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Assessing the Factors that Determine Renewable Electricity Consumption in the United States: Using ARDL Approach[1]

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ABSTRACT

Panel cointegration estimates are utilized for four groups of consumers of renewable electricity—residential, commercial, transportation, and industrial—from 1985 to 2020. The paper study uses panel cointegration for long and short-run effects using panel autoregressive distribution lag (ARDL) with several causality tests. This research finds that in the long run, tax credit, gross domestic product, and CO2 emission elasticities affect residential renewable energy consumption positively. Furthermore, natural gas affects the consumption of renewable energy negatively. The findings have social impacts which are that the consumption of renewable energy significantly emphasizes the global warming and energy security phenomena. The federal government of the United States should continue to increase the allocation of tax credits for renewable electricity generation projects and decrease it for projects that depend heavily on non-renewable consumption, thereby causing emissions. These policies could significantly help domestic renewable energy projects to compete with non-renewable energy producers, as well as serve different energy consumer sectors. Further, the result shows that lower natural gas price levels make electricity generation from natural gas cost competitive and shift electricity consumption from the competitive to the cheaper cost. Based on other results that support this finding, electricity price has a significant positive impact on renewable energy consumption. No studies examine the impact of energy tax policies and energy price elasticity on renewable electricity consumption.

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I. Introduction

Since 1985, the U.S. government of the United States, federal government, has provided funds for the development, production, and use of clean energy production. The tax credit was the type of government fiscal policy for clean production. This fund was shifted to adopt technology that can generate energy using renewable sources. However, no studies examine the impact of energy tax policies and energy price elasticity on renewable electricity consumption. The present study takes advantage of the availability of consumption data and examines the impact of those indicators on four main consumption sectors, that is, residential, commercial, industrial, and transportation, in the U.S. Evidently, the emission level moves at the same rate over the years, while data recorded an increase in consumption rate for the industry and transportation renewable electricity.

This research is important for consumers and policymakers to understand how energy tax policies and energy prices impact the diffusion rate of renewable energy, consumption. This study fills the gap by adding two important contributions to the literature. First, this study uses panel cointegration for four groups of renewable electricity consumers, that is, residential, commercial, transportation, and industrial. Second, the present study accounts for the long- and short-run effects using panel autoregressive distribution lag (ARDL) with several causality tests. The rest of this research is divided into five sections which are literature review, methodology, empirical analysis, research findings, and conclusion and implications.

II. Literature Review

Many literature streams discussed renewable energy demand and its indicators. Among them, studies that covered the global sample cases and others discussed the comparative cases between groups of countries. Reboredo (2015, 32) uses global index data and tests the substitution of fossil fuels with renewable energy. He reports that renewable energy helps to reduce the rate of dependency on oil and gradually lowers the cost of renewable energy production. He also states that "policymakers also need to better understand how oil prices affect the renewable energy industry, given that public expenditure aimed at progressively reducing dependence on finite fossil fuels and CO_2 emissions could be reduced when oil price dynamics provide the necessary supply - or demand-side incentives to invest in the renewable energy industry." (Reboredo 2015)

King and Neo (2016) studied the causal effect of oil prices and renewable energy consumption. They reported that there is the negative impact of oil prices on renewable energy consumption. Anis and Duc (2014) examine the determinants of renewable energy consumption in high-, middle-, and low-income countries. They predict that purchasing more energy-efficient products would be the main driver of oil prices. They use panel cointegration techniques in 64 countries and establish that the impact of oil on renewable energy consumption is lower in middle- and high-income countries than in low-income countries owing to the sharp decrease in oil prices during that period. They further report that openness to trade and emission impacted renewable energy consumption positively. They provided some policies for government to subsidize the consumption of renewables.

Dulal et al. (2013) in their study discussed the impact of the growth of the population on the consumption of fossil fuels and renewable energy. They tried to list the barriers in the market that eliminate the consumption of renewable energy in Asian countries. They found that financial constraints, lack of technology and development, and lack of government subsidies are the constraints to renewable technology use and development. They reported that government support is crucial to transfer to renewable energy consumption. Reboredo, et, al (2017) report that “the price of oil is one of the main drivers of renewable energy investment projects as it makes the substitution of exhaustible energy resources with sustainable energy resources more or less economically profitable.” (2017). Thus, the literature suggests that the success of new renewable energy projects influences the demand for oil and the supply of energy, and, consequently, oil prices.

