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Public-private partnerships as a policy response to climate change

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ABSTRACT

The negative impacts of climate change on the environment and economic activities are increasingly obvious and relevant. Private response to this threat often proves to be inadequate. For example, empirical evidence reveals a sub-optimal investment by firms in energy efficiency projects capable of reducing energy costs and CO_2 emissions, as well as adaptation projects able to reduce the vulnerability of the ecosystem. On the other hand, past public programs that provided financial subsidies to the above-mentioned projects have proven to be not particularly cost-effective or able to enhance final performances.

In this paper, as an alternative to public subsidies, we propose and assess the opportunity to implement Public-Private Partnerships (PPPs) where the public regulator plays a more active role in the investment choice. Precisely, we model the decision-making process through a Nash bargaining procedure between public and private actors. We end up with two main results: (i) compared to public subsidies, the use of PPPs leads to higher outcomes/performances and allows governments to overcome incompleteness in contracts; (ii) PPPs are optimally chosen only when there is a fair allocation of the bargaining power between the two sides and when bargaining procedures are not perceived as being too lengthy or costly.

1. Introduction and background

Observations and direct measurements of the climate system over recent decades have provided evidence of global warming and long-term changes in the atmosphere, the ocean, the cryosphere, and the land surface (IPCC, 2013). Indeed, citing the IPCC report of 2013: "many of the observed changes are unprecedented over decades to millennia."

Some consequences of changes in the climate system are the increase of atmospheric carbon dioxide (CO_2), rising temperatures and altered precipitation patterns. These disturbances affect the community as a whole and, in particular, private households whose main sources of revenues are from land and water resources (farmers, foresters, fishermen, etc.). Detailed descriptions of climate change effects on land and water resources are provided in several institutional and academic analyses (USDA, 2012; European-Commission, 2009; Backlund et al., 2008; European-Forest-Institute et al., 2008; Sohngen and Mendelsohn, 1998). With a special focus on the agricultural and forest sectors, previous studies describe evidence of abiotic disturbances (changes in fire occurrence, changes in wind storm frequency and intensity) and biotic disturbances (frequency and consequences of pest and disease outbreaks).

Despite the growing public concern over climate change, actions undertaken by private firms and public institutions to deal with these threats are still highly inadequate. In this respect, it is relevant to mention the existence of both an "energy efficiency" and an "adaptation" gap. On the one hand, as evidence of the first gap, empirical analyses show that firms and individuals under-invest with respect to what would be optimal for the society in terms of energy-efficient equipment and technologies capable of reducing energy consumption and C02 emissions (Gillingham and Palmer, 2014; Brown, 2001; Jaffe and Stavins, 1994). On the other hand, according to the UNEP report of 2016, "the adaptation gap can be defined generically as the difference between the level of adaptation actually implemented and a societally set target or goal, which reflects nationally determined needs related to climate change impacts, as well as resource limitations and competing priorities." (UNEP, 2016).

The sub-optimal investment in energy-efficient technologies or adaptation projects by private firms and individuals may be explained by market failures. In such contexts, market failures can be caused by the presence of environmental externalities, market barriers, insufficient and incorrect information, credit constraints and incomplete financial markets (UNEP, 2016; Gillingham and Palmer, 2014; Jaffe and Stavins, 2005, 1994; Brown, 2001).

These failures motivate government intervention that can take several forms. Traditional tools to deal with the presence of

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environmental externalities are Pigouvian taxes or subsidies, while credit constraints may be addressed through government financing programs (Gillingham and Palmer, 2014). Past programs and policies promoted by public entities included economic incentives and subsidies with the main goals of both removing barriers for the development of innovative procedures and boosting private incentives to invest in adaptation or energy-efficient technologies (Gillingham and Palmer, 2014; Filatova, 2014; Zhang and Maruyama, 2001). However, the outcomes of such programs have often not been consistent with their initial targets and the debate about their capacity to improve welfare continues. Empirical analyses show that energy efficiency programs in most countries had not led to the desired outcomes and were not cost-effective (Gillingham and Palmer, 2014; Arimura et al., 2012; Rivers and Jaccard, 2011). Indeed, it is expected that government policies to promote private adaptation will not be as effective if they are not sufficiently linked to private strategies (Urwin and Jordan, 2008) and especially if they merely provide funds to cover ex-post damages provoked by catastrophic/systematic events (Skees and Barnett, 1999).

Public-Private Partnership (PPP) may represent, within these contexts, a valid alternative to traditional public policies. Brown (2001) describes PPPs in the energy sector as "industry-government alliances that involve joint technology road mapping, collaborative priorities for the development of advanced energy-efficient and low-carbon technologies, and cost sharing." Similarly, Agrawala and Fankhauser (2008) suggest the use of PPPs in climate change adaptation to obtain an efficient and fair allocation of risks and incentives among public and private actors. In the energy sector, most PPPs were developed with the intention of promoting energy-efficient technologies for housing, appliances, schools, commercial and public buildings, vehicles, etc. (Jaffe and Stavins, 2005, 1999; Sperling, 2001). PPPs have also been tested in the forest sector as a way to restore forest management (Knoot and Rickenbach, 2014; Sturla, 2012), and in the agricultural sector as a tool to develop innovative technologies and enhance the use of sustainable agricultural practices (Spielman et al., 2010). Moreover, the use of PPPs has been acknowledged as a contribution to climate change adaptation in the tourism sector (Wong et al., 2012) and in agriculture (Urwin and Jordan, 2008).

