Energy Policy 90 (2016) 24–36

Contents lists available at ScienceDirect

Energy Policy

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

Designing incentive schemes for promoting energy-efficient appliances: A new methodology and a case study for Spain

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HIGHLIGHTS

- A new methodology for the optimal design of incentive schemes is presented.
- This is done minimising the Dead Weight Loss for different goals and restrictions.
- Efficient bonus malus schemes can be designed with this method.

ARTICLE INFO

Article history:
Received 11 August 2015
Received in revised form
17 November 2015
Accepted 8 December 2015

JEL Classification:
C13
C20

Keywords:
Energy efficiency
Taxes
Subsidies
Bonus-malus
Spain
Appliances

ABSTRACT

The energy-efficiency gap has been high on research and policy agendas for several decades. Incentive schemes such as subsidies, taxes and bonus-malus schemes are widely used to promote energy-efficient appliances. Most research, however, considers instruments in isolation, and only rarely in the context of political constraints on instrument use, or for alternative policy goals. This paper presents a methodology for the optimal design of incentive schemes based on the minimisation of Dead Weight Loss for different policy goals and policy restrictions. The use of the methodology is illustrated by designing optimal combinations of taxes and subsidies in Spain for three types of appliance: dishwashers, refrigerators and washing machines. The optimal policies are designed subject to different policy goals such as achieving a fixed reduction in emissions or a certain increased market share for efficient appliances, and for policy constraints such as budget neutrality. The methodology developed here can also be used to evaluate past and current incentive schemes.

1. Introduction

The energy-efficiency gap has been high on research and policy agendas for several decades. The idea is that there is a large gap between potential energy-efficiency gains and realized energy-efficiency gains. The seminal paper by Jaffe and Stavins (1994) discusses potential market and non-market failures that could explain the existence of an energy-efficiency gap. Potential market failures such as public good attributes of information about energy efficiency and principal-agent problems may justify government interventions to try to bridge the energy efficiency gap. Linares and Labandeira (2010) state that a clear understanding of the barriers and motivations to investment in energy efficiency is essential in designing effective policies. Allcott and Greenstone (2012) argue that if energy use externalities (such as climate change) are the only market failure, the social optimum is to internalise the externality through Pigouvian taxes or equivalent instruments. Only if other market failures such as imperfect information also play a role might there be a role for other policies such as subsidies or energy-efficiency mandates.

The idea of an energy-efficiency gap has generated considerable political momentum and yet reliable estimates on the costs and benefits of energy efficiency policies remain highly controversial (Gillingham and Palmer, 2014). EU climate and energy

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[1] Economics for Energy (http://www.eforenergy.org/).

http://dx.doi.org/10.1016/j.enpol.2015.12.010
0301-4215/

policies, for instance, pay considerable attention to policies and measures to overcome failures relating to imperfect information. The EU website[2] highlights eight measures for improving energy efficiency, four of which relate to improving access to information (mandatory energy efficiency certificates for buildings, energy efficiency labelling, rollout of smart meters and rights of consumers to access data on energy consumption).

The literature review here focuses on measures relating to overcoming the energy efficiency gap. Because it has been a particular priority area for governmental intervention, as illustrated by the EU example above, we focus on measures targeting household appliances, in particular energy-efficiency labels and incentive schemes.

1.1. Energy efficiency labels and incentive schemes

Energy-efficiency labels are one of the most widespread instruments for overcoming the energy-efficiency gap. Mandatory labels exist, for instance, for houses, cars and household appliances in the EU, and voluntary schemes exist for electrical appliances in Australia and the USA. There is a substantial literature analysing the potential of energy-efficiency labels for promoting energy efficiency (Banerjee and Solomon, 2003, Sanchez et al., 2008, Webber et al., 2000, Abadie and Galarraga, 2012, Galarraga and Abadie, 2012, Galarraga et al., 2011a , 2011b).

An energy-efficiency label is a form of eco-label specifically designed to address any information deficiencies by highlighting the energy efficiency of the product. The label is a trustable logo that informs consumers about the attributes and impacts of a product throughout its life cycle (Galarraga and Abadie, 2012).

