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Are renewable energy subsidies effective? Evidence from Europe

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ABSTRACT

We test if policy support for renewable electricity have been effective in promoting renewables in the five largest European countries in the period 2000–2010. We collect data on the exact amount of monetary incentives and the average tariffs granted. The econometric analysis reveals a positive correlation between subsidies and the production of incentivized energy, as well as the installed capacity. We find that a 1% (1c€) increase in the incentive (tariff) leads to an increase in renewable generation of 0.4–1% (18–26%). Feed-in tariffs appear to outperform tradable green certificates. Overall, the analysis shows that these policies have been effective in promoting renewable energy, both in the short and in the long run.

1. Introduction

One of key pillars of the European Union energy strategy of the past ten years has been the focus on the promotion of renewable energy sources. At the beginning of the 21st century, the EU Directive 2001/77/EC [13] imposed mandatory targets for renewable energy. This process has culminated in 2009 with the EU Directive 2009/28/EC [14], that sets the target of a 20% share of energy from renewable sources in the Community's gross final consumption of energy. In accordance, member states have implemented a number of different policies in order to increase the production of electricity from renewable sources. Such support schemes are now being progressively phased out, due to rising policy costs and to the significant reduction in renewable investments costs, which has occurred thanks also to these policies. This change of course is also visible in the EU policy discussion, as testified by the reduced focus on renewables in the recently proposed 2030 energy and climate strategy [15]. It is thus an appropriate time for evaluating the effectiveness and efficiency of these policies.

In this paper, we investigate how monetary incentives affect the production of renewable energy sources electricity (RES-E) in the five largest European countries in terms of population and GDP, namely France, Germany, Italy, United Kingdom and Spain, over the period 2000–2010. We collect information on the exact amount of incentive granted, distinguishing by energy source and instrument adopted (i.e. feed-in tariff or tradable green certificates).

We consider three different indicators of RES-E production: the incentivized production, the total production and the installed capacity. These are regressed on our quantitative measures of incentives. To this aim, we contribute to the literature by adopting for the first time in an econometric exercise two exact measure of incentives: the amount of incentives granted as well as the corresponding average tariff. Additionally, we include in the econometric analysis a number of energy specific factors, economic and political control variables. Country and source dummies control for time invariant specificities, while time dummies are added to account for the economic cycle and year-specific factors.

Our contribution to the literature is manifold. First, this the first exercise, to the best of our knowledge, that measures the exact amount of incentives granted, rather than adopting more approximate measures, i.e., dummy variables or indicators, for the presence of incentives. We are thus able to produce quantitative evidence on the amount of subsidies granted and their effectiveness. Second, we develop our analysis across five different sources, instead of focusing only on a specific one or on aggregate values, thus allowing a comparison across sources. Third, our analysis adopts a cross-country perspective, focusing of the five larger EU countries in the 2000–2010 decade. Fourth, by collecting information on FIT and tradable green certificates, we are able to test which instrument is more successful in promoting RES-E production. Finally, by considering different measures of RES-E production we are able to compare the impact of the incentives in the short term, i.e., whether they affect the amount of incentivized production or total production, and in the long term, i.e., whether they affect the installed capacity.

Our results suggest that these policies have been effective in promoting renewable energy, both in the short run, as we observe a

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positive relationship with the production of incentivized energy, and in the long run, as there is a positive relationship with the installed capacity. We find that a 1% (1c€) increase in the incentive (tariff) leads to an increase in incentivized renewable generation of 0.4–1% (18–26%). In terms of policy instrument, we find that feed-in tariffs (FIT) outperform tradable green certificates (TGC): the former policy is more efficient in promoting RES-E production, at least in the short run.

The paper is structured as follows: Section 2 discusses the related literature, first presenting policies that have been implemented in the five countries considered in the analysis, and then looking at the current literature on the effectiveness of renewable energy policies. Section 3 presents the methodology adopted, describes the data selection criteria and the variables used in the econometric analysis. Section 4 shows the results, while Section 5 discusses and concludes.

2. Literature review

2.1. European union policy for renewable energy

The policies adopted by European governments might be classified in two groups: feed-in tariff and feed-in premium (FIT and FIP, respectively), and tradable green certificates (TGC).

FIT usually include three key provisions: (1) guaranteed access to the grid; (2) stable, long-term purchase agreements (typically, about 15–20 years); and (3) payment levels based on the costs of renewable energy generation [30]. The FIT is also known as fixed-price policy as it includes a premium payment and a constant over the spot market electricity price. It grants a fixed payment for renewable electricity production and an additional premium on top of the electricity market price. The tariff rate is usually differentiated on the basis of the source and the size of the project.

