does investment in renewable energy. On the other hand, when foreign direct investment increases, the potential for investment in renewable energy increases.

The variables that were selected and used for the tests are Renewable Energy Consumption (REC), Renewable Energy Investment (REI), Oil Rents (Oil Rents), Interest Payments (IP), GDP Growth (Growth), Broad Money Growth (MS), Taxes on goods and services (Taxes), Taxes on Investments (Taxes I), Oil Prices (Oil Prices), Gross Domestic Product (GDP), and Foreign Direct Investment (FDI). All variables were obtained from the World Bank, except for renewable energy investment, which was exported from the Bloomberg Green Energy database, and oil prices, which were collected from Macrotrends.com.

The Granger causality test was performed to discover the causal relationship between the variables of interest, primarily oil rents and renewable energy consumption.

Cointegration methods can be used to illustrate long-run equilibrium relationships between nonstationary time series variables if the variables in question have a unit root of order 1. This is because economic and financial theory usually postulates that such variables exist. Preliminary tests for unit roots are a common starting point for this purpose (Maddala & Kim, 1998). Unit root testing was conducted for all variables in both samples to see if the data needed to be originally differentiated or regressed on deterministic functions of time to make the data stable. To further investigate the potential long-term correlation between the samples' variables, a panel cointegration test was run. Correlation matrices were generated to detect any possible high correlation between pairs of independent variables, and multi-collinearity was resolved by dropping some variables when a correlation coefficient of above +0.7 or below -0.7 was recorded.

Multiple regressions with both fixed and random effects were used to figure out the significance and direction of the relationship between the considered dependent and independent variables. The fixed effect model assumes that the unobserved variables are allowed to have a correlation with the observed variables. In a fixed-effect model, time-invariant effects govern the effects of time-invariant variables. All variables, whether or not they are formally measured, are subject to this rule (Williams, 2015). In the random effect model, unobserved variables are assumed to have no relationship with any of the observable ones. Random effects provide an estimate of the effects of time-invariant variables, despite the fact that the assumption might be erroneous because standard errors may be quite high with fixed effects. Generalized Least Squares can be used to estimate the model, which is only really taken into account under certain conditions (Williams, 2015).

The Hausman test is used to differentiate between the fixed effects model and the random effects model in panel data analysis. Under the null hypothesis, Random effects (RE) are favored due to their greater efficiency; however, under the alternative, Fixed effects (FE) are chosen due to being at least as accurate. So, we ran the Husman test on both sets of data and picked our regression model accordingly.

4. FINDINGS AND RESULTS

For the first sample, according to the Granger causality test, oil rents affect renewable energy consumption. With a 5% level of significance, the null hypothesis that oil rents don't cause renewable energy consumption is rejected, leading us to conclude that "oil rents" is an independent variable causing renewable energy consumption. For the second sample, the Granger causality test was not performed to provide evidence of the significant effects of oil prices and investment taxes on renewable energy investment, since the effects of the control variables on renewable energy investment are backed up by theory.

[2] These countries are: Australia, Brazil, Canada, France, Germany, Italy, Japan, Spain, United Kingdom and United States.

Table 1 shows the pre-estimation tests performed on samples 1 and 2. To maintain stationarity, unit root tests were performed with a 5% level of significance. It's concluded that all variables for sample 1 are stationary except for oil rents, for which the first differencing was applied, and all variables for sample 2 are stationary except for oil prices, for which the second differencing was applied.

Table 1. Pre-estimation tests.

