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Uncertainty, cost-effectiveness and environmental safety of robust carbon trading: integrated approach

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Abstract Carbon markets, like other commodity markets, are volatile. They react to stochastic "disequilibrium" spot prices, which may be affected by inadequate policies, speculations and bubbles. The market-based emission trading, therefore, does not necessarily minimize abatement costs and achieve emission reduction goals. We introduce a basic stochastic model integrating emissions reduction, monitoring and trading costs allowing us to analyze the robustness of emission and uncertainty reduction policies under environmental safety constraints asymmetric information and other multiple anthropogenic and natural uncertainties. Explicit treatment of uncertainties provides incentives for reducing them before trading. We illustrate functioning of the robust market with numerical results involving such countries as the US, Australia, Canada, Japan, EU27, Russia, Ukraine. In particular, we analyze if the knowledge about uncertainties may affect portfolios of technological and trade policies or structure of the market and how uncertainty characteristics may affect market prices and change the market structure.

1 Introduction

The paper aims to analyze cost-effective and environmentally safe carbon trading systems operating under uncertainty about emissions and their abatement and monitoring cost functions, asymmetric information, and irreversibility. For analyzing robust emission trading schemes, we introduce an integrated multiagent emission reduction model under multiple natural and human-related uncertainties. The model pursues the goal that all trading parties jointly achieve individual emissions targets at minimum costs by investing in emissions

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abatement, uncertainty reduction and by redistributing the emissions permits through trading. Safety constraints imposed on the trades require that the reported emissions plus uncertainty are below the targeted level (cap) with a given probability, therefore this creates incentives for parties to invest into uncertainty reduction prior to compliance. Proposed mutually beneficial bilateral trading scheme corresponds to a special distributed optimization method. The implementation of this trading scheme is discussed in section 4 using a computerized multiagent trading system avoiding irreversibility of real trades and asymmetric information of partners.

Different uncertainties affect emission trading in different ways, which may cause market crashes and instabilities similar to financial markets. To limit the role of uncertainties, advocates of regulated trades argue in favor of uncertainty indicators distinguishing sources by their uncertainty levels (Kerr 2000; Godal et al. 2003), which is usually their private information. Therefore, the use of these indicators is similar to the ideas of "signaling" well known in treating the asymmetric information (see e.g. Milgrom and Roberts 1986). Market regulators may set restrictions on source category to be included in trading, and trading scheme may demand a party to set source-specific targets depending on the level of uncertainty.

Emissions cap and trade programs (de Jong and Walet 2004; Kerr 2000) are economic instruments for environmental regulations which become popular both among policy-makers and scientific communities (Stavins 2010). These programs are now a key element in climate change policy negotiations establishing carbon prices as a "new currency" and emission permits as a new asset type (Kerr 2000).

In theory, the market price of tradable emissions permits (allowances) should set up the marginal cost of emissions reductions to meet the cap. In reality, the market prices exhibit periods of high volatility which may be a result of political decisions, information disclosure, speculations. The short-term information about spot prices in different periods may be contradictory and cause parties to revise their "myopic" decisions which, however, may not be reversible. As studied by Potsdam Institute for Climate Impact Research (Roos 2011), immaturity of the existing market policies triggered a major "dash for coal setting out on the construction of dozens of new coal plants. …". Also, in the Netherlands, "… CO2 emissions trading is a marginal consideration in the choice of fuel. Evidently, electricity producers are not too bothered about the price they pay for carbon emissions. The vast majority still favors coal, the worst carbon polluter. The reason is simple: the expected costs of emission rights are negligible compared to other investment outlays." The building of coal-fired plants now will lock-in energy decisions for about 40 years (Stikkelman et al. 2010).

Lessons learned from the existing emission trading (Betz and Sato 2006) point out the need for market safety regulations to smoothen its performance.

In this paper, we propose a computerized multiagent trading system (COMATS) which may function as a prototype of a real decentralized emission trading market under uncertainty without revealing the private information of parties about costs and emissions. The system may enhance real markets by analyzing conditions for strategic robust trades and stable market's performance avoiding potential irreversibility and "lock-in" equilibriums. COMATS is designed as a multicomputer network of traders and can be viewed as a device for decentralized collective regulation of trades towards their cost-effectiveness under safety constraints.

The paper is organized as follows. Section 2 reviews the classical approach to emission trading and discusses its shortcomings in situations with uncertainty. In section 3 the integrated stochastic multiagent model is introduced and analyzed. Section 4 outlines the structure of the COMATS and summarizes numerical results on trading involving such countries as US, Australia, Canada, Japan, EU27, Russia, Ukraine, etc. In this section we show how the knowledge about uncertainties may affect structure of the market, e.g., turn buyer into seller,