The Role of Raw Material Prices in Renewable Energy Diffusion

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Research

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Abstract

The foremost need for countries especially Pakistan and other Asian countries is the hunt for renewable and alternative energy because the scarcity of energy is faced by many countries like Pakistan. There are a number of approaches seeking to demonstrate the diffusion of renewable energy technologies (RET). Learning and experience curves are the highest generally exercised instruments, followed by further economic, policy- and barrier-related analyses. The purpose of this study is to support research on the role of raw material prices specifically oil price and gas price on Renewable energy diffusion. Panel regression with fixed effects model is applied on data of 3 Asian countries namely Pakistan, India, and China for the period 1990 to 2012 gathered from World Bank and EIA (Energy Information Administration). The findings reveal that the model confirms an adequate fit and a very significant influence of oil prices on investments in renewable energy technology capacity whereas the insignificant influence of natural gas prices in a renewable energy technology capacity.

Introduction

The progress of international energy seems to be apparent with respect to their particular features in future years despite some necessary reservations. The growth in the world economy, population, and a nonstop change in the focus of energy consumption to emerging Asia and other economies result in an ongoing upsurge in energy services demand (OECD/IEA, 2015). Now the foremost need for countries especially Pakistan is the hunt for renewable and alternative energy because the scarcity of energy is faced by many countries like Pakistan also and therefore it is severely touching economic growth.

Renewable energy has a minor portion of the overall energy mix. Cost demerit is a general assessment regarding the generation of renewable energy. But to achieve grid parity, the growing prices of fossil fuel in the Islamic Republic of Pakistan and the sufficient accessibility of renewable energy (RE) might facilitate (Awan & Khan, 2014).

The present reserves of oil are about to remain for an additional 40 years only if existing fossil fuels are consumed at a similar percentage. In the case of Gas, these are about to remain for an additional 65 years. The present reserves of coal are about to remain for an additional 155 years as suggested by Bionomic fuel. A lot of coal will be consumed with alternative energy sources if reserves of oil and gas are used nonstop at a constant rate (Iwaro & Mwasha, 2010).

Wasteful energy deployment, the absence of public knowledge, and unprogressive infrastructure are the main problems faced by Pakistan with respect to its requirements for energy. For the successful conversion of energy into renewable, it is needed that extensive investment and strategic support took place in addition to the program and projects of the government that are in progress.

To attain its energy requirements through renewable, satisfactory targets are set by Pakistan in their strategies. Also, Pakistan spends 3 Billion US dollars each year to bring in oil from other countries being a poor country and 1% is the annual increment ratio in this spending (Shah et. al, 2011).

The alternatives of technology attainable to decrease emissions of carbon in the energy sector also comprise renewable energy sources (RES) that are not all the time but normally free of carbon. But the cost of these technologies is exceeding the cost of conventional fossil fuels (Popp, Hascic & Medhi, 2011).

Somewhat rapid and unpredictable changes in prices of raw material markets prove the dependency of a large number of technologies on prices of raw material mainly in recent years (Kehrel & Sick, 2015).

Over the earlier few decades, the national development agenda of many of the established countries includes the deployment of renewables. The emphasis is largely on the production then "crises of energy" in the 1980s plan consequently showing the volatile characteristics of oil prices in those days. So, the emerging viable substitutes for traditional fuels are renewables. In the years the 1990s, maintainable development, establishing the role of worldwide action expected at deal with climate change consequently connected the renewable energy sources (RES). In the last few years, renewable energy sources (RES) deployment has faced an outstanding worldwide growth profile, supported by this rising significance (Aguirre & Ibikunle, 2014).

Throughout the most recent decade although, an extensive rise in the amount and influence of ups and downs in crude oil and natural gas prices can be witnessed. With regard to prices of raw material, this research would like to highlight, that from the perspective of this study, since prices are for manufacturing firms of renewable energy technology tools, they are measured to be externally programmed. Due to that, the emphasis at this point is fixed entirely on price history, putting away the reasons (circumstances of demand and supply, assumptions, etc.) that could be at the core of these changes.