Sample 1		**Sample 2**	
Causality test	**F-statistic**	**Causality test**	**F-statistic**
OILRENTS does not granger cause REC	4.08**		
Levin, Lin & Chu t* probability values, for unit root test			
Variable	P=value	Variable	P=value
REC	0.01	IRE	0.01
Taxes	0.00	TaxesI	0.00
Oilrents	0.42	Oilprices	0.91
D(Oilrents)	0.00	D(Oilrents,2)	0.00
IP	0.00	GDP	0.04
Growth	0.00	FDI	0.00
MS	0.04		

Note: *: Significant at 5%, **: Significant at 1%

Table 2 exhibits the correlation matrix between the variables for samples 1 and 2 to detect multicollinearity between the selected independent variables. For sample 1, the matrix indicates that there is no multicollinearity between any of the independent variables, and the correlation coefficients are all close to zero. For sample 2, the matrix indicates that there is multicollinearity between Taxes, GDP, and FDI; thus, GDP and FDI were dropped from the model since the major goal of the paper is to detect the effects of oil prices and taxes on renewable energy investment.

Table 2. Correlation matrix.

Sample 1					
Variable	**Growth**	**IP**	**MS**	**Oil rents**	**Taxes**
Growth	1.00	-0.02	-0.11	0.19	0.07
IP	-0.02	1.00	-0.03	-0.08	-0.02
MS	-0.11	-0.03	1.00	0.01	0.01
Oil rents	0.19	-0.08	0.01	1.00	-0.43
Taxes	0.07	-0.02	0.01	-0.43	1.00
Sample 2					
Variable	GDP	FDI	Oil prices	Taxesi	
GDP	1.00	0.77	0.06	0.93	
FDI	0.77	1.00	0.07	0.80	
Oil prices	0.06	0.07	1.00	0.09	
Taxesi	0.92	0.80	0.09	1.00	

The relevance and nature of the relationship between the dependent variable and the independent variables were investigated through the use of regression analysis. The regression test with a fixed effect was applied to Equations 1 and 2 in the first stage and then with a random effect in the second stage.

$$REC = \beta_1 + \beta_2 TAXES + \beta_3 D(OILRENTS) + \beta_4 IP + \beta_5 GROWTH + \beta_6 MS + ui \quad (1)$$

$$REI = \beta_1' + \beta_2' TAXESI + \beta_3' D(OILPRICES, 2) + ui \quad (2)$$

Where β_1 and β_1' are the model intercepts

β_2 *to* β_6 and β_2' are partial slope coefficients.

ui = stochastic disturbance term assumed to be normally distributed.

The regression coefficients are provided in the table below:

Table 3. Summary table of performed regressions.

Regression results										
REC										
Variables	**C**	**Taxes**	**D(OILRENTS)**	**IP**	**Growth**	**MS**	**F-statistic**	**Hausman F-statistic**	**Std Res Skewness**	**Jarcque-Bera p-value**
Equation with fixed effects	33.16**	-0.21**	0.23*	-0.01	0.07	6.91E-14 **	476.82*	476.82*	0.7	329.7*
Equation with random effects	32.50**	-0.18**	0.23*	-0.01	0.07	6.69E-12 **	7.44*			
REI										
Variables	C	Taxesi	OILPRICES	GDP	FDI		F-statistic	Hausman F-statistic	Std Res Skewness	Jarcque-Bera p-value
Equation with fixed effects	3.47E+09	0.02*	18174618	Not retained	Not retained		28.86*	28.86*	1.09	24.36
Equation with random effects	1.76E+09	0.02	17772771	Not retained	Not retained		12.83*			

Note: Bold: the result of the retained regression, *: significant at 5%, **: significant at 1%

Table 3 represents the regression results for samples 1 and 2. It shows that the F-statistic P-value is inferior to the level of significance of 5%, which means that the overall models for both fixed and random effects are significant for both samples. For sample 1 and with fixed effects regression estimation, oil rents, taxes, and money supply were the only variables with a P-value lower than the level of significance of 5%, indicating that all other variables don't affect renewable energy consumption. For sample 1 and with random effects regression estimations, oil rents, taxes, and money supply were the only variables with a P-value inferior to the 5% level of significance, indicating that all other variables don't affect renewable energy consumption. So, holding everything else constant, a one-unit increase in taxes will decrease renewable energy consumption by 0.18 units. The negative sign of the coefficient helps us retain the claim that taxes on goods and services are inversely related to REC. On the other side, holding everything else constant, a one-unit increase in oil rents will increase renewable energy consumption by 0.23 units. The positive sign of the coefficients provides evidence of the direct relationship between oil rents and renewable energy consumption. Finally, money supply came to directly affect renewable energy consumption, as previously claimed. Holding all other variables constant, a one-unit increase in money supply will lead to $6{,}69E^{-14-12}$ units increase in REC.

