IJEEP
INTERNATIONAL JOURNAL OF ENERGY ECONOMICS AND POLICY
EJ EconJournals
ISSN: 2146-4553

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2016, 6(2), 144-151.

EJ EconJournals

Estimating the Impact of Feed-in Tariff Adoption: Similarities and Divergences among Countries through a Propensity-score Matching Method

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ABSTRACT

Feed-in tariff (FiT) is one of the most popular policy measures for supporting the generation from renewable energy sources. In this paper we individuate the determinants driving a country's choice of adopting FiT and investigate the reasons at the bottom of their distinctions in the choice of energy policies. The novelty of the paper relates to the methodology used to obtain the second aim that is based on the comparison and cross-checking (matching) between national heterogeneous data of several nature among which the country-effects drawn from a panel analysis conducted, at national level, on a dataset of 54 countries. The results allow us to identify some specific features related to the energy choices of the countries.

Keywords: Feed in Tariff, Renewable Energy, Propensity Score Matching, Energy Investments
JEL Classifications: C23, C38, Q42, Q48

1. INTRODUCTION

Nowadays, about the 80% of electric power is generated by fossil sources (coal, gas and oil), but there are growing global concerns regarding the lack of sustainability of these forms of electricity production that bring into question their use in a long-term energy development strategies. Nevertheless, in the last years, the needful to (i) promote the local economic development and (ii) reduce the global climate change and the dependence on imported fossil fuels have driven policymakers to adopt a wide variety of grants and/or incentives aimed to support renewable energy investments[1]. There is a wide range of policies used to support renewable energy development around the world, including economic tools, distributed generation measures, disclosure and green marketing measures. Among these, feed-in tariff (FiT) and renewable portfolio standards (RPS) represent two of the most popular policy instruments employed by policymakers in order to promote the investments in renewable energy sources (RES). As known, countries can adopt many policy instruments and a brief overview can be found in a report by the United Nations Environment Program (UNEP, 2012).

Literature about RES and policy instruments is wide and scholars generally study this relationship with a double viewpoint. The former, in which they study the drivers and the economic characteristics of the policy instruments and the latter, in which scholars individuate the key factors underlying the RES investments and the effectiveness of public policies supporting RES. Del Rio (2012) builds a theoretical framework for efficiency analysis and assesses the properties of different design elements of FiTs. He shows that several design elements can have a significant impact on the different dimensions of dynamic efficiency while Dong (2012) analyses the effectiveness of FiT and RPS, with reference to the development of wind generation. He finds that FiT has a positive effect on RES development while

1 In 2011, 73 countries have implemented policy targets for renewable electricity at federal or regional levels.

RPS policies have a negative effect in the development of wind generation. Hsu (2012) employs a system dynamics model in order to develop a simulation (until 2030) for assessing which policy, or combination of policies, promoting photo-voltaic applications presents the greatest economic benefit. He finds that FiT price or subsidy is a good approach. Recently, Stokes (2013) presents a case study of Ontario's FiT policies between 1997 and 2012 in order to analyze how the political process affects renewable energy policy design and implementation. Islam and Meade (2013) concentrate their attention on Ontario - Where a generous FiT is available to households generating electricity from solar panels - And measure the household preferences for solar panels. They then use these preferences along with household characteristics to predict adoption time intentions. Lesser and Su (2008) propose an innovative two-part FiT, consisting of both a capacity payment and a market-based energy payment, which can be used to meet the renewable policy goals of regulators. They find that the proposed two-part tariff design draws on the strengths of traditional FIT, relies on market mechanisms, is easy to implement, and avoids the problems caused by distorting wholesale energy markets through above-market energy payments. Other studies examine the key factor underlying the RES development and the effectiveness of policies to increase the investments in RES in order to quantify the effect of these instruments in the promotion of RES. Menz and Vachon (2006) and Carley (2009) study the renewable investments in the USA, the former using a country regression model and the latter with a panel regression approach while Marques et al. (2010) analyze the drivers promoting renewable energy in European countries and find that lobbies of traditional energy source and CO_2 emission restrain renewable deployment. Marques and Fuinhas (2012) study a panel of European countries and find that public policies improve the RES generation while Romano and Scandurra (2014) analyse the key factors promoting the investments in RES in a panel dataset of Petroleum Exporting Countries members. They find that lack of grants and/or incentives to promote the installations of new renewable power plants is a limit for energy sustainable development of these countries. Recently Romano et al. (2015 and 2011[) analyze the factors behind the adoption of FiT and estimate the probabilities that countries not yet adopted the FiT will propose it under different scenario hypotheses. They find that he probability to adopt FiT increases as gross domestic product (GDP) grows up.