Problem Statement

To describe facts and hurdles of RET diffusion, scholars began studying the renewable energy diffusion (RET) diffusion in the later years of 1990, and up to now, various techniques have been reported by a number of researchers. In literature, renewable energy diffusion obstacles, strategy attributes, experience and learning outcomes, and integrated system models are the highly investigated characteristics. But the impact of prices of raw materials

specifically oil and gas prices on the diffusion of renewable energy technology (RET) is one new viewpoint in this domain. Every part otherwise being equivalent, the prices have been expected to continue unchanging up till now (Kehrel & Sick, 2015).

The general purpose is the diffusion of RETs and to accomplish it, the key emphasis of the research eventually is to offer paths to organize all elements happening independently to come together and function as a separate entity (Shah et al. 2011).

Since the market of energy is fundamentally a commodity industry, prices act for the toughest benchmark in assigning shares of the market. Regardless of the type of raw materials that are required for the production of Renewable energy technology, the energy product prices specifically crude oil and natural gas act as important parts while evaluating the diffusion of renewable energy technology. Although prices of raw material have each time appealed concentration in the scientific society and are presently a topic of discussion in the academic world alongside in industry.

As in my knowledge, there is no study exclusively on the relationship between RET diffusion and Raw material prices especially in Pakistan and Asian countries presently. So this research would contribute to the study on Renewable energy diffusion (RET) by adding up the prospect of prices of raw materials includes Crude Oil price and Natural Gas price.

Research Question

This study is carried out to discover answers to questions as mentioned below.

RQ₁: Is there a significant impact of Oil prices on Renewable energy diffusion?

RQ₂: Is there a significant impact of Gas prices on Renewable energy diffusion?

Definitions of the Terms

Renewable Energy and RET Diffusion

Renewable Energy (RE) is originated through natural procedures that are replaced repetitively. Primarily or secondarily, produced renewable energy in its several shapes from the sun and heat within the earth. Renewable energy includes energy produced from solar, biofuels, geothermal, wind, and hydro and ocean resources.

In this research, the investment in RET per capita for country and time described the diffusion of renewable energy technology (RET). First, the renewable energy installed capacity is converted from GW to KW. Then, by way of dividing net capacity in KW by population, the Net Investment will be the result.

Raw Material Prices (RMP)

In this piece of research, the prices of raw material are at first denoted by a 1-year gap because of a particular response time of investments in RET on raw material price changes. Here prices of raw material include crude oil price and natural gas price.

Crude Oil Price.

A few of the very main commodities for the worldwide economy is Crude Oil. To determine the spot price of the various barrels of oil, the crude oil price is applied. There are a number of factors that influence the demand and supply of crude oil on which crude oil prices depend from which several products like gasoline are obtained. Home cooking oil, gasoline, electric power production, and manufacturing are directly affected with respect to their cost by the higher crude oil prices.

For the data analysis, Europe Brent Spot Price FOB (Dollars per Barrel) on an annual basis has been taken in this research.

Natural Gas Price.

In order to encounter the growing need for energy in the country, the Government is spending its energies on improving the production of gas. Demand and supply develop the prices of natural gas primarily like with other commodity prices. Yet, the crude oil price and petroleum products also develop natural gas prices. The prices of natural gas traditionally followed oil prices, but in the last few years, natural gas prices are changing to some degree with coal prices instead of Oil prices. In this study, natural gas prices in terms of US dollar per MMBTU (million British Thermal Units).

LITERATURE REVIEW

In this study, the diffusion of Renewable Energy Technology (RET) is primarily built on environmental and matters of energy security. To build Renewable energy technology (RET) further competitive in comparison with reputable technologies of fossil fuel, the approaches of learning and experience curve place influence on the necessary decreases in Renewable energy technology (RET) cost. It will demand excessive financings or subsidies to make RET economical, although Renewable Energy Technology (RET) has a greater proficiency for cost reduction as determined by a number of approaches.

The concept of the learning and experience curve is built on the thought that as the experience is obtained by the worker; the expected time to accomplish a task reduces. The main idea is that as the aggregate production double up, the time or cost of accomplishing a task (e.g. manufacturing a production unit) lowers. This connection was perhaps first determined in the year 1936 at Wright-Patterson Air Force Base in the United States (US).

