

Multilateral Reforms of Trade and Environmental Policy of an Environmental Union

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Introduction

- The interconnection between international trade and the environment and the global nature of their policy consequences drives motives for international coordination, through IEA and REA, in addressing environmental concerns
- Despite changing their policies in accordance with the international agreements, signatory countries do not always benefit from an improvement in welfare
 - Global nature of pollution, Pollution haven effect, Pollution leakage, International competitiveness
- Piecemeal multilateral reforms to achieve Pareto improvements in signatories' welfare are the way forward

Relevant Literature

- Direction of reform
 - Perfect competition (Copeland, 1994; Turunen-Red and Woodland, 2013)
 - Imperfect Competition (Lahiri & Symeonidis, 2007; Gautier, 2013)
- Impact of reforms
 - On welfare (Turunen-Red and Woodland, 2004; Metcalfe & Beghin, 2015; Kawahara, 2013)
 - On global emissions (Lahiri & Symeonidis, 2007, 2017; Hoel, 1991; Hatzipanayotou et al., 2003, 2005; Gautier, 2013)
- Level of Cooperation
 - Unilateral (Copeland, 1994; Beghin et al., 1997; Metcalfe & Beghin, 2015)
 - Fully Cooperative (Turunen-Red & Woodland, 2004; Lahiri & Symeonidis, 2007; Hatzipanayotou et al., 2005, Keen & Kotsogiannis 2014)

Aim of the Paper

Analyze environmental and trade policy reforms undertaken by a subset of countries that are bound by an environmental agreement

- Characterize optimal environmental and trade policies for participating and non participating countries in an Environmental Union
- Identify the necessary and sufficient conditions for the existence of strict Pareto-improving reforms of trade and environmental policy for an Environmental Union
- Characterize and apply specific reforms to analyze the change in welfare of the union and non-union countries
- 3X3 example is used to elaborate on the specific reforms and the conditions under which the union Pareto improving reforms are welfare reducing for the non-union countries

Model Set Up: Description

- The basic framework is a perfectly competitive general equilibrium model of international trade, consist of N large open economies
- In each country there is a private sector (with a representative consumer) that produces Q tradable goods
- Production generates Q types of emissions, denoted by vector z^j (pollution is a by-product of production).
- Pollution affects utility of consumers and not the production capabilities of firms
 - Emissions are subject to a sector specific emissions tax denoted by the vector s^j
 - The internationally traded goods are subject to a nation specific trade tariffs denoted by the vector t^j . Thus $p^j = p + t^j$ and $p'=(1, w')$
 - Tariff and tax revenue are returned to the consumers in a lump-sum manner.

Model

Production function

$$G^j(p + t^j, s^j) = \max_{y,z} \{p'y^j - s^{j'}z^j : (y, z) \in T^j\} \quad j = 1, 2, \dots, N$$

with $G_p^j = y^j$

Consumer Preference

$$E^j(p + t^j, k, u^j) = \min_x \{p'x^j : U^j(x, k) \geq u^j\} \quad j = 1, 2, \dots, N$$

with $E_p^j = x^j$ and $E_k^j > 0$

Emissions

$$z^j = -G_s^j(p + t^j, s^j) \quad j = 1, 2, \dots, N.$$

$$k = \sum_{j=1}^N i' z^j$$

Model

- Maximal net revenue function

$$S^j (p + t^j, s^j, k, u^j) = G^j (p + t^j, s^j) - E^j (p + t^j, k, u^j) \quad j = 1, 2, \dots, N$$

- Net exports: S_p^k
 - Net substitution matrix: $S_{pp}^j = G_{pp}^j - E_{pp}^j$
 - S_{ps}^h gives the effect of a change in environmental taxes on net exports
 - S_{sp}^j gives the impact of change in prices on emissions
- Assume that a subset of countries form an “environmental union”
 - $h \in [1, M]$ denotes the participating countries
 - $f \in [M+1, N]$ denotes the non participating countries

Equilibrium Conditions

Market clearing condition

$$\sum_{j=1}^N S_w^j (p + t^j, s^j, k, u^j) = 0_{N-1}$$

Union's budget constraint

$$\sum_{h=1}^M p' S_p^h (p + t^h, s^h, k, u^h) = \sum_{h=1}^M b^h, \quad u = 1, 2, \dots, M$$