The feed-in premium instead offers a premium on top of the spot market electricity price [8]. This implies that the total price received per kWh by the producer is less predictable in the premium scheme than under a FIT, as it depends on the electricity price.

With the tradable green certificate instrument the government defines the targets for renewable-based electricity and obliges the generators at their fulfilment. A market for renewable certificates is established and their price is set following demand and supply conditions. The generators are obliged to supply or purchase a certain percentage of electricity from renewable sources and have to submit the required number of certificates to demonstrate the compliance. The agents obliged may obtain certificates in three ways:

- from their own electricity generation;
- by purchasing renewable electricity and associated certificates;
- by purchasing certificates without purchasing the actual power from a generator.

The FIT policy guarantees a stable and secure market for investors, raising a hedge against the volatility of electricity price and enhances market access for investors and participants. On the other hand, it has a number of limitations. It distorts electricity market prices and does not directly address the high up front costs of renewable energy technologies. Finally, it does not encourage direct price competition between project developers.

On the other hand, the TGC system guarantees a strong regulation of capacity development and costs less than the FIT to public finances. However, as it does not generally distinguish the incentive across technologies, it promotes more mature technologies and is not able to favour less mature, and more expensive, technologies. Additionally, it is less attractive to investors because of market fluctuations: in case of over investment the price of the certificate could theoretically drop to zero.

As shown in Table 1, the FIT policy is widely adopted in the five European countries considered in the analysis. Indeed, four of this countries – France, Germany, Italy and Spain – have adopted it from the beginning and the United Kingdom, while relying initially on the tradable green certificates to promote renewable energy, recently moved to a FIT.

The first two countries to introduce a policy in support of renewable energies have been Germany and the United Kingdom in 1991, following two different strategies. Germany adopted the Strom EinspG, a feed-in tariff, while the United Kingdom opted for the Renewable Non-Fossil Fuel Obligation, a green certificate mechanism. These measures have been replaced by the Erneuerbare-Energien-Gesetz (EEG) in 2000 and by the Renewable Obligation in 2002, respectively. The EEG, the German FIT, is a fixed tariff that includes both support payment and the electricity price. The tariffs differ among technology and project size and decrease over the years. Great Britain chose a tradable green certificate, the Renewable Obligation. Since 2010 a FIT has also been implemented. The latter can be broken into two components: the generation payment, which is a fixed payment for every kWh generated by the plant, and the export payment, which corresponds to a fixed payment for every kWh exported to the grid.

Italy followed shortly and one year later, in 1992, the Italian government introduced the CIP 6, a feed-in tariff. The Italian system is more complex, as other instruments have been introduced thereafter. Since 2002 a tradable green certificate mechanism has been implemented. However, due to initial excess demand, the authority intervened to buy the unsold certificates. In 2006 a feed-in premium for solar photovoltaic plants only has been introduced, and in 2008 another feed-in tariff has been created for small plants in bio-energy, wind and hydropower technologies.

Spain introduced the Regimen Especial in 1997, by the Royal Decree 2017/1997 and the Law on the Electricity Sector. It encompasses a feed-in tariff and a feed-in premium and the generator can choose between the two. As in the other countries, the tariffs differ among technology and plants size, are adjusted to inflation, cost of technology and market development of the technology.

France introduced the Obligation d'Achat in 2000, which is a typical feed-in tariff: the fixed tariff is composed by two parts, the electricity price and the premium. The electricity generated under the Contrat d'Achat has purchases obligation and the contract expires after 15 years.

Due to escalating costs, and public budget constraints, most of these incentive schemes are now being phased out.

2.2. Current studies

Given the policy relevance of this topic, several papers have assessed the drivers that push renewable energy development, from a qualitative as well as quantitative point of view.

A first strand of research focuses on case studies at the country level. Verbruggen [36,37] describes the tradable certificate mechanism in Flanders, Bird et al. [5] focus on wind power development in the US and suggest that state tax and financial incentives, as well as state renewable portfolio standards (which are a kind of tradable green certificate mechanism), have an important effect on energy development. Mitchell et al. [32] compare the German feed-in tariff with the renewable obligation mechanism enhanced in England and Wales, which works as a tradable green certificates market. The former is esteemed to be more effective in promoting the deployment of renewable energy, as it reduces risk for generators in a more effective way. Jacobsson and Lauber [22] explain the high rate of diffusion of wind turbines and solar cells in Germany not only by the particular features of the German regulatory framework in the energy sector but also by the ideas and processes which led various political bodies to adopt that framework. Wüstenhagen and Bilharz [39] discuss the role of public policy instruments driving green energy supply as well as the role of green power marketing driven by customer demand in Germany. Breukers and Wolsink [6] compare three cases of onshore wind power