Rao and Kishore (2010) stated that the diffusion of renewable energy technology (RET) involved adaptation barriers of renewable energy technology and techno-economic, learning, and experience curve approaches. They applied the learning and experience curve to examine the diffusion methods of Renewable Energy Technologies (RETs). They discussed that technological advancement linked along with technology. For example, the enhancements made by experimentation, execution and research and development (R&D) during the production activity is controlled by social and economic policies together with economic potentials as indicated by the learning curve concept.

With the purpose of taking into attention that Renewable Energy Technology (RET) because of their excellent capability for cutbacks in cost, results in an excessive rate of learning and fewer inclined to environmental taxation are supposed to effectively challenge the traditional technologies in coming time (therefore working such as backstop technologies), thus, (Kumbaroglu, Madlener, and Demirel, 2008) make use of learning curves for Renewable Energy Technologies (RETs). Research and development (R&D) expense influence on decreases in costs is also involved whereas Latest methodological developments with regard to learning curves applied two-factor models, wherever as well as learning-by-using.

Harijan, et.al, (2011) stated that an S-Curve as presented in Fig. 1 describes the diffusion of technology over a period of time. S-curve is a mix of slow initial growth, after that rapid growth subsequent to a definite take-off point and then once again a slow growth on the way to a finite upper limit to the distribution.

Empirical Review

Ata (2016) engages panel data for the time span of 1990 to 2008 to perform econometric analysis of four types of renewable energy (RE) policies i.e. feed-in-tariffs (FITs), tenders, quotas and incentives in tax in supporting the deployment of renewable energy technologies (RETs) in 27 nations of European Union (EU) and 50 status of United States (US). A fixed-effects regression model and primarily panel data set with instruments of policy and further factors around nationwide or state-level are used. The results present that tax and feed-in-tariffs (FITs) both positively and significantly influence the potential of deployment of renewable energy (RE) in both the US and Europe. The quota has an insignificant impact on renewable energy deployment. However, incentives in tax and tender positively impact renewable energy (RE) deployment. Also, renewable energy deployment is significantly affected by electricity usage, nuclear energy, and prices of coal while income, prices of gas, security elements, and CO2 emissions are insignificant in the deployment of renewable energy.

For the period between 1997 and 2014, Biresselioglu, Kilinc, Onater-Isberk, and Yelkenci (2016) in their study examines the influence of factors related to environmental, political, and economic on the development of installed wind capacity all over the world with consideration of various regions. The variables employed for this research are the development of installed wind capacity, GDP (Gross Domestic Product) per capita, the dependence of total energy import, formation of carbon dioxide (CO2) emission, stock of foreign direct investment (FDI), the potency of primary energy, and the apportions of wind and hydroelectricity utilization in the production of electricity and electricity price. System GMM (System Generalized Method of Moments) program is executed to disclose dynamic relationship on the variables in the model. Including non-continental & Southern Europe, Northern Europe, Western & Central Europe, and non-European OECD (The Organization for Economic Cooperation and Development), the approximations for the phase 1997 to 2014 are narrated for the experiment of 26 nations, along with dissimilar territories. For the estimated influences, a group of prior hypotheses is further investigated. The findings disclose that the capacity growth of installed wind is influenced by various indicators that confirm prior hypotheses of this research. Also, it was found that in the prior phase, the greater capacity of installed wind has a positive influence as compared to the present phase. Similarly, the capacity growth of installed wind capacity is also influenced by greater carbon dioxide (CO2) discharges. On the other hand, dissimilar states encounter different influences on many variables, for example, electricity price and entire import dependence.

Lin, Omoju and Okonkwo (2016) applying data for the time period of 1980 to 2011 to concentrate on time series data and studies the determinants affecting the amount of renewable electricity usage in China. In their article, the Johansen co-integration method and vector error correction model are employed. The outcome indicates that gross domestic product (GDP) per capita, openness to trade, foreign direct investment (FDI), financial development, and fossil fuel share in energy usage have long term connection with usage of renewable electricity. GDP and financial development have positive effects on the usage of renewable electricity while FDI, openness to trade Fossil fuel share diminish the renewable energy (RE) share in total consumption of electricity in China.