The added value of this paper is its contribution to a greater understanding of possible forms of public-private partnerships for energy efficiency and climate adaptation investments. The topic is extremely relevant for policy implications because, as is emphasized by several authors, most of these types of investments are in the hands of private actors that, in many cases, do not offer enough incentives to provide optimal levels of investment and effort (Tompkins and Eakin, 2012; Mees et al., 2012). The use of PPPs in such cases is suggested and encouraged by researchers and practitioners, but there is still a lack of awareness of the nature and functioning of such partnerships (Jaffe and Stavins, 2005). In this paper, we provide a first insight into the topic through a model of public-private bargaining.

The goal of this paper is to compare PPPs with public subsidies as policies that aim at enhancing investments and efforts by private agents in terms of adaptation and energy efficiency projects. The paper develops a theoretical model where a private firm must decide the level of investment in technologies that may reduce the subsequent operational and management costs. Some examples are the choice of a private firm to invest or not in energy-efficient machinery (co-generation plants) capable of reducing energy production costs, or the decision of a forest owner to invest in infrastructure and technologies (road networks, irrigation canals or machine technology) that facilitate adaptive management practices such as fire prevention systems, changes in species composition, maintenance and thinning treatments. Energy efficiency investments and climate adaptation treatments lead to higher private returns in the form of reduced uncertainty or lower costs but, at the same time, they generate positive spillovers for the society in the form of lower CO_2 emissions and the reduced vulnerability of the ecosystem to climate change. In comparing the two government policies, we consider that in the case of public subsidies, the transfer is contingent on the level of initial investment, whereas in the case of PPPs, a bargain must be struck between the private and public sectors to determine both the investment level and the optimal sharing of costs between the two sides.

On the basis of our analysis, we can put forward some results that may be useful for policy implications: (i) government interventions correct market failures and, as already intuited by some authors such as Tompkins and Eakin (2012), the adoption of PPPs may be particularly beneficial in a context of high uncertainty and incomplete contracts[1]; (ii) PPPs are always optimal with respect to public subsidies in terms of final outcomes, but they represent the best solution only when the decision-making process is not perceived to be too lengthy or costly; (iii) As already intuited by Mees et al. (2012), it is easier to achieve a successful adoption of governance arrangements involving public and private participants when the bargaining power is not excessively concentrated in one part and when private and social returns are similar.

The following sections are organized as follows. In Section 2, we present the model and study the first best case; thereafter, we consider that the private owner carries out the investment without any public help and we adopt this scenario as a benchmark. In Section 3 we introduce and compare the two possible types of public intervention in a context of incomplete contracts. In Section 4, we then propose a numerical example and a comparative statics analysis to determine which type of intervention is preferable depending on either the level of uncertainty or the bargaining power parameter. Finally, in Section 5, we conclude and discuss policy implications.

2. Methodology

In this section, we present a stylized model designed to deal with all of the relevant elements that characterize climate change and energy efficiency projects, including: their public/private nature, the high level of uncertainty, the presence of asymmetric information between public and private agents (moral hazard), and the risk aversion of private investors.

We consider these investments as quasi-public goods provided by private firms or individuals, but that generate some positive spillovers for society (Tompkins and Eakin, 2012). Then, since such projects are characterized by a high level of uncertainty, we include both exogenous and endogenous risks in the model. The first source of uncertainty depends on external factors and affects the payoff of the private agent because of the presence of risk aversion. The second source of uncertainty is related to the effort that the private agent may exert to include the new adaptation and/or energy-efficiency practices in the daily activities of the firm.

In the model we start by considering a private firm that owns a business that, in the absence of uncertainty, generates a certain level of revenue (R_0). W.l.o.g. and to simplify the notation, it is assumed that $R_0 = 0$ from now on.

In managing their activity, private agents may exert effort, for example, to reduce energy costs or to implement adaptation practices (e). This effort can generate additional revenue that is assumed to be equal to $Re + f(e)\epsilon$. In addition, such activities have a positive spillover for society that is assumed to be equal to $Se + f(e)\epsilon$. The expected revenue and social functions positively depend on the effort of the private agent and are further related to a parameter ϵ that is assumed to follow a random distribution with a mean equal to zero and a variance equal to σ_ϵ^2. This latter parameter reflects a certain degree of uncertainty that may be explained by the difficulty to either forecast climate change scenarios and future energy prices or to assess the expected effectiveness of adaptation action. A positive (negative) shock means that the

[1] Nevertheless, the government intervention may be limited in the presence of budget constraints (shadow cost of public funds).