Energy Economics 48 (2015) 70–80

Contents lists available at ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneco

Environmental taxes and international spillovers: The case of a small open economy[☆]

Muhammad Shahid Siddiqui

Department of Economics, University of Ottawa, Social Sciences Building, 120, University, Ottawa, Ontario K1N 6N5, Canada

ARTICLE INFO

Article history:
Received 22 May 2012
Received in revised form 16 December 2014
Accepted 17 December 2014
Available online 26 December 2014

JEL classification:
D58
D62
F18
H23

Keywords:
Small open economy
Externality
Efficiency cost
Abatement cost
Border tax adjustment
Free emissions allocations

ABSTRACT

In the existence of trade interaction, a sub-global climate change policy can generate externality, which can cause competitiveness issues for the producers in compliant regimes. However among compliant regions, a small economy also receives a significant *spillins* effect when a large economy takes some regulatory actions that affect, particularly, the world prices of traded commodities. This externality can have notable impacts on the efficiency and pollution abatement opportunities of the small compliant regime with a trivial converse effect. In some cases, these impacts on the efficiency and emissions abatement can be in opposite directions. We capture these findings by incorporating two protection polices (i.e., border tax adjustment and free emissions allocations to emission-intensive and trade exposed industries) in a multi-region analytical and numerical general equilibrium modeling framework. These results convey that the large economies hold leading strategic positions towards a cooperative global climate change movement because of their policies' influences on the small economies.

1. Introduction

This paper investigates spillovers effects in a situation in which two regions implement mutually exclusive environmental policies while they differ in their size. The only interaction that they have is through international trade. Given the fact that the size of economy matters (e.g., see Kennan and Riezman, 1988), it evokes that the large economy is able to shift part of its policy-induced economic burden to the small economy while the vice-versa effect is trivial. Moreover, if the large economy decides to protect its producers through some interior or border measures, then the small economy receives a significant *spillins* effect,[1] even though the large economy does not directly impose the protection policy to the small region.

Understanding the direction and the strength of such *spillins* effect on the small region seems an interesting research topic. Surprisingly, the issue of such spillovers within the context of small and large environmentally regulated open economies has received little attention by researchers; nonetheless the idea of spillovers in other contexts is well covered.[2] Williams (1966) indicates that the decisions of a jurisdiction, in a multi-jurisdictional framework, affect and are affected by the decisions of others. These spillovers (they are created by either economic interaction, fiscal interdependence, or resource mobility) are so complex which makes it difficult to predict a priori whether the spillovers will be positive or negative (see Brainard and Dolbear, 1967; Hirsch and Marcus, 1969; Williams, 1966).

To investigate Williams's (1966) argument within an environmental perspective, we apply environmental regulations in a small region and a large region; and allow the latter one to implement either border tax adjustment (BTA) or free emissions allocations to its emission-intensive and trade-exposed (EITE) industries.[3] While considering only trade as

☆ I would like to thank an anonymous referee for the useful and constructive comments and suggestions on an earlier version of this paper.
E-mail address: msidd062@uottawa.ca.

[1] Williams (1966) refers to "*spillins*" as imports of benefits or costs to a community from a service provided elsewhere.

[2] Grossman and Helpman (1991) show that knowledge spillovers, from abroad, affect the economic growth of a small country. Krutilla (1991) examines the impact of environmental regulations on a large economy's terms of trade. Contrary to Krutilla (1991), this paper focuses on the issues relevant to a small country, which implements an environmental regulation in an open economy context. Bohringer and Rutherford (2002) consider a region alternatively as a small and a large economy. Later they estimate the differences in welfare under the two cases to demonstrate the terms of trade effects.

[3] Environment-induced BTA policy has been discussed in several papers (see Dissou and Siddiqui, 2013; Fischer and Fox, 2011; Monjon and Quirion, 2011). Similarly, free emissions allocations to major EITE sector options have been implemented in Phases I and II of the European Union Emissions Trading System (see Betz and Sato, 2006) and also has been considered in the U.S. H.R.7146 bill.

http://dx.doi.org/10.1016/j.eneco.2014.12.007
0140-9883/

a source of interaction between the two regions, the large economy has an advantage over the small one; because a protection policy implemented by the former region particularly affects the world prices of traded commodities. This effect transmits to other trading countries through demand and supply channels and thus generates an externality. On the demand-side, a change in the world relative prices of polluted goods, for instance, affects the efficiency level of the small country. On the supply-side, a change in the world relative prices influences industries' decisions of emissions abatement in the small country. Hence, these channels indicate that not only the efficiency but also the emissions abatement of a small region is sensitive to a policy imposed by the large economy.

The novelty is that the effects on efficiency and abatement opportunities in the small region can significantly be in opposite directions depending on how a policy in the large economy affects world relative prices. Using an analytical and a numerical general equilibrium framework, we find that an environmental regulation imposed by the large economy has *spillins* effect to the small economy. If the regulation is accompanied by a BTA policy, it turns into positive spillovers to the small region. In contrast, if the regulation is accompanied by free emissions allocations, it shows deeper negative spillovers to the small regime. We are not aware of any study that investigates international spillovers along the line of mutually exclusive environmental and protection policies in a small and a large economy framework. Copeland and Taylor (2005) discuss the impact of emissions reductions in a North–South framework. In their analysis North is an emissions binding region while South is a non-binding as well as a price-taker. They further decompose North into East and West regions. However, they do not distinguish between the sizes of the East and West economies, while this differentiation is the core of our analysis.