In this paper, we focus on the FiT adoption that, as known, is one of the most applied policies for the promotion of renewable energy generation[2]. In particular, we want to investigate the drivers underlying the FiT adoption and the similarities (or dissimilarities) within countries that, although developed, have not yet adopted the FiT. For these reasons, we employ a dataset that take into consideration several indicators (among these alternative and complementary policies).

In summary, the aim of this paper is twofold. First, we identify the determinants of the FiT adoption, and after we investigate the reasons at the bottom of their distinctions in the choice of energy policies. To reach the first goals, we estimate a panel probit model while for the comparative analysis among countries which have adopted the tariff and those which have not do it is carried out through the technique of propensity score matching (PSM). PSM, in fact, allows to match countries on the strength of determinants individuated and on the strength of the individual characteristics represented by country-specific components. The results of these contemporaneous analyses allow making some interesting considerations about the behavior of the analyzed countries in terms of energy investment decisions. A panel of 56 countries with different social, economic and policy structure has been considered. Of these, about the 23% have not yet adopted the FiT in 2011 (last year of time series). The organization of the paper is as follows: Section 2 describes data while Section 3 analyses the models and reports the empirical results discussing about the policy implications. Section 4 contains a comparative analysis between features of countries that have adopted the tariff and countries that have not do it. Section 5 reports the concluding remarks.

2. DATA

The empirical analysis focuses on a panel of 56 countries observed during the period 2004-2011. Despite presenting various social, political and economic characteristics, all of the countries included in the dataset generate electricity from renewable sources. We have first individuate the key-factors underlying the adoption of the FiT as support policy to promote the investments in RES, and then, we have focused on the subsample of countries which have not yet adopted this policy instrument. In this way, we individuate the reasons why they have not yet adopted this policy and we can also study the similarities within these countries. As reported by the United Nations Environment Programme Report (UNEP, 2012), the explanatory variables can be classified in homogenous groups based on their characteristics and their supposed relationship with the outcome variable. The 4 macro-areas of interest, in which the variables utilized fall (environment, economics, production and support policies), have been outlined in Table 1. In the same table we also report the descriptive statistics.

Variables included in the class of environmental factors are the energy intensity (expressed in terms of the ratio as the measure of how many energy units are required to produce a GDP unit) and the total emissions of CO_2 (expressed in millions of tonnes) from the use of electric energy. These variables are generally considered good proxies for technological progress (energy intensity) as well as the level of environmental pollution linked to economic development (the total CO_2 emissions). Generally, developing countries present high carbon emissions and high energy intensity, while countries which have reached a consolidated level of development, and thus are more technologically advanced, present a better degree of energy efficiency and a greater inclination towards the reduction of emissions. The total CO_2 emissions from the utilization of electric energy represent approximately 60% of total emissions (IEA, 2013) and present an strong variability among the countries; this is due to the choice of utilizing the variable in a logarithmic form. In addition, the choice of utilizing total carbon emissions (instead of per-capita emissions) help us to take into account that the international agreements on CO_2

2 In fact, about the 77% of the countries included in our sample adopt, in 2011, this policy instrument. The other incentive and/or grants have generally a significantly lower adoption frequency.