The use of incentive schemes to promote energy-efficient appliances (or to discourage sales of inefficient appliances) is also widespread. Taxes are often applied upstream and on the use of energy (e.g. on the importing or production of fossil fuels), whereas subsidies are more frequently used at product level (i.e. it is more common to find energy use taxed and the purchase of a specific energy-efficient product subsidised). The economics of Pigouvian taxes and subsidies are also well researched and well understood at both theoretical and empirical levels (e.g. Ballard and Medema, 1993, Revelt and Train, 1998, Gillingham et al., 2006). Similar to Galarraga et al. (2013), we assume that we are not in a first best setting where a Pigouvian solution can be applied. We assume that market failures may occur in other adjacent market, such as the electricity market, and not in the durable goods market. Furthermore, that labels might correct, at least partially, the information asymmetries in the durable goods market (Howarth et al., 2000). Allcott and Greenstone (2012) argue that when consumer responses are not sensitive to changes in electricity prices, subsidies for energy efficient durables can be useful to design optimal policies. One can argue for the existence of a distortion in the durable goods market when such subsidies are used, and consequently the existence of a dead weight loss (hereafter DWL). That is, "that energy efficiency rebates may have introduced distortions in consumers not subject to (investment) inefficiencies and therefore may have led to economic efficiency losses, meaning that the cost of the subsidies may have exceeded the gains in consumer and producer surpluses" (Galarraga et al., 2013).

Compared to the literature on the effectiveness of energy-efficiency labels, few studies analyse the effectiveness of incentive schemes in encouraging consumers to purchase energy-efficient appliances. Revelt and Train (1998) find that although rebates can help to promote energy-efficient refrigerators in the USA, loans may be more effective. Datta and Gulati (2014) estimate that a 1 USD rebate increases the market share of energy efficient washing machines on the US market by 4.5%. Markandya et al. (2009) consider rebate schemes for labelled appliances and show that they might be cost-effective under certain conditions.

Galarraga et al. (2013) study the so-called Renove programme, a rebate programme for dishwashers in Spain. They find that when a subsidy is introduced to incentivise purchases of efficient appliances, total energy use can be expected to increase as the total number of appliances will increase (referred to here as a rebound effect[3]). Total energy use is estimated to increase by 1.4–2.0%, while the number of dishwashers labelled A or better increases by 4.8–7.7%[4]. They also find that the subsidy generates a welfare loss, which is explained by its inefficiency as a policy instrument. They conclude that the current RENOVE rebate programme in Spain generates a welfare loss, a rebound effect (as the total number of appliances increases) and a considerable deficit in the public-sector budget. An alternative policy such as a tax on inefficient appliances could potentially improve the policy outcome. The paper ends by showing the effect of a combination of a tax for "bads" (i.e. inefficient appliances) and a subsidy for "goods" (i.e. efficient ones) in what is known as a bonus-malus scheme. The authors conclude that the use of such a scheme would outperform both taxes and rebates used in isolation, as it would enable the subsidy scheme to be partially financed by taxes, significantly reducing the cost of the policy for the fiscal authority. Because it performs better on this criteria, the policy might be more politically feasible. The authors offer a range of possible combinations of taxes and subsidies that could lead to similar outcomes. They do not estimate the optimal combination of taxes and subsidies compatible with a specific policy target.

Bonus-malus schemes are an extensively researched topic in the fields of risk management and insurance companies (see e.g. Chiappori and Salanie, 2000, Lemaire, 1988). However, few studies have focused on understanding the use of bonus-malus schemes as an instrument for addressing environmental externalities. We therefore devote some additional space to presenting the literature on this particular instrument.

Some refer to bonus-malus schemes as "Feebates", a term coined as a combination of 'fee' and 'rebate'. Proposals have been put forward and analysed for using bonus-malus schemes in the car market in the US (Langer, 2005; Banerjee and Solomon, 2003), for fuel efficiency (Greene et al., 2005), for vehicles in France based on CO2 emissions (D'Haultfœuille et al., 2014), for food groups (Gustavsen and Rickertsen, 2013; Markandya et al., Forthcoming), for fair trade and regular coffee (Galarraga and Markandya, 2006) and for nitrogen oxide (NOx) in Sweden (Johnson, 2006).

Additional applications include bonus-malus schemes for energy efficiency in buildings or household appliances in the US (Eilert et al., 2010). The authors define the instrument as "a market-based, technology-neutral policy that can be used to levy surcharges ("fee") on less efficient products and provide rebates ("bates") for higher efficient products" and argue that it can be designed to achieve several different policy targets such as achieving certain emission reductions or energy savings. The

[2] URL: http://ec.europa.eu/energy/en/topics/energy-efficiency [Visited on April 28 2015]

[3] The term "rebound effect" refers to situations in which efficiency improvements encourage increased use of the appliance, limiting the effect of the policy and in some cases even making it backfire, i.e. bringing about an increase in total consumption. The increase in energy consumption in the case discussed here is a consequence of the increase in the total number of appliances.

[4] The authors state that although the rebate is designed to keep the total amount of appliances constant as it is only granted in exchange for an old appliance, many "old" appliances given in exchange are already disused and are recovered merely to benefit from the rebate".