Energy Policy ∎ (∎∎∎∎) ∎∎∎–∎∎∎

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Evaluation of property tax bonus to promote solar thermal systems in Andalusia (Spain)

Antonio Sánchez-Braza [1], María del P. Pablo-Romero *

Economic Analysis Department, Facultad de CC. Económicas y Empresariales, University of Seville, Ramon y Cajal 1, 41018 Seville, Spain

HIGHLIGHTS

- This paper evaluates the effects of a tax bonus to promote solar–thermal energy.
- We analyse the effect of this measure for 585 Andalusia municipalities.
- The propensity score-matching methodology is used.
- The percentage increase of square meters installed ranged from 70.74% to 98.38%.
- Tax bonus was an effective tool to promote solar thermal in Andalusia.

ARTICLE INFO

Article history:
Received 3 July 2013
Received in revised form
29 November 2013
Accepted 4 December 2013

Keywords:
Public policies evaluation
Statistical causal inference
Propensity score matching
Solar thermal
Property tax
Tax incentives

ABSTRACT

This paper evaluates the effects of a property tax bonus to promote the installation of solar–thermal energy systems in buildings in Andalusia (southern Spain). The propensity score matching methodology is used. The treatment group consists of municipalities of Andalusia that established property tax bonuses in their municipalities in 2010. The control group consists of municipalities that did not. The response variable measures the number of new square meters of solar thermal systems installed in 2010. The analysis leads to the conclusion that municipalities that established a property tax bonus had installed, on average, 102.245 to 122.389 square meters more. These results indicate that the percentage increase in squares meters installed in municipalities which adopted the tax bonus promotion ranged from 70.74% to 98.38%. These percentages were lower for rural municipalities (49.00% to 77.06%).

1. Introduction

The residential sector is a key sector in the Spanish and European Union 27 (EU27)[2] from an energy perspective, due to the importance of its energy demand. Total energy consumption accounts for up to 17% at the national level and 25% at the EU27 level, according to the Institute for Diversification and Energy Saving (IDAE, 2011). In Spain, 47% of that consumption relates to heating and around 19% is for sanitary hot water. Renewable energies (REs) account for only 1.9% of heating consumption, including a small solar thermal energy presence of only 0.5%. For sanitary hot water, REs represent 1.7%, with solar thermal energy being the major contributor at a little over 63% of this value. These figures show the limited contribution of REs in the sector, particularly that of readily available solar thermal energy in this country.

Some barriers restrict people from installing RE technology in their homes, and solar energy in particular. While there are some technical barriers to installing solar energy-based systems (Timilsina et al., 2012; Zhang et al., 2012), perhaps economic barriers are of greater significance. One of the main reasons for this low percentage of solar thermal energy installation is due to a high initial outlay and a long payback period of seven years for investors (Egger and Öhlinger, 2012; Timilsina et al., 2012). These costs discourage the installation of solar systems in the residential sector and do not allow adequate use to be made of the advantages that these technological systems offer in terms of environmental benefits (Solangi et al., 2011), national energy independence, greater diversification of energy sources and security of the energy supply (Tsoutsos et al., 2005).

The advantages that these solar thermal systems present and the existence of these barriers have encouraged countries to

* Corresponding author.
E-mail addresses: asb@us.es (A. Sánchez-Braza), mpablorom@us.es (M.P. Pablo-Romero).
[1] Tel.: +34 954557529; fax: +34 954557629.
[2] All abbreviations used throughout the text are reported in the Appendix A.

0301-4215/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.enpol.2013.12.004

develop policies to stimulate the development of solar thermal systems. Globally, the measures implemented to date are diverse (Cansino et al., 2011; Sarzynski et al., 2012; Solangi et al., 2011; Timilsina et al., 2012)

In Spain, such measures are articulated around three jurisdictions (Pablo-Romero et al., 2013). The national government provides tax incentives and direct aids. In addition, in the regulatory sphere, in 2006 the Technical Building Code (TBC) was established, which requires new construction or renovation projects to use solar–thermal energy systems to cover between 30 and 70% of domestic hot water needs. Regional governments can both set up additional subsidies and also manage those granted by the central government. Finally, according to Royal Decree Law 2/2004, local governments can provide tax bonuses on business tax, construction tax and real estate tax – RET – (*impuestos sobre bienes inmuebles-IBI-*) for those who install solar–thermal or solar–photovoltaic systems. Thus, local governments have authority to promote the installation of solar thermal systems in buildings.

Prior to the regulatory reform, the area of installed solar–thermal systems had only grown by 4 m^2 per thousand inhabitants, per year (2002–2006), which was only about half that for Germany. As such, the delay in the TBC regulatory reform did not permit the introduction of solar–thermal systems, even though the Spanish construction boom began in 2000 (Bürger et al., 2008). The TBC was adopted in March 2006, and its solar thermal section entered in force on the 29 September 2006. Nevertheless, the Spanish TBC applies at the time of authorisation of building construction, so there was a natural delay of 1–2 years before solar systems started being operative. Therefore, it was only in the 2008–2009 period that the TBC began to exert its full impact on the solar panel market (EREC, 2013). Since 2008, and before the current crisis in the construction sector in Spain, 80% of total capacity installed was related directly to the TBC. However, since the decline in construction of new buildings, the installation of new solar panels has again decreased, which is one of the reasons for the poor figures for this type of solar system in Spain.