Table 1: Variables and descriptive statistics

Macro-area	Variable	Definition	Mean±SD	Min	Max
Environmental	ei	Energy intensity	6,173.969±2,215.821	906.252	13,628.830
	$lnCO_2$	CO_2 emissions (log)	4.449±1.758	0.475	9.072
Economic	lngdp	GDP per-capita (log)	9.799±0.812	6.766	11.394
	lncons	Consumptions of electric energy (log)	4.031±1.767	0.389	8.344
	Netimports	Net electric imports	1.079±12.858	−63.341	49.155
Production	Shnonhydro	Share of Renewable energy produced by non-hydroelectric sources (%)	0.335±0.311	0	1
	Gas_prod	Natural gas production	1,186.228±3625.158	0	28,479
	Oilsupply	Oil production	577.678±1,462.998	−0.636	10,136.210
	Coalrprod	Carbon profuction	115,796.5±44,0203.1	0	3,878,012
	Shfossil	Share of electricity produced by fossil fuel (%)	0.714±0.270	0.001	1
Policies	lnprice	Average ectricity price (log)	−2.033±0.554	−4.605	−0.766
	Totalnofit	Number of policies (except fit) adopted	3.395±2.157	0	9

reduction are based on total emissions. Among the economic variables, the GDP per-capita (expressed in dollars in PPP) is considered one of the most efficacious indicators of the economic development of a country. Instead, the electricity consumptions (measured in Kwh) are a proxy of the wealth of countries. Even in this case, the choice of a logarithm instead of the observed value is a consequence of the strong heterogeneity of the values observed. Finally, among the economic values, the net electricity imports (percentage of imported energy on the total consumed) have been taken into consideration, which are a measure of the level of independence and thus of the energy security of countries.

Among the generation variables, we consider the oil supply (in terms of offer-millions of barrels), the coal (given in tonnes) and natural gas productions (millions of cubic meters), which are the main traditional energy production sources. In the same class, we also include (i) the share of renewable energy produced by non-hydroelectric sources (e.g., wind, solar, biomass, geothermal), expressed as the ratio between electricity generated by non-hydroelectric renewable source and the total renewable electricity generated, and (ii) the share of electricity generated from fossil fuel, as the ration between thermal (fossil) production and total electricity generated in the country in that year. The share of non-hydroelectric generation is considered a proxy for the investments in RES (e.g., Romano and Scandurra, 2014) while the latter is a proxy for the level of investments in traditional sources of electricity generation. In the class of policy factors we include the natural logarithm of electricity prices (expressed in dollars per Kwh) and the number of policies (except the FiT) already adopted by each country. The FiT, in fact, is only one of the support policies for the production of energy from RES and cannot be analyzed without being correlated with the number of the other policies that have possibly already been introduced.

3. THE PSM MODEL

PSM is a statistical method that permits the construction of a match, of a probabilistic type, among individuals that have participated in a treatment (treated) and individuals that have not participated (untreated), utilizing characteristics that are common to both groups (Rosenbaum and Rubin, 1983). The match is made based on a score (the propensity score) that consists in the conditioned probability of each individual of participating in the treatment given by a series of covariates (the control variables chosen to represent the common characteristics of the individuals).

Classification of countries in homogeneous groups on the basis of their characteristics is often made using cluster and factor analyses. Berlage and Terweduwe (1998), among others, compared with these methods categories of least developed countries and of newly industrialized countries. Abizadeh and Basilevsky (2004) present a method to classify countries on the basis of preselected socioeconomic variables use the maximum likelihood factor analysis model. Vicent Alcàntara and Duarte (2004) propose an input-output structural decomposition analysis model to identify energy differences in European countries. In a recent paper, Romano et al., (in press), reveal similarities among countries through a *k*-means cluster analysis. However, when analyzed countries belong to a wide longitudinal dataset, like the one in this study, the classification on the basis of the traditional methods, particularly suitable for cross sectional datasets, do not reveal well separate heterogeneous groups and results appear quite fuzzy. The PSM method, respect to the traditional classification methods, provides that classification is made only on the basis of the propensity scores estimated by the panel probit model. The scores summarize both the exogenous variables and the individual effects, unobservable and useless in the other methods, in terms of probability to adopt the tariff and appear as an adequate measure of similarity between countries.