Various studies measured the determinants of renewable energy consumption and their impact. The impacts can be summarized as follows: renewable energy consumption is determined by CO_2 emission, growth of population, and financial development in a country case. However, the literature lacks an investigation of the impact of specifying the government fiscal policies in terms of development. For example, the energy tax credit is one of the government fiscal policies that shifted to renewable energy development. This study will have a significant contribution by discussing the impact of tax credits and the other control variable on renewable energy consumption in a specific country case, the United States. This study takes the advantage of data availability for the groups of renewable energy consumption that was collected from the archive of the U.S. Energy Information Administration.

III. Methodology

i. Model Equation

The empirical model that is built in the present study is consistent with earlier studies on the consumption of renewable energy. Omri and Nguyen (2014) and Sadorsky (2009) used a linear relationship between the dependent variable, renewable consumption, and explanatory variables such as GDP and emission.

Herein, panel data are used to determine the renewable electricity consumption factors. Ideally, the demand function should have a price, as an independent variable, for renewable electricity. However, in the present study, there is no price for renewable electricity; the dependent variable is a composite variable that reflects renewable electricity from different renewable sources (solar, wind, etc.). Therefore, there is no price available. Table 1 below presents the variables, their expression, data sources, and measurement.

Table 1
Definitions of the Variables

Variable	Expression	Data Source	Measurement
Renewable electricity consumption	RE	U.S. Energy Information Administration 2021	Trillions of British thermal units (Btu)
Federal tax credit	$TAXCREDIT_t$	Congressional Budget Office 2021	Billions of U.S. dollars. Credit is calculated by multiplying the electricity kilowatt-hours produced using renewable resources by 1.5.
oil price (Crude)	$POIL_t$	BP Statistical Review of World Energy 2021	U.S. dollars per barrel
price of Natural gas	$PNGAS_{it}$	U.S. Energy Information Administration 2021	U.S. dollars per thousand cubic feet
Coal price	$PCOAL_t$		U.S. dollars per short ton
CO2 emissions	$CO2_t$	World Development Indicators 2021	Kiloton (kt)
price of electricity	$PELECTRICITY_{it}$	U.S. Energy Information Administration 2021	Cents per kilowatt-hour
Gross domestic product	GDP_t	World Development Indicators 2021	US Dollar

For each sector, there is a linear relationship which is between the natural logarithm of renewable electricity consumption and the other explanatory variables (in logarithmic form). The relationship is written in a linear form as follows:

$$REit = \beta_{1i} + \beta_{2i}POILt + \beta_{3i}PNGASit + \beta_{4i}PCOALt + \beta_{5i}PELECTRICITYit + \beta_{6i}CO2t + \beta_{7i}TAXCREDITt + \beta_{8i}GDPt + \varepsilon_{it} \quad (1)$$

where i = 1,…,4 denotes the sector and t = 1985,…,2020 denotes the time period. Lastly, γ_j is the sector-specific effect. β_0 is an estimated parameter, and epsilon is ε is the error term. The explanatory variables are presented in Table 1. Equation 1 provides the long-run elasticity; it is computed using the panel cointegration techniques of Mitić, Munitlak Ivanović, Zdravković (2017), and Pedroni (2001). Mitić, Munitlak Ivanović, and Zdravković (2017) show that a vast majority of the studies use panel datasets and panel estimation methods to analyze the effect of CO2 emission and economic growth. Using a panel database over the individual time series would present some advantages, such as controlling for heterogeneity issues, increasing the degree of freedom, and more stability in the estimated parameters (Mitić, Munitlak Ivanović, and Zdravković, 2017).

For each sector, long- and short-run elasticity for renewable electricity is computed. An error correlation method is used to calculate the short-run elasticity (Mitić, Munitlak Ivanović, and Zdravković, 2017; Sadorsky, 2007). If the error correlation mechanism (ECM) exists, it means that there is cointegration between some variables. According to Engle and Granger (1987), Sadorsky (2007), and Masih and Masih (1996), once cointegration is detected between variables, error correlation exists. Sadorsky (2007) states that "changes in the dependent variables are modeled as a function of the level of the disequilibrium in the cointegrating relationship and changes in the other explanatory variables." (2007).

