Trade & Environmental Policies with Domestic and International Transportation

Kenzo Abe, Osaka University

&

Yoshitaka Kawagoshi, Kyoto Sangyo university

July 23, 2016

JSIE WEST

Introduction

- Total global emissions from int'l transportation

V

Sum of emissions from all sources in UK and France

・International Energy Agency (2014)

CO_2 emissions from international marine bunkers have been increased by approximately 66% between 1990 and 2012.

・COP21 and the World Trade Organization

Do not discuss how to reduce the CO_2 emissions from the maritime transportation.

Introduction

Domestic transportation

- The United States (United States Environmental Protection Agency)

  27 percent of Greenhouse gas emission is from transportations

  40 percent of GHG emission from U.S. transportations is yielded from light-, medium- and heavy-duty truck transportation.

- The EU (European Commission)

  GHG emissions from transportation is the second biggest source. Two thirds of these emissions are road transportation.

- Japan (Ministry of Land, Infrastructure, Transport and Tourism)

  The share of the CO2 emissions from truck transportation is about 6%

Introduction

- The importance of the transportation sector

  the new trade theory and the new economic geography

  the trade cost plays very important role.

  Most of them assume the "***iceberg***" transportation costs

Ignore the role of the transportation sectors

Introduction

- Previous works

☐ Int'l trade with the int'l transportation

Francois and Wooton (2001), Andriamananjara (2004), Ishikawa and Tarui (2016)

☐ Int'l trade with the int'l transportation and emission from int'l transportation

Takarada (2013), Abe et al. (2014)

☐ Int'l trade with the intermediate-good sector and emission from this sector (**NOT** transportation sector)

Hamilton and Requate (2004), Lee (2007), Csordas and Krysiak (2011)

