Short Summary of Paper and Results

The Price of Emissions Permits under Market and Regulatory Uncertainty

by

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Abstract

In this paper, we explore the effects of uncertainty on pricing of pollution permits. We consider two major sources of uncertainty – that arising from the volatility of demand for the underlying resource (e.g. electricity) and that coming from the regulatory environment. Both sources of uncertainty are common in pollution permit trading as not only does the market respond to the volatility of fundamentals but also to the vagaries of the institutional structure, created by public policy and enforced through regulation. The paper shows that even in the presence of strategic behavior on the part of the agents involved, the trading of permits effectively reduces emissions, and pricing does reflect opportunity costs and environmental objectives. Firms that are more efficient in reducing their emissions gain greater market share. Furthermore, and somewhat paradoxically, the higher uncertainty, the greater the impact of regulation.

Introduction

Pollution permits and trading are becoming increasing important as a market friendly instrument to control pollution at lower costs. Although such schemes have had their birth with sulfur dioxide trading in the United States, they really did not hit international prominence until the Kyoto Protocol came into force. By building into Protocol carbon emission trading and with the emergence of the European Trading System (ETS), pollution trading became a multi-billion dollar market. Despite their growth, the economics underlying these pollution markets are not well understood.

Although it is assumed that these markets promote least cost means of meeting targets on carbon emissions, the economics of pricing of permits and penalties are not well understood, along with a host of other issues associated with important policy decisions, including regulatory uncertainty. Because the markets for an externality such as pollution are essentially artificial markets, created by legislation, an additional form of uncertainty is added to the normal randomness of prices: the vagaries of regulatory enforcement. This regulatory uncertainty is quite evident in the carbon emissions trading of the Clean Development Mechanism (CDM) of the Kyoto Protocol and under the ETS where over 12,000 installations must be monitored and comply under the threat of fines and ultimately enforcement is by a combination of fines and litigation against a sovereign nation.

Policies to achieve environmental quality have particular importance as the challenge of mitigating climate change and reducing emissions has taken on currency. Two instruments have received particular support from economists: marketable permits and emission taxes or charges (Pigou, 1920 and 1932; Crocker, 1966; Dales, 1968; Montgomery,1972;Kneese and Schultze, 1975). In theory, pollution taxes or tradeable permits will minimize the costs of achieving a targeted level of pollution (Baumol and Oates, 1988). It will also provide incentives for adoption and diffusion of new and cheaper technologies (Milliman and Prince, 1989).

Analysis of these regulatory instruments under uncertainty has invoked the use of real options analysis where volatility and decision making are collapsed into a option value. This real options approach has been used to determine the value of flexibility or exit and the timing of capital investments of a regulated firm under uncertainty (Teisberg, 1994), finding that investments of utilities will be delayed when there is asymmetry between profits and losses due to regulation. Using real options valuation, it has been also found that a major reason US electrical utilities delay the decision to invest is to gather more information on regulatory restructuring (Ishii and Yan, 2004).

In this paper, we use a real options approach to examine strategic behavior under two sources of dynamic uncertainty: market or demand uncertainty and regulatory uncertainty. These uncertainties have particular relevance to the design of emissions trading permits under cap and trade systems as is currently in operation for carbon in the EU Emissions Trading

System (ETS) and potentially for a United States's system under policy discussion by states and the federal government.

Under the Kyoto Protocol and the Marrakesh Accords, three forms of emissions trading were permitted:

1. The trading of Certified Emission Reductions (CERs) under the CDM;
2. The trading of Emission Reduction Units ERUs) under the Joint Implementation mechanism; and
3. The trading of Assigned Amount Units (AAUs) under International Emissions Trading.

Each one of these mechanisms for carbon trading face high regulatory uncertainty. The CDM as the regulations are enforced by a semi-political CDM Executive Board which has made inconsistent decisions and later reversed others. With each change the market has responded with a major variation in prices. Furthermore the Executive Board has relied on Designated Operating Entities (DOEs) to enforce the regulations and standards set by the EB. Since the DOEs are private, standards of validation and verification differ between DOEs. A project developer may find that depending on the particular DOE, even though certified by the EB, a different intensity of enforcement.

The other two markets face similar regulatory uncertainty but of different forms. The ERUs in JI market depends on a supervisory body similar to the EB of yet unknown dimensions and rigor. The market for AAUs while in theory the simplest, depending only on governments to trade a relatively known instrument, has the uncertainty of not only how many AAUs does a country actually possess but also on the political demand by buying countries that the AAUs be greened, that is associated with some other environmental investment scheme of unknown dimensions and rules. These regulatory uncertainties are coupled with the normal market drivers of carbon, e.g. energy prices, industrial activity, economic growth etc.

All these uncertainties are focused on the ETS market which accepts for compliance purposes EUAs, CERs, ERUs and indirectly AAUs. The rules of this market are administered by the European Commission (EC) and depend on the allocation of EUAs to the market and which industries will

fall under the ETS and which will not. Furthermore, when there is a miscalculation as with the May 2006 collapse of price of EUAs of 2006 vintage because of an overallocation of EUAs, politics quickly emerges to try and adjust enforcement or standards.