In that respect, the ECM is the fitted value of equation 2.

$$\Delta RE_{it} = c_i + \sum_{j=1}^{p=1} \gamma_{1j}\, \Delta RE_{i\_j} + \sum_{j=0}^{p=2} \gamma_{21j} \Delta POIL_t - j + \sum_{j=0}^{p=3} \gamma_{31j}\, \Delta PNGAS_{it\_j} + \sum_{j=0}^{p=4} \gamma_{41j} \Delta PCOAL_t + \sum_{j=0}^{p=5} \gamma_{51j} \Delta PELECTRICITY_{it\_j} + \sum_{j=0}^{p=6} \gamma_{61j} \Delta CO2_{t\_j} + \sum_{j=0}^{p=7} \gamma_{71j} \Delta TAXCREDIT_{t\_j} + \sum_{j=0}^{p=8} \gamma_{81j} \Delta GDP_{t\_j} + \gamma_9 EC_{it-1} + \upsilon_{it} \quad (2)$$

We now define the EC which is the fitted value of equation (1):

$$EC_{it} = RE_{it} - \beta_{1i} - \beta_{2i} POIL_t - \beta_{3i} PNGAS_{it} - \beta_{4i} PCOAL_t - \beta_{5i} PELECTRICITY_{it} - \beta_{6i} CO2_t - \beta_{7i} TAXCREDIT_t - \beta_{8i} GDP_t \quad (3)$$

The EC equation presented above embodies the long-run dynamic through the changes in the independent variables, and the long-run equilibrium through the cointegration term (Sadorsky, 2007).

ii. Data

Crude oil prices differ from gas prices range and coal prices in the United States. Therefore, the present study uses U.S. gas and coal prices to investigate renewable electricity consumption, as the electricity price from non-renewable sources is slightly higher than from renewable sources. However, I use it to measure the impact of renewable electricity consumption. Table 1 presents the variables that are used for the present study for each type of consumer between 1985 and 2020. Renewable energy consumption, gas price, and electricity price are taken for each type of consumer. This is to measure the cross prices of elasticity between renewable electricity consumption and other energy source prices.

Table 2 presents the data descriptive (statistics). It provides the mean, maximum, and minimum values, as well as the standard deviation for each variable.

Table 2
Descriptive Statistics[2]

Variable	Mean	Min	Max	Std. Dev.	Skewness[3]	Kurtosis[4]
RE	6.1	3.2	7.82	1.26	-.31	1.90
CO_2	8.53	8.3	8.6	.083	-.46	3.11
POIL	3.85	2.93	4.77	.53	.28	.05
TAXCREDIT	.56	-.35	2.31	.68	.91	3.02
GDP	9.43	8.94	8.95	.27	-.22	1.94
PELECTRICITY	2.16	1.81	2.60	.19	.22	2
PNGAS	1.86	.98	2.63	.44	-.157	2.01
PCOAL	3.21	8.3	8.65	.28	.24	1.56

IV. Empirical Analysis

i. Unit Root Tests

The test of unity root test is one of the analyses that verify the stationarity of the data series. Table 3 presents the Fisher Type results along with the ADF unit root test. The result shows that the credits have unit roots at their levels. However, the rest of the variables become stationary at the first difference at the 1% significance level.

Table 3
Results of Unit Root Test (Panel)

Variable	(ADF Test) Statistic chi-square (P-value)	Levin, Lin, & Chu
RE	0.560 (0.287)	0.125 (0.549)
ΔRE	2.500 (0.006) Lag of 3	-1.859 (0.031) Lag of 3
PELECTRICITY	-1.49 (0.93)	1.245 (0.893)
Δ PELECTRICITY	55.42 (0.00)	1.687 (0.954 Lag of 3
PGAS	-1.47 (0.93)	-2.99 (0.001)
ΔPNGAS	40.84 (0.00)	-1.043 (0.148) Lag of 1

[2] All the variables in Table 3 are expressed in natural logarithms.

[3] For the data to be symmetrical, skewness is -.5 and .5.

[4] For the data to be symmetrical, kurtosis is -2 and 2.

Table 4
Unit Root Test for the Other Variables

Variable	(ADF Test) Statistic chi-square (P-value)	
CO_2	-1.83 (0.966)	0.050 (0.520)
Δ *CO_2*	-1.904 (0.971) Lag of 3	
POIL	-0.649 (0.742)	
Δ *POIL*	-1.186 (0.882) Lag of 3	
TAXCREDIT	4.177 (0.000)***	
Δ *TAXCREDIT*	31.48 (0.00)	
GDP	-1.66 (0.9)	
Δ *GDP*	52.92 (0.00)	
PCOAL	-1.17 (0.88)	
Δ *PCOAL*	24.01 (0.00)	

