Interdependence of Trade Policies in General Equilibrium

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Motivation

The Quantitative Revolution

- Explosion of quantitative gravity models featuring:

  1. Many differentiated (or homogeneous) sectors.

  2. Various *general equilibrium* interactions.

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- Gravity models have transformed the way economists think about international trade...

- ...but little impact on how we think about *trade policy!*

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1. Studies using multi-sector gravity frameworks.
    - Either purely computational...
    - ...or abstract from revenue-generating trade barriers (RTBs).
2. Many analysis of RTBs using the classical approach.
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    - Abstract from GE interactions.

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This Paper

- Adopt a GE multi-sector gravity model.
- Sectors are inter-related through:
    1. Factor price linkages.
    2. Cross price elasticity effects.

Goal 1: Solve for the optimal trade policy.

Goal 2: Characterize the interdependence of sector-level policies

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Main Findings

- GE environment $\Longrightarrow$ distinct tax structure:
  - Uniform tariffs + non-uniform export taxes
  - Key parameter: *sector-level trade elasticity*
- Policy interdependence:
  - Sector-level tariffs are complementary
  - Import policy *cannot* substitute export policy

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Theoritical Framework

The Environment

- K sectors
- Two countries: Home (h) and ROW (f)
- Perfect competition
- One *"Hicksian composite"* factor of production (L_i)

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Preferences

Total welfare in country i

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$$W_i = V_i(Y_i, P_{i,1}, ..., P_{i,K})$$

- Y_i : total income
- $P_{i,k}$: price index of sector k in country i

Preferences

Total welfare in country i

$$W_i = V_i(Y_i, P_{i,1}, ..., P_{i,K})$$

- Income effects: $Q_{i,1}/Q_{i,2}$ can vary with Y_i
- Cross-elasticity effects: $Q_{i,1}$ responds to changes in $P_{i,2}$

Within Sector Trade

CES import demand structure within sectors:

$$P_{i,k} = \sum_{j=h,f} A_{j,k} \left[\tau_{ji,k} \left(1 + t_{ji,k}\right) \left(1 + x_{ji,k}\right) w_j\right]^{-\theta_k}$$

- $A_{j,k}$: country j's productivity level in sector k
- w_j: wage rate in country j
- θ_k: trade elasticity in sector k

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Three policy instruments:

- RTBs
    - Import tax by country i on country j exports: $t_{ji,k}$
    - Export tax by country j on own exports to country i: $x_{ji,k}$
- NRTBs
    - Iceberg or wasteful trade barriers: $\tau_{ji,k}$

Within Sector Trade

Share of country i's spending on country j varieties in sector k:

$$\lambda_{ji,k} = \frac{A_{j,k}\left[\tau_{ji,k}\left(1+t_{ji,k}\right)\left(1+x_{ji,k}\right)w_j\right]^{-\theta_k}}{\sum_{n=h,f} A_{n,k}\left[\tau_{ni,k}\left(1+t_{ni,k}\right)\left(1+x_{ni,k}\right)w_n\right]^{-\theta_k}}$$

Special case:

- $\theta_k \rightarrow \infty$: sectors are homogeneous.
- Ricardian model with K (possibly infinite) commodities.

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Trade and Income Levels

Total income in country i

$$Y_i = \text{factor income} + \text{IM tax rev.} + \text{EX tax rev.}$$

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- $X_{ji,k}$: f.o.b. value of exports from j to i
- $Y_{i,k}$ income spent on sector k

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Optimal Policy

Optimal Policy

- No foreign RTBs: $t_{hf,k} = x_{fh,k} = 0 \; \forall k$
- (For now) take the NRTBs as given.
- Solve for $\{x_k^*, t_k^*\}_k$
  - $t_k^* \equiv t_{fh,k}^*$ (Home's optimal tariff in sector k)
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Intermediate Step

