

14.03/14.003 Recitation 7

Midterm 2 Review

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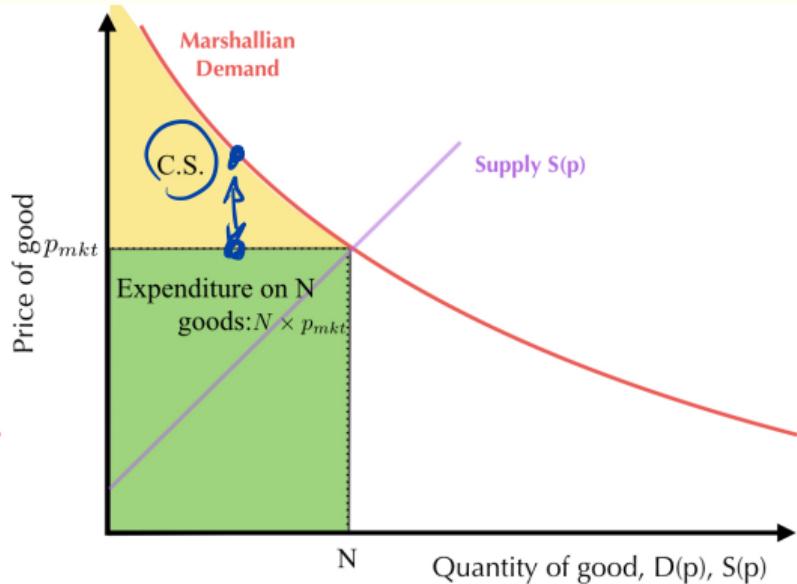
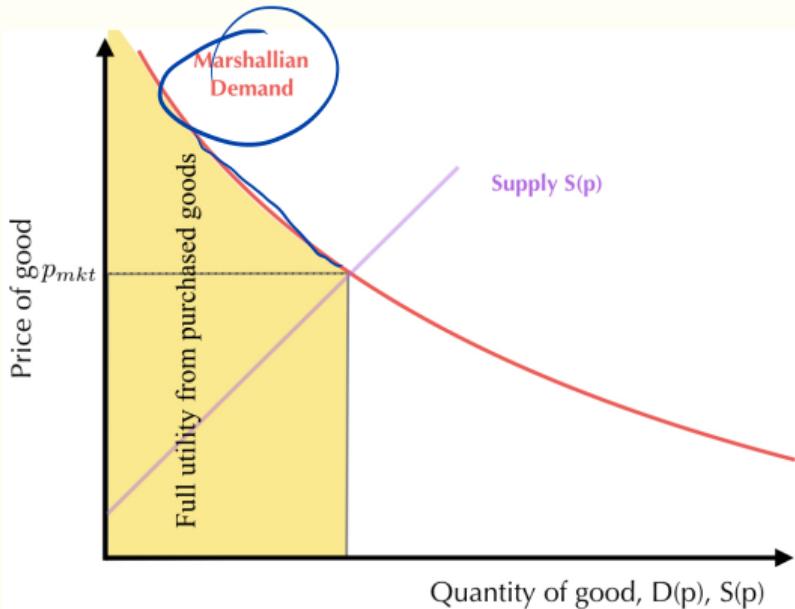
Agenda

- Applied Competitive Analysis: Producer and Consumer Surplus.
- Deadweight loss and how to compute it.
- General equilibrium in pure exchange.
- Gains from international trade relative to autarky, endowment, and within-country trade.