As the unit root tests clearly show that the panel data at their levels are not stationary; therefore, we need to take the necessary lags and then use multivariate cointegration tests, such as the test of Johansen multivariate cointegration. It examines cointegration among the variables (Dogan 2016; Apergis and Apergis 2017). Therefore, to test for cointegration in the panel data between the dependent and the explanatory variables, we implement the Dicky and Fuller test. This test is widely used and has power because of its strong assumption of cross-sectional dependency among the variables (Jingwen et al. 2020). All the variables of the ADF statistic test are cointegrated by fitting Model 1 using ARDL, predicting the residual ε_{it}, and then fitting the ADF regression model.

$$\varepsilon_{it} = \rho_i \varepsilon_{i,t-1} + \sum_{i=1}^{\rho} \rho_{ji} \Delta\varepsilon_{i,t-1} + \upsilon^*_{it}$$

$\Delta\varepsilon_{i,t-j}$ is the *j*th first difference lag of the fitted error $\widehat{\varepsilon_{it}}$, and ρ is the lag difference number.

V. Research Findings

i. Empirical Results and Discussion

Our method is based on FMOLS which is Fully Modified Ordinary Least Square and DOLS, as Sadorsky (2009) uses for his analysis. In this study, we apply the approach to test the impact of tax credits and energy prices on the consumption of renewable energy. The estimated parameters can be interpreted as the long-run elasticity. Sector-specific price elasticities, tax effect, CO_2 emission, and GDP effect are estimated using FMOLS as presented in Table 5.

The effects of price elasticity are different for each sector. The elasticities of electricity prices are significant at the 1% and 5% levels for the commercial and transportation sectors, respectively, and positive too. The natural gas price elasticities are negative and significant at the 1% level for the residential, commercial, and industrial sectors; coal price elasticities are negative and significant at the 1% level for the commercial sector, while it is positive and significant for the industrial and transportation sectors. The tax credit is statistically positive and significant at the 1% level for the residential sector.

The GDP is positive and significantly affects renewable electricity consumption at the 1% level for the commercial, industrial, and transportation sectors, while it has a negatively significant effect on residential consumption at the 5% level. Lastly, CO_2 emission has a positive and significant effect on commercial and industrial consumption at the 1% and 5% levels, respectively. Notably, CO_2 emission affects residential consumption negatively at the 5% level. For most of the sectors, there are no significant differences between FMOLS and DOLS.

For the panel results, the tax credit is significant, and it influences the consumption of renewable electricity at the 10% level. The 0.283 coefficient indicates that increasing the tax credit by 1% raises the renewable electricity consumption in these sectors by 0.283%. The price elasticities of electricity and coal are positive and significant, and their values are much similar in the estimation techniques. Lastly, the elasticities of gas prices are significant and negatively affect renewable electricity consumption.

Table 5
Long-run Elasticities - Renewable Electricity Consumption

	FMOLS					DOLS				
	Residential	Commercial	Industrial	Transportation	Panel Result	Residential	Commercial	Industrial	Transportation	Panel Result
CO_2	-1.218 [.5537]**	3.492 [.660]***	.517 [.2103]**	-.576 [.742]	2.557 [1.569]*	-1.218 [.627]*	3.491 [.749]***	.517 [.238]***	-.5767 [.844]	2.557 [1.614]
POIL	.333 [.312]	.223 [.187]	-.053 [.072]	-.208 [.105]*	.913 [.422]**	.0463 [.1224]	.223 [.212]	-.053 [.082]	-.208 [.119]*	.9134 [.435]**
TAXCREDIT	.108 [.030]***	-.0766 [.0476]*	.032 [.024]	-.044 [.028]	.283 [.155]*	.1084 [.035]***	-.0766 [.054]	.032 [.028]	-.044 [.032]	.282 [.160]*
GDP	-.235 [.1104]**	.482 [.156]***	.1807 [.034]***	2.65 [.177]***	-1.002 [.715]	-.235 [.1251]*	.4826 [.177]***	.180 [.039]***	2.653 [.202]***	-1.002 [.736]
PELECTRICITY	-.0684 [.397]	7.153 [1.150]***	-.246 [.283]	1.403 [.477]***	8.923 [.975]***	-.068 [.450]	7.153 [1.30]***	-.246 [.321]	1.403 [.543]**	8.923 [1.003]***
PNGAS	-.432 [.1652]***	-2.017 [.2682]***	-.166 [.071]**	.262 [.199]	-2.95 [.244]***	-.432 [.1873]**	-2.017 [.304]***	-.166 [.081]**	.262 [.227]	-2.958 [.251]***
PCOAL	.046 [.1080]	-1.723 [.7019]**	.572 [.213]***	1.368 [.408]***	-2.788 [.983]***	.420 [.440]	-1.723 [.795]**	.572 [.241]**	1.368 [.464]***	-2.788 [1.012]***
CONSTANT	18.53 [5.613]***	-36.37 [6.456]***	.511 [2.046]	-21.38 [6.321]***	-14.93 [13.95]	18.532 [6.3]***	-36.37 [7.321]***	.5118 [2.32]	-21.38 [7.197]***	-14.936 [14.35]

