Energy Policy 37 (2009) 5662–5674

Contents lists available at ScienceDirect

Energy Policy

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

Analysis of tax incentives for energy-efficient durables in the EU ☆

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ARTICLE INFO

Article history:
Received 20 May 2009
Accepted 13 August 2009
Available online 5 September 2009

JEL classification:
Q40
Q43
Q48
Q52
Q54

Keywords:
Tax incentives
Energy efficiency
Durables

ABSTRACT

Climate change is one of the most significant challenges faced by societies this century. Energy consumption is directly associated with CO_2 emissions and climate change. The European Commission has set out emission reduction targets that require a great deal of energy consumption savings in the next 10 years in European countries. This paper presents the results of an analysis of the potential cost-effectiveness of different policy options aimed to foster the production and consumption of energy-efficient appliances in different European countries. Our results suggest that incentives to promote the use of energy-efficient appliances can be cost-effective, but whether or not they are depends on the particular country and the options under consideration. From the cases considered, tax credits on boilers appear to be a cost-effective option in Denmark and Italy, while subsidies on CFLi bulbs in France and Poland are cost-effective in terms of €/ton of CO_2 abated. Comparing the subsidies against the energy tax options, we find that the subsidies are in most cases less cost-effective than the energy tax.

1. Introduction

Energy transformation and consumption account for a significant share of anthropogenic greenhouse gas (GHG) emissions worldwide, which are now widely accepted as associated with global climate change (IPCC, 2007). Mitigating and adapting to climate change has become one of the greatest challenges of our time, requiring policymakers to design policy options that provide the right incentives for producers and consumers to improve energy efficiency and mitigate GHG emissions, especially carbon dioxide. The European Union (EU) with its 27 countries and approximately 500 million consumers is the world's second largest energy market; consequently, European policymakers have an important role to play in increasing energy efficiency, reducing CO_2 emissions, and mitigating climate change. Indeed, topics such as energy security, climate change and competitiveness are high on the European Commission agenda, which has identified them as guiding principles of a prospective European Energy Policy. However, the achievement of such goal requires an immediate effort for finding the optimal balance between competitiveness and sustainability (Ortiz et al., 2008).

The European Commission identifies increased energy efficiency as the most cost-effective and rapid way to reduce CO_2 emissions. It argues that achieving the ambitious task of 20% reduction in CO_2 emissions by 2020 requires, among other things, approximately 20% savings in energy consumption, most likely through energy efficiency measures (European Commission, 2008). In this context, and at the household level, incentives are needed to complement the existing initiatives and foster the production and sales of more energy-efficient appliances in the EU. However, energy-efficient appliances often present a higher market price for the consumers, which limit their taking more significant market share and discourage the industry to invest in such products.

This paper aims to assess, from both economic and environmental perspectives, the interaction and comparability of a number of fiscal incentives designed to foster the production and consumption of appliances in the EU. We investigated how cost-effective a group of policy options applied for specific goods would be in selected European countries. Table 1 summarises the policy options,

☆This study is based on work undertaken for the European Commission in connection with its policies to promote energy efficiency. We would thank Katri Kosenen from the tax division, as well as other officials for their comments. Useful comments were also received at a seminar at ETH in Zurich in March 2009. All errors and omissions remain of course ours alone.

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doi:10.1016/j.enpol.2009.08.031

Table 1
Description of case studies and policy options.

Case-study	Product	Member State	Baseline scenario	Policy option 1 (parameters)*	Policy option 2 (parameters)*
1	Refrigerator	France	Increase in electricity price (12%)	Subsidy for consumers (€50 class A+ only)	Energy tax: further increase in electricity price (10%)
2		Denmark			
3	Washing machine	Italy	Increase in electricity price (12%)	Tax credit for manufacturers (€100 per appliance cl. A+; sold above historical levels 3- years average)	B-class and lower removed from the market (market share of classes B and C shifted to class A)
4		Poland			
5	Boiler	Denmark	Increase in gas price (15%)	Tax credit for consumers (deducted from income tax; 25% of the appliance price for condensing boiler)	Energy tax: further increase in gas price (10%)
6		Italy			
7	CFLi	Poland	Increase in electricity price (12%)	Subsidy for consumers (€1 classes A and B)	Energy tax: further increase in electricity price (10%)
8		France			

Note: (*) policies 1 and 2 are applied on top of baseline scenario (an increase in energy prices associated with the implementation of the European Emission Trading Scheme (ETS)).

countries and goods evaluated.[1] The paper is organised as follows: Section 2 summarises the methodology used while Section 3 describes the data utilised and the main assumptions necessary in order to undertake the analysis with the limited data. Results are in Section 4, as well as a comparison between policy alternatives. Section 5 presents a sensitivity analysis of some parameters of our analysis and Section 6 discusses the results and indicates some methodological limitations.