The application of the PSM technique requires the execution of several sequential steps (Rubin, 1997):

1. A variable indicator I_i is fixed for each individual that assumes a value of 1 if the individual results as being treated and 0 otherwise
2. Evaluation of a probit/logit regression model of the type:
$$\pi_i = \alpha + \sum_{j=1}^{k} \beta_j x_{i;j} \quad (1)$$
3. The creation of a vector of the propensity scores composed of *i*-scalars each of which is equal to:
$$p_i = \Phi(\pi_i) = Prob(I_i = 1 | X)$$
Where φ(·) is the cumulative distribution function (cdf) of a Normal distribution (if one has chosen to estimate the scores with a probit model) or a logistic distribution (if one has

chosen to estimate the scores with a logit model) and X is the vector of the covariates included into the model as control variables.
4. The matching, based on the similarity of the scores, of the individuals treated with those untreated.

PSM is generally utilized, after having effected the matches, as:
a. An imputation technique for missing values
   Where relative values of possible missing variables that have been measured for the treated subjects are imputed to the untreated (for example the level of evasion identified in scrutinized taxpayers with similar characteristics is imputed to taxpayers not exposed to fiscal scrutiny, as in Braiotta et al., 2015 or as in D'agostino and Rubin, 2000).
b. A correction method of the distortion in the selection of samples
   Non-extracted individuals that have the same probability as the first individuals to be part of the sample can be added to a sample extracted in a non-casual way, in order to correct the distortion of the selection (e.g., Guo and Hutchinson, 2006).

When PSM is utilized as an imputation technique, or as a correction method of the distortion of the samples, several strong hypotheses have to be respected: Conditional independence of the treatment variables (the participation of each individual in the treatment does not condition that of all the other participants) and dimension of the reference population. For this reason, this technique is generally employed on micro-data with high dimension. In this analysis we use PSM only as classification method focusing exclusively on the evaluation of the average effects of the match and, also for this reason, not referring to inference, the two hypotheses (in particular that of the numerosity of the sample set) can also be considered "non-restrictive."

The more frequently utilized matching method is that of the nearest neighbor matching (Rosenbaum and Rubin, 1983). Such a procedure consists in matching to each treated individual another untreated individual, that has the nearest numerical propensity score. Once the match has been made, the average total effect of the treatment (*AT*), for each variable, is expressed by the average of the difference between the treated (*I=1*) and the non-treated. Analytically, for a generic variable Y, it is equal to:

$$AT = \frac{\sum_{i=1}^{N}\left(Y_i^{I=1} - Y_j^{I=0}\right)}{N}$$

Where $Y_i^{I=1}$ represents the value of the variable Y, of the i-th individual exposed to the treatment, $Y_j^{I=0}$ represents the same value for the j-th non-treated individual and N is the total number of matches. Due to the fact that the algorithm at the basis of the nearest neighbor matching method foresees that each untreated individual, once it is matched, is re-inserted into the procedure to be possibly matched to another treated individual, that is however numerically near it (based on a predefined margin), thus at the end of the procedure, each non treated individual can be:

a. Matched to only one treated individual
b. Matched to more than one non-treated individual
c. Unmatched.

For this reason N, the total number of matches, can be higher than the number of non-treated. Furthermore, for this very same reason, it is possible to also calculate an average effect in the groups of the treatment that measures the difference between the value of the generic variable Y of the single non-treated individual and the average value of the treated group to which it has been matched. Analytically:

$$AT_j = \left(\bar{Y}^{I=1} - Y_j^{I=0}\right) \tag{4}$$

$\bar{Y}^{I=1}$ is the average of Y calculated in the group of (one or more) individuals to which individual j was matched.

In the continuation of the analysis, the term treatment will indicate the adoption of the FiT type incentive policies and the reference individuals will be the countries that are the object of the analysis.