Demand and Supply, PS and CS

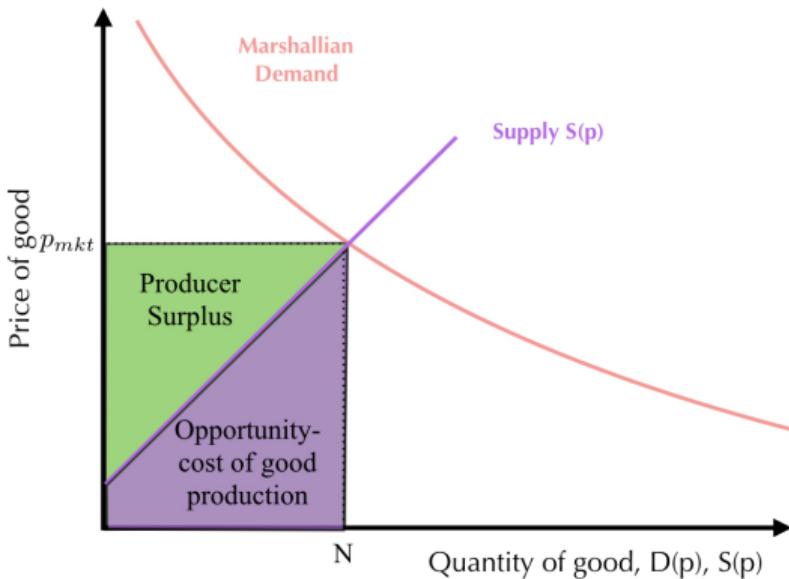
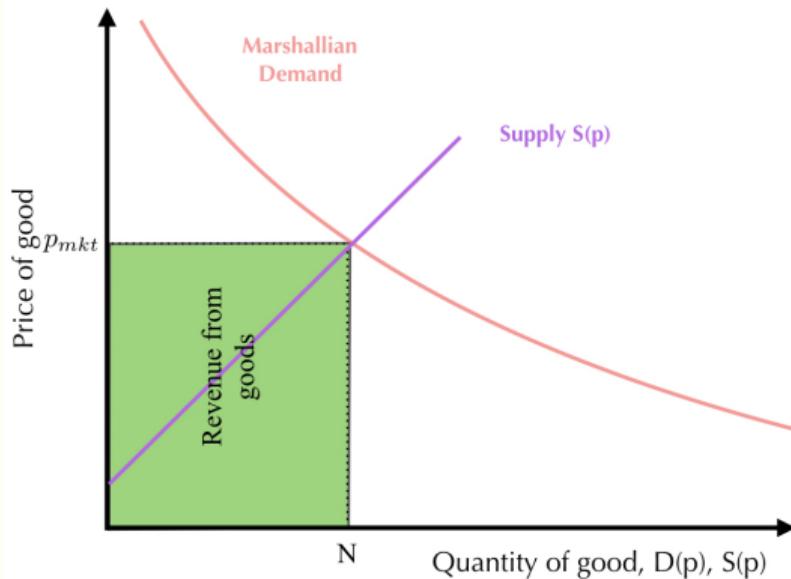
- Market demand curve: the set of consumers arranged in inverse ordering from the person with the highest willingness to pay (WTP) to the person with the lowest WTP for a commodity. It is aggregated from Marshallian demands.
- Market supply curve: the set of producers arranged in order from the firm willing to produce at the lowest price to the firm demanding the highest price to produce a good.
- Consumer surplus: the difference between the maximum value that a consumer is willing to pay for a quantity of commodity minus the market price of that quantity of commodity.
- Producer surplus: what the producer receives for goods in excess of the cost of production.
- A competitive market maximizes the sum of producer and consumer surplus: all gains from trade are realized; all transactions that benefit both parties occur; no transactions occur that do not benefit both parties.

Demand and CS



Left: Demand curve. Each value on the vertical axis is the valuation of marginal units by the consumer. Shaded area is total willingness to pay for all units up to N (utility in dollar terms from consuming N). Right: CS is the total willingness to pay for N goods minus the expenditure on those goods.

