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White certificate schemes: Economic analysis and interactions with the EU ETS

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ABSTRACT

This paper examines the economic, environmental and distributional impacts of an idealised tradable white certificate (TWC) scheme and shows how the impacts are modified when the scheme operates in parallel with the EU emissions trading scheme (EU ETS). It uses simple graphical techniques to assess whether a TWC scheme will increase, decrease or have an ambiguous effect on electricity demand, wholesale and retail electricity prices, carbon emissions and investment in energy efficiency, paying particular attention to the interpretation of 'additionality'.

Following a comparable analysis of the impact of the EU ETS, the paper examines the implications of introducing a white certificate scheme in a country that is already participating in the EU ETS. It compares the effect of this combination of instruments to that of the EU ETS operating in isolation. It concludes that there is no necessary link between the price of white certificates and marginal cost of energy efficiency investment, the price of electricity or the ability of the suppliers to eliminate free riders from their subsidy schemes. Also, a TWC scheme will make no contribution to reducing global carbon emissions unless and until it leads to a tightening of the EU ETS cap.

1. Introduction

This paper addresses two questions. First, what does basic economic theory tell us about the economic, environmental and distributional impacts of an idealised tradable white certificate (TWC) scheme? Second, how are these impacts modified when the scheme operates in parallel with the EU emissions trading scheme (EU ETS)? These questions are explored through elementary graphical models of the markets for electricity and energy efficiency.

The paper abstracts from the empirical details of individual schemes and makes a number of standard but radically simplifying assumptions regarding the operation of the relevant markets. In particular, much of the analysis assumes that markets operate without any significant 'barriers' or market failures. This approach may seem odd to readers familiar with energy efficiency policy, since the multiple and reinforcing barriers to energy efficiency form the *raison d'etre* for white certificate schemes and related instruments (Sorrell et al., 2004). Nevertheless, while these barriers influence the response to market and regulatory signals and are relevant to both the design and justification of policy interventions, they do not significantly affect the economic impacts of those instruments that are the main focus of this paper (described below). We therefore consider that much insight can be gained from a simplified approach, which can then form the basis for more detailed investigation of particular schemes, including economic modelling.

TWCs are attracting increasing interest within the EU as a cost-effective means of encouraging investment in energy efficiency by energy suppliers (Farinelli et al., 2005; Harrison et al., 2005; Langniss and Praetorius, 2006; Oikonomou et al., 2007; Vine and Hamrin, 2008). Variations of this instrument are currently in operation in Italy and the UK, about to be introduced in France and under serious consideration in Denmark and the Netherlands.[2] In this context, the interactions between such schemes and the EU ETS become a key policy concern (Sorrell, 2003). These interactions may occur through a number of routes, but most importantly through the operation of electricity markets. The paper, therefore, investigates the behaviour of an idealised national TWC scheme that is aimed solely at improving the efficiency of electricity use. To provide an

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[2] A number of non-European countries are also expressing interest in this type of instrument, with schemes in operation in Australia (New South Wales) and the United States (Connecticut) (Vine and Hamrin, 2008). White certificates are termed 'energy saving certificates' in the US.

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Box 1–Key variables

Price variables:

- wholesale electricity prices,
- retail (consumer) electricity prices,
- EU ETS allowance price and
- white certificate price.

Quantity variables:

- electricity demand,
- renewable electricity generation,
- non-renewable electricity generation,
- carbon dioxide emissions,
- investment in end-user energy efficiency and
- investment in new renewable energy generation.

Distributional variables:

- impacts on electricity producers,
- impacts on producers of energy efficient equipment and
- impacts on electricity consumers.

organising framework, the paper focuses on a small number of *price*, *quantity* and *distributional* variables, which are summarised in Box 1. The impacts of the policy instruments on each variable are explored using simple graphical techniques, with distributional impacts being assessed through the standard measures of consumer and producer 'surplus'.