Non participating countries' budget constraint

$$p' S_p^f (p + t^f, s^f, k, u^f) = b^f, \quad f = (M + 1), \dots, N$$

Global emission

$$k = \sum_{j=1}^N i' z^j$$

$$z^j = -S_s^j (p + t^j, s^j, k, u^j), \quad j = 1, 2, \dots, N$$

International transfers

$$\sum_{j=1}^N b^j = 0$$

Changes in Welfare of the Union & Non-Union

$$\sum_{h=1}^M \tilde{p}' E_{pu}^h du^h = \sum_{h=1}^M (\tilde{p}' S_{pp}^h + \tilde{s}' S_{sp}^h) dt^h + \sum_{h=1}^M (\tilde{p}' S_{ps}^h + \tilde{s}' S_{ss}^h) ds^h - \sum_{f=M+1}^N \tilde{p}' E_{pu}^f du^f$$

- Change in welfare of the Union depend on
 - changes of union tariffs:
 - 1) **direct** impact on net compensated union exports
 - 2) **indirect** impact on union emissions
 - changes of union's environmental taxes:
 - 1) **indirect** impact on its production allocation
 - 2) **direct** impact on the union's emissions
 - Change in welfare of the non-union country

Optimal Environmental & Trade Policies

- In the presence of international transfers

$$s^{h-opt'} = -\tilde{p}' \sum_{j=1}^N \left(S_{pk}^j \right) = \tilde{s}'$$

$$t^{h-opt'} = -0, p' R_{pw} R_{ww}^{-1} = \tilde{t}'$$

- In the absence of transfers

$$s^{h-opt'} = p^{h'} \sum_{h=1}^M E_{pk}^h + t^{h-opt'} \sum_{f=M+1}^N E_{pk}^f$$

$$t^{h-opt'} = - (p' R_{pw}^H + S_w^{H'}) R_{ww}^{-1}$$

where R_{pw} represent the pollution augmented world net export matrix

Existence of Strict Pareto Improving Reforms

Applying Motzkin's theorem of the Alternative, we develop the necessary and sufficient conditions for the existence of strict Pareto-improving reforms of union tariffs dt^h , and environmental taxes ds^h

If there is at least one union country satisfying the generalised Hatta normality condition ($\tilde{p}' E_{pu}^h > 0$) and R_{pp} for non-numeraire good's is of full rank, then there exists a strict Pareto-improving differential tariff and/or environmental tax reform (accompanied by suitable income transfers) if, and only if, there is at least one union country for which:

$$\tilde{p}' S_{pp}^h + \tilde{s}' S_{sp}^h \neq 0$$

$$\tilde{p}' S_{ps}^h + \tilde{s}' S_{ss}^h \neq 0$$

Characterising Environmental Policy Reforms

Assuming:

1. the matrix R_{pp} for non-numeraire goods is of full rank
2. the reallocation of union's output of traded goods (caused by the environmental reform and measured by the vectors $\tilde{p}' S_{ps}^h$) is positively correlated with the marginal damage of pollutants (represented by \tilde{s}) i.e.

$$\sum_{h=1}^M \tilde{p}' S_{ps}^h \tilde{s} > 0$$

then a multilateral union reform of environmental taxes along the vector θ^h

$$\theta^h = \delta \tilde{s}, \quad \delta > 0$$

is strictly Pareto-improving for the union.

- This implies a change in union members' environmental taxes proportional to the global marginal damage of pollutants.

Characterising Environmental Policy Reforms

Assuming

1. the matrix R_{pp} for non-numeraire goods is of full rank
- 2 $\sum_{h=1}^M \tilde{p}' S_{ps}^h \tilde{s} > 0$

then a multilateral union reform of environmental taxes along the vector θ^h

$$\theta^h = \delta (s^{h-opt} - s^h), \quad \delta > 0$$

is strictly Pareto-improving for the union.

- This reform moves the environmental taxes of the union countries towards a common target (optimal union tax), i.e., it reduces any initial differences that may exist in the environmental taxes across the members.

Characterising Trade Policy Reforms

Assuming

1. the matrix R_{pp} for non-numeraire goods is of full rank

2. the re-allocation of union's output of emissions (caused by the indirect effect of the tariff reform on emissions via changes in production levels, as measured by $\tilde{s}' S_{sp}^h$) is correlated with the shadow prices for traded goods (\tilde{p}), i.e. $\sum_{h=1}^M \tilde{s}' S_{sp}^h \tilde{p} \neq 0$

then, a multilateral union reform of trade tariffs along the vector α^h

$$\alpha^h = \epsilon \tilde{p}, \quad \epsilon > 0$$

is strictly Pareto-improving for the union; where ϵ ; is a positive scalar.

- This reform suggests that the union countries change their tariffs proportional to the world price vector.