Ma, Chen and Li (2013) investigate the renewable energy (RE) usage rate and their procedures throughout the growth of the renewable energy (RE) market which is influenced by market need, policy encouragement, and technological development. In order to investigate the influence of the market,

policy, and technology on the usage rate of renewable energy (RE), a panel data set of 28 nations of OECD (The Organization for Economic Cooperation and Development) for a total of 34 years is built. The findings of their research reveal that the price of oil is slightly statistically significant merely in the whole set, plus the coefficients' sign is positive which is coherent by the argument that renewable energy (RE) is an alternative for fossil energy. Also, GDP (log) per capita and the level of imported energy's dependency, are expected to have a positive link to the renewable energy's usage rate. In all 28 OECD nations' regression, the indication of the coefficient is certain with the expectation however statistical impact of those coefficients has a big difference.

Romano and Scandurra (2016) discover the prevailing differences in the main elements influencing investments in two distinctive production sources of renewable energy (RE). In their study the researchers suggested a dynamic panel analysis of investment in renewable energy for a sample of 32 countries includes countries of OECD (The Organization for Economic Cooperation and Development) and Brazil, China, India, South Africa, and Russia) with dissimilar social and economic compositions for the years concerning 2000 and 2008. As proved in the result the main aspects encouraging Renewable energy sources investments differ as per generation basis measured. The policies are proving to be an influencing factor for renewable energy (RE) investment. Progress in the conditions of environment performed through investing in sources of hydroelectric however further sources found insignificant. The findings further indicate that the thermal and nuclear electricity share slow down renewable energy (RE) investment.

Zamfir, Colesca and Corbos (2016) intended to analyze the public related policies employed to promote renewable energy (RE) growth in Romania for the period of past 10 years. They examine Romania's renewable energy (RE) sector with regards to economic and analytical ability, generation, and utilization of renewable energy (RE) and regulation associated with renewable energy (RE). The finding state that development of renewable energy (RE) is backed by public policies

Marques and Fuinhas (2012) analyze the effect of public policies encouraging renewable energy (RE) by concentrating at a panel of 23 European nations for the time period of 1990 – 2007. Somewhere further factors proposed by the empirical review, a realistic evaluation of the positive share of every type of public policies classified by the International Energy Agency (IEA) is catered in a situation of difficulty. Factors for example quota obligations, research, and development (R&D) plans or tradable licenses, and product classification as concerns utilization of energy have not been supporters with regard to the deployment of renewable energy. But the outcomes present that policies regarding incentive and subsidy like feed-in-tariffs (FITs) and policy processes like strategic arrangement act as a main part in the deployment of renewable energy (RE) in European countries.

Salim and Rafiq (2012) recognize the factors of renewable energy spending in six prominent renewable energy financier evolving countries by using panel data together with time series econometric techniques. In the long-term, income and emission of pollution in China, Brazil, Indonesia, and India significantly affect the consumption of renewable energy. If talk about Turkey and the Philippines, this study found income as a major driver for the consumption of renewable energy. With reference to each of these countries, the spending on renewable energy is negatively and less significantly affected by oil prices. The elasticity indicated from both panel methods is observed to be reasonably stable for fully modified OLS (FMOLS) and Dynamic OLS (DOLS) and the Autoregressive distributed lag (ARDL).

In the study conducted by Gan and Smith (2011) among The Organization for Economic Cooperation and Development (OECD) nations, find key drivers that support the promotion of renewable energy technology and bioenergy. By panel data modeling, their results disclose that renewable energy supply per capita and bioenergy in OECD states are significantly affected by market consumption of alternative energy and bioenergy and Gross domestic product (GDP). Along with these regular motivating influences, there were a few additional particular country-level elements also that impact renewable energy and bioenergy progress in single countries. Alternative energy and bioenergy, innovation-related policies, market-related energy policies that offer incentives else wise enforce taxes to moderate the market and environmental exterior, and prices of energy, CO2 discharges, and government have a mathematically insignificant influence of these elements on the dependent variable.