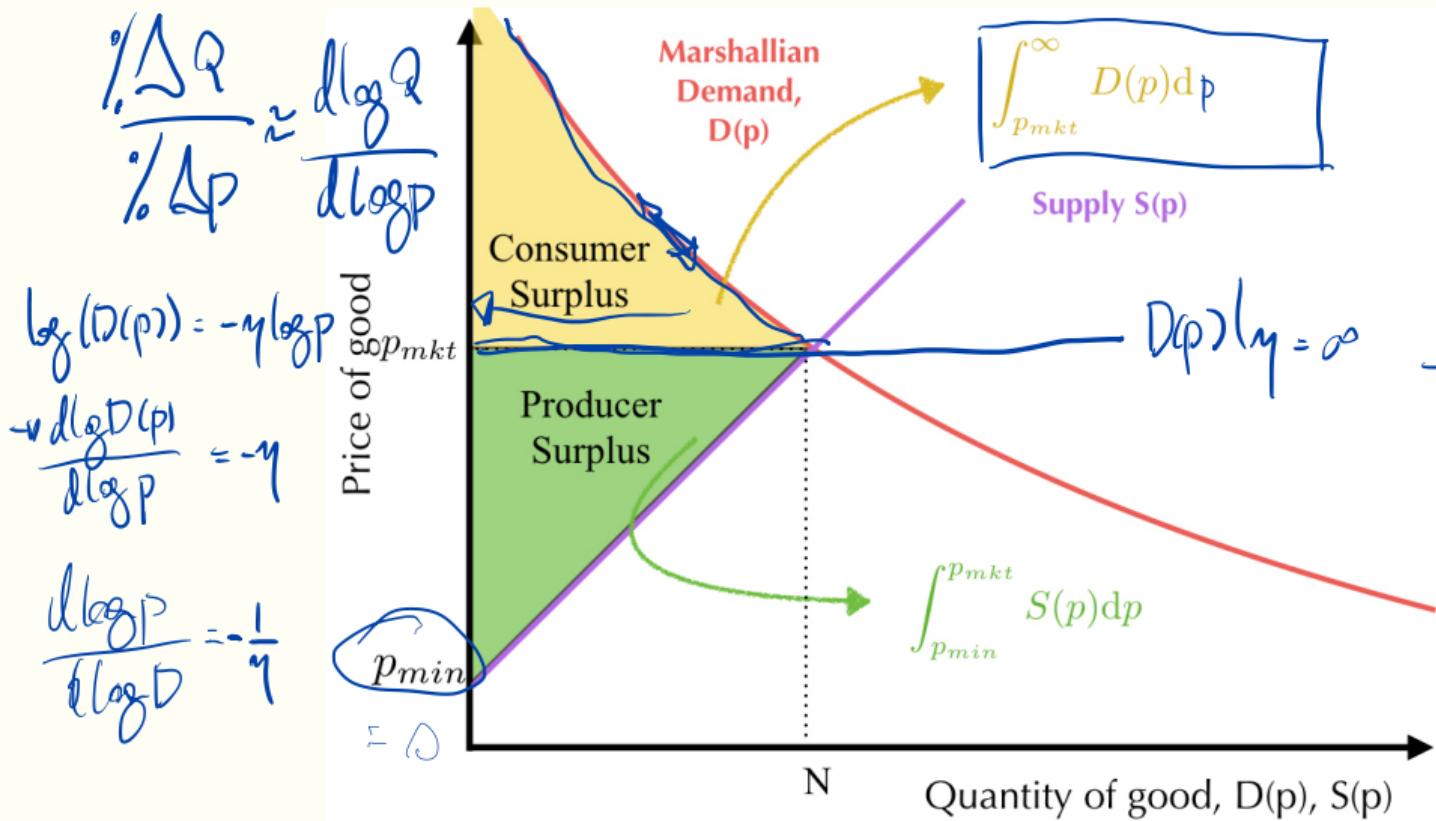
Supply and PS



Left: Shaded area is total revenue received by supplier.

Right: PS is the total revenue for N goods minus the total opportunity cost of the resources employed for the production of N goods. The Supply gives the marginal opportunity cost of each unit of the good.

Computation



CS and PS computations

Denote the equilibrium price before a price change as p_{mkt} .

Consumer surplus is the region below the demand curve and above the price, and is equal to:

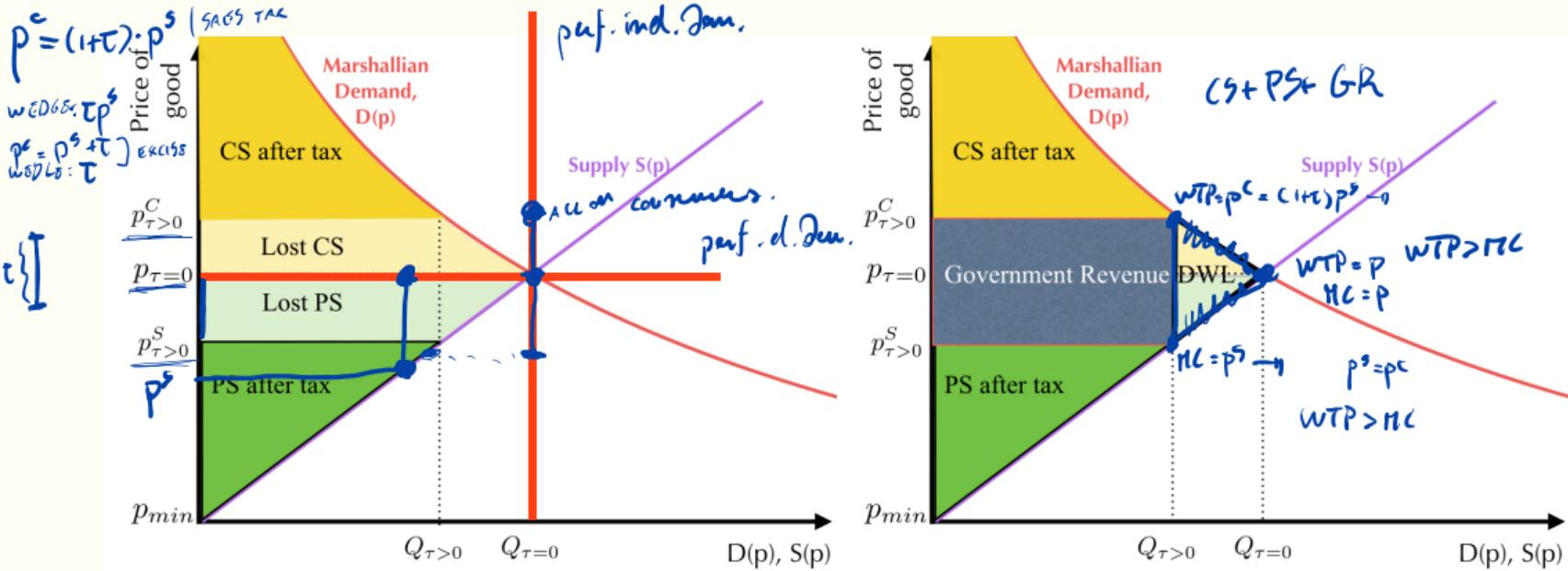
$$\int_{p_{mkt}}^{\infty} D(p)dp.$$

Let p_{min} denote the price required to supply 0 units of the good. Producer surplus is the region below the market price and above the supply curve, and is equal to:¹

