



# **Ninth ARTNeT Capacity Building Workshop for Trade Research "Trade Flows and Trade Policy Analysis"**

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# Partial-equilibrium (PE) trade policy analysis and simulation

# Content

- a. Market access analysis with PE modelling
- b. Basic PE model for analyzing welfare changes
- c. Empirical tool for trade policy simulations: SMART

## a. Market access analysis with PE modelling

- [Rationale](#) for market access analysis
- [Rationale](#) for PE modelling
  - Advantages
  - Disadvantages

## b. Basic PE model for analyzing welfare changes

- Derivation of social welfare function
- Perfect competition
  - Small open economy (SOE)
  - Large country

## Social welfare

- Each consumer  $h$  has quasi-linear utility function  $c_0^h + U^h(c^h)$
- Budget constraint:  $c_0^h + p'c^h \leq I^h$
- FOC:  $1 = \lambda$  and  $U' = \lambda p = p$  (demand for non-numeraire goods is independent of income)
- Demand functions are  $c^h = d^h(p)$  and  $c_0^h = I^h - p'd^h(p)$
- Welfare is defined as the sum of individual indirect utilities  $V^h$ :

$$W(p, I) \equiv \sum_{h=1}^H V^h = \sum_{h=1}^H \{I^h - p'd^h(p) + U^h[d^h(p)]\}$$

- Notice that:
  - $\sum_{h=1}^H I^h = I$  (total income)
  - $\frac{\partial W}{\partial I} = 1$  and (by envelope theorem)  $\frac{\partial W}{\partial p} = \sum_{h=1}^H -d^h(p) \equiv -d(p)$
  - $\sum_{h=1}^H \{-p'd^h(p) + U^h[d^h(p)]\} = CS$  (consumer surplus)

## Social welfare (ct'd)

- To simplify, let there be only one good subject to specific tariff  $t$
- World price is  $p^*$  and  $p = p^* + t$
- Numeraire good is freely traded at fixed world price of unity
- Labor is the only factor of production. Each unit of numeraire requires one unit of labor
  - Therefore,  $w = 1$  and  $WL = L$
- Output of the good subject to the tariff is  $y$ . Produced by firms with cost function  $C(y)$  and marginal costs  $C'(y)$
- Imports  $m = d(p) - y$ , with  $d'(p) < 0$
- Tariff revenue  $tm$  is redistributed to consumers
- Consumers are also entitled to profits from import-competing industry
  - Under perfect competition,  $py - C(y) = PS$  (producer surplus)
  - Under imperfect competition,  $py - C(y) = \pi$  (industry profits)
- Social welfare is then:

$$W(p, I) = W[p, L + tm + py - C(y)] \equiv W(t)$$

## Social welfare (ct'd)

- How does social welfare vary with the tariff?

$$dW = \underbrace{\frac{\partial W}{\partial p}}_{-d(p)} dp + \underbrace{\frac{\partial W}{\partial I}}_{=1} dI$$

$$dW = -d(p)dp + d[L + tm + py - C(y)]$$

$$dW = -d(p)dp + mdt + tdm + pdy + ydp - C'(y)dy$$

$$\frac{dW}{dt} = -d(p) \frac{dp}{dt} + m + t \frac{dm}{dp} \frac{dp}{dt} + y \frac{dp}{dt} + [p - C'(y)] \frac{dy}{dt}$$

$$\frac{dW}{dt} = t \frac{dm}{dp} \frac{dp}{dt} - m \frac{dp^*}{dt} + [p - C'(y)] \frac{dy}{dt} \quad (1)$$



## Perfect competition, SOE

- Perfect competition implies that  $p = C'(y)$
- SOE assumption implies that  $dp^*/dt = 0$ , therefore  $dp = dt$  (there is full pass-through of the tariff to domestic price)
- Equation (1) simplifies to:

$$\frac{dW}{dt} = t \frac{dm}{dp}$$

- Since  $\left. \frac{dw}{dt} \right|_{t=0} = 0$ , the optimal tariff for a SOE is zero

## Welfare loss from a tariff (SOE)

- Taking a second-order Taylor series approximation of welfare:

$$W(t) \approx W(0) + t \left. \frac{dW}{dt} \right|_{t=0} + \frac{1}{2} t^2 \left. \frac{d^2 W}{dt^2} \right|_{t=0}$$