Before the current crisis in the construction sector in Spain, 80% of total capacity installed was related directly to the TBC. However, since the decline in construction of new buildings, the installation of new solar panels has decreased.

Therefore, it is necessary to establish effective promotional measures to make the installation of solar thermal collectors on existing buildings more attractive so as to achieve the targets set out in Spain's national renewable energy action plan 2011–2020. Solar thermal energy's contribution to meeting the binding 2020 targets is estimated at 644 ktoe produced by the 10,000,000 m^2 envisaged by 2020. This implies an increase of approximately 7,600,000 m^2 over the period. In order to reach this installed surface area, the number of square meters installed each year must rise from 376,000 m^2 estimated for 2011 to over 1,300,000 m^2 calculated for 2020 (MITC, 2011). In this sense, local measures are of particular interest because it is estimated that cities produce more than a third of total greenhouse emissions (Satterthwaite, 2008).

Although measures to promote the use of RE have frequently been used, and the need to use them has been emphasized, few studies exist that objectively evaluate the effectiveness of measures to promote RE (Carley, 2009). Most of the literature on RE incentives relies on exploratory analyzes and qualitative evaluation (Cansino et al., 2010, 2011; Gan et al., 2007; Rabe, 2007). However, few studies attempt to empirically estimate the effectiveness of state RE policies, nor explore the causal inference between RE policies and RE deployment. Of the limited studies, most econometric studies assessing the effectiveness of RE policies to date have focused on state-level policies in the United States, particularly that of the Renewable Portfolio Standard (RPS). The studies by Menz and Vachon (2006), Carley (2009), Yin and Powers (2009), Shrimali and Kneifel (2011), Lapan and Moschini (2012), and Hitaj (2013) may be highlighted.

With regard to European countries, the studies by Marques et al. (2010) and Jenner et al. (2013) are particularly noteworthy. These studies analyzed whether the adoption of energy policies has had a positive effect on increasing RE use. Nevertheless, they do not specify the measures taken or which REs have increased. Rather, they use a binary variable indicating whether or not there has been some kind of measure to promote RE use. Only the studies by Menz and Vachon (2006), Shrimali and Kneifel (2011), Dong (2012), and Jenner et al. (2013) referred to specific RE technologies. Among these studies, only Jenner et al. (2013) focused on a unique policy design feature. They analyze the effect of state tax incentives on increasing photovoltaic capacity.

Following this more concrete approach, the aim of this paper is to analyze whether one of the measures currently being implemented in Spain positively contributes to stimulate new solar thermal installations. Specifically, we perform a counterfactual analysis of the impact a tax bonus on RE technologies adopted by some municipalities has had on increasing solar installations in 2010.

We compare the performance – in terms of the number of square meters installed in 2010 – of Andalusian municipalities that have adopted the tax bonus on RET with a sample of municipalities that have not adopted this policy. This comparison is carried out by using statistical causal inference. We use the propensity score matching technique to tackle issues like self-selection and group-membership bias.

In economic literature, propensity score matching was initially used to estimate the impact of job training programs (Dehejia and Wahba, 2002; Heckman et al., 1998; Smith and Todd, 2005), and subsequently extended to other areas of study. In the environmental field and in resource economics literature, this approach has been used in the evaluation of the Clean Air Act (Greenstone, 2004; List et al., 2004), open space and agricultural land protection programs (Liu and Lynch, 2011; Lynch et al., 2007; Towe, 2010), agricultural research, farm programs, forestry management (Jumbe and Angelsen, 2006; Pufahl and Weiss, 2009) and city climate planning efforts towards greenhouse gas reduction targets (Millard-Ball, 2012). This methodology has also been used recently in other fields, analysing the effects of taxes and local measures for which the studies by Borge and Rattsø (2008) and Accetturo and de Blasio (2012) are particularly relevant.

Regarding the structure of this paper, in the following section we detail general aspects of the real estate tax deduction program to promote solar thermal technology uptake. In the next sections, we outline the methodology used, and we describe the database and define the covariates used. After specifying the analysis framework, we present the results and discuss the lessons learned. Finally, in the last section we summarize the main conclusions.

2. Property tax reduction to promote solar thermal systems

RET is the main local property tax affecting owners of properties in Spain payable yearly to local councils. The amount of the tax is calculated by reference to the *cadastral value* (official value of the property) registered in respect of all properties in Spain. The percentage charged varies from area to area, and is roughly 0.5% to 1%, paid by all property owners, resident or non-resident. In accordance with Royal Legislative Decree 2/2004, local councils can establish a reduction of up to 50% of the RET percentage charged for properties (excluding new construction) in which solar thermal systems have been installed. Other formal and substantive aspects of this bonus are specified in each tax ordinance. The temporal extend of this tax reduction is often from one to three years.