The paper first examines the potential effect of a TWC scheme operating in isolation and then examines the effect of the EU ETS in isolation. The TWC scheme is treated in more detail than the EU ETS, since its impacts are both less familiar and more complex. The paper then examines how these effects may be modified when both instruments operate in parallel. In each case, the paper assesses whether the variables listed in Box 1 are likely to be *increased*, *reduced* or *unaffected* by the instrument or instrument combination, or whether the outcome is *ambiguous* and therefore depends on individual circumstances. These results are summarised in tables, which provide a useful overview of the analysis. Where possible, commentary is provided on the likely magnitude of these different effects. The paper pays particular attention to the impact of a TWC scheme on national, European and global carbon emissions.[3]

2. Economic analysis of an idealised white certificate scheme

This section provides a simplified, partial-equilibrium analysis of the impact of a TWC scheme on the markets for electricity and energy efficiency. The focus is on a national TWC scheme operating in isolation from other trading schemes and within a national electricity market that is isolated from international competition. It is assumed that the TWC scheme imposes energy efficiency obligations *solely* on the electricity sector. In practice, existing and proposed TWC schemes are not confined to electricity markets, both because they impose obligations on retailers of other energy carriers (notably gas) and because they allow electricity retailers to meet their obligations by investing in projects that affect energy carriers other than electricity. However, this simplification allows us to isolate those effects that are most relevant for studying the interactions of a TWC scheme with the EU ETS.

The analysis also assumes that the obligations to achieve energy savings fall on *retailers* of electricity. These are responsible for the purchase of wholesale electricity and the sale to end-users, but since they do not own the distribution network they have no monopoly elements.[4] Retailers are assumed to be operating in a liberalised and competitive market where electricity is supplied at marginal cost. The TWC scheme imposes obligations on retailers to achieve a certain quantity of 'electricity savings' through improvements in the efficiency of electricity use by consumers. No restriction on the type of projects or the location of consumers is assumed. Each project is assumed to involve some form of subsidy to the host consumer, to encourage them to adopt the relevant technologies.[5] These subsidies are provided by the electricity retailers, who recover the costs by increasing electricity tariffs for all consumers.

As the above description suggests, a TWC scheme is analogous to a traditional demand-side management (DSM) scheme in that it requires electricity companies to invest in projects that reduce the demand for their product. In this sense, the tradable certificates simply provide a mechanism for achieving the electricity savings target at least cost. This means that the conceptual analysis of a TWC scheme can draw upon the extensive literature on the economics of DSM schemes (Gillingham et al., 2004; Nadel and Geller, 1996). There are also some useful parallels with the operation of green certificate schemes (Bye, 2003; Jensen and Skytte, 2002a, b; Morthorst, 2001, 2003). The following discussion draws in particular upon the work of Braithwait and Caves (1994) and Huber et al. (2005).

2.1. Price and quantity effects in a national electricity market

The demand for electricity and electricity conversion equipment is derived from the demand for the services (e.g. heat, light and cooling) that these, in combination, provide. The same level of electricity service can be provided from an inefficient conversion technology with higher electricity use, or an efficient conversion technology with lower electricity use. Hence, the attribute of conversion technologies that is of interest is their energy efficiency, and this can be represented as a 'market' for energy efficiency measures ('EEM'). In practice, consumers rarely purchase 'energy efficiency' in isolation, but instead purchase products and services that have multiple attributes, including energy efficiency. Also, the energy efficiency of services such as heating is not determined solely by the attributes of conversion devices but also by the attributes of the whole system, such as the thermal insulation in a building. The notion of a market for EEM is, therefore, an abstraction, but nevertheless a useful one.

Households are assumed to purchase the combination of electricity and EEM that maximise their welfare. Firms and

[3] This paper is based on a comprehensive analysis of the interactions between white and green certificate schemes and the EU ETS, conducted on behalf of the European Commission (Harrison et al., 2005). Readers interested in exploring these issues in more detail should refer to this report—available at http://ec.europa.eu/environment/climat/pdf/ec_green_final_report051117.pdf.

[4] The model for this analysis is the current electricity market arrangements in the UK. Market arrangements are different in other Member States and may make it more appropriate to impose obligations on other parties, such as electricity distributors. This is the case, for example, with the Italian TWC scheme (Pagliano et al., 2003; Pavan, 2002).

[5] This is a considerable simplification of real-world arrangements, where retailers meet much of their energy-saving obligations through contractual arrangements with third parties, including managers of housing stock, suppliers, installers and retailers of energy efficiency equipment, and energy service companies (Klevnas et al., 2006).