$$\int_{p_{min}}^{p_{mkt}} S(p)dp.$$

¹Usually $p_{min}=0$.

DWL from a Tax and Surplus Changes



Left: Lost CS is the area under the demand curve between the price after-tax and that before tax. Lost PS is the area above the supply curve between the price before tax and that after-tax.

Right: Part of the lost surplus goes to the government in the form of tax revenues. DWL is given by the loss of efficient exchanges caused by the tax.

Surplus Change Computations and DWL

Suppose that the tax changes the price paid by consumers (from $p_{\tau=0}$ to $p_{\tau>0}^C$) and received by suppliers (from $p_{\tau=0}$ to $p_{\tau>0}^S$). Then, the change in consumer surplus is:

$$\Delta CS = \int_{p_{\tau>0}^C}^{\infty} D(p)dp - \int_{p_{\tau=0}}^{\infty} D(p)dp = \boxed{\int_{p_{\tau=0}}^{p_{\tau=0}^C} D(p)dp}$$

C.S. AFTER
C.S. BEFORE

The change in producer surplus is:

$$\Delta PS = \int_{p_{min}}^{p_{\tau>0}^S} S(p)dp - \int_{p_{min}}^{p_{\tau=0}} S(p)dp = \boxed{\int_{p_{\tau=0}}^{p_{\tau>0}^S} S(p)dp}$$

$p(Q) = Q(p)$

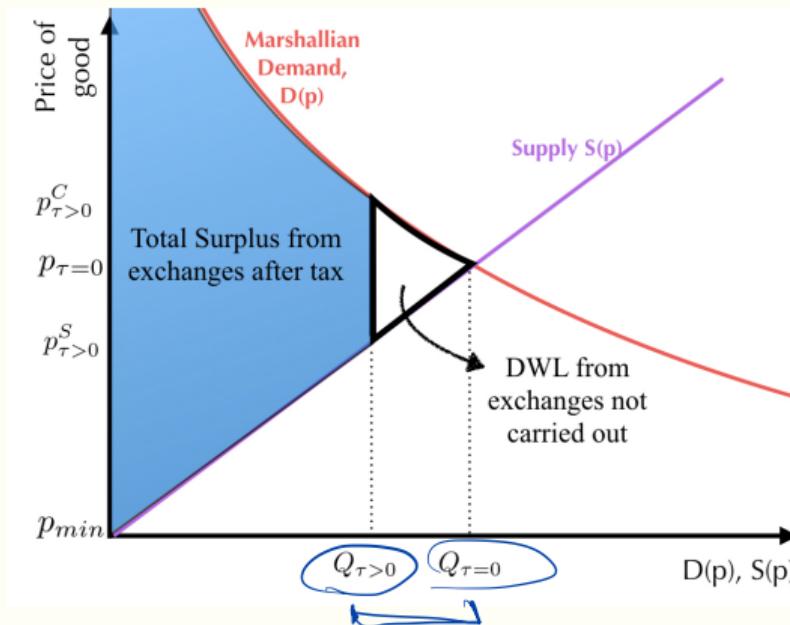
DWL is then given by:²

$$DWL = \Delta CS + \Delta PS + \text{Government Revenue.}$$

< 0

²For how we wrote the integrals, this quantity is negative, but this is just a convention, we could flip all signs and write DWL as a positive quantity (absolute value).

DWL Depends Only on Quantity Adjustments...



DWL comes from lost exchanges, prices only determine how this loss is shared by consumers versus producers. Of course the size of the DWL will depend on the smallest elasticity across the two agents. If any of the two parties is fully inelastic, there is no DWL.