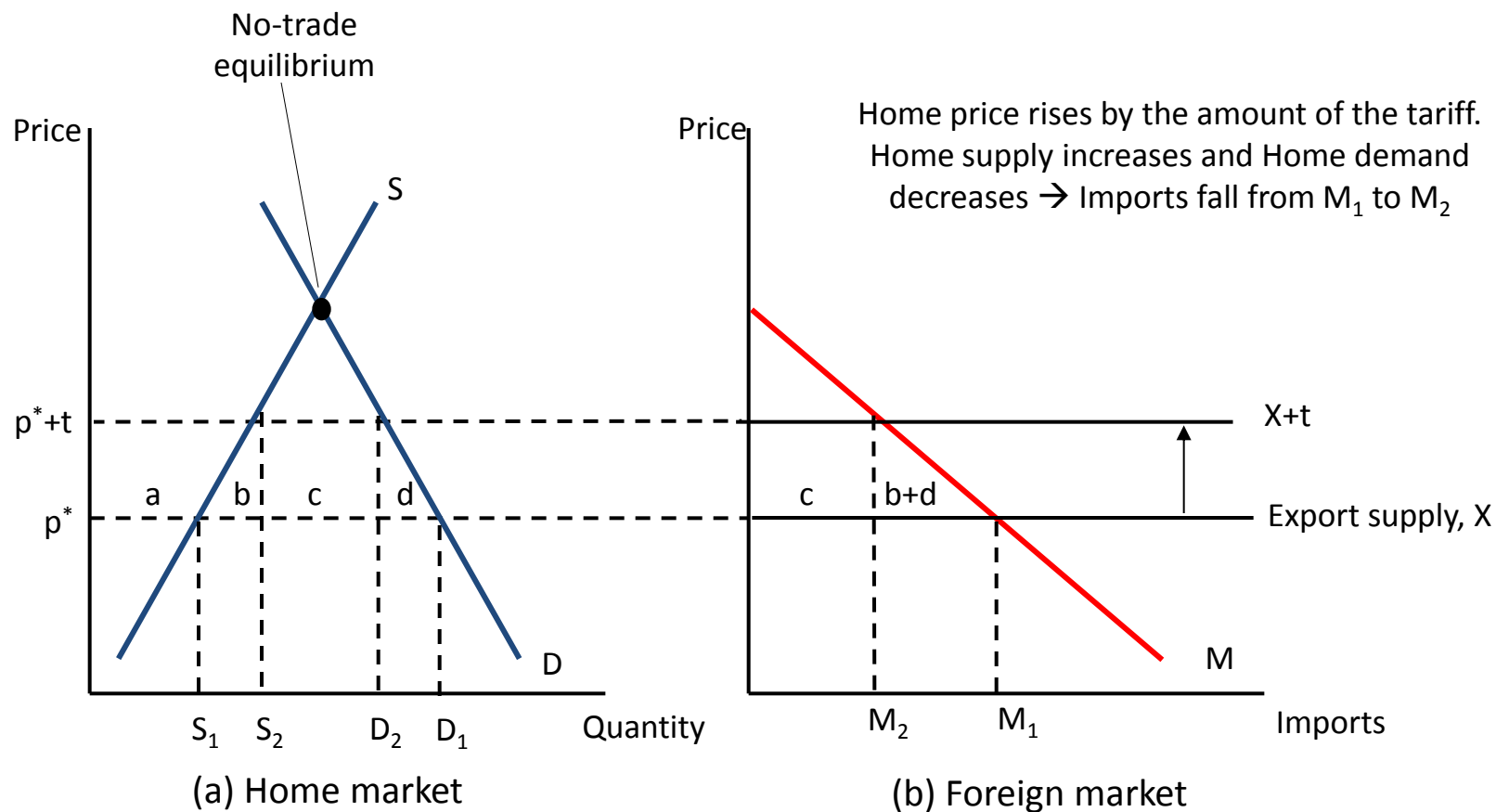
$$W(t) - W(0) \approx 0 + \frac{1}{2} t^2 \frac{dm}{dp} < 0$$

- This is the deadweight loss (DWL). It can also be expressed as fraction of import expenditure  $pm$ :

$$\frac{W(t) - W(0)}{pm} \approx \frac{1}{2} \left( \frac{t}{p} \right)^2 \underbrace{\left( \frac{dm}{dp} \frac{p}{m} \right)}_{IDE}$$