Popp et al. (2011) applying the dataset of PATSTAT including 26 nations of The Organization for Economic Cooperation and Development (OECD) consider investing in solar photovoltaic (Solar PV), geothermal, and electricity from biomass, wind, and waste for the time span from 1991 till 2004. They measure the consequence of increased intelligence on renewable energy investment. The findings show that knowledge stock has a significant impact on investing in Energy capacity per capita means the gain in knowledge growths the investment in renewable energy.

Shrimali and Kniefel (2011) evaluate the influences of public policies on the diffusion of several emergent sources of renewable electricity, comprising solar photovoltaic, wind, biomass, geothermal by making use of a panel data on 50 US states and for the period 1991 to 2007 and a model of state fixed-effects including state-particular time-trends. There is a significant influence of portfolio standards of renewable with one or the other capability or sales needs on the diffusion of each kind of renewable. On the other hand, that influence is changeable be governed by the kind of renewable source, like it affects the combined renewables, biomass, and wind in the negative; and it influences the solar and geothermal in the positive. Lastly, economic factors like the price of electricity, natural gas price, and per capita Gross domestic product (GDP) are observed to be normally insignificant and proposing a vital part of the policy in expanding the renewables penetration.

Research Method

Climate variation has been challenging in current centuries as CO2 discharges keep on rising in established and developing nations. There is an opportunity for evolution concerning a society (that is less carbon) is to enlarge the energy share especially electrical energy produced through the

sources of renewable energy (RE). In recent time, investments in clean energy plans have been rising and entire fit for an appropriate extent. So far the investments in traditional fossil-based fuel power are higher than the volumes of renewable energy technologies (RETs) (Polzin et al. 2015).

As the energy sector is ultimately an industry of commodity and the prices indicate the utmost yardstick in distributing shares in the market Lund(2007). Crude oil and natural gas that represent energy commodities prices perform a major part in investigating the diffusion of renewable energy technologies (RETs), regardless of the type of raw materials that are required for renewable energy technology (RET) production.

Research Model

We used the below model established by Johnstone, Hascic and Popp (2010) and Popp et al. (2011) with the aim of discovering empirical proof for the role of oil and gas prices on renewable energy technology (RET) diffusion, which is applied to this study framework and broadened to a factor of raw material price:

Equation: Research Model

$$RET_{i,t} = \beta_1 + \beta_2 RMP_OIL_{t-1} + \beta_3 RMP_GAS_{t-1} + \beta_4 GDP_{i,t} + \beta_5 GROWELEC_{i,t-1} + \beta_6 COAL_{i,t} + \beta_7 NUCLEAR_{i,t} + \epsilon_{i,t}$$

Where,

i = country

t = time

Whereas,

RET = Renewable Energy Technology (RET's net investment)

RMP_OIL = Crude Oil Prices

RMP_GAS = Natural Gas Prices

GDP = Growth of Income per capita

GROWELEC = Electricity consumption growth

COAL = % of electricity produced from coal

NUCLEAR = % of electricity produced from nuclear power

Research Hypotheses

The purpose of this research is to describe the diffusion of renewable energy technologies (RET). The raw material price like oil and gas prices plays a role in describing this diffusion. So in order to define the diffusion of RET, the below hypotheses have been built.

H₁: Oil prices have a significant impact on Renewable Energy Diffusion

H₂: Gas prices have a significant impact on Renewable Energy Diffusion

Research Design

To conduct this research, a quantitative research approach is applied. The data is gathered from the secondary source and this is explanatory research.

Data Source

The secondary sources of data collection are World Bank, Datamarket.com and IEA (International Energy Agency) that covers 23 years (1990 – 2012). Raw material prices (RMP) are denoted by a year gap due to some response time of renewable energy technology (RET) investments on raw material price changes.

Population

The projects in Pakistan, India, and China that contribute in the diffusion of solar, wind, and all renewable energy sources are examined.