To develop an environmental segment in the model, we adopt an approach similar to that of Hoel (1994) and Fullerton and Heutel (2007).[4] Particularly, we argue that polluting industries are more capital intensive than other industries (see Antweiler et al., 2001; Hettige et al., 1992). Hence, pollution control policies can harm the remuneration of capital more than that of labor. Therefore, when a region imposes an environmental regulation to its producers and consumers, this causes the post-regulatory demand for domestic clean goods as well as imported polluted goods to increase. However, the supply of such goods will increase only if their relative prices increase. Since the small economy has trivial effects on the world relative prices, it will incur efficiency losses as long as the transformation curve between domestic and imported goods is strictly concave.

The rest of the paper is organized as follows: Section 2 discusses an analytical model which covers economic and environmental contents in an open economy context. Section 3 develops a multi-sector and multi-region static general equilibrium model to assess some empirical analyses, which are covered in Sections 4 and 5. Section 6 concludes.

2. Analytical model

In this section, first we set up an environmental-based closed economy general equilibrium model to assess the post-regulatory changes in relative prices and quantities of goods in a region. Later, we integrate the model in an open economy context to examine external effects in the *post-policy* general equilibrium solutions of that regime.

2.1. Autarky

Consider a competitive economy r having two commodities: clean (X) and dirty (F) goods. The use of good F generates pollution (Z) with a fixed proportion. For illustration purposes only, assume that commodity F represents a composite good of fossil fuel products.[5] A proportion of commodity F is used as an intermediate good (F^M) in its own production while the rest (F^Y) is used as the final demand. The production of both goods uses primary factors: labor (L) and capital (K), which are mobile across sectors. Wages (w) and rents on capital (r_K) refer to the prices of factor inputs, whereas P_X and P_F represent the market prices of clean and dirty commodities, respectively. Moreover, assume that the dirty good is more capital intensive than the clean one with no factor intensity reversal; so the elasticity of substitution between capital and labor in two sectors is the same (see Minhas, 1962). Also assume that government has an option to impose a specific pollution tax t^F on the use of commodity F either by consumers or producers or both.[6] This regulation affects the general equilibrium prices and quantities of region r through demand and supply channels.

On the demand-side, we assume that preferences can be represented by a twice-continuously differentiable utility function. As consumers' preferences are homothetic, at the optimum, the ratio of the demand for the two goods (i.e., $\frac{F^Y}{X}$) is independent of the level of income; it depends only on the relative price

$$\frac{F^Y}{X} = f\left(\frac{P_X}{\tau + P_F}\right) \quad \text{with} \quad f' > 0 \tag{1}$$

where $\tau = e_{ZF}t^F$ is the value of emissions tax, and e_{ZF} is the emissions content on per unit use of the dirty product. While decomposing fossil fuels good F by components in the next section, we will see that for the same specific tax t^F, the value τ varies depending on the emissions intensity e_{ZF} associated with each component. Assume that $\widetilde{P}_F = \tau + P_F$ is the post-regulatory consumer price of commodity F^Y; $a_{\tau\widetilde{P}_F}$ and $a_{P_F\widetilde{P}_F}$ are respectively the shares of emissions tax and producer price of F in $\widetilde{P}_F$. If there is no pollution tax on final consumption, then $a_{\tau\widetilde{P}_F} = 0$ and $\widetilde{P}_F = P_F$. Totally differentiating Eq. (1) yields:

$$\hat{X} - \hat{F}^Y = -\sigma^d\left(\hat{P}_X - a_{P_F\widetilde{P}_F}\hat{P}_F - a_{\tau\widetilde{P}_F}\hat{\tau}\right) \tag{2}$$

where the hat notation (e.g., $\hat{X} = \frac{dX}{X}$) shows the proportional change in a parameter (or variable). σ^d is the elasticity of substitution between the two goods — a local measure of the curvature of their indifference curve. In Eq. (2), an increase in the pollution tax will reduce the ratio of the relative demand for the dirty good.

On the supply-side, assume that the technology exhibits constant return to scale. Hence with a homothetic production function, the cost minimizing input proportions are independent of the required output. Therefore, if $\mathrm{q} = [w\ r_K\ \tau]$ and $\mathbb{B} = [X\ F]$ are respectively the vectors of input prices and output; if $c(\mathrm{q};\ 1)$ is the vector of minimized unit costs, then the cost function can be written as:

$$C(\mathrm{q}, \mathbb{B}) = \mathrm{q}\mathbb{Q} = \mathbb{B}c(\mathrm{q}, 1) \tag{3}$$

where $\mathbb{Q} = [L\ K\ F^M]$ is the vector of conditional factor demands. At the optimum, each firm sets its price equal to its marginal cost and determines the optimal level of inputs through cost minimization. The

[4] Notice that Hoel (1994) incorporates environmental ingredients in a partial equilibrium setting, while we introduce environment–economy interaction in a general equilibrium system. On the other hand, the policy orientation in our analytical model is more generalized than that of Fullerton and Heutel (2007).

[5] A similar assumption is used by Hoel (1994). The illustration is purposely designed to demonstrate a sequence of steps so that the viewer better understands the intuition. However, we relax the assumption of composite fossil fuel good in our numerical examples where we incorporate each fossil fuel market separately.

[6] Some literatures, particularly Hoel (1994) and Golombek et al. (1995), show the feasibility of incorporating pollution tax on both production and consumption activates. Also Babiker (2005) and Bohringer and Rutherford (2010) empirically apply an economy-wide carbon tax (i.e., on all fossil fuel activities).