The probabilistic model employed for the determination of the propensity score consists in a specification of the panel type (random effect) of Equation 1) which thus becomes:

$$\pi_{it} = \sum_{j=1}^{k}\beta_j x_{it;j} + u_i$$

And, consequently Equation 2:

$$p_i = \Phi(\pi_i) = Prob(I_i = 1 \mid X; u_i)$$

The choice of the specification panel permits to take into consideration the individual effects u_i, which encompass the "country-specific" peculiarity of the countries and guarantee that even the particular characteristics, typical of each country, influence the ultimate specification of the scores. The principal limit attributed to the PSM method regards the fact that it controls only the confounding factors that can be observed. Resorting to a specification of the panel type, in which unobserved effects also come into play, similar countries will be matched based on observed similar characteristics as well as their common individual specificities, which are unobserved and thus not encompassed by the control variables. The random-effects specification, in comparison to that of the fixed-effects, is a direct consequence of the presence of time-invariant variables, for some countries, among the selected repressors.

4. RESULTS

4.1. The Determinants of the FiT

The estimated coefficients of the panel probit model, reported in Table 2, are in line with the expected results and they are coherent with the principal theoretical implications. The negative and significant coefficients of the variables that measure energy intensity (ei) and energy consumptions (lncons) indicate the inverse influence of these variables compared to the probability of adopting the FiT. The signs of the coefficients of the variables that measure, respectively, the incidence of renewable energy from non-hydroelectric sources (shnonhydro) and the oil supply (oilsupply) are also in line with the theoretical implications. Countries with a high level of electricity generated from renewable sources, or where the oil supply is high, are less prone to adopt the tariff. These countries cover a significant part of their energy needs through renewable sources or, alternatively, can meet demand through increased generation based on fossil fuels, especially oil.

The significant and positive coefficients describe the capacity of the variables to increase the probability of adopting the FiT. In the developed countries (lngdp), there is a greater awareness of environment policies and hence the probability of adopting the FiT is high. An similar conclusion can also be formulated for countries with high levels of carbon emissions ($lnCO_2$) and those with a significant coal production (coalproduction). For these countries there is a strong international pressure to encourage them to adopt more incisive environmental policies. Albeit at the limit of the 10% significant threshold level there appears to be direct relationships between the probability of adopting the FiT, energy imports (netimports) and the number of other support policies for renewable energy (total withoufit). In the first case, the estimation results could indicate that energy dependency from abroad is an incentive to promote and increase the generation from renewable sources. In the second case, the policy-makers, once they have decided to introduce policies to support the production of renewable energy, tend to do so by resorting to diverse and alternative means. Finally, the statistical significance of the variance of the effects (sigma_u) confirms the choice of resorting to a panel model as opposed to a specification of the "pooled" type.

Furthermore, the model presents good values in the indexes of adaptation goodwill. In fact, both the percentage of the correctly envisaged observations (*PCF*):

$$PCF = \text{Prob}\ (p_i > 0.5 | I_I = 1 \cap p_i < 0.5 | I_I = 0)$$

The percentage of recall (*RECALL*):

$$RECALL = \text{Prob}\ (p_i > 0{,}5 | I_I = 1)$$

Table 2: Coefficients, P values and statistics of the model

Variable	Coefficients	P values
ei	−0.0006	0.0010
shnonhydro	−2.7194	0.0580
shfossil	−1.8581	0.3480
lncons	−3.3712	0.0040
netimports	0.0423	0.1030
$lnCO_2$	2.4625	0.0400
gas_prod	0.0000	0.9430
oilsupply	−0.0025	0.0050
coalrpod	0.0002	0.0000
lngdp	1.5507	0.0700
lnprice	0.6337	0.4240
totalnofit	0.2169	0.1000
constant	−1.8547	0.8200
sigma_u	7.3015	0.000
Log likelihood	−105.7754	

Table 3: Indexes use for assess the goodness of fit

PCF	*RECALL*	*RHO*
0.734	0.948	0.982

And the quota of the total variance of the erroneously explained component of the country-specific component (*RHO*), show high values. Table 3 reports the three adaptation indexes.