Sample Period

The sample size is 69 as data covers 23 years (1990 – 2012) for 3 countries. The data has been collected for all variables from 1990 because there is no such boom of renewable energy before this period. And the data has been collected till 2012 as renewable energy installed capacity data is not available after 2012. Pakistan, India and China have been selected as previously the related research has been conducted for European and other OECD countries. So, in this research, Asian top countries i.e. Pakistan, India, and China on the basis of their energy use has been selected

Statistical Technique

To analyze the role of oil prices along with gas prices on Renewable Energy Technology diffusion, the Panel regression model is used.

Results

Table 1
Descriptive Statistics

Pakistan							
Variables	COAL	GDP	GROWELEC	NUCLEAR	RET	RMP_GAS	RMP_OIL
Mean	0.241929	1.621031	2.201709	2.484144	37.48087	4.142969	52.89000
Maximum	0.772513	5.499028	12.33300	5.536860	44.08104	10.16560	111.6300
Minimum	0.030000	-1.453653	-7.974619	0.434065	26.19438	1.814953	12.76000
Std. Dev.	0.236962	1.760094	4.097860	1.589440	4.268905	2.318400	38.65650
Skewness	1.235512	0.600994	-0.084298	0.293837	-1.234992	1.071129	0.559938
Kurtosis	3.033955	3.006543	3.861816	1.807526	4.466608	3.068451	1.645641
India							
Variables	COAL	GDP	GROWELEC	NUCLEAR	RET	RMP_GAS	RMP_OIL
Mean	68.89515	4.586658	4.501580	2.419628	34.74510	4.137784	53.03630
Maximum	75.12000	8.754970	8.806352	3.311112	58.25000	10.16560	114.3200
Minimum	65.46363	-0.980435	0.038239	1.445192	21.56784	1.814953	12.76000
Std. Dev.	2.597574	2.178151	2.259795	0.528863	13.11086	2.316232	38.89014
Skewness	0.928798	-0.266794	-0.209922	-0.145109	0.537626	1.087099	0.566559
Kurtosis	2.973643	3.012860	2.765777	1.920747	1.765392	3.080950	1.656421
China							
Variables	COAL	GDP	GROWELEC	NUCLEAR	RET	RMP_GAS	RMP_OIL
Mean	76.61519	8.792331	8.219079	1.470067	111.5954	4.201117	52.92481
Maximum	80.87967	13.60011	15.45354	2.289016	240.3000	10.16560	111.8500
Minimum	71.04036	2.419933	2.096362	0.000000	31.78160	1.814953	12.76000
Std. Dev.	2.300685	2.438325	4.010477	0.691418	78.69411	2.282129	38.71136
Skewness	-0.280416	-0.031192	0.302512	-1.111918	0.708733	1.075711	0.561381
Kurtosis	2.744909	3.414151	1.935442	3.182483	1.878615	3.124438	1.647808

Table 2
Unit Root Estimates

Level Data							
Countries	COAL	GDP	GROWELEC	NUCLEAR	RET	RMP_GAS	RMP_OIL
Pakistan	-0.588	-3.153	-3.958**	-3.323	-2.524	-1.607	-2.606
India	-1.437	-3.886**	-3.100	-3.923**	-2.266	-1.551	-2.597
China	-2.429	-3.692**	-2.104	-2.552	-2.593	-1.663	-2.603
First Difference Data							
Pakistan	-3.836**	-5.929*	-6.677*	-5.721*	-4.840*	-6.548*	-5.774*
India	-4.099*	-5.110*	-6.562*	-4.966*	-3.457***	-6.731*	-5.838*
China	-5.786*	-3.897**	-5.105*	-4.076**	-3.026	-6.607*	-5.780*

Table 2 shows the estimates of the Augmented-Dickey Fuller unit root test and found that COAL exhibits the non-stationary level series while stationary at the first difference, hence we may safely conclude that this variable has an order of integration is one, i.e., $I(1)$ variable in all three countries. Similarly, RMP_GAS and RMP_OIL both are differenced stationary variables, i.e., $I(1)$ variables in all three countries. The variable GDP is level stationary in the case of India and China, while it is differenced stationary in case of Pakistan. The GROWELEC is level stationary in the case of Pakistan, while it is differenced variables in the case of India and China. The NUCLEAR holds $I(0)$ property in the case of India, while it holds $I(1)$ property in the case of Pakistan and China. Finally, RET is differenced stationary in the case of Pakistan and India, while it does not hold the stationary property even at the first difference in the case of China. The different order of integration between the variables provides a good justification to used country-specific estimates by panel fixed-effect model for robust inferences.

