The climate funds for energy sustainability: a counterfactual analysis

I Fondi per il clima a sostegno della sostenibilita' energetica: una analisi di impatto

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Abstract In this paper we analyze the effectiveness of climate funds to combat climate change and promote mitigation and adaptation policies. We analyse the funds received by the recipient through a counterfactual analysis. The results show that the policy contributed to the decreasing of greenhouse gas emissions and promoted the change in generation energy systems supporting the replacement of fossil sources with renewable sources.
Abstract Si vuole analizzare l'efficacia dei fondi per il clima nella lotta al cambiamento climatico e per la promozione di politiche di mitigazione e adattamento. Sono analizzati i fondi ricevuti dai Paesi beneficiari attraverso un'analisi controfattuale. I risultati mostrano che questa politica ha contribuito alla riduzione delle emissioni di gas serra ed ha promosso il cambiamento nei sistemi di generazione elettrica favorendo la sostituzione delle fonti fossili con fonti rinnovabili.

Key words: climate finance, propensity score matching

1 Introduction

During the 15^{th} Conference of the Parties (COP15) held in December 2009 in Copenhagen, developed countries pledged to provide new and additional resources to combat climate change, approaching USD 30 billion for the 2010-2012 period, with balanced allocation between mitigation and adaptation

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strategies. This collective commitment is known as fast-start finance and prefigures the institution of Green Climate Fund (GCF) established by the 194 countries that are members of the United Nations Framework Convention on Climate Change (UNFCCC) in 2010, to support a paradigm shift in the global response to climate change. Through the GCF mechanism, donor governments distribute funds to recipient developing countries to finance low-emissions and climate-resilient projects and programs in these countries. As they are proliferating, the challenges of coordinating funds and the monitoring of recipient countries emissions became an important matter to assess their effectiveness. In this paper, we want to evaluate the impact of the climate funds distributed by donor countries on environmental and economic factors analyzing the flow of funds among countries and conducting a counterfactual analysis. To achieve our aims, we employ propensity score matching (PSM) analysis on a large dataset of 149 countries.PSM is a statistical method which make the construction of a probabilistic match among units that have participated in a treatment (treated) and units that have not participated (untreated), utilizing characteristics that are common to both groups [1]. The remainder of the paper is organized as follows: Section 2 describes the data. Section 3 reports the empirical results while in Section 4 we discuss the results. Finally Section 5 offers some concluding remarks.

2 Data

To assess the impact of fast-start finance, we use the AidData Research Release 2.1 database that is based on the Credit Report System database, managed by the OECD's Development Assistance Committee (DAC).We consider the funds for energy generation and supply by renewable sources and the flows of funds targeted at biosphere protection using a dataset of 149 countries. It considers the totality of countries eligible to receive funds according to the OECD's Official Development Assistance (ODA) list. Dataset includes countries that have received funds in 2010 (treated –- 83 countries) and those that did not receive funds (untreated –- 66 countries). Explanatory variables can be grouped as target and control indicators.
Among the target variables, we include i) the share of renewable energy in the total energy generated (shren), ii) GDP per capita (gdp), iii) CO_2 per capita emissions (CO_2) and iv) the share of fossil energy in the total energy generated (shfoss).

In the group of control variables, we consider those typically indicated by the previous literature [2] as key factors that drive countries toward increasing generation from renewable energy sources: electricity consumption, the oil supply, energy intensity, the female population and the population growth rate.

3 Empirical Results

The coefficients of the propensity score probit model are reported in Table 1.

Table 1 Coefficients and goodness of fit statistics of the probit propensity score model

Variables	Coefficients
Intercept	1.5527
Electricity Consumption	0.3752[a]
Oil Supply	-0.0003[c]
Energy Intensity	-0.4111[c]
Female	0.0207
Population Growth	0.8419[b]
Electricity Consumption Squared	0.0225
Population Growth Squared	-0.2019[b]
Loglikelhood	-73.7389
Pseudo R^2	0.3185

Significance: [a] 0.01; [b] 0.05; [c] 0.1

Climate funds are more attractive for countries characterized by increasing population growth rates, even though at decreasing marginal rate (because the second order coefficient is negative), and high levels of energy consumption. There is no empirical evidence that climate funds are attractive to countries where the female population composition is higher, probably because in the developing countries the women feeling for environmental issues are less consolidated. By contrast, oil-exporting countries and those that are more oriented toward the use of traditional energy sources (high energy intensity) prove to be more resistant to these types of policies in support of renewable energy generation because they imply structural changes in their industrial structures and economic systems that are generally well-developed. The results of the probit model confirm several consolidated issues and they represent an important starting point for the next step of the work, which concentrates on the analysis of impact of the funds on countries that have obtained them. Moreover, the matching performed using the fitted values of the model (the propensity scores) ensures that the similarities between matched countries are respected: the average values of the control variables of the untreated countries are not significantly different from those of the countries to which they have been matched (Table 2 column 2). The matching is obtained using the nearest neighbor (1) algorithm that provides a one-to-one matching setting the caliper threshold equal ton 0.25 [3].