- E.g. with a 10% tariff and import demand elasticity (IDE) of 2, DWL (relative to import expenditure) is 1%

## Perfect competition, SOE: graphical representation



- CS loss =  $-(a+b+c+d)$
- PS gain =  $+a$
- Tariff revenues =  $c$
- DWL =  $b+d$  (also shown as triangle under import demand curve)

## Perfect competition, large country

- Large country assumption implies that  $dp^*/dt \neq 0$ , therefore  $dp/dt \neq 1$ 
  - $dp^*/dt < 0$  (intuitively, if a large country imposes a tariff it reduces its imports sufficiently to drive down the world price)
  - $dp/dt < 1$  (intuitively, the pass-through of the tariff is not full, and foreign exporters absorb part of the tariff in the form of lower world price ( $dp^*/dt < 0$ ))
- Equation (1) becomes:

$$\frac{dW}{dt} = t \frac{dm}{dp} \frac{dp}{dt} = -m \frac{dp^*}{dt} \quad (2)$$

- Therefore:

$$\left. \frac{dw}{dt} \right|_{t=0} = -m \frac{dp^*}{dt} > 0$$

- A small enough tariff will necessarily raise welfare for a large country
- What does “large” mean?

## Optimal tariff for large country

- “Large ” means that the export supply is upward sloping (i.e. elasticity of export supply is finite – vs. SOE case in which export supply is horizontal, i.e. infinitely elastic)
- Optimal tariff  $t^{opt}$  for such large country is computed where (2) equals 0:

$$\frac{dW}{dt} = 0 \Rightarrow \frac{t^{opt}}{p^*} = \left( m \frac{dp^*}{dt} \right) \left( \frac{dm}{dp} \frac{dp}{dt} \right)^{-1} \quad (3)$$

- Since domestic imports  $m =$  foreign exports  $x$ ,  $\frac{dm}{dp} \frac{dp}{dt} = \frac{dx}{dt}$ . Therefore:

$$\frac{t^{opt}}{p^*} = \left( \underbrace{\frac{dx}{dp^*} \frac{p^*}{x}}_{XSE} \right)^{-1} \quad (4)$$

- Optimal % tariff is equal to the inverse of the export supply elasticity (XSE)

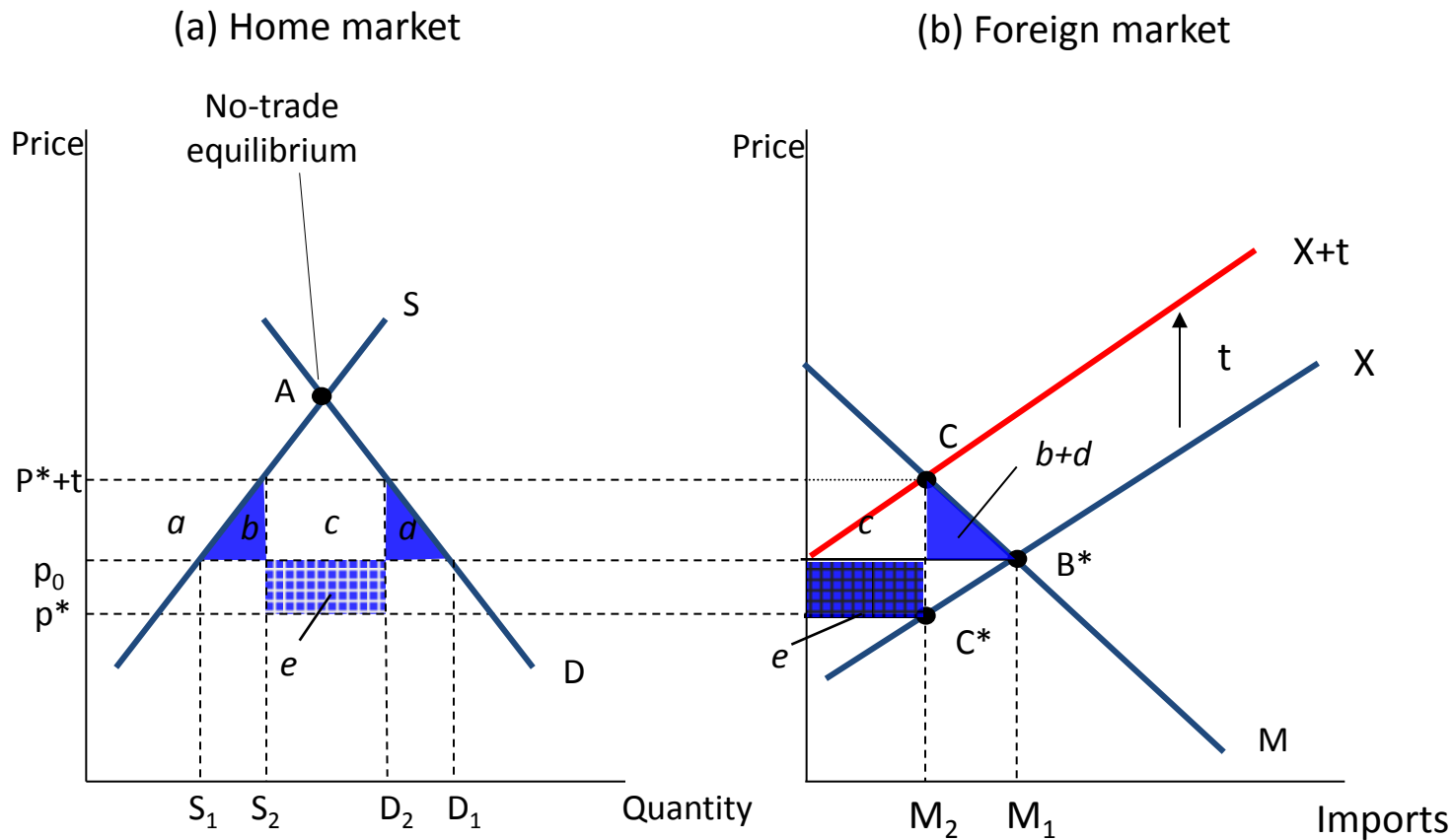
## Optimal tariff for large country (ct'd)