`

Table 6
Renewable Electricity Consumption: Short-Run Elasticities

	Residential	Commercial	Industrial	Transportation
ΔRE (-1)	-.0472	-.0298	.014	-.288
	[.131]	[.047]	[.194]	[.158]*
ΔRE (-2)	-.341	.023	.0731	-.015
	[.124]**	[.046]	[.156]	[.168]
ΔRE (-3)	.400	-.025	-.271	-.238
	[.215]*	[.033]	[.101]***	[.114]*
ΔCO_2 (-1)	-.089	-1.263	-.737	.7179
	[.566]	[.350]***	[.289]**	[1.132]
ΔCO_2 (-2)	.086	-.734	-.402	-.903
	[.677]	[.350]**	[.289]	[.502]*
ΔCO_2 (-3)	2.326	-1.301	.254	1.98
	[.827]***	[.313]***	[.312]	[.697]***
ΔCO_2	-.471	1.000	1.25	-1.99
	[.827]	[.458]**	[.269]***	[.786]**
ΔPOIL(-1)	-.0776	-.069	-.025	-.003
	[.101]	[.065]	[.028]	[.096]
ΔPOIL(-2)	.1069	.099	.0008	-.008
	[.084]	[.067]	[.0262]	[.084]
ΔPOIL(-3)	-.203	.0324	.021	.0003
	[.084]**	[.048]	[.027]	[.084]
ΔPOIL	.046	.079	.047	-.111
	[.102]	[.058]	[.031]	[.121]
ΔTAXCREDIT	-.0195	-.0766	-.006	-.053
	[.045]	[.0476]*	[.010]	[.053]
ΔGDP(-1)	-.684	.812	-.366	-2.16
	[.617]	[.174]***	[.149]**	[1.55]
ΔGDP	.0257	.079	.416	3.83
	[.1104]**	[.088]	[.070]***	[1.189***]
ΔPELECTRICITY(-1)	1.324	.429	.341	.987
	[.155]	[.477]	[.292]	[.445]**
ΔPELECTRICITY(-2)	-.096	.054	.235	.579
	[.807]	[.428]	[.235]	[.424]
ΔPELECTRICITY(-3)	.826	.818	.001	-.8155
	[1.025]	[.440]*	[.274]	[.427]*
ΔPELECTRICITY	-.941	-1.151	.093	-.199
	[1.39]	[.6480]*	[.295]	[.328]
ΔPNGAS	.1074	.0267	-.166	.503
	[.394]	[.1670]	[.071]**	[.153]***
ΔPCOAL(-1)	.0285	.065	-.057	.118
	[.416]	[.222]	[.145]	[.353]
ΔPCOAL	.-.1746	-.349	-.093	.478
	[.438]	[.236]	[.134]	[.341]
CE(-1)	1.436	.027	2.58	.079
	[.423]***	[.009]***	[1.46]*	[.023]***
CONSTANT	-14.267	15.654	2.38	-11.48
	[15.09]***	[3.957]***	[1.462]*	[6.59]*
Breusch-Pagan test	9.709	2.46	2.96	3.893
Pr	[0.001][a]	[.116]	[0.085]	[0.0485][a]

<u>Short run elasticity</u>

CO_2	-1.44	2.212	.870	-.719
	[.605]**	[.495]***	[.253]***	[.785]
POIL	.0952	-.116	-.0191	-.181
	[.122]	[.126]	[.071]	[.126]
TAXCREDIT	.1006	.103	.006	-.082
	[.0427]**	[.042]**	[.022]	[.056]
GDP	-.271	.302	.275	2.852
	[.129]**	[.121]**	[.045]***	[.276]***
PELECTRICITY	.221	3.055	.109	1.731
	[.465]	[.669]***	[.286]	[.461]***
PNGAS	-.4049	-1.260	-.274	.499
	[.228]*	[.197]***	[.081]***	[.199]**
PCOAL	.1693	.069	.376	1.10
	[.3991]	[.392]	[.224]*	[.437]**

[a] *significant at $\alpha=0.05$*

The CO2 elasticities are mostly positive, while the tax credit elasticities are positive and significant for commercial and residential consumers. The GDP elasticities are mostly positive and are all significant. Furthermore, the electricity price elasticities are positive and significant for the commercial and transportation sectors. The gas price elasticities are almost negative but significant. Lastly, the coal price elasticities are positive and significant for the industrial and transportation sectors.