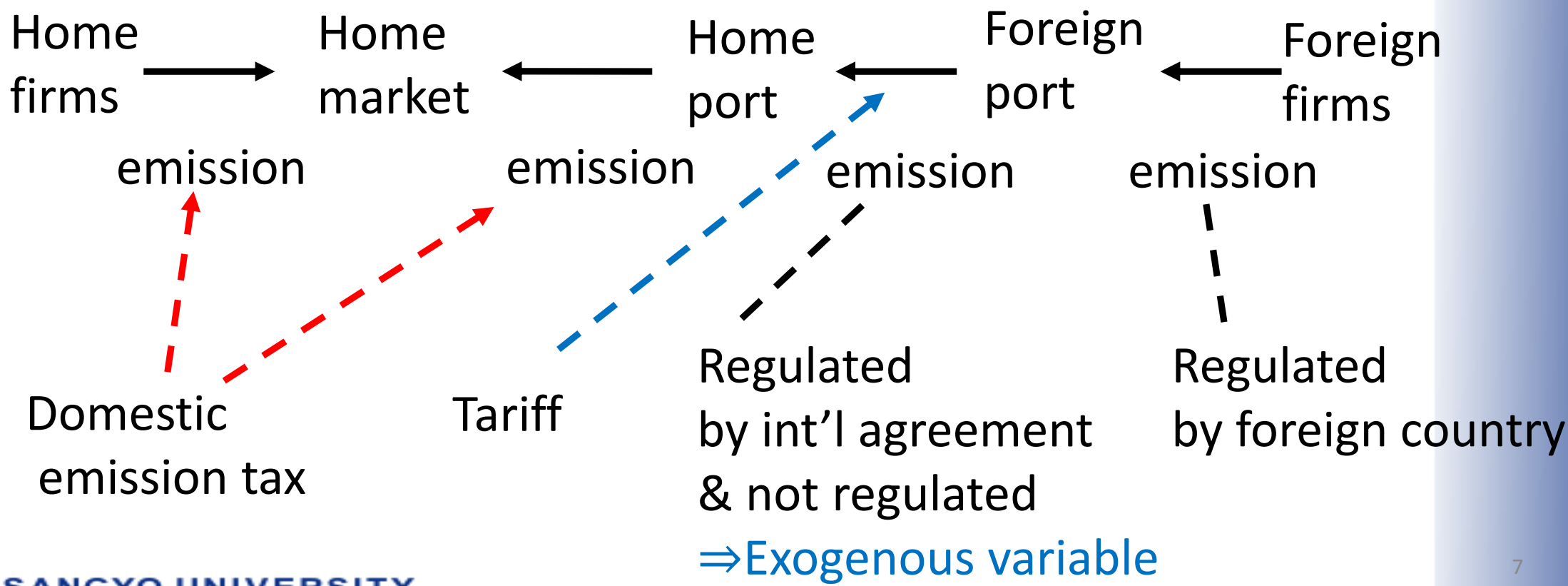
Introduction

What's new?

1. Transportation sectors
   - -Int'l transportation
   - -Domestic transportation
   - -Domestic transportation related to the int'l trade
2. Distance of domestic and int'l transportations