...but Incidence Depends on Relative Elasticity

Remember the inverse elasticity formula. With demand and supply:

$$D(p) = p^{-\eta}, \quad S(p) = p^{\varepsilon}$$

the tax burden on consumer is:

$$\frac{\varepsilon}{\eta + \varepsilon} \tau,$$

- exact if: $p^{\text{SUS FTR}}$
1. D,S are INELASTIC
 2. TAX is proportional
(SALES TAX)
 3. Change is small
(τ is small)

$$\frac{|\eta|}{|\eta + \varepsilon|} \tau.$$

and on producer is:

Finally, if you have a percent tax, so that:

$$p^C = (1 + \tau)p^S,$$

$$p^C = p^S + t$$

the percent change in quantity,

which determines the DWL, is approximately:

$$\% \Delta Q = -\frac{\eta \varepsilon}{\eta + \varepsilon} \tau.$$

$$\begin{aligned} \varepsilon &= 0 \Rightarrow \text{NO TRADES} \\ \eta \rightarrow \infty &\approx -\varepsilon \tau \end{aligned}$$

General Equilibrium in Pure Exchange

A General Equilibrium is a set of **prices** $\{p_1, p_2\}$, and **allocations** for consumption $\{\underline{c}_1, \underline{c}_2\}$ such that, given initial endowments of goods $\underline{e}_1, \underline{e}_2$:

- ① Consumers choose consumption $\{\underline{c}_1, \underline{c}_2\}$ subject to their budget constraint for given **prices**;
- ② The good markets clear.

Solving GE \rightarrow (NOT MOL. PURE EXCHANGE)

- ① Technology \Rightarrow PPF (in pure exchange this is just given by the endowments);
- ② Preferences \Rightarrow Indifference curves;
- ③ Endowments with 1 and 2 \Rightarrow price ratio.

Solving GE in Pure Exchange

GE is given by the point **in the Edgeworth box** such that indifference curves are tangent to each other and utility is maximized for given initial endowments, and the price ratio that is tangent to the indifference curves.

Steps:

- ① Solve the consumer problem for given income I for both consumers;
- ② For each consumer, set $I = p_1 e_1 + p_2 e_2$, find c_1, c_2 as a function of price ratio;
- ③ Impose market clearing: $c_1^1 + c_1^2 = e_1^1 + e_1^2 = E_1$.³

$$\frac{p_2}{p_1}$$

³Superscripts denote the agent's identity, subscripts the goods.

Edgeworth Box: An example

Consider an economy with two goods, x and y , and two agents, A and B, with preferences:

$$U^A(x^A, y^A) = x^A \times y^A,$$

(1)

$$U^B(x^B, y^B) = (x^B)^{\frac{2}{3}} \times (y^B)^{\frac{1}{3}},$$

(2)

$$p_x = 1 \quad p = p_y / p_x = p_y$$

denote the price ratio $p_y/p_x \equiv p$ (level does not matter), and let the total endowments of goods be $X=10$, $Y=10$, and denote individual endowments by e_{good}^i for good in $\{x, y\}$ and i in $\{A, B\}$.

The budget constraint for each agent i is then: *in case from endowments*

$$\boxed{x^i + py^i = I^i = e_x^i + p e_y^i}$$

(3)

The general equilibrium of this economy is an allocation $\{x^A, y^A, x^B, y^B\}$ and a price p , such that $\{x^A, y^A\}$ and $\{x^B, y^B\}$ maximize (1), (2) subject to (3), and markets clear, that is:
Total cons. Total Endow.

$$\boxed{x^A + x^B = e_x^A + e_x^B = X, \quad y^A + y^B = e_y^A + e_y^B = Y}$$

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Example Solution

$$U(x^A, y^A) = x^A y^A \quad \Rightarrow \quad x^A = \frac{I}{2P} \xrightarrow{\text{END.}} \frac{1+9P}{2} = x^A$$

s.t. $x^A + py^A = I$

$$y^A = \frac{I}{2P} = \frac{I}{2P} \rightarrow y^A = \frac{1+9P}{2P}$$

$$U(x^B, y^B) = (x^B)^{2/3} (y^B)^{1/3} \Rightarrow x^B = \frac{I}{2/3} \quad y^B = \frac{1}{3} \frac{I}{P}$$