Table 2 Tests of balance: similarities of means of the control variables before and after matching

Variable	Before Matching	After Matching
Electricity Consumption		
Mean Treated	2.2136	2.2136
Mean Untreated	0.7167	2.2912
p-value	0.0001	0.7083
Oil Supply		
Mean Treated	407.1200	407.1200
Mean Untreated	535.0500	220.1200
p-value	0.6155	0.1324
Energy Intensity		
Mean Treated	8.4311	8.4311
Mean Untreated	8.5444	8.6231
p-value	0.4435	0.1874
Female		
Mean Treated	50.2560	50.2560
Mean Untrated	49.0910	50.3640
p-value	0.0697	0.4943
Population Growth		
Mean Treated	1.6457	1.6457
Mean Untreated	1.7591	1.7338
p-value	0.6837	0.5587
Electricity Consumption Squared		
Mean Treated	9.6207	9.6207
Mean Untreated	5.8147	8.6408
p-value	0.0162	0.3964
Population Growth Squared		
Mean Treated	3.6393	3.6393
Mean Untreated	7.3523	4.0908
p-value	0.0709	0.3631

4 Discussion

The treatment effect on treated (ATT) represents a comparison between the observed values and the expected values of the target variables for the treated countries if they had not participated in the treatment. Countries that have received funds, in fact, are similar, in terms of the control variables, to the countries that have not received funds to which they have been matched. However, they are different in terms of the target variables, and the basic hypothesis is that this difference is due to the treatment. Table 3 reports the values of the estimated ATT.

Table 3 Average treatment effects on treated

Variables	ATT
Shren	0.1872^{b}
Shfoss	-0.1670^{c}
CO_2	-2.8205^{b}
GDP	$1{,}344.3^{b}$

Significance: ^{a} 0.01; ^{b} 0.05; ^{c} 0.1

In terms of CO_2 emissions , without the funds, there would have been no differences between treated countries and their similar matched countries. Instead, the significant reduction of about 2.8 metric tons in the CO_2 per capita emissions of treated countries is a result that is in line with the global climate finance architecture. This result suggests that climate finance mechanisms, in fact, are useful to enhance the efforts to reduce emissions. Focusing on per capita GDP, we observe another difference between treated and untreated countries. On average, the GDP of countries that have received funds increases approximately 1,340 USD with respect to that of the counterfactual part. This result confirms those of several recent studies on the positive effects of climate financing on the economies of developing countries [4] with renewable energy being a crucial component for the economic growth of developing countries [5]. Observing the estimation results, we note that treated countries have, on average, a share of energy produced by renewable sources (shren) that is significantly higher with respect to their similar untreated countries by approximately 19%. Complementarity, the share of energy produced by fossil fuel (shfoss) is significantly lower, on average, by approximately 17% with respect to the counterfactual part of countries. This important result suggests that climate finance can help countries increase investments in RES generation and can substitute for fossil power generation. Moreover, this result indicates that the climate funds help to change the electricity basket generation, increasing the share of RES generation in place of fossil fuel generation .

5 Conclusion

The results obtained in this paper provide clear indications on the effectiveness of climate funds in promoting the green growth. The results show that funds have been devoted to enhance energy efficiency and sustainability: the recipient countries, in fact, reduced their GHG emissions respect to their similar counterparts. The factors that explain this empirical result are the positive consequence of the policies implemented in the last years in which the need to reach the targets imposed by the climate finance leaded them to-

ward an increasing attention for environmental issues. Moreover, the results show a decrease in the shares of electricity generated by fossil fuels and an increase in RES generation. In particular in these countries, we observe that the decrease of the generation of energy by fossil sources is balanced by the increase of the generation of RES. The increase in GDP per capita occurs in the recipient countries, with respect to the counterfactual part. Climate funds can be considered helpful instruments to promote the path towards a sustainable energy system, based on a high share of RES generation, for developing countries. In order to ensure the efficient funding allocation, policy makers have to regularly monitor the achieved results of financed projects. Our results could support the Ad Hoc Working Group on the Paris Agreement (APA) in monitoring the progresses made to reach the goals of the climate funds. Moreover, the findings provide a starting point to plan environmental policies to be undertaken in preparation to the full implementation of the Paris Agreement. The analysis carried out shows that the beneficiary countries have increased the share of electricity from renewable sources and have reduced the share of electricity from fossil ones, finding it more useful and advantageous to replace them with renewable ones. However, funding should be better targeted.

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