In summary, the energy price elasticities are worth discussing. The electricity price elasticities are positive and significant for the commercial and transportation sectors. The elasticities are greater than 1, which implies that any change in the price of electricity causes a greater change in renewable electricity consumption for the commercial and transportation sectors. The electricity price elasticity for the transportation sector is positive, while it is negative for the other sectors. This is due to the interaction with short-run movements in renewable electricity consumption and other variables. The government is thus advised to subsidize the prices of gas for certain uses, as gas is used to generate renewable electricity.

However, in the long term, the estimates of CO2 elasticities are consistent with the view that the federal government has recently provided a lower level of government credit (subsidy) for greenhouse gas because of its emission. Thus, in the long run, CO2 emission increases renewable energy consumption. Notably, GDP, electricity price, coal price, and gas price elasticities determine renewable electricity consumption in the long run.

In this case, the long-run relationship presents the cross-price elasticity. The elasticity of electricity price is high (coefficient is greater than 1) for the commercial and transportation sectors. As the price of electricity generated from non-renewable sources increases, so does renewable electricity consumption. The above-mentioned coefficient indicates that, in the long run, consumers behave rationally and consume more renewable electricity. Energy technology nowadays is highly supported by research and development; therefore, consumers will not continue paying higher prices for electricity as long as they have access to renewable electricity sources. The cost of switching is seemingly cheaper than continuing to pay higher costs for electricity bills.

Additionally, the elasticity of the price of gas is conducted as described above. As the price of gas increases, the consumption of renewable electricity decreases. This is because one of the ways to generate electricity is by using gas. As the price of gas increases, so does the cost of electricity generation, and thus, the consumption, in the long run, will decrease. There are many ways to generate renewable electricity, but we include the relevant energy prices due to the need to measure the cross-price elasticity, as well as data availability. According to the Energy Information Administration (EIA) 2021, in generating electricity, shifting from coal to gas raises the average price of gas by 41% in 2021 relative to the price in 2017. This causes energy and economic experts in the EIA to allocate renewable electricity generation sources from gas-intensive to other renewable energy sources through several approaches, such as using government fiscal policies (e.g., tax credits, energy price subsidies, etc.).

In summing up, the analysis above shows that tax credit has a positive impact on the consumption of renewable electricity in the short run. Moreover, CO_2, electricity, and gas prices affect renewable electricity consumption in both the short and long run. However, this study finds no significant impact of crude oil prices on renewable electricity consumption in the short and long run. This finding contradicts that of Omri and Nguyen (2014).

VI. Conclusion and Implications

The U.S. Short- and long-run energy price elasticities show that renewable electricity is the most appropriate substitute for electricity over other energy sources as it facilitates the elimination of CO_2 emission over time. The present study investigates the key factors that drive renewable electricity consumption in the U.S. I use panel data for four consumption sectors between 1985 and 2020, and the findings show that tax credit elasticities affect residential renewable energy consumption in the short and long run. For both the long and short run, an increase in income is the major driver for renewable electricity consumption for all the sectors.

Furthermore, in the short run, natural gas negatively affects the consumption of renewable energy, as the price of natural gas increases, the consumption of renewable energy decreases. It is important to know that natural gas is used to generate electricity. Whereas, in the long run, as the price of natural gas increases, concerning the other energy prices and factors, the consumption of renewable electricity decreases. Renewable electricity is the best substitute for natural gas in the long run. In future studies, with the assumption of data availability, we would attempt to test the impact of the variable costs of renewable energy projects—solar and wind—on renewable electricity consumption. The variable costs are used as a proxy for renewable electricity prices. The transition to renewable electricity consumption requires intensive and continuous support of federal funding for renewable energy facilities, which will affect the consumption of renewable electricity.

There are several policies, and their implication can be written based on our findings. The federal government, as a fiscal policy maker, would evaluate the impact of the tax credit in the short and medium run. Further, the CO2 emission level for factories was assigned; therefore, sorts of fiscal policies should be shifted to maintain the CO2 emission level. Balancing the fiscal policies between developments (attracting technology when generating energy) as well as eliminating the emission of nonrenewable sources should be performed.

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