Enforcement mechanisms on industries which receive the EUAs also are uncertain. The EC has the weapon to enforce compliance but only at the national level through the European Court of Justice where fines can be imposed on member states for non-compliance with EC regulations. However the process is laborious, usually taking many years and with uncertain results both on rulings and penalties. At the national level, each EU government finds its own means of enforcement at the industry or entity level. This uncertainty creates a gamesmanship between the EC, the EU states and the industries that eventually have to face the imposition of regulation and possible fines. Furthermore the EC must pursue its enforcement in a political environment and sometimes without the complete capacity to deal with all the legal filings, documentation and defenses.

Finally, the master stroke of uncertainty is no one knows for sure if the markets will continue and if they do, what form they are likely to take. The Kyoto Protocol expires in 2012 and the EC has not announced the 2008 allocations or coverage. Meanwhile trading of all these carbon emissions is taking place at a frenzy pace, and with a great deal of fluctuations in prices. The World Bank reports that trading of all Kyoto instruments has exceeded $20 billion in 2006.

To model such a market in any detail would create such a black box that analytic light is unlikely to emerge. Instead our purpose in the paper is to explore in simple abstract models how regulatory uncertainty could affect the market and prices of permits. Even though several authors have offered a basic treatment (Field 1997, Kahn 1998 Tietenberg 2000, Weber 2002), economic and regulatory issues behind the properties and use of these innovative market instruments still need to be explored, particularly when markets are dynamic and the fundamental drivers are themselves uncertain.

In order to approach the problem gradually, we present a model that focuses on the link between pollution abatement penalties and demand and supply of permits when market demand is stochastic and regulation is uncertain. Trading permits under uncertainty allows firms to behave strategically, by optimally deciding when to exercise opportunities and

managing threats of penalties from regulators. From the policy perspective, this approach to pollution trading under uncertainty brings forth the effect of a pollution penalty on the market for permits and on the price of output, how the transaction costs of the regulator affect the price of permits, and how increased level of uncertainty in general affects the market.

In doing this, we are not attempting to model exactly the complexity of any single market such as the ETS but to build an approximation of permit trading markets under regulation that yields insight into the effect of various policy parameters on the market for permits and output. In this respect, we abstract from some of the regulatory complexities, including quantitative restrictions on the importing from secondary markets such as the CDM while giving the regulator more flexibility in the timing of the imposition of the fine. We model the behavior of the regulator as an agent that extracts penalties on firms that exceed their allowances supplemented by market purchased permits but does so only when it is able to cover the transaction costs of enforcement and when the violation is not caused by a transitory increase in output demand of the firm. On the industry side, the firm knows that the regulator will not attack at any violation but only when they suspect that the violation is more permanent, in a sense, imbedded into the fundamentals of the firm and market. But the firm does not know how the demand for output will emerge over the future and may find itself in the position of polluting beyond its allowances and be forced into the market for permits when their prices are high to avoid the imposition by the regulator of penalties. On the other hand, it may find that demand for its output has fallen and that it is in a position to sell to the market excess allowance. In a dynamic market and regulatory regime, the firm has to decide whether to be short or long in permits and by how much to buffer against the uncertainty of the market and the behavior of the regulator. In turn, the policymaker has to decide what penalties to impose on violations and how overall allocation of permits will affect the industry and the price of output.

Results of Paper

The dynamic uncertainty inherent in pollution permit markets and the strategic decision-making that is demanded of participants in the market both on the part of firms and the regulator create market behavior that is not evident from simple static models of supply and demand. As we have shown in the paper using a real options model operating under dynamic uncertainty, the effect of regulation on permit pricing is not straightforward.

The regulator operating also under uncertainty has two instruments at its disposal: the rate of the fine and the timing of the imposition of the fine. The firm on the other hand has several instruments: the amount of output or market share, the amount of pollution permits it secures from the market and the efficiency by which it uses technology to reduce polluting emissions.

We have found that under uncertainty the combination of the threat of the sanction and the market for permits may be effective in reducing the emission levels by shifting the competitive advantage in favor of less polluting firms. This will occur both because of the reduction of firm value to the potential imposition of the sanctions and because less polluting firms will be able to sell part or all of their allowances to the more polluting ones. Uncertainty, however, tends to reduce the value of the market price of permits, since in equilibrium this is simply equal to the expected present value of the fine. Thus, higher uncertainty will require, for the regulation to be effective, comparatively higher fines.

Even under uncertainty of regulation and demand for output, the effect of pollution permit trading is positive to achieving a cleaner industrial base. Firms that are more technologically efficient in reducing pollution will tend to acquire larger market shares, with the exact effect depending on the uncertainty of demand for output and the severity of the fine.

Using this type of real options approach, we believe that avenues of research are open. For example, through relatively simple analytic models other issues with respect to permit trading can be explored, for example, the effect on new entry into the market – when will new firms with cleaner technologies enter the market when demand is uncertain and the behavior of the regulator uncertain. We will explore this issues and others in later papers.

Figure 1
Equilibrium price (Euro/ton) of Permitsunder alternative hypotheses on uncertainty and Compliance targets (fine value $\gamma = 100 Euro/ton$).