4.2. The Effects of FiT

This study uses nearest neighbor matching approach, with reference to the year 2011 (last year of observation), for several variables previously individuated as determinants. In this year, 11 countries had yet to adopt the policy: Belgium, Chile, Guatemala, South Korea, Morocco, New Zealand, Poland, South Africa, Sweden, Tunisia and Mexico (Table 4). Of these countries, Belgium, Chile, Guatemala, Morocco, New Zealand, Poland, South Africa and Tunisia were matched to one group alone (a) of 38 countries, Sweden to a group (b) of 3 countries, South Korea to a group of 2 countries (c) and Mexico to a single country (d) (Table 4).

In the next tables, we summarize the main results. In particular, the tables report the effect of the adoption of the FiT (treated countries) as compared to the non - adoption of this policy instrument (untreated countries). The analysis of the results give the possibility to identify the effect of the treatment in the countries and the determinants that influence the choice in energy policies. Each table also reports the Average Total Effect of the treatment (*AT*, Equation 3) and the values of the average effect in the groups (*ATj*, see Equation. 4). Table 5 outlines the average of per capita GDP calculated within each group and compared with that of each country. On average, the per capita GDP of the untreated countries is lower than in the treated countries which seems to indicate that

Table 4: Results of match

Countries	Groups	N
Belgium	a	38
Chile	a	38
Guatemala	a	38
Morocco	a	38
New Zealand	a	38
Poland	a	38
South Africa	a	38
Tunisia	a	38
Sweden	b	3
South Korea	c	2
Mexico	d	1

Table 5: Per capita GDP: Average total and within groups effects

Paese	Gdp_pc	Average GDP_pc (within group)	*ATj*	Groups
Belgium	39840	27000	12840	a
Chile	20169	27000	−6831	a
Guatemala	6962	27000	−20038	a
Morocco	6698	27000	−20302	a
New Zealand	31554	27000	4554	a
Poland	21748	27000	−5252	a
South Africa	11848	27000	−15152	a
Tunisia	10343	27000	−16657	a
Sweden	41763	28556	13207	b
South Korea	29035	24427	4608	c
Mexico	15749	40384	−24635	d

AT: 1571 (P=0.167)

the richer countries are the first to adopt the policy. However, in relation to the group to which they have been matched, Sweden, South Korea, Belgium and New Zealand have a higher per capita GDP, and probably for this reason, the average total effect of the treatment (*AT*) is indeed positive (on average the per capita GDP of the treated is higher than 15,741 US dollars) but not significant (test of the difference between the averages of the two populations).

Table 6 reports the results of the matches for total carbon emissions. Results indicate that the CO_2 emissions are a key-factor in the choice of the policy's adoption. The untreated countries present average CO_2 emissions significantly lower than treated ones (*AT*=371). These countries have probably not adopted the FiT because they still maintain lower levels of CO_2 emission compared with similar Countries to which they have been matched. Only South Korea (AT_i=365) goes against the general tendency and have a higher CO_2 emissions respect to its comparison group.

Analogous deductions can be reached observing the results of the matches for the electricity consumption (Table 7). The untreated countries have consumptions, on average, significantly lower (214.4 is the average effect of the treatment) which seems to indicate that a country may not be interested in adopting the tariff when it is able to maintain its consumptions at a lower level. Once again, South Korea, within its group goes against the flow. Untreated countries are generally those in which the environmental sensitivity is higher. In particular, the lower (compared to the group average) CO_2 emission and electricity consumption identify energy efficient countries.

Focusing on all the countries that have adopted the FiT (and not only to the group of similar countries), we observe that South Korea appears to go against the flow, as can be clearly seen in Figure 1. Here, we report the CO_2 emissions (Y-axis) and the electricity consumptions (X-axis) of the untreated countries and these are compared with the average values of the treated countries (dotted lines).