$$X = 10 \quad Y = 10$$

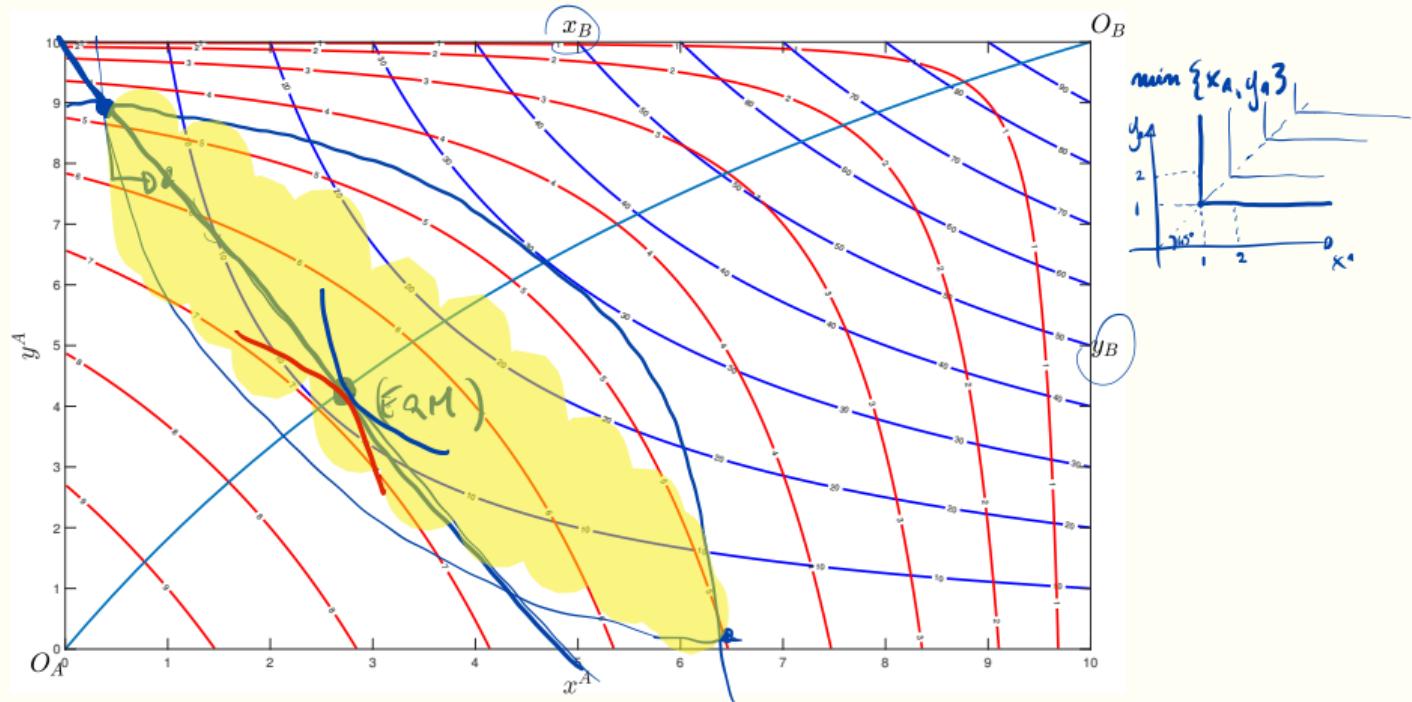
$$x^B = \frac{2}{3}[9+P] \quad y^B = \frac{1}{3} \frac{[9+P]}{P}$$

$$x^A = 1 \quad y^A = 9 \quad x^B = 9 \quad y^B = 1$$

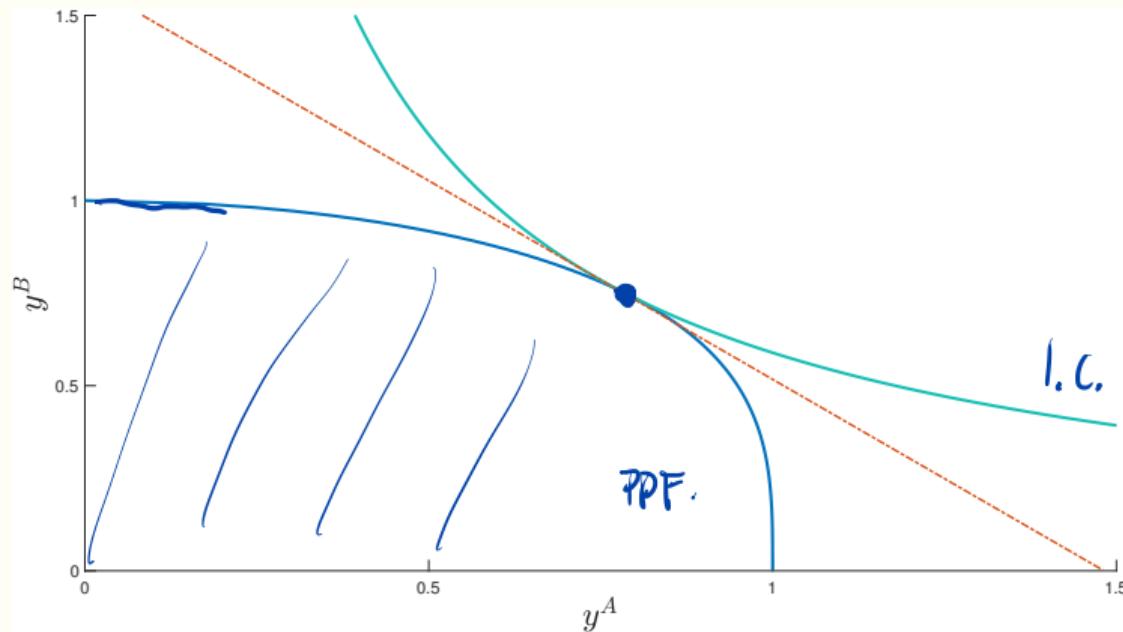
$$x^A + x^B = X = 10 = \frac{18+2P}{3} + \frac{1+9P}{2} =$$

