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Assessment of initial emission allowance allocation methods in the Korean electricity market☆

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ABSTRACT

Korea will introduce an emission trading policy from 2015. The rules for the initial allocation of emission allowances have not been decided yet. This paper assesses the effect of various initial emission allowance allocation methods of the Korean electricity market. This study employs the mixed complementarity problem, which is able to incorporate operation, investment, and emission trade decisions in the deregulated electricity market in order to provide more realistic results. In particular, the allocation rules to existing plants and new entrants are modeled separately in this study. The model quantifies the impacts of different allocation rules on emissions, capacity mix, emission allowance prices, electricity prices, and social welfare. We examine typical allocation rules such as auction to all power plants, best available technology (BAT) benchmark to all power plants, fuel-specific benchmark to existing power plants along with BAT benchmark to new entrants, and fuel-specific benchmark to all power plants. We find that giving free allocations to new power plants prompts more new investment and this raises overall social welfare even though the direct cost of achieving the emission reduction target rises. While the auction is the most powerful policy to reduce emissions in the electricity sector, giving away permits to all power plants based on a fuel-specific benchmark encourages investment, increases output, and leads to a greater level of welfare from an imperfectly competitive industry.

1. Introduction

On 17 November 2009 the Korean Cabinet approved the 2020 target of reducing projected CO_2 emissions for 2020 by 30% from "Business-as-usual" (BAU) levels, or a 4% reduction from the 2005 level of 594.4 million tonnes of CO_2. The BAU emission projection for 2020 is estimated at 813 million tonnes. The government initially set a plan for a three-phase cap-and-trade scheme, with the first phase running for three years from 2013 to 2015, then the second phase starting in 2016 to run through 2020, and the last phase commencing from 2021. Over 300 of the largest companies emitting 60–70% of the nation's greenhouse gasses will be involved in the cap-and trade scheme. In the initial stage, 90% of emission allowances will be allocated to emitters free of charge. The remainder would be auctioned, with the proportion to be auctioned to increase over time after the first phase. In the final phase, all allowance will be auctioned.

However, the government decided in February 2011 to postpone emission trading, mainly due to opposition from industrial sectors. According to the revised bill, emission trading will be implemented in 2015. Besides, as vested interests' (carbon intensive industries) resistance increases, the bill would allow for a higher proportion of emission allowances to be handed for free to heavy emitters. Debates have been continuing over the amount of emission allowances to be given to specific sectors for free and handling new entrants.

This argument has also been observed in European Union Member States (MSs) since preparation for the European Union Emission Trading Scheme (EU-ETS) Phase (2005–2007). All MSs had to distribute their allowances to industrial installations for free: at least 95% of total allowances in the first ETS period and 90% in the second period. The vast majority of emission allowances have been distributed to existing emitters in proportion to their historical emissions, which is referred to as grandfathering.[1]

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[1] More precisely, we define grandfathering as the method of allocating emission allowances to existing emitters for free based on their historical emissions in a recent base period of specific years.

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Auctioning was an option for the remainder. This contradicts the economic perspective that advocates the auction (see Cramton and Kerr, 2002). Nevertheless, the grandfathering allocation has remained the dominant rule in most MSs because of political resistance and concerns such as adverse effects on industrial competitiveness.

After the first phase of EU-ETS, the effect of the free emission allowances to existing firms has been investigated empirically and the potential effects of other allocation options have been assessed by scholars. In particular, studies have paid attention to the electricity sector, since electricity has been considered a special sector which is able to determine the emission price. In fact, electricity is the largest sector in the ETS, as over 40% of total allowances in the ETS were distributed to the sector. Besides this, electricity was the only sector in a net short position over the initial period (Trotignon and Delbosc, 2008). This means that the situation of power generation determines overall demand for the allowances and would have a major impact on allowance prices. The long economic life of power plants also has a durable effect on the cost of achieving future emission targets.

Existing power plants were provided with allowances in most MSs based on historic emissions for the first phase of the EU-ETS. Historic emissions are calculated for a recent reference period within a fixed time frame or updated. Finally, adjustment factors such as expected growth and future compliance for reduction could be applied to the historic emission records.

Grandfathering has several advantages for introducing an emission trading policy; it reduces political resistance from carbon intensive industries as they are guaranteed sustainable profits under the regime (Åhman et al., 2007) and provides incentives for industries to report installations' past emissions at the same time. In fact, reasons to favor the historic emissions were that EU-MSs did not have enough time to build up a suitable benchmark, mainly because of difficulties for various sectors and legal issues at the beginning of the EU-ETS (Ellerman et al., 2010). On the other hand, most MSs applied the benchmark to new entrants from the first phase.