- Alternatively, equation (4) can be re-arranged to yield:

$$\frac{t^{opt}}{p} = \left( \underbrace{\frac{dm}{dp} \frac{p}{m}}_{IDE} \right)^{-1} \left( \frac{dp^*/dt}{dp/dt} \right)$$

- Optimal % tariff is larger:
  - the smaller the pass-through  $dp/dt$
  - ( $\Leftrightarrow$ ) the larger the terms-of-trade (TOT) gain  $dp^*/dt$

## Optimal tariff for large country: graphical representation



- The increase in the domestic price is less than the tariff ( $dp/dt < 1$ )
- Foreign exporters absorb part of the tariff ( $dp^*/dt < 0$ ): area "e" = TOT gain
- If the gain of e is greater than the DWL loss (b+d), Home gains

## Empirical evidence

- [Broda et al. \(2008\)](#) find that prior to WTO membership, countries set import tariffs 9 percentage points higher on inelastically supplied imports relative to those supplied elastically
- See [bonus exercise](#) for a replication of their results
- See also the R. Feenstra, “Advanced International Trade” (Princeton, 2004), Chapter 7, Section “Tariffs on Japanese Trucks and Motorcycles” (pp. 233-240).



## c. Empirical tool for trade policy simulations: SMART

- Chapter 4 of the [Practical Guide to TPA](#) discusses various empirical tools
- Here we use SMART (built-in in WITS)

### SMART

- [Overview](#)
- [Theoretical underpinnings](#)
  - [Export supply side](#)
  - [Demand side](#)
- [Effects of policy changes](#)
  - [Trade effects](#)
  - [Effects on Tariff Revenue, Consumer Surplus and Welfare](#)
- More details and formulas in [Jammes and Olarreaga \(2005\)](#)

## SMART example: Albania's unilateral trade liberalization with the EU

- In 2007, Albania sourced buses (HS 870210) from 19 trading partners, of which 11 were European Union countries
- Albania levied tariffs from all sources, including the EU
- Using SMART, the user can simulate the effect of a full trade liberalization towards the EU, but not to the rest of the world
- SMART yields the results that all 11 EU countries would be able to increase their exports to Albania, for example Germany, the biggest exporter, by almost 1 million USD
- Non-EU countries, by contrast, would see their shares shrink, in particular the US, by about 0.3 million USD
- SMART results indicate that the tariff liberalization would:
  - Increase imports
  - Lower tariff revenues
  - Raise consumer surplus (Albania is a SOE)
- Results in [this](#) folder