$$\approx \frac{36+4P+3+27P}{6} = 10 \quad 31P = 60 - 11 = 49 = \frac{29}{51}$$

Edgeworth Box: Indifference curves for A and B



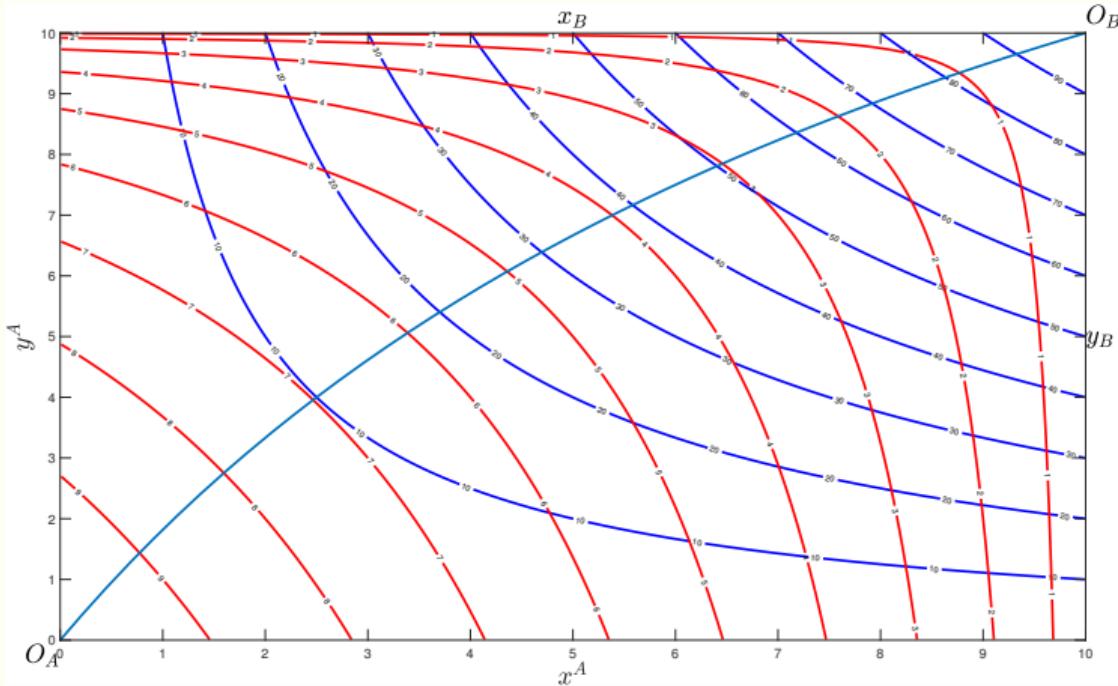
GE with Production in Autarky: Equilibrium