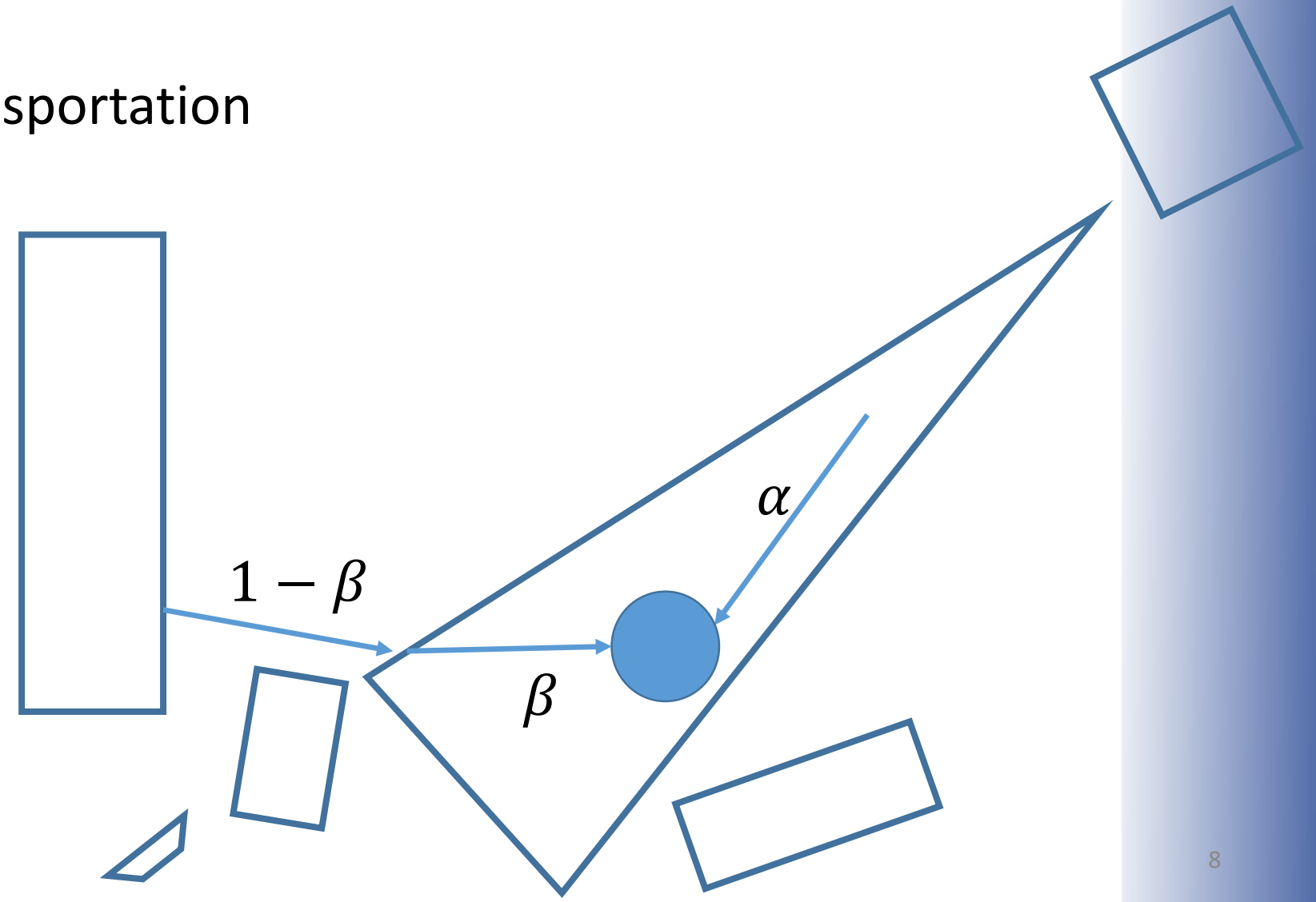
Introduction

Int'l and domestic logistics and emission



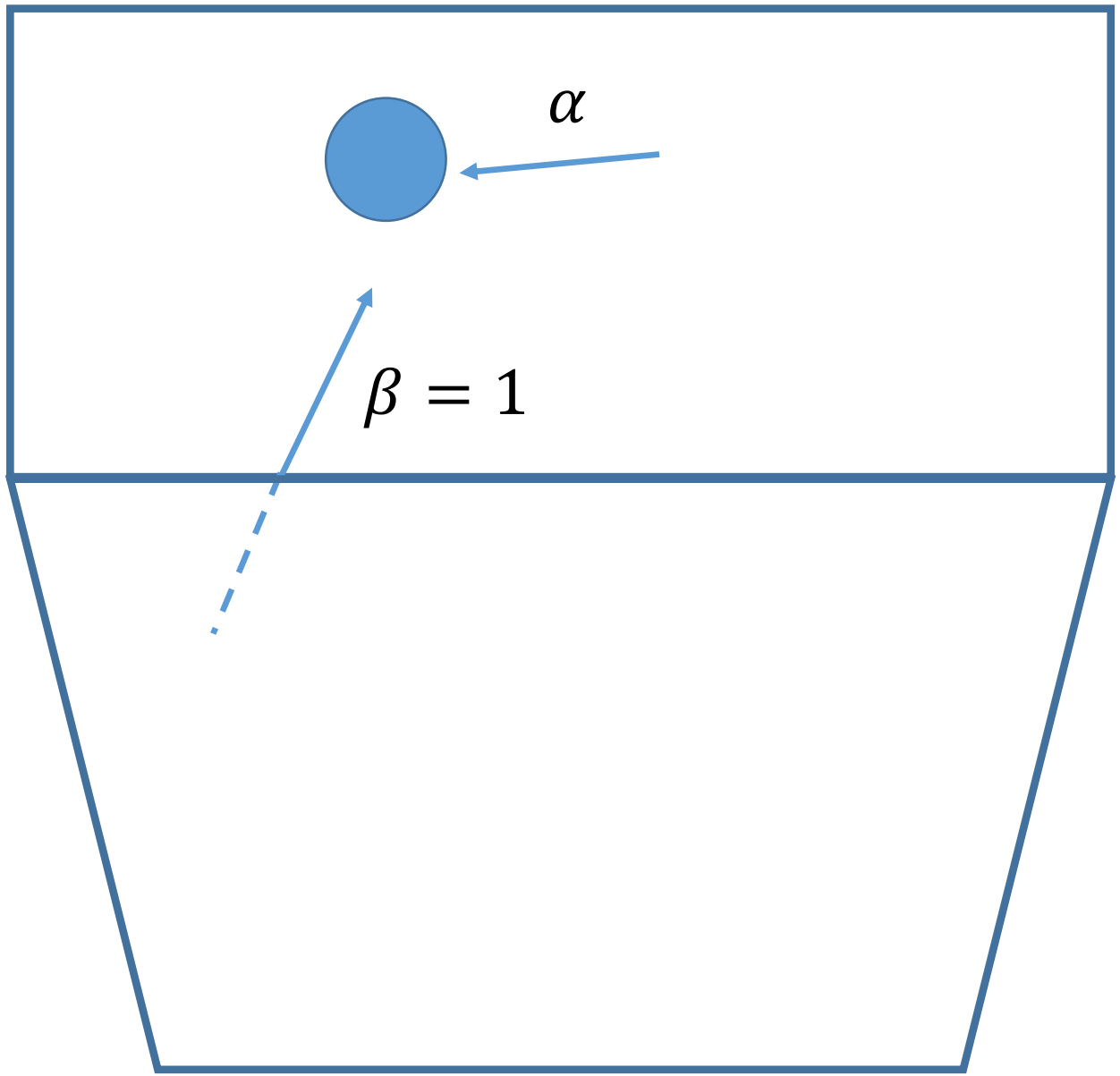
Introduction

- Trade with int’l transportation



Introduction

- Trade without int'l transportation



Main results

Sub-optimal tariff/ emission tax

The sign of the sub-optimal tariff and domestic emission tax are affected by the distances of domestic and int'l transportation

Optimal policy combination

