Course 603 (Environmental Economics)

Summer Semester 2016

Lecture Notes on Emissions Trading

A la Montgomery, aka WDM (*JET* 1972), looking at two types of tradable permits……..(also see Krupnick et al., *JEEM 1983)*

A. Ambient Permit System (APS)

q_j^* permits issued (defined in terms of allowable increase in pollution at j) at each receptor point, such that $\sum_i e_i d_{ij} \leq q_j^*$. This would effectively create a separate market corresponding to each receptor. Each source/firm needs to buy a "portfolio" of permits from the various receptor markets at which its emissions have an impact on air quality. Specifically, firm *i* would need $e_i d_{ij}$ permits from j[th] receptor mkt (if $d_{ij} \neq 0$).

Note

(i) We are not talking here about emissions of a firm but about the effect of these emissions on levels of pollution at a particular point in space or location (i.e., receptor).

(ii) Permits will not trade on a 1-to-1 basis – a source whose emissions per unit are more damaging to a particular receptor will have to purchase commensurately more permits from another source whose discharges contribute less per unit to pollutant concentrations at that receptor point.

B. Emission Permit Scheme (EPS)

Permits are defined in terms of levels of emissions rather than in terms of the effects of these emissions on ambient air quality. "An emission license (aka permit) confers on the firm holding it the right to emit pollutants at a certain rate." (WDM p.411).

There are two variants to this:

(i) Region divided into emission zones. Within each zone firms trade permits to emit on a 1-to-1 basis (that is, within each emission zone emissions of a particular pollutant are treated as equivalent). The environmental authority/regulator (e.g., CPCB/SPCB) determines an allocation of permits for each zone, and sources within the zone trade permits on a 1-to-1 basis. No trades across zones (this restriction could be relaxed--trading across zones could be made possible at "exchange rates" set by CPCB to reflect damage due to emissions from the various zones). Thus, each zone is a self-contained market where price is determined by demand for permits and supply by CPCB. Regardless of the number of zones each source lies only in a single zone and will thus operate in only one permit market.

Problem: EPS may not achieve least-cost solution. Why?

(1) since sources with different d_{ij} are aggregated into one zone, 1-to-1 trades will not reflect differences in concentration at receptors due to their emissions (i.e., price of emissions to each polluter will not reflect accurately the shadow price of the binding pollution constraint). In addition, beneficial trades across zones prevented. (Solution: ↑number of zones to reduce dispersion in d_{ij}; *if* d_{ij} not very different within a zone, problem not very serious but then you may get a 'thin' market.)

(2) Even if we assume there is no difference in d_{ij} within each zone, CPCB must still determine an allocation of permits for each zone. This requires the complete solution by CPCB of the cost-minimization problem. That is, it should not only know the D matrix and the E vector (emissions inventory) but also $C(e_i)$ for all i--with all this information, though, a market may hardly be necessary! (see KOV footnote 8)

Variant (ii) of EPS a la Montgomery

Right to emit pollutants at a certain rate. No zoning or 1-to-1 trade. Rule governing trading – firm "allowed to emit up to a level which causes pollution equal to that which would be caused if each firm from which it obtained rights emitted to the maximum extent permitted by the rights which it has given up." (WDM p. 411) [We must differentiate rights to emit by the location at which they allow emissions to occur] Thus, $L_k \quad (k = 1, ..., n)$ is the quantity of licenses to emit at location k and l_{ik} = quantity of licenses allowing emissions at location *k* held by firm $i \Rightarrow \sum_i l_{ik} = L_k$.

Under APS if firms are cost-minimisers, trading equilibrium = least cost solution i.e., the E vector and shadow prices that emerge under the least cost solution satisfy the same set of conditions as do the vector of emissions and permit prices for a competitive equilibrium in the permits market.

Firm's problem:

$$\begin{Bmatrix} \min \\ e_i l_{ij} \end{Bmatrix} \quad c_i(e_i) + \sum_j \rho_d \left(l_{ij} - l_{ij}\right) \quad or \quad \max - c_i(.) - \sum \rho_j \left(l_{ij} - l_{ij}^o\right)$$

$$\text{subject to } e_i d_{ij} \le l_{ij} \qquad \forall \quad j = 1, ..., m$$

$$L = -C_i(C_i) - \sum_d P_j \left(l_{ij} - l_{ij}^o\right) + \sum_j n_j \left(L_{ij} - e_i d_{ij}\right)$$

$$\frac{\partial L}{\partial e_i} \le 0 \Rightarrow -C_i' - \sum_d \eta_j d_{ij} \le 0 \qquad (1)'$$

[To be completed]