- Step 1: assume $\{x_k\} = 0 \implies$ solve for $\{t_k^*\}$

- Social planners problem:

$$\max_{t_k} V_h(Y_h, \boldsymbol{P_h} \mid \boldsymbol{x} = 0)$$

$$\text{s.t.} \sum_k X_{fh,k} = \sum_k X_{hf,k}$$

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$$\text{s.t.} \quad \underbrace{\sum_k X_{fh,k} = \sum_k X_{hf,k}}_{\text{Balance Trade}}$$

Optimal Tariffs

Proposition 1: the optimal import tariff is uniform ($t_k^* = \bar{t}^* \ \forall k$):

$$\bar{t}^* = \frac{1}{\frac{\partial \ln X_{hf}}{\partial \ln w} - 1}$$

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wage effects

cross-elasticity effects

Optimal Tariffs: *Special Cases*

- One sector economy (Gross 1987): $t^* = \frac{1}{\theta \lambda_{ff}}$
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- Step 2: jointly solve for $\boldsymbol{x}^*$ and $\boldsymbol{t}^*$

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Optimal Tax Schedule

Proposition 2: the optimal trade tax is composed of uniform tariff, t^*, and sector-specific export taxes such that:

$$(1+t^*)(1+x_k^*) = \frac{1}{\theta_k \lambda_{ff,k}}$$

- Unique *only* up to a uniform tariff, t^*.

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- Optimal protection depends on:
  1. Sector-level trade elasticity, θ_k
  2. Sector-level comparative adv. (implicit in $\lambda_{ff,k}$)

     special case

Optimal NRTBs

- NRTBs: non-revenue trade barriers or *iceberg trade costs*
- All policy instruments available $\implies$ optimal policy includes

1. Zero NRTBs

$$\tau^*_{fh,k} = 0 \ \forall k$$

2. Uniform tariffs + sector-specific export taxes:

$$(1 + t^*)\,(1 + x^*_k) = \frac{1}{\theta_k \lambda_{ff,k}}$$

Optimal NRTBs

- What if RTBs are unavailable?

Proposition 3: when RTBs are unavailable, the optimal NRTBs are *non-uniform* and *strictly positive* in sectors where θ_k is sufficiently large.

- Optimal **U.S.** NRTBs positive in *Wheat, Rice, Diary,* and *Apparel* sectors.

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Policy Interdependence

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- Proposition 4: import tariffs are complementary: graph

$$t_1 \downarrow \implies t_2^*(t_1) \downarrow$$

- Proposition 5: import tariffs cannot substitute export taxes/subsidies

$$\text{Welfare}(\boldsymbol{x}^* \mid \boldsymbol{t} = 0) > \text{Welfare}(\boldsymbol{t}^* \mid \boldsymbol{x} = 0)$$

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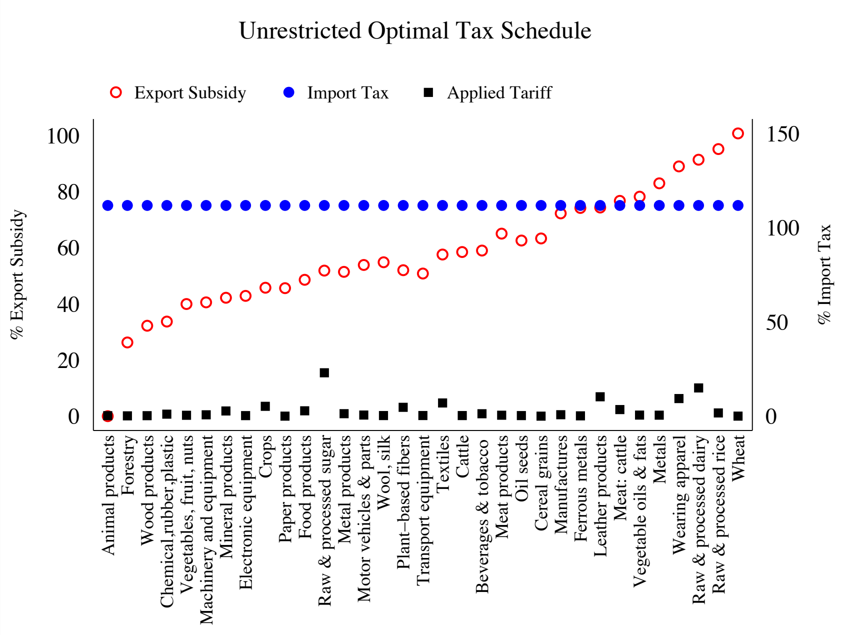
Quantitative Analysis