The value of the optimal policies depend on the distances.

Introduction

Transportation sector

Example of Japan

The big three shipping companies in Japan (Nippon Yusen Kabushiki Kaisha, Mitsui O.S.K. Lines, Ltd. and Kawasaki Kisen Kaisha, Ltd.) are operating the int'l container shipment.

These firms do not operate the domestic truck transportation directly.

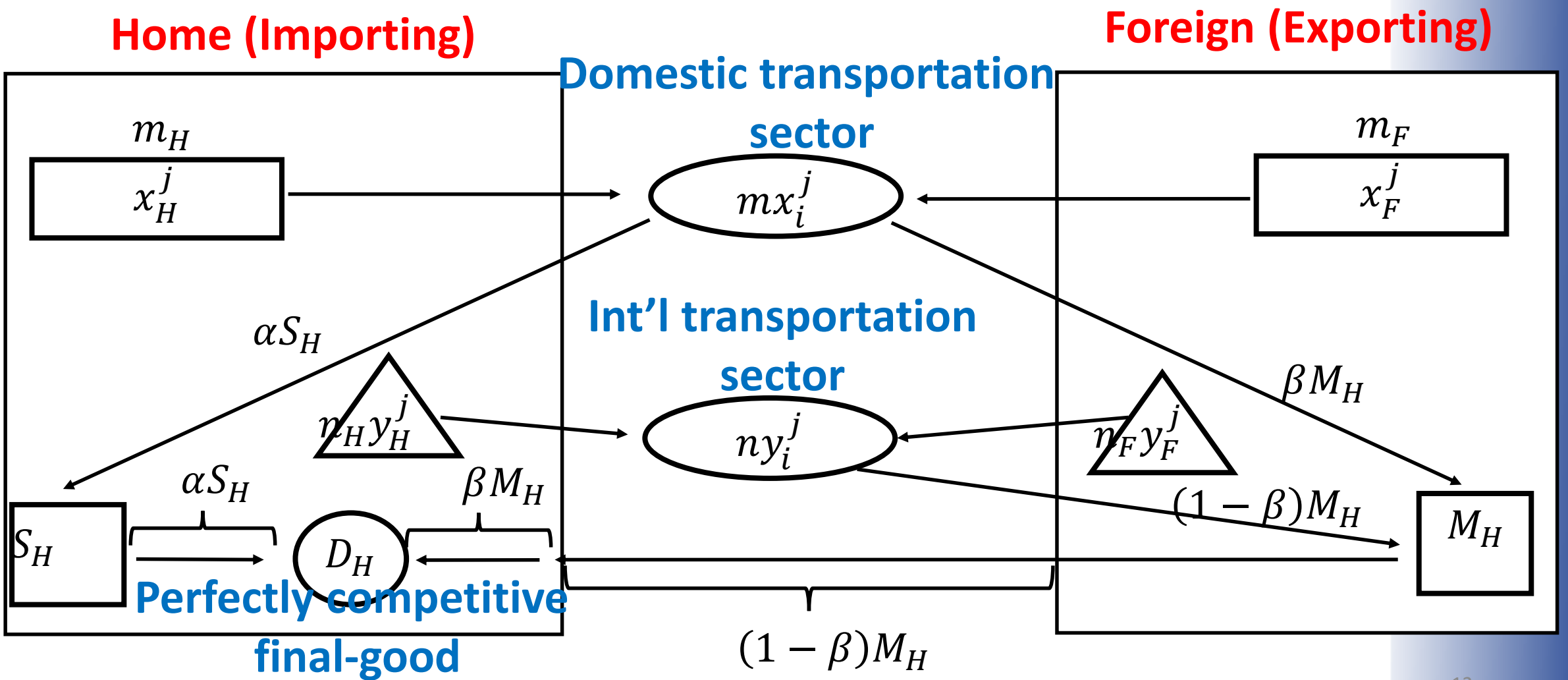
Int'l transportation companies ≠ Domestic transportation companies