In order to infer accurately the benefits associated with proposed tax incentives, we need to estimate detailed demand functions for different appliances and countries (differentiating per energy class types of products), from which predictions of future sales could be drawn under new prices resulting from the policies. Ideally, such demand equations should be estimated as a system of equations. The limited market data available in the countries studied, however, did not allow us to estimate such econometric models. To get round this difficulty, we have developed a simple economic-engineering-type model of consumers' behaviour to support our analysis. We used this model to assess the effects of the policy options on sales of energy-efficient appliances, estimating the energy savings and CO_2 reductions resulting from the observed changes in sales of different kinds of appliances. The benefits were then compared to inferred costs of the selected policy options.

The method used to estimate the welfare gains and losses in this study is one based on a partial equilibrium approach—i.e. it looks at one market at a time and does not consider the impacts of changes in prices across markets. An economy-wide approach would certainly be more inclusive of other effects but would run into problems of estimation of many of the parameters, for which data are very limited. There are studies that look at multi-market impacts that consider energy taxes (see for example Bergin et al., 2002; and Kim, 2002; Konrad, 2000; Hasset and Metcalf, 1995) but they do not operate at a detailed enough level to consider specific commodities such as energy-efficient versions of durable goods. Our study is one of the first to compare energy taxation and subsidies for specific versions of consumer durables. We should also note that we did not have the resources to undertake such an economy-wide analysis, which would indeed be further original work. Nevertheless we believe the relative results obtained here are valid and would not be overturned in a more sophisticated study, using CGE models. The same applies to the limitation of looking at environmental effects only from the use of the durable equipment and not from its manufacture.

[1] The choice of policies evaluated for each good and country was determined after discussions with the EC tax division, and reflects EC policy interests. In future (more extensive) analyses of the same policy(ies) may be tested with all goods and countries at once, and provide a wider picture of the impacts of this/these policy(ies).

2. The model and general assumptions

The approach used to evaluate how sales of energy-efficient appliances would be affected by tax incentives involves an economic model of consumer behaviour towards the provision of services of appliances. It assumes that consumers compare the net present value (NPV) of the operational costs of services provided by appliances, during its lifetime (T), and choose the cheapest alternative. In mathematical terms:

$$NPV_i = \lambda[s - \pi e_i] - P_i$$

$$\lambda = \frac{(1-\delta^T)}{(1-\delta)} \text{ and } \delta = \frac{1}{(1+r)},$$

where: NPV_i is the net present value from equipment of type (i); i the energy class of the appliance; s^j the service provided by appliances in period (j), ($j = 1, \ldots, T$) assumed to be constant in each period and equal to s; T the lifetime of appliance; π the price per unit of energy; e_i the amount of energy used per energy class type (i); P_i the price of appliance of type (i); r the discount rate; and λ the discount factor.

In deriving the above it is assumed that (i) each consumer buys one and only one product of one each energy type; (ii) all products of different energy types have the same fixed lifetime; and (iii) products are identical in terms of service provided (s) but vary in terms of energy efficiency. Thus, for each preferred choice (i^*) it must be true that:

$$\lambda[s - \pi e_{i^*}] - P_{i*} > \lambda[s - \pi e_k] - P_k, \text{for all } (k \neq i^*)$$

From assumption (iii) above we have:

$$-\lambda \pi e_{i*} - P_{i*} > -\lambda \pi e_k - P_k, \text{for all } (k \neq i^*)$$

or

$$\lambda \pi e_{i*} + P_{i*} < \lambda \pi e_k + P_k, \text{for all } (k \neq i^*) \quad (1)$$

We estimate choices based on inequality (1) using the market data for the most recent year available and assuming personal discount rates ranging between zero and 50% (100% in a sensitivity analysis). The results show, for each type of product or energy class, the range of the personal discount rates for which inequality (1) holds; i.e. the discount rates that make the NPV of appliances of each type the cheapest, and thus preferable for