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Emissions trading of global and local pollutants, pollution havens and free riding

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ABSTRACT

In the presence of local (sulfur) and global (carbon) pollutants, we examine the pollution haven hypothesis and free riding behavior. Under domestic emissions trading, poorer Southern countries become pollution havens when free trade opens up whenever sulfur damage functions are linear or when sulfur levels in equilibrium are not higher in the South. With global trading of carbon permits, the pollution haven effect emerges in equilibrium whenever the convex sulfur damage functions are nonlinear. Countries that do not participate in a Global Protocol designed to reduce carbon emissions enjoy double benefits, stemming from free riding and cleaner local environments.

1. Introduction

The "pollution haven hypothesis" (PHH) predicts that poor countries with lax environmental regulations can become pollution havens as polluting industries migrate to these countries from rich countries with stringent pollution standards.[1] To date, the theory behind the pollution haven hypothesis has focused on one type of pollutant, either a global [6,9] or a local one [5,7], but not both.

In reality, many polluting industries generate multiple pollutants that create global as well as local environmental problems. A typical example is the use of fossil fuels in energy-intensive industries, such as cement, glass, ceramics, paper and pulp, and metal-casting industries. The combustion of fossil fuels not only generates greenhouse gases such as carbon dioxide, methane and nitrous oxide, but also generates air pollutants with more localized effects, such as sulfur dioxide, volatile organic compounds and particulate matter.[2] While local pollutants are subject to domestic environmental

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[1] Taylor [22] reviews recent theoretical studies of the PHH. The review includes papers that consider problems arising with information asymmetry [23], factor mobility [12], strategic technology adoption [20], among others. Michida and Nishikimi [19] extend [5] to consider industry-specific pollutants. See [2,8,10,14,18] for recent empirical contributions.

[2] Due to the growing scientific knowledge about the close linkage between global and local pollutants, economists studying problems other than pollution havens have increasingly treated the two types of pollutants in an integrated manner. For example, Ref. [4] propose a global mechanism to efficiently control both pollutants. Ref. [13] provide a review of recent quantitative researches on the co-benefits of joint greenhouse gas and air pollution policies.

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regulations, global pollutants may be regulated through domestically administered regimes (e.g., national carbon taxes or domestic carbon emission permit markets) or, through certain international arrangement. With the entry into force of the Kyoto Protocol, international efforts are being made to set up a global carbon dioxide emission permit market to reduce greenhouse gas emissions. An important question yet to be addressed by the literature is: does a pollution-intensive industry obey the PHH if it generates multiple pollutants leading to negative global and local externalities, taking into account the impacts of different global pollution control mechanisms?

Ignoring either type of pollutant does not produce a sufficient framework to check the PHH. One of the main motivations of the current paper is to answer the question above by exploring pollution-intensive trade flows when the dirty industry faces regulations of both global and local pollutants. For this purpose, we introduce a global pollutant into the pollution haven framework of Copeland and Taylor [7] and establish a North–South trade model where the production of the dirty good releases emissions of a global pollutant – carbon dioxide—and of a local pollutant – sulfur dioxide.

We show that if pollutants are controlled through the creation of domestic permit markets, the conventional logic of the PHH goes through whenever the sulfur damage functions are linear. Allowing international carbon dioxide emissions trading with global participation equalizes carbon permit prices across countries. This eliminates the pollution haven effect for an industry generating only carbon dioxide emissions [6, pp. 727]. If the dirty industry also generates sulfur emissions and the sulfur damage functions are linear, sulfur permit prices are also equalized across nations. Similar to the single global pollutant case, the pollution haven effect disappears because there is no difference in the stringency of Northern and Southern environmental policies. If instead, the convex sulfur damage functions are nonlinear, the pollution haven effect is present in equilibrium. It results from higher sulfur permit prices in the North.

Less ideally, as suggested by the current state of the Kyoto Protocol, international carbon dioxide emissions trading may not feature global participation. An immediate implication is that the carbon emission abatement efforts made by the Kyoto signatories may be ineffective if non-participating countries respond by increasing their carbon emissions, with the overall increase offsetting the reduction promoted by the coalition of Kyoto countries. The economic literature has analyzed how carbon emission cutbacks in the Kyoto countries may increase carbon emissions in non-participating countries due to the free riding effect, changes in the prices of fossil fuels, or changes in the prices of energy-intensive goods [1,9,15]. Our focus in this paper, however, will be the free riding effect [9,16], which occurs with fixed world prices. Free riding behavior originates from strictly convex environment damage functions.

We show that nations that do not participate in a Global Protocol that attempts to reduce carbon emissions will emit more carbon dioxide in response to carbon emission mitigation of Global Protocol nations. However, another important yet unexplored aspect of the impacts of free riding is how the nations' local environmental quality is affected. Our investigation suggests stronger free riding incentives if local environmental quality is accounted for. By emitting more carbon dioxide, any non-participating country would have a higher level of income, which leads the government in that country to tighten local environmental policy and issue fewer sulfur permits. Hence, non-participants enjoy double benefits by staying out of the Global Protocol: free ride on global pollution reduction efforts with the benefit of a cleaner local environment. The scenario in every Global Protocol nation is opposite: they spend more resources to reduce carbon emissions and suffer from deteriorating local environments due to increases in sulfur emissions.

2. The model

We consider a world economy consisting of two regions, North and South, each of which consists of n identical countries, where n is large. The regions differ only in their endowments of inelastically supplied primary factors, capital and labor. Each Southern country has K^* units of capital and L^* units of labor.[3] A Northern country's endowment is larger than that of a Southern country by a factor of λ with $\lambda > 1$, i.e., $K = \lambda K^*$, $L = \lambda L^*$.

We assume that a country produces two good, X and Y. Good X generates pollution during its production, but good Y does not. We also assume that the polluting sector is capital intensive and the clean sector is labor intensive. For any set of capital and labor prices, r and w, respectively, the capital/labor ratio in the dirty sector is higher than that in the clean sector: $(K_X/L_X) > (K_Y/L_Y)$. We treat the clean good as the numeraire and denote the relative price of the dirty good by p. Both goods are produced under constant returns to scale. The production functions for the clean and dirty goods are $Y = H(K_Y, L_Y)$ and $X = F(K_X, L_X)$, respectively. We assume that both production functions are increasing, concave and exhibit decreasing marginal products.

Production of the dirty good generates carbon dioxide and sulfur dioxide emissions. Carbon dioxide emissions produce global damages. Sulfur dioxide emissions produce local damages. Let Z_C and Z_S denote the amounts of carbon dioxide and sulfur dioxide emitted, respectively. Without abatement, each unit of output generates one unit of each type of emissions. Nevertheless, firms can allocate endogenous fractions θ_C and θ_S of their inputs to the abatement of carbon and sulfur emissions, respectively. We assume that abatement technologies are separable, exhibit constant returns to scale and use the same factor intensity as the production of the dirty good.[4] These assumptions allow us to write emission functions as

[3] Southern variables are indicated by an asterisk.

[4] If abatement technologies are separable, firms' abatement decisions do not depend on the relative price of the emission permits of the two pollutants. There in fact exist synergies and tradeoffs between the technical measures controlling the emissions of the global and the local pollutants.