We consider BOTH sectors!

The model

j: index of firms

i: index of country H or F



The model

- Consumer price of the final-good

$$q_C \equiv q^* + \left\{ \beta p_D + (1-\beta) p_I \right\} + \tau$$

- Producer price of the final-good

$$q_P \equiv q^* + \left\{ \beta p_D + (1-\beta) p_I \right\} + \tau - \alpha p_D$$

q^*: the world price for the final-good, constant (assumption)
p_D: the domestic transportation price
p_I : the int'l transportation price
τ : the specific import tariff

The model

- The demand function for the final-good in H

$$D_H(q_C), \quad D' \equiv dD_H(q_C)/dq_C < 0, \quad D'' \equiv dD'/dq_C = 0.$$

- The supply function for the final-good in H

$$S_H(q_P), \quad S' \equiv dS_H(q_P)/dq_P > 0, \quad S'' \equiv dS'/dq_P = 0.$$

- The import demand function for the final-good in H

$$M_H \equiv D_H(q_C) - S_H(q_P)$$

The model

- Total demand for the domestic transportation

$$X \equiv \sum_{j=1}^{m_H} x_H^j + \sum_{j=1}^{m_F} x_F^j = \alpha S_H(q_P) + \beta M_H = (\alpha - \beta) S_H(q_P) + \beta D_H(q_C)$$

- Total demand for the int'l transportation

$$Y \equiv \sum_{j=1}^{n_H} y_H^j + \sum_{j=1}^{n_F} y_F^j = (1-\beta) M_H = (1-\beta)\{D_H(q_C) - S_H(q_P)\}$$

- The inverse demand function

  The domestic transportation

$$p_D(X, Y, \tau)$$

  The int'l transportation

$$p_I(X, Y, \tau)$$

The model

- Total differentiation

$$dX = -\left\{(\alpha-\beta)^2 S' - \beta^2 D'\right\} dp_D$$
$$+(1-\beta)\left\{\alpha S' - \beta(S'-D')\right\} dp_I + \left\{\alpha S' - \beta(S'-D')\right\} d\tau$$
$$= -\left\{(\alpha-\beta)^2 S' - \beta^2 D'\right\} dp_D + (1-\beta) k dp_I + k d\tau$$

and

$$dY = (1-\beta) k dp_D - (1-\beta)^2 (S'-D') dp_I - (1-\beta)(S'-D') d\tau$$

where $k \equiv \alpha S' + \beta(D'-S')$

Additional explanation of k

- The demand for the domestic transportation

$$\alpha S - \beta(S - D)$$

$$k \equiv \alpha S' + \beta(D' - S') = (\alpha - \beta)S' + \beta D'$$

price ↑ → domestic transportation ↑

↘ domestic transportation related to trade ↓

(i) $\alpha < \beta \Leftrightarrow k < 0$

(ii) $\alpha > \beta \quad \alpha S' - \beta(S' - D') < 0 \Leftrightarrow \dfrac{\alpha - \beta}{\beta} S' < -D'$

