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Optimal emission pricing in the presence of international spillovers: Decomposing leakage and terms-of-trade motives

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ABSTRACT

Carbon leakage provides an efficiency argument for differentiated emission prices in favor of emission-intensive and trade-exposed sectors under unilateral climate policy. However, differential emission pricing can be used as a beggar-thy-neighbor policy to exploit terms of trade. Adopting an optimal tax framework, we propose a method to decompose the leakage and terms-of-trade motives for emission price differentiation. We employ our method for the quantitative impact assessment of unilateral climate policy based on empirical data. We find that the leakage motive yields only small efficiency gains compared to uniform emission pricing. Likewise, the terms-of-trade motive has rather limited potential for strategic burden shifting. We conclude that in many cases the simple first-best rule of uniform emission pricing remains a practical guideline for unilateral climate policy design.

1. Introduction

Non-differential pricing of uniformly dispersed pollutants across all sources constitutes a first-best strategy to meet an emission reduction target implemented via harmonized emission taxes or likewise a system of tradable emission quotas. The marginal cost of emitting a given pollutant should be the same so that the economy as a whole will employ the cheapest abatement options.

However, incomplete regulatory coverage of emission sources provides an efficiency rationale for emission price differentiation across sectors. When unilateral emission regulation aims at combating international externalities, such as global warming, global cost-effectiveness of unilateral action can be hampered through the relocation of emissions to countries without emission regulation—so-called emission leakage (Hoel, 1991; Felder and Rutherford, 1993). There are two major intertwined channels for leakage. The fossil-fuel-price channel refers to increased energy consumption in non-regulated countries as reduced energy demand of emission-constrained countries depresses international fuel prices. The competitiveness channel refers to shifts in comparative advantage for emission-intensive and trade-exposed (EITE) industries. EITE sectors in regulated countries are put at a cost disadvantage vis-à-vis competitors abroad—domestic EITE production declines along with decreasing exports and increased imports from non-regulated countries.

In order to reduce leakage and improve global cost-effectiveness, unilateral emission regulation should complement uniform emission pricing with tariffs on traded goods—as a tax or subsidy on net imports or net exports (Markusen, 1975; Hoel, 1991). In the climate policy debate, this theoretical finding is reflected in proposals for border carbon adjustments where emissions embodied in imports from non-regulated countries are taxed at the emission price of the regulating country and emission payments for exports to non-regulated countries are rebated. The applied economic literature (see Böhringer et al., 2012 for a comprehensive model comparison study) finds that while border carbon adjustment can effectively reduce leakage and ameliorate excessively adverse impacts for EITE industries in regulated countries, the scope for global cost savings is small. The reasoning behind this is that import tariffs levied at the industry-average of embodied carbon do not provide direct abatement incentives for foreign producers.

If border adjustments are not available, perhaps due to legal, administrative or political barriers, Hoel (1991) shows that differential emission pricing across domestic sectors constitutes a second-best strategy to cope with international spillover effects. As a matter of fact, emission taxation schemes in many OECD countries involve a differentiation of tax rates among sectors where tax rates are typically differentiated

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in favor of EITE industries, including complete tax exemptions (OECD, 2007). While differential emission pricing may be justified as a second-best strategy to reduce leakage and improve global cost-effectiveness of unilateral climate policy, the fundamental problem is that price differentiation can be strategically used to exploit terms of trade. Open economies may be tempted to differentiate emission prices as a substitute for optimal tariffs shifting the domestic emission abatement burden as much as possible to unregulated trading partners. The terms-of-trade motive induces countries to increase domestic emission taxes on “dirty” commodities which are exported and lower taxes on “dirty” commodities which are imported (Krutilla, 1991; Anderson, 1992).

The challenge for an informed policy debate on emission price differentiation is that the leakage and terms-of-trade motives are inherently intertwined. It is not obvious to what extent emission price differentiation can be justified on global efficiency grounds to combat leakage or should be disguised as selfish strategy to manipulate terms of trade. Likewise, a domestic regulator may want to sort out the pure leakage motive for differential emission pricing in negotiations with representatives of influential EITE industries that lobby for preferential treatment at the expense of other sectors in the domestic economy.