To appropriately select the model, the Hausman test was performed, and it was found that the random effect model is appropriate. Yet, the distribution of the residuals is not normal according to the Jarque-Bera test, with a p-value of zero. Thus, it can be concluded that renewable energy consumption depends on oil rents, taxes, and the money supply. Table 4 shows the panel cointegration test that was done for both sample variables to see if there is a long-term relationship between the dependent and the significant independent variables. Keep in mind that the null hypothesis says that there is no cointegration (no long-term relationship between variables). Based on the results provided in the table below, the null hypotheses are rejected at the 0.05 level of significance, and it can be concluded that there is a long-term association between the selected variables in both samples.

Table 4. Summary table of panel cointegration test.

Johansen fisher panel cointegration test Series: REC oil rents taxes money supply. Included observation 528 Unrestricted cointegration rank test (Trace and maximum eigenvalue)				
Hypothesized no. of CE(s)	**Fisher stat. from trace test**	**Prob.**	**Fisher stat. from max-eigen test**	**Prob.**
None	570	0.00	465	0.00
At most 1	180	0.00	161	0.00
At most 2	92.7	0.00	92.7	0.00
At most 3	186	0.00	186	0.00
Series: IRE taxesi oil prices. Included observations 121				
Hypothesized no. of CE(s)	Fisher stat. from trace test	Prob.	Fisher stat. from max-eigen test	Prob.
None	80.5	0.00	80.3	0.00
At most 1	123	0.00	111	0.00
At most 2	49.6	0.00	49.6	0.00

Renewable energy consumption is related to oil rents in a positive way. This result is consistent with what Boyer and Filion (2007) found, with what Deane (2018) and Le (2015) found about Europe and how it became less dependent on fuel when fuel prices went up, and with what (Menichettti et al., 2017) found about oil importer countries like Egypt, Jordan, Mauritania, Morocco, Tunisia, Turkey, and Yemen, where the governments cut back on oil use and invested in renewable energy. In general, the findings support the results of the research related to oil-importing countries (Deniz, 2017). These findings, on the other hand, seem to contradict the results found for Nigeria, Egypt, Ethiopia, the DR Congo, and South Africa with annual data samples ranging between 1990 and 2015 (Olanrewaju et al., 2019) and for the Balkan (Akar, 2016), where renewable energy consumption decreased with the increase of oil rents. The literature and the regression results may diverge depending on whether or not the country under study imports oil. While oil importers look to reduce their reliance on oil to cut expenses, oil exporters rely on revenue from commodity sales and high gasoline prices to keep their economies afloat. Higher oil rents would lead to higher

selling prices of oil-dependent items, which in turn would encourage countries, especially importer ones, to look for alternate energy sources and possibly switch to renewable ones. Moreover, renewable energy consumption is negatively related to taxes on goods and services that rely on non-renewable energy. These findings seem to contradict the results found in the literature by Donastorg et al. (2017), Liobikienė et al. (2019) and Talpos and Vancu (2009). This can be explained by the Laffer Curve if studied with the samples chosen.

Furthermore, renewable energy consumption is significantly positively related to the money supply; these findings are aligned with the results found in Harchaoui, Tarkhani, and Yuen (2005), Pettinger (2019), Villaverde and Maza (2012), and Wall et al. (2019). The findings of the paper couldn't estimate the predictor value of the money supply variable, as the result showed a coefficient close to zero. On the other hand, the findings contradict the findings of Lee (2013), which revealed no statistical proof of the relationship between renewable energy consumption and money supply. Sample 2 fixed effects regression estimates found no significant relationship between oil prices and renewable energy investment, with the only significant variable being investment taxes.