Table 3
Panel Fixed Effect Regression Estimates

Dependent Variable: RET				
Method: Panel Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	96.81802	107.6471	0.899402	0.3716
COAL	-1.027522	2.230003	-0.460772	0.6464
GDP	-4.469278	2.253046	-1.983660	0.0513
GROWELEC(-1)	1.537498	1.261859	1.218438	0.2272
NUCLEAR	-10.20387	4.908257	-2.078920	0.0413
RMP_GAS(-1)	1.052557	1.890670	0.556711	0.5795
RMP_OIL(-1)	0.959619	0.138695	6.918913	0.0000
Effects Specification				
Cross-section fixed (dummy variables)				
R-squared	0.687460	Mean dependent var		62.60123
Adjusted R-squared	0.651223	S.D. dependent var		58.64813
S.E. of regression	34.63603	Akaike info criterion		10.03583
Sum squared resid	82776.14	Schwarz criterion		10.30776
Log likelihood	-382.3975	Hannan-Quinn criter.		10.14469
F-statistic	18.97143	Durbin-Watson stat		0.279594
Prob(F-statistic)	0.000000			

Table 3 explains the regression analysis for the dependent variable which is RET on various independent variables such as Coal, GDP, Growth in electricity, Nuclear, Gas, and Oil. The findings explained the insignificant relationship of Coal, Growth in electricity, and Gas with RET which also rejected the hypothesis that there is a significant relationship of Gas with RET whereas Oil has a positive significant relationship with RET similarly, and accept the hypothesis Oil has a significant relationship with RET similarly GDP and Nuclear has a negative significant relationship with RET. R squared is 0.68 which indicated that 1-time change occurred in RET due to 0.68 times of independent variables.

Conclusion

In the context of this contribution, we have studied a model for demonstrating the influence of raw material prices on RET diffusion. As a first step, we tested the explanatory power of crude oil and natural gas prices for Renewable energy technology. The model exhibits an adequate fit and a highly significant influence of oil price on investment in RET capacity as measures of diffusion. A strong model fit is observed. Electricity production from coal sources also found to be an influencing factor in the diffusion of RET.

In contrast, Natural gas price which is among the main independent variable in this model is non-significant as also confirmed by Ata (2015). GDP (per capita growth) also proves to be non-significant factors on the diffusion of RET in the perspective of Pakistan, India and China. GDP per capita growth indicates that Renewable energy technology diffusion is not essentially associated with the well-being of economy as also examined by past researchers. Growth of electricity consumption and electricity production from nuclear sources also found to be non-influencing factors on the diffusion of RET. Johnstone et al. (2010) and Popp et al. (2011) also authenticate the result that the electricity demand or energy demand at large is not a key reason for the diffusion of RET. Similarly, Nuclear power does not have many effects on RET diffusion, which may be due to the low percentage of Nuclear power share in electricity production in Pakistan, India and China.

Recommendations

In the light of the above analysis and interpretations, it is suggested that

1. When companies do planning or forecasting related to renewable energy, they should also consider changing the prices of oil and gas.
2. However, it is found that Oil price impact RET diffusion, organized and efficient incorporation of raw material price changes into devising and projecting procedures of companies can be practiced.
3. Officials from the energy sector and interrelated industries should evaluate the effect of raw material price fluctuations on energy market evolutions.
4. As electricity production costs emerge to perform a key role for the examination of diffusion of RET, they should be incorporated in the model as an alternative of non-significant variables like the growth of electricity consumption.

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Figures

Figure 1

Diffusion Curve