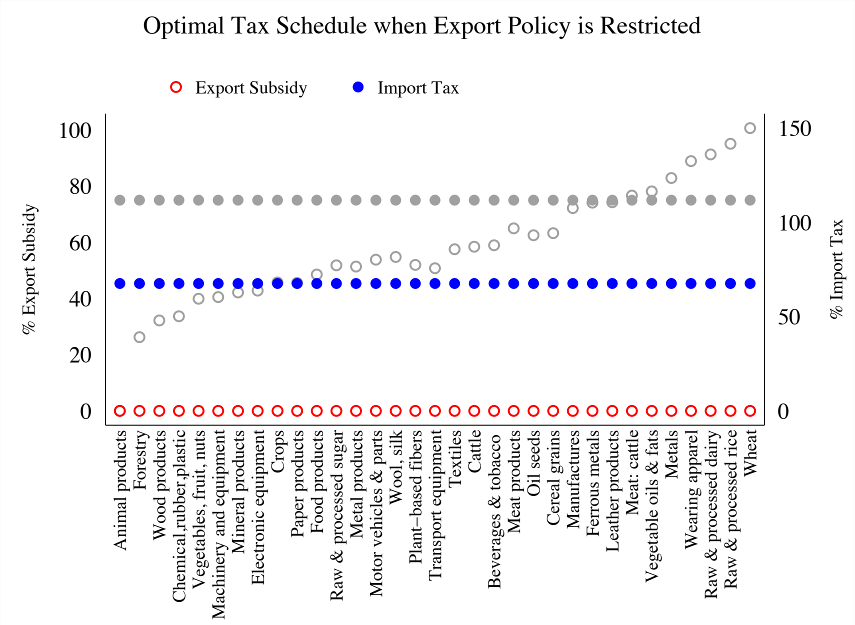
- We have established that GE effects matter, *theoretically*...
- ....but how important are GE effects, *quantitatively*?

Calibrated Model

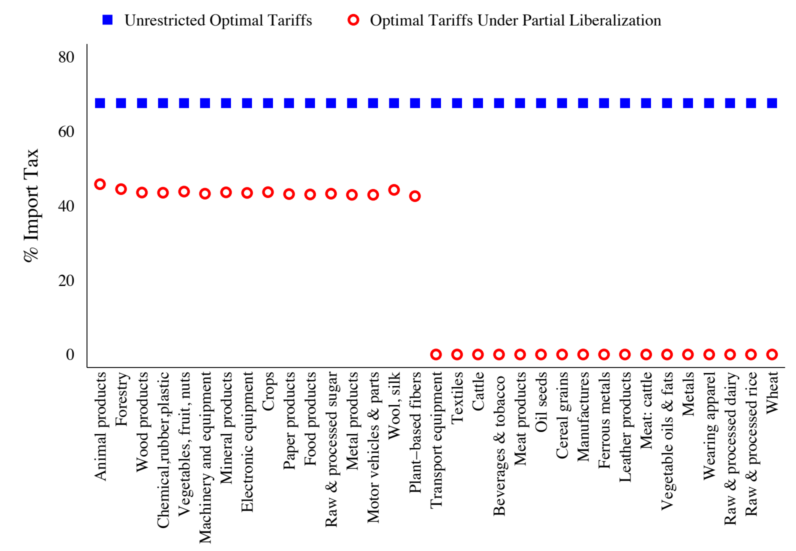
- Home: US
- Foreign: ROW
- 33 sectors
- θ_k's from micro-level estimation.
- Match sector-level *production*, *trade*, and *expenditure* shares.