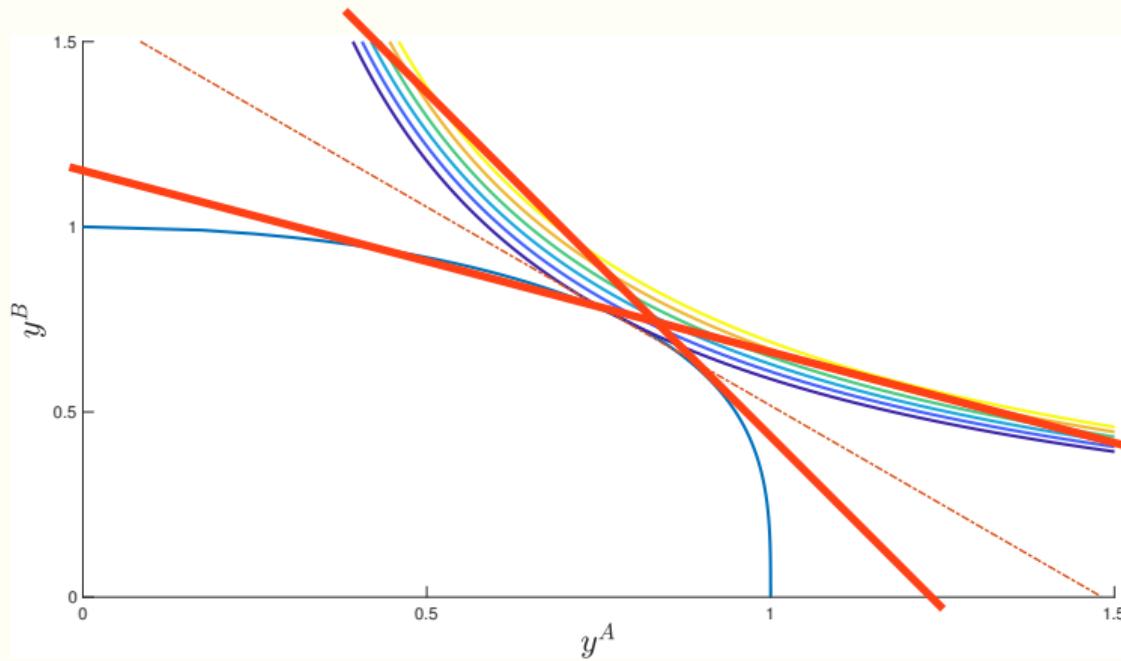
Trade as Constraint-Relaxation

- A Pareto-Improvement will be realized when trade relaxes a constraint.
- Within-country trade always generates a Pareto-improvement *relative to endowment consumption*. The relaxed constraint is consuming **one's own endowment**, now all trades starting from it are possible.
- International trade always generates a Pareto-improvement *relative to production in autarky without within-country exchange*. The relaxed constraint is consuming along the PPF at **domestic price ratio**, now all trades starting from it are possible.
Moreover, gains from specialization and comparative advantage.
- However, international trade does not *always* generate a Pareto-improvement *relative to within-country exchange*. Allocation before: pure exchange economy between different parts of the economy. Allocation after: trade with abroad at different price ratio.
- In the last case, agents that are endowed with more of the relatively expensive good benefit gain, while those with more of the relatively cheap good lose (see ADH Figure in next slides).

International trade versus endowment



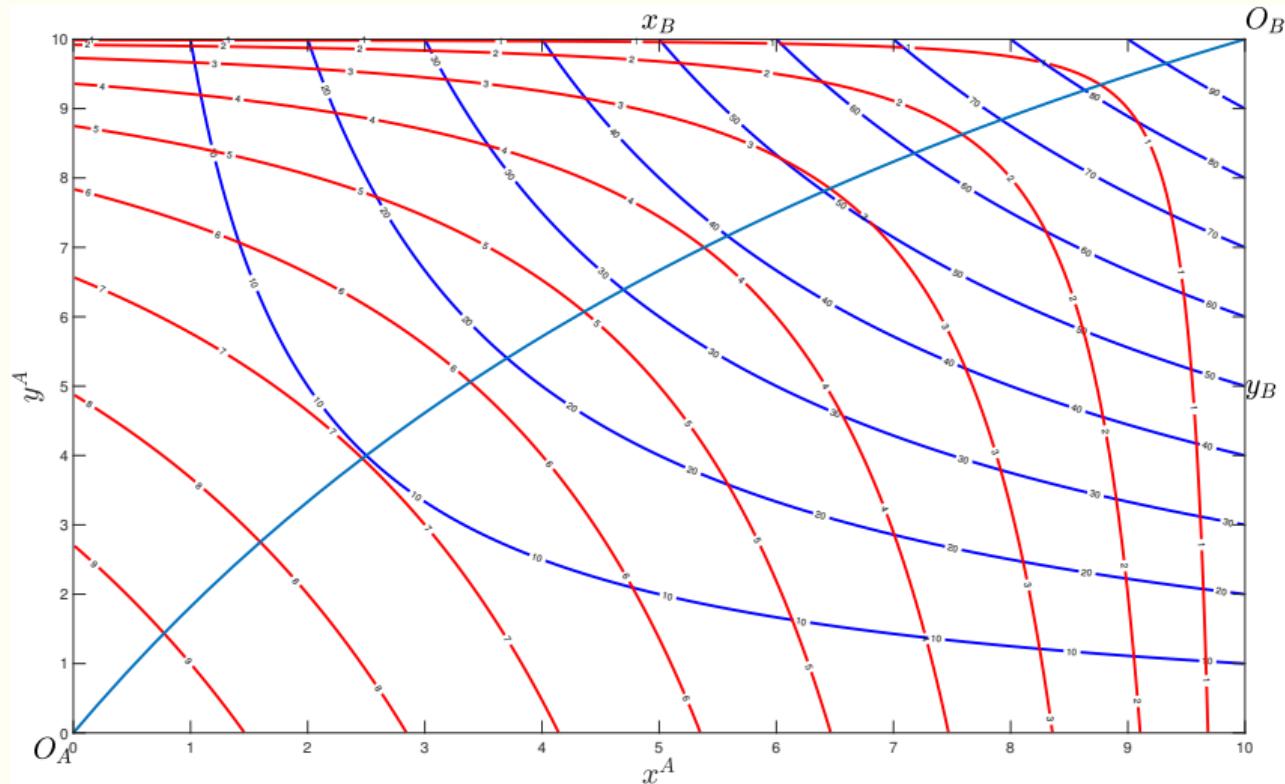
GE with Production: Trade