(iii) $\alpha > \beta \quad \alpha S' - \beta(S' - D') > 0 \Leftrightarrow \dfrac{\alpha - \beta}{\beta} S' > -D'$

The model

Effects of X, Y and τ on p_D

$$\frac{dp_D}{dX} = \frac{S'-D'}{\alpha^2 D'S'} < 0, \quad \frac{dp_D}{dY} = \frac{k}{\alpha^2(1-\beta)D'S'} \lessgtr 0 \quad if \ k \gtrless 0, \quad \frac{dp_D}{d\tau} = 0.$$

Effects of X, Y and τ on p_I

$$\frac{dp_I}{dX} = \frac{k}{\alpha^2(1-\beta)^2 D'S'} \lessgtr 0 \quad if \ k \gtrless 0, \quad \frac{dp_I}{dY} = \frac{(\alpha-\beta)^2 S'-\beta^2 D'}{\alpha^2(1-\beta)^2 D'S'} < 0,$$

$$\frac{dp_I}{d\tau} = \frac{1}{1-\beta} > 0.$$

The model

- Profit maximization and the reaction functions

A domestic transportation firm j in country i

$$\pi_{Di}^{j} = p_D x_i^j - t_D e_D x_i^j, \quad i = H, F.$$

F.O.C. $$\frac{\partial p_D}{\partial X} x_i^j + p_D - t_D e_D = 0 \Leftrightarrow \frac{S' - D'}{\alpha^2 D' S'} x_i^j + p_D - t_D e_D = 0$$

A int'l transportation firm j in country i

$$\pi_{Ii}^{j} = p_I y_i^j - t_I e_I y_i^j, \quad i = H, F.$$

F.O.C. $$\frac{\partial p_I}{\partial Y} y_i^j + p_I - t_I e_I = 0 \Leftrightarrow \frac{(\alpha - \beta)^2 S' - \beta^2 D'}{\alpha^2 (1-\beta)^2 D' S'} y_i^j + p_I - t_I e_I = 0$$

Comparative statics

		X	Y	p_D	p_I
τ	$k > 0$	$+$	$-$	$+$	$-$
	$k < 0$	$-$		$-$	
t_D	$k > 0$	$-$	$+$	$+$	$+$
	$k < 0$		$-$		$-$

Comparative statics

		Total emission $e_D X + e_I Y$
τ	$k > 0$	?
	$k < 0$	−
t_D	$k > 0$	?
	$k < 0$	−

Decomposition of the welfare of the H

- Definition

$$W = CS + PS + m_H \pi_{DH}^j + n_H \pi_{IH}^j + TR - E\left[e_D X,\ e_I Y\right].$$

$CS \equiv \int_{q_C}^{\bar{q}_C} D_H(z)\,dz$: the consumers' surplus for the final-good firms in H

$PS \equiv \int_{\underline{q}_P}^{q_P} S_H(z)\,dz$: the producers' surplus for the final-good firms in H

$TR \equiv \tau M_H + t_D e_D X + t_I e_I Y$: the tariff and tax revenue

$E\left[e_D X,\ e_I Y\right] \equiv \sigma\left(e_D X + e_I Y\right)$: the damage function