When using random effects regression estimations for sample 2, investment taxes are statistically significant (P 0.05). The positive sign of the coefficient denotes a correlation between taxes and investment in renewable energy. For the purpose of debate, we'll say that renewable energy investment rises by 0.025 units for every unit that investment taxes rise. Since the P-value for oil prices was higher than the 5% level of significance, the model did not give adequate evidence of the significance of oil prices in determining investment in renewable energy. For sample 2, the random effect model was selected since the Hausman test results provided a significant Fisher test, retaining that the random effect model is suitable. On the other hand, the distribution of the residuals shows a positive skewness, indicating the absence of normality of the residuals according to the Jarque-Bera test. The findings confirm that renewable energy investment is positively related to taxes on investments that mainly depend on non-renewable energy. The outcomes found by Harrison (2015) and Aflaki and Netessine (2018) are consistent with this result. The sample result couldn't confirm any relationship between renewable energy investment and oil prices, which contradicts the findings of Boyer and Filion (2007). It also contradicts the findings of Deane (2018) and Le (2015), who indicated that Europe increased its nuclear and non-renewable energy investments because of fuel price increases. According to Menichettti et al. (2017), this was also evident in oil-importing nations like Egypt, Jordan, Mauritania, Morocco, Tunisia, Turkey, and Yemen, where governments have more incentives to invest in renewable energy.

5. CONCLUSION AND RECOMMENDATIONS

The loss of biodiversity on Earth is accelerating as human activity increases atmospheric carbon dioxide and other global warming emissions. Humanity faces an uncertain future unless serious efforts are made to alter the current state of affairs and protect the planet for future generations. The use of renewable energy is on the rise, but it is still not widely adopted. This is especially true in nations with weak regulatory systems that fail to produce rules and effectively enforce them. Taxes on toxic emissions and the use of nonrenewable resources are two ways in which governments might penalize the extraction, processing, and consumption of nonrenewable materials. By switching to renewable energy sources and greener technologies, businesses can reduce their reliance on finite supplies. (Gramkow, 2020). In addition, firms can adapt product design, get rid of unnecessary packaging, reduce pollution, and hire by-products, i.e., secondary products that are used for other production (Lankoski, 2010). Conversely, financial incentives, such as tax breaks, tend to reduce the amount of taxes paid by the industry as a reward for meeting environmental performance standards and encourage firms to adopt sustainable practices and technologies. Policy incentives, such as government spending, are also important for encouraging long-term innovation, but they are risky, costly, and unpredictable. In this paper, the first sample allowed us to conclude that oil rents are a dependent variable causing the variation in renewable energy consumption while also directly affecting it. Results from the second sample provided evidence of the importance and direct relationship between investment taxes and renewable energy investments. When investment taxes increase, investors look for other opportunities that would reduce

production costs, and they find investment in renewable energy projects more encouraging, so investment in renewable energy increases. Yet we have not been able to show that oil prices directly affect investment in renewable energy. This could be due to the sample size, the fact that oil prices were not stationary before applying the second differentiation, and the fact that investment in renewable energy varies depending on whether the country is an oil exporter or importer. The government must take action to plan and establish regulations and laws to force a gradual shift from non-renewable to renewable energy due to the numerous benefits of renewable energy. The government, yet, cannot accomplish the goals it has set without the help of the business sector. However, there is a lack of effective implementation of laws that are related to modern issues and that are conducive to governance. This requires a systematic review of laws to remove those that are no longer applicable and to simplify the implementation of relevant laws. There is a need to formulate appropriate mechanisms to integrate laws. Many policies were developed either before renewable energy use became a major issue or from a sectoral perspective. These policies should be reviewed with sustainability in mind. This opens the door for oil rents and investment taxes to be considered in policy and regulatory development. Governments can increase investment taxes to shift investor attention to less expensive projects, such as renewable energy. Governments can also use incentives, such as facilitating legal logistics, to help investors invest more in renewable energy.

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