However, there has been a consensus that the free allocation, namely the historic emission approach, led to two main problems: 'windfall profits' and distortion of investment. Power companies gained substantial windfall profits from the grandfathered emission allowances. They could pass the opportunity costs of CO_2 in liberalized electricity markets, as economic studies demonstrate (Sijm et al., 2006), even though their monetary costs did not rise. Even worse, some allocation methods to new technology give the wrong signal to investment decisions. Generally, carbon intensive power plants such as coal receive more allocations than lower carbon technology such as gas, under the historic emission allocation. Therefore, the allocation distorts investment decisions towards carbon intensive technology. Considering fossil fuel power plants' life of decades and fixed allowance budgets, distorted investment decisions significantly increase the total cost of achieving the emission target in the future (Åhman and Holmgren, 2006; Neuhoff et al., 2006).

After the ETS phase 1, there was a tendency to gradually adopt benchmarks instead of the historic emission approach. Although the majority of MSs base their allocation method on historical emissions (for an overview of allocation provisions in all MSs, refer to Rogge and Linden, 2008), this movement recognizes the adverse effects on the economy mentioned before. This study defines the benchmark as a free allocation method to both existing and new entrants using a specific emission rate per unit output (e.g. tCO_2/MWh) combined with a unit capacity and actual or common operation time for installation. Glancing at the benchmark systems adopted in MSs for the second phase, they show different provisions. But the benchmarks could be divided into two main categories. Firstly, emission values based on the best available technology (BAT) or on average performance could be applied to a particular technology group, which is called the fuel-specific benchmark. Secondly, a single BAT emission value could be set for all plants, known as the uniform benchmark.

In general, compliance and strict emission factors under the benchmark improve energy efficiency compared to the historic emission approach, but the following criticism has been made regarding the fuel-specific benchmark: it often sets a higher emission factor for more carbon intensive power plant types, meaning that more emission allowances are provided to coal power plants than to gas power plants. As existing studies (Hepburn et al., 2006; Neuhoff et al., 2006) point out, this creates a bias towards more carbon intensive technology in terms of firms' operating and investment decisions. Consequently, it increases CO_2 emissions and drives up CO_2 prices. Finally, consumers face higher electricity prices,[2] reflecting the CO_2 prices in the long term.

In contrast, the uniform benchmark prevents the distortion problems in that all plants receive emission allowances equally. If the emission factor is based on low-carbon technology, gas fired power plants such as CCGT are a more attractive option for investment, so that effective abatement of CO_2 in the power sector for long periods can be accomplished. However, several European countries are vulnerable to the security of natural gas supplies, with concerns about their long-term availability and an increase in dependence on a few countries. For this reason, the uniform benchmark to new entrants has been avoided in several MSs (typically, Germany) where coal-fired plants account for the majority of the power mix. These various allocation provisions in MSs will be harmonized in the third phase (European Parliament and Council, 2009).

The Korean government is at the point where it needs to decide initial allocation methods. However, there have been few attempts to investigate the impact of the allocation plans on the Korean electricity sector so far, even though the sector is the largest source of emissions. The electricity sector is expected to play a major role in deciding the emission price.

Therefore, the purpose of this study is to assess the effect of initial allocation methods consisting of full auction, the fuel-specific benchmark, and the uniform BAT benchmark for existing and new entrants on social welfare in order to draw a reasonable political implication.

In order to do this, this paper employs a mixed complementarity problem (MCP) model which is able to incorporate operation and investment decisions, taking account of capacity and emission constraints under different allocation scenarios in the competitive electricity market. In particular, the model is designed to allow endogenous investment decisions subject to different allocation rules to new entrants, which has a contribution to the existing literature. The main outcomes from the model consist of capacity mix, electricity prices, emission prices, and social welfare, under the allocation scenarios. We found that firms invest more with the fuel-specific benchmark than with auctioning, and though the cost of emissions reduction is higher, the extra investment (which had been below socially optimal levels) means that social welfare actually rises.

The remainder of this study is organized as follows. Next section explains how the emission trading market reacts to different allocation method. Section three overviews the MCP framework and describes the full model of this study. In section four, we apply the MCP model to the Korean electricity market. Section five compares the results of the electricity sector's emissions, total new investment capacity, emission allowance prices, electricity prices, and social welfare for all allocation scenarios. The final section concludes.

2. Theory

Panel A in Fig. 1 depicts how the permit price is determined under different emission permit allocation methods to existing power plants in the emission trading system. Let us assume that there are two players in the emission trading market: an aggregated electricity sector and non-electricity sector. The marginal abatement cost (MAC) curves of

[2] This would hold unless the allocation of permits to new plants leads to a large increase in capacity.