Decomposition of the welfare

The effect on the consumers' surplus

The general case

$$q_C = q^* + \tau$$

$$\Rightarrow \frac{dq_C}{d\tau} = 1$$

This model

$$\frac{dq_C}{d\tau} = \beta \frac{dp_D}{d\tau} + (1-\beta)\frac{dp_I}{d\tau} + 1$$

$$= \beta \frac{nk(S' - D')}{\alpha^4 (1-\beta)^2 D'^2 S'^2 J_2}$$

$$- \left[\frac{(1+m)(S' - D')\left\{(\alpha - \beta)^2 S' - \beta^2 D'\right\}}{\alpha^4 (1-\beta)^2 D'^2 S'^2 J_2} \right]$$

$$+1$$

Decomposition of the welfare

- Total differentiation

$$dW = -n_F y dp_I - m_F x\left(dp_D - e_D dt_D\right) + m_H\left(p_D - t_D e_D\right)dX$$
$$+ n_H\left(p_I - t_I e_I\right)dY + \tau dM_H + t_D e_D dX + t_I e_I dY - dE.$$

ToT ***Rent-shifting effect*** ***Tariff and tax revenue*** ***Damage***

$$= \left(m_H - m_F\right)x\left(dp_D - e_D dt_D\right) + \left(n_H - n_F\right)y dp_I$$
$$+ \tau dM_H + \left(t_D - \sigma\right)e_D dx + \left(t_I - \sigma\right)e_I dy$$

The sub-optimal tariff

$$\tau^S = \frac{k}{(1+m)(S'-D')}\left\{(m_F - m_H)x\frac{S'-D'}{\alpha^2 D'S'} + e_D m(t_D - \sigma)\right\}$$

$$-(1-\beta)\left\{\frac{(n_F - n_H)}{n} y \frac{(\alpha-\beta)^2 S' - \beta^2 D'}{\alpha^2(1-\beta)^2 D'S'} + e_I(t_I - \sigma)\right\}$$

Proposition 1.

(a) *The sub-optimal tariff is affected by the distance*

(b) *Suppose* $t_I = \sigma$ *and* $t_D = \sigma$

the sub-optimal tariff becomes positive(negative)

if $(m_H - m_F)k > (<)0$ *and* $n_H < (>)n_F$

(c) *Suppose* $t_I < \sigma$, $t_D < \sigma$ *and* $k < 0$

the optimal tariff becomes positive

if $m_H < m_F$ *and* $n_H < n_F$

The sub-optimal emission tax

$$t_D^S = \frac{k}{e_D(1+n)\left\{(\alpha-\beta)^2 S' - \beta^2 D'\right\}}$$

$$\times\left[(n_F - n_H)\, y \frac{(\alpha-\beta)^2 S' - \beta^2 D'}{\alpha^2(1-\beta)^2 D'S'} + n\left\{e_I(t_I - \sigma) + \frac{\tau}{1-\beta}\right\}\right]$$

$$-\frac{(m_F - m_H)}{e_D m} x \frac{S' - D'}{\alpha^2 D'S'} + \sigma$$

Proposition 2.

(a) *The sub-optimal emission tax is affected by the distance.*

(b) $t_I = \sigma$ *and* $\tau = 0$

The optimal emission tax on the domestic transportation is greater (smaller) than the Pigouvian level if $(n_H - n_F)k > (<)0$ and $m_H < (>)m_F$.

The optimal policy cooperation

Proposition 3. *The optimal policy combination*

$$t_D^* = \frac{(m_H - m_F)}{e_D m} x \frac{(S' - D')}{\alpha^2 D' S'} + \sigma.$$

$$\tau^* = (1-\beta)\left\{ \frac{(n_H - n_F)}{n} y \frac{(\alpha-\beta)^2 S' - \beta^2 D'}{\alpha^2 (1-\beta)^2 D' S'} - e_I (t_I - \sigma) \right\}$$

Suppose $t_I \le \sigma$, $t_D^* > 0$ *and* $\tau^* > 0$ *if* $m_F > m_H$ *and* $n_F > n_H$

In this case, the value of the optimal policies depend on the distance.

Concluding remarks

- Results

  1. The sign of the sub-optimal tariff and emission tax are affected by the distances of domestic and int'l transportation.

  2. The value of the optimal policies depend on the distances under the optimal policy combination.

- Future tasks

  Role of foreign country

  transportation within the foreign country; government

  Cooperative firms between the domestic and int'l transportation

Thank you very much!