In this paper we present an analytical optimal tax framework that decomposes the leakage and terms-of-trade motives for differential emission pricing. We then incorporate the decomposition method in a computable general equilibrium model to investigate the relative importance of the leakage and the terms-of-trade motives for the direction and magnitude of emission price differentiation based on empirical data. Furthermore, the numerical analysis permits us to assess the magnitude of global cost savings as well as the scope of shifting the burden through differential emission pricing compared to uniform emission pricing. We find that while leakage concerns may justify distinct emission price discrimination in favor of EITE industries, the infra-marginal global cost savings are very small. Emission price differentiation (including exemptions) is a very indirect and thus weak instrument to reach out to foreign emissions. At the same time, the efficiency gains from leakage reduction trade off with higher direct abatement cost due to diverging marginal abatement cost across domestic emission sources. Our quantitative results also show that the potential for exploiting terms of trade through differential emission pricing is very limited when unilateral action must comply with a global emission reduction target, i.e., the need for cuts in global fossil fuel demand. The distributional impacts of unilateral action through terms-of-trade effects are then predominantly driven by changes in international fossil fuel prices which are robust to alternative unilateral emission pricing strategies. We conclude that uniform emission pricing remains a practical guideline for unilateral climate policy design.

The remainder of this paper is organized as follows. Section 2 presents the basic theoretical framework underlying our decomposition of the leakage and the terms-of-trade motives for emission price differentiation. Section 3 entails a non-technical overview of the computable general equilibrium model and discusses our numerical findings. Section 4 concludes.

2. Theoretical background

Leakage and terms-of-trade effects provide theoretical arguments for emission price differentiation across domestic sectors of a unilaterally regulating country. Both effects are intertwined. Emission constraints in an open economy not only cause adjustments of domestic production and consumption patterns but also influence international prices, i.e., the terms of trade, via changes in trade flows. Simultaneously, leakage occurs with changes in relative prices as emission reductions in the regulating country are partially offset through an increase in emission-intensive production and energy demands in unregulated countries. A rigorous assessment of the relative importance of the leakage and the terms-of-trade motives for differential emission pricing requires a decomposition of these international spillover effects. Our decomposition method is based on the idea that the unilateral abating country must compensate other countries for induced terms-of-trade losses and thus will no longer have an incentive for strategic terms-of-trade manipulation.

In this section we present an analytical framework to illustrate our decomposition technique which will be used later in the empirical general equilibrium analysis. We start with a stylized two-region, multi-commodity economy where we first derive a Pareto-optimal allocation to satisfy a transboundary emission constraint. We show that any unilateral emission tax (price) by one country cannot achieve efficiency as long as transboundary pollution is taken into account. Next, we derive the first-order conditions for optimal unilateral emission policies from the perspective of a large open economy where the domestic regulator might want to deviate from uniform emission pricing for two reasons: the terms-of-trade motive and the leakage motive. We then show that we can suppress the terms-of-trade motive by demanding that the unilaterally taxing region must keep the other regions at the initial welfare level through compensating transfers. While the general finding on differential emission pricing is comparable with Hoel's seminal contribution (Hoel, 1996), our analytical setting allows for an innovative and policy-relevant decomposition of the terms-of-trade and leakage motives.

2.1. The basic model

We consider a simple two country model (regions $r = 1, 2$) in which consumption goods $i = 1, \ldots, n$ are produced with capital k^{ir} and energy (emissions) e^{ir}. Energy is produced in the countries with capital k^{er}. Production in sector $i = 1, \ldots, n$ (y^{ir}) and the energy sector (y^{er}) are characterized by production functions

$$y^{ir} = f^{ir}\left(k^{ir}, e^{ir}\right) \qquad y^{er} = f^{er}\left(k^{er}\right).$$

For ease of exposition, we assume that capital k^r in each region is immobile across domestic borders such that $k^{er} + \sum_{i=1}^{n} k^{ir} = k^r$.

Energy as well as the produced consumption goods can be traded internationally. Total energy use e^r in the respective countries is denoted by

$$\sum_{i=1}^{n} e^{ir} = e^r$$

such that market clearance requires

$$e^1 + e^2 = y^{e1} + y^{e2}.$$

We assume a representative consumer in country r who derives utility

$$u^r = U^r\left(c^r\right)$$

from consuming goods, $c^{ir}(i = 1, \ldots, n)$. The representative consumer receives all income. Energy and consumption goods are traded at world market prices p_e and p_y. We use energy as a numeraire on the world market, i.e., $p_e = 1$.

Finally, market clearance for consumption goods requires

$$c^{i1} + c^{i2} = y^{i1} + y^{i2}$$

and the balance of payments (current accounts) is warranted through

$$0 = p_y\left(y^r - c^r\right) + \underbrace{p_e}_{=1}\left(y^{er} - e^r\right) - Tr^r$$