Similar to South Korea (ROK) but in a less marked way, Poland (PL), South Africa (ZA) and Mexico (MEX), register higher values, of both variables, in comparison to the average values of the totality of the countries which have already introduced the tariff. These are developing countries with high positive differentials in their growth rate, and their positioning in the Cartesian plane could be interpreted as the consequence of a poorer awareness towards environmental issues in the country-specific component. The countries that position themselves similarly in comparison to these latter (in the third quadrant) present lower values for both variables. This perhaps indicates a greater awareness towards environmental issues in the case of Belgium (B), Sweden (S) and New Zealand (NZ) (despite not having yet introduced the FiT), and a consequence of the economic backwardness, in the case of Chile (RCH), Morocco (MA), Guatemala (GCA) and Tunisia (TN).

The renewable energy generation (measured in this case in terms of the share of non- hydroelectric electricity of the total of renewable energy) seems to be a determinant for taking the decision to adopt or not the incentive policies. The countries that in 2011 had not adopted the FiT present quotas that are on average and significantly higher than those of the countries which have already adopted the tariff (in terms of average total of 7 points percentage). The data indicates that probably the countries that have already a high incidence of non-hydroelectric renewable energy production therefore have less interest in adopting this policy. The comparison data of each group are in Table 8.

Table 6: CO_2 emissions: Average total and within groups effects

Paese	CO_2	Average CO_2 (within group)	AT_j	Groups
Belgium	131	536	−405	a
Chile	80	536	−456	a
Guatemala	12	536	−524	a
Morocco	44	536	−492	a
New Zealand	37	536	−499	a
Poland	308	536	−228	a
South Africa	462	536	−74	a
Tunisia	21	536	−515	a
Sweden	53	501	−448	b
South Korea	611	246	365	c
Mexico	462	553	−91	d
AT: 371.1 (P=0.000)				

Table 7: Electricity consumptions: Average total and within groups effects

Country	ElecCons	Average ElecCons (within group)	*ATj*	Group
Belgium	83.1590	309.7040	−226.545	a
Chile	57.8930	309.7040	−251.811	a
Guatemala	8.1430	309.7040	−301.561	a
Morocco	25.1411	309.7040	−284.563	a
New Zealand	40.4471	309.7040	−269.257	a
Poland	137.5455	309.7040	−172.159	a
South Africa	218.3025	309.7040	−91.4015	a
Tunisia	12.9400	309.7040	−296.764	a
Sweden	128.0614	401.0527	−272.991	b
South Korea	472.1920	242.5605	229.6315	c
Mexico	232.3452	551.6070	−319.262	d
AT: 214.1 (P=0.000)				

Finally, from the comparison between the countries (Table 9) in terms of energy policies, it emerges that some countries (Belgium, Poland, South Korea, Sweden) have adopted a number of alternative policies to the FiT, higher than the average already present in the countries to which they have been matched. Although the total effect of the treatment on the whole is not significant, it appears that for some of the countries considered, one of the reasons for which the FiT has not yet been adopted is the fact that they have already organized alternative policies for the sustainment of renewables in terms of public financing, fiscal incentives and regulation policies.

5. CONCLUDING REMARKS

The choice of a country to, or not, adopt a specific form of incentive for the production of renewable energy is certainly the result of

