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Resource and Energy Economics 28 (2006) 1–23
RESOURCE and ENERGY ECONOMICS
www.elsevier.com/locate/ree

Marginal abatement cost curves in general equilibrium: The influence of world energy prices

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Received 12 January 2003; received in revised form 17 September 2004; accepted 26 April 2005
Available online 20 July 2005

Abstract

Marginal abatement cost curves (MACCs) are a favorite instrument to analyze international emissions trading. This paper focuses on the question of how to define MACCs in a general equilibrium context where the global abatement level influences energy prices and in turn national MACCs. We discuss the mechanisms theoretically and then use the CGE model DART for quantitative simulations. The result is, that changes in energy prices resulting from different global abatement levels do indeed affect national MACCs. Also, we compare different possibilities of defining MACCs—of which some are robust against changes in energy prices while others vary considerably.

JEL Classification: C68; D58; F18; Q41

Keywords: Climate change; Marginal abatement cost curves; Energy prices; Computable general equilibrium model

1. Introduction

In the last years marginal abatement cost curves (MACCs) have become a standard tool to analyze the impacts of the Kyoto Protocol and emissions trading. Once such curves are available for the different world regions it is very easy to determine permit prices, total abatement cost and regional emissions for different scenarios of international emissions

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0928-7655/$ – see front matter
doi:10.1016/j.reseneeco.2005.04.001

trading. A detailed description of the use of the MACCs is provided in the papers of Ellerman and Decaux (1998) and Criqui et al. (1999). A number of other authors have followed the approach (Blanchard et al., 2002; den Elzen and de Moor, 2002; Löschel and Zhang, 2002; Lucas et al., 2002; van Steenberghe, 2002) analyzing scenarios such as emissions trading with and without the participation of the USA, the use of market power by Russia and the Ukraine, multiple gas abatement and banking.

All these studies implicitly assume that each region/country has its unique marginal abatement cost curve independent of, e.g. the abatement levels of other regions or whether emissions trading is taking place or not. One justification for this assumption is the finding of Ellerman and Decaux (1998) that MACCs are indeed robust with respect to such policy parameters. This is somehow a surprise as Ellerman and Decaux note themselves that with international trade the abatement level in one country influences trade flows such that the MACCs may change in other countries. Their simulations with the EPPA model though, show that the variation in prices is less than 10% between different scenarios for any given level of abatement.

Commonly, the marginal abatement cost for a certain abatement level is derived as the shadow price for the associated emission constraint. As we will discuss, this shadow price is influenced by world energy prices which differ across different abatement scenarios. The reason behind this is that abatement levels in one country influence its energy demand, which might in turn influence the world energy price. With, for example, higher world energy prices regions automatically demand less energy and emit less carbon so that the same emission target becomes less binding. The magnitude of the difference in shadow prices depends on a number of factors such as trade elasticities and trade structures. This suggests that MACCs depend on world energy prices and may shift across different abatement scenarios.

Against this background, this paper tries to clarify what MACCs are, what factors influence the MACCs in different scenarios and how the MACCs should be used. In addition, the problem of choosing the reference point for the MACC is discussed. We will first explore the energy price effects theoretically in a stylized model and second quantify them using the computable general equilibrium model DART. The main result is that not only theoretically MACCs change with varying energy prices, but that the difference can reach a magnitude that cannot be neglected.

The paper proceeds as follows. The next sections defines marginal abatement cost curves, explains how they are constructed and used in practice and presents estimates for different regions. Section 3 shows in different settings how shadow prices depend on energy prices and how this affects MACCs. Section 4 introduces the computable general equilibrium model DART, defines our scenarios and presents the results of the simulations. Section 5 concludes.

2. Marginal abatement cost curves

The idea of a marginal abatement cost curve (MACC) comes from firm or plant level models of reducing emissions. In production theory the interpretation is straightforward. Given that some activities in the production process lead to emissions of undesired