Characterising Trade Policy Reforms

Assuming

1. *the matrix R_{pp} for non-numeraire goods is of full rank*
2. $\sum_{h=1}^M \tilde{s}' S_{sp}^h \tilde{p} \neq 0$

then a multilateral union reform of trade tariffs along the vector α^h

$$\alpha^h = \epsilon \left(t^{h-opt} - t^h \right), \quad \epsilon > 0$$

is strictly Pareto-improving for the union.

- This reform involves a proportional shift towards optimal union tariffs.
- In the case where there are international transfers the reform indicates a proportional reduction in trade distortions.

Impact of Specific Reforms on Welfare

- To understand further the welfare effects of the policy reforms on participating and non participating countries we develop a special 3x3 case
 - Each country is completely specialised in the production of one good and imports the other two.
 - Good 1 is assumed to be the numeraire with respect to which the prices of the other goods are expressed.
 - Country 1 and 2 form the environmental union and do not impose a trade tariff on each other $t_1^1 = t_2^1 = t_1^2 = t_2^2 = 0$.
 - the environmental union can choose to eliminate trade tariffs within itself and impose different tariffs with the non-union countries (as a trade union)
 - Or eliminate tariffs amongst each other and impose a common external tariff with the non-union countries (as a customs union)
 - Or reduce trade tariffs amongst each other (akin to Preferential Trading Agreements)
 - The goods are substitutes in consumption.

Participating countries' Trade Policy Reform

Assuming that $ds=0$

Case	Direction of Tariff Reform
$\bar{s} - s^1 < 0$ and $\bar{s} - s^2 < 0$	Decrease intra-union tariff; Impose BTA on Non-Union
$(\bar{s} - s^1) > 0$ and $(\bar{s} - s^2) < 0$	In the direction of the difference of the tax from shadow prices
$(\bar{s} - s^1) > 0$ and $(\bar{s} - s^2) > 0$	Decrease difference of tariff from shadow tariffs
Decrease in Welfare of Non-Union	Union Emissions Leakage > Non-Union's Terms of Trade
Decrease in Global Pollution	Union's Terms of Trade & Emissions Leakage Effect on Welfare > Direct effect of union emissions and indirect effect on compensated demand

Participating countries' Environmental Policy Reform

Assuming $dt=0$

Case	Direction of reform
$\left(\tilde{t}_3^1 - t_3^1 \right) < 0 , \left(\tilde{t}_3^2 - t_3^2 \right) < 0$	Decrease environmental tax
$\left(\tilde{t}_3^1 - t_3^1 \right) < 0$ and $\left(\tilde{t}_3^2 - t_3^2 \right) > 0$	In the direction of the difference between tariffs and shadow tariffs
$\left(\tilde{t}_3^1 - t_3^1 \right) > 0 , \left(\tilde{t}_3^2 - t_3^2 \right) > 0$	Increase environmental standards
Decrease in Welfare of the Non-union country	Emissions leakage effect on compensated demand > Welfare improving terms of trade effect
Decrease in Global Pollution	Emissions Leakage Effect (on union welfare & global compensated demand) + Direct Union Emissions Effect > Impact of Emissions Leakage on production

Concluding remarks

- The presence of international transfers internalise the impact of the negative externalities stemming from the non-union countries, which leads to the union optimal policies being closer in nature to a globally (fully) cooperative case.
- There exists a negative relationship between the changes in welfare of the union and non-union countries.
 - This stems from the international trade balance and highlights the role of the terms of trade in the union's policy reforms that can lead to an increase in welfare for the union while ensuring a decrease in welfare of the non-union countries.
- Specific policy reform proposals suggest that an environmental union that raises its environmental standards can reduce intra-union tariffs or have free trade within the union.
- The reforms also suggest that countries within a free trade agreement can “afford” to set more stringent environmental standards.
- The impact of a union policy reform on global pollution and on the welfare of the non-union country depend on:
 - The terms of trade effect of the union & non-union countries
 - The emissions leakage effect – within the union and in the non-union country.

Impact of Trade Policy Reforms on Welfare

- The assumption $(\tilde{s} - s^h)' G_{sp}^h \left[\overbrace{t^h} - t^h \right] > 0$ now become

$$(\tilde{s} - s^h)' G_{sp}^h \left[\overbrace{t^h} - t^h \right] = (\tilde{s} - s^h)' \left[0 \quad -\frac{dz_1^h}{dp_2} \quad -\frac{dz_1^h}{dp_3} \right] \left[\begin{array}{c} \left(\overbrace{t_1^h} \right) - t_1^h \\ \left(\overbrace{t_2^h} \right) - t_2^h \\ \left(\overbrace{t_3^h} \right) - t_3^h \end{array} \right]$$

This leads to 3 cases