Figure 1: Electricity consumptions versus CO_2 emissions

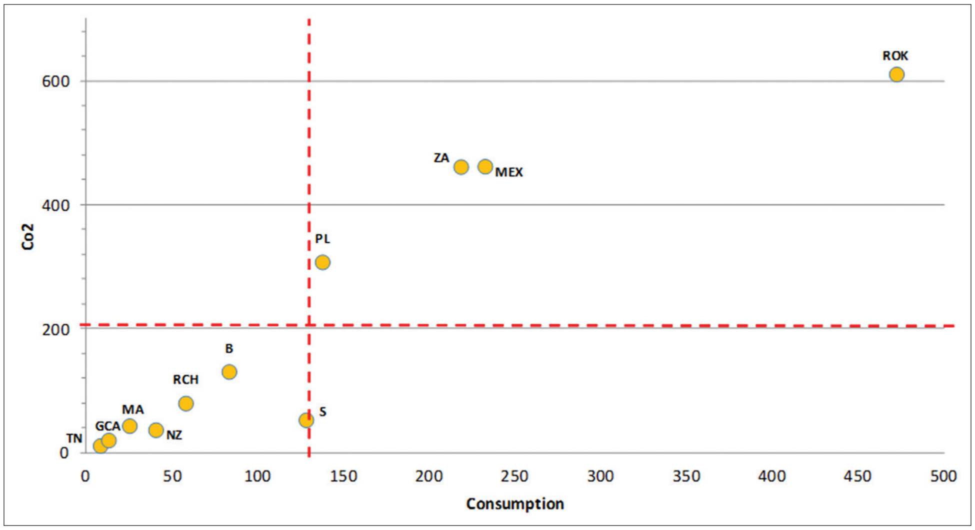

Table 8: Share of renewable energy: Average total and within groups effects

Country	RenNH (%)	Average RenNH (within group) (%)	*ATj* (%)	Groups
Belgium	98	47	51	a
Chile	15	47	−32	a
Guatemala	45	47	−2	a
Morocco	32	47	−15	a
New Zealand	26	47	−21	a
Poland	82	47	35	a
South Africa	14	47	−33	a
Tunisia	75	47	28	a
Sweden	21	35	−14	b
South Korea	39	17	22	c
Mexico	20	7	13	d

AT: −7% (P=0.004)

Table 9: Fit alternative policies: Average total and within groups effects

Paese	Alternative policies	Average totalnofit (within group)	*ATj*	Groups
Belgium	7	4	3	a
Chile	3	4	−1	a
Guatemala	4	4	0	a
Morocco	2	4	−2	a
New Zealand	1	4	−3	a
Poland	6	4	2	a
South Africa	2	4	−2	a
Tunisia	4	4	0	a
Sweden	5	4	1	b
South Korea	7	3	4	c
Mexico	4	7	−3	d

AT: −0.16 (P=0.313)

heterogeneous, and not easily modelized, factors. In fact, the real reasons that compel a country to introduce some energy policies are to be found in complex and articulated contexts in which the relationships that govern them can assume various aspects. For this reason, the choice of resorting to a specification panel, as well as the use of the country-specific component to determine the propensity scores utilized to make the matches was considered as a means to approach and introduce into the analysis the set of unobserved aspects, which are casual to the phenomenon. In the light of these considerations, the objectives of this paper were fixed in terms of: (i) Understanding how and to what extent the selected variables relate to the choice of a State to adopt the fit; (ii) permitting the emergence, when they exist, of similarity relationships between the countries in comparison to both the phenomenon which is the object of this study as well as the factors which determine it. With regards to the first objective, the results of the model, in terms of the significativity of the coefficients but also in terms of the adaptation indexes, seem to lead to sharable conclusions. The interpretation of the results take up, in fact, the principle theoretical implications and the diagnostics seem to confirm the adequacy of resorting to a specification of the panel type as opposed to the pooled type. With regards to the second objective, the matching analysis, undertaken utilizing the results of the model together with the "country-specific" component, contemporarily permits the emergence of both similitudes, in terms of the observed characteristics as well as divergences in terms of the choices of intervention policies.

All the variables considered in this paper (except per capita GDP) are significant. The untreated countries are more energy efficient or, in other words, they have a high degree of environmental sensitivity. These countries, in fact, present lower CO_2 emissions and electricity consumption compared to the treated countries. Furthermore, they produce more renewable energy than the other countries. In these countries, we can individuate similar pattern. They have adopted an energy system in which the energy sustainability is greater than other countries and in which is high the attention to the environmental issues. Even if untreated countries have no adopted the FiT they have already promote the investment in renewables with other incentive policies. This suggest that FiT, even if it is the more utilized, can be substitute by a combination of other incentive and/or grants in order to promote the RES generation. The analysis of the average effects of the treatment, in fact, lead to interesting conclusions with regards to those which are the consequences of the adoption of support policies and permit hypothesizing possible scenarios that could open for the countries which have not adopted such policies yet. At the same time, the comparison of the groups gives the possibility to make several considerations in relation to what could be the possible reasons why countries do not introduce incentive policies despite having an energy context similar to those countries in which such polices are already in force. These topics will be investigated in future research.

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