Unrestricted Optimal Tax Schedule
Export Subsidy
Import Tax
Applied Tariff
% Export Subsidy
% Import Tax
100
80
60
40
20
0
150
100
50
0
Animal products
Forestry
Wood products
Chemical,rubber,plastic
Vegetables, fruit, nuts
Machinery and equipment
Mineral products
Electronic equipment
Crops
Paper products
Food products
Raw & processed sugar
Metal products
Motor vehicles & parts
Wool, silk
Plant−based fibers
Transport equipment
Textiles
Cattle
Beverages & tobacco
Meat products
Oil seeds
Cereal grains
Manufactures
Ferrous metals
Leather products
Meat: cattle
Vegetable oils & fats
Metals
Wearing apparel
Raw & processed dairy
Raw & processed rice
Wheat


Optimal Tax Schedule when Export Policy is Restricted
Export Subsidy
Import Tax
% Export Subsidy
% Import Tax
0
20
40
60
80
100
0
50
100
150
Animal products
Forestry
Wood products
Chemical,rubber,plastic
Vegetables, fruit, nuts
Machinery and equipment
Mineral products
Electronic equipment
Crops
Paper products
Food products
Raw & processed sugar
Metal products
Motor vehicles & parts
Wool, silk
Plant−based fibers
Transport equipment
Textiles
Cattle
Beverages & tobacco
Meat products
Oil seeds
Cereal grains
Manufactures
Ferrous metals
Leather products
Meat: cattle
Vegetable oils & fats
Metals
Wearing apparel
Raw & processed dairy
Raw & processed rice
Wheat

Partial Liberalization



Welfare Effects

These policies have non-trivial welfare effects.

- US:
  - Optimal import policy $\Longrightarrow$ 3.48% welfare gains
  - Allow export policy $\Longrightarrow$ 0.07% higher gains
- China:
  - Optimal import policy $\Longrightarrow$ 2.26% welfare gains
  - Allow export policy $\Longrightarrow$ 0.20% higher gains

Concluding Remarks

- ***Bottomline:*** GE effects have important & non-trivial implications for trade policy.

- ***Next step:*** relax the linear cost assumption.
  - Marry the GE and traditional approaches.
  - Shed light on classical protectionist arguments (Graham 1923)

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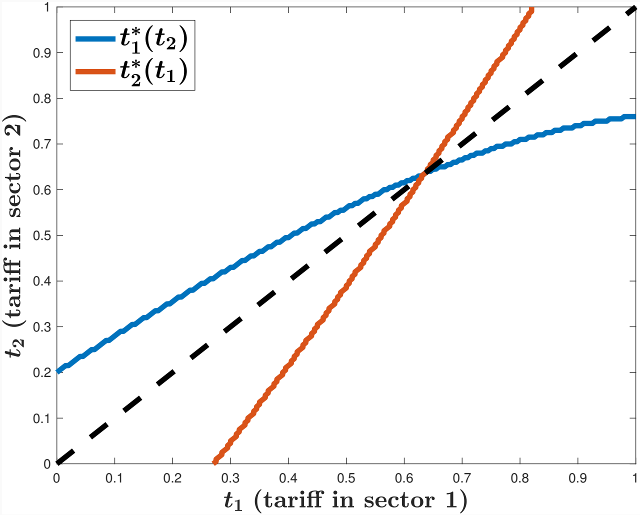
Special Case: *Costinot et al 2015, QJE*

- $\theta_k \to \infty \implies$ limit-pricing tax formula.
- Uniform tariff $\bar{t}^*$on import sectors.
- Tax on export sector:

$$\left(1 + \bar{t}^*\right)\left(1 + x_k^*\right) = \frac{\tilde{A}_{h,k}}{\tilde{A}_{f,k}} \tau_{hf,k} w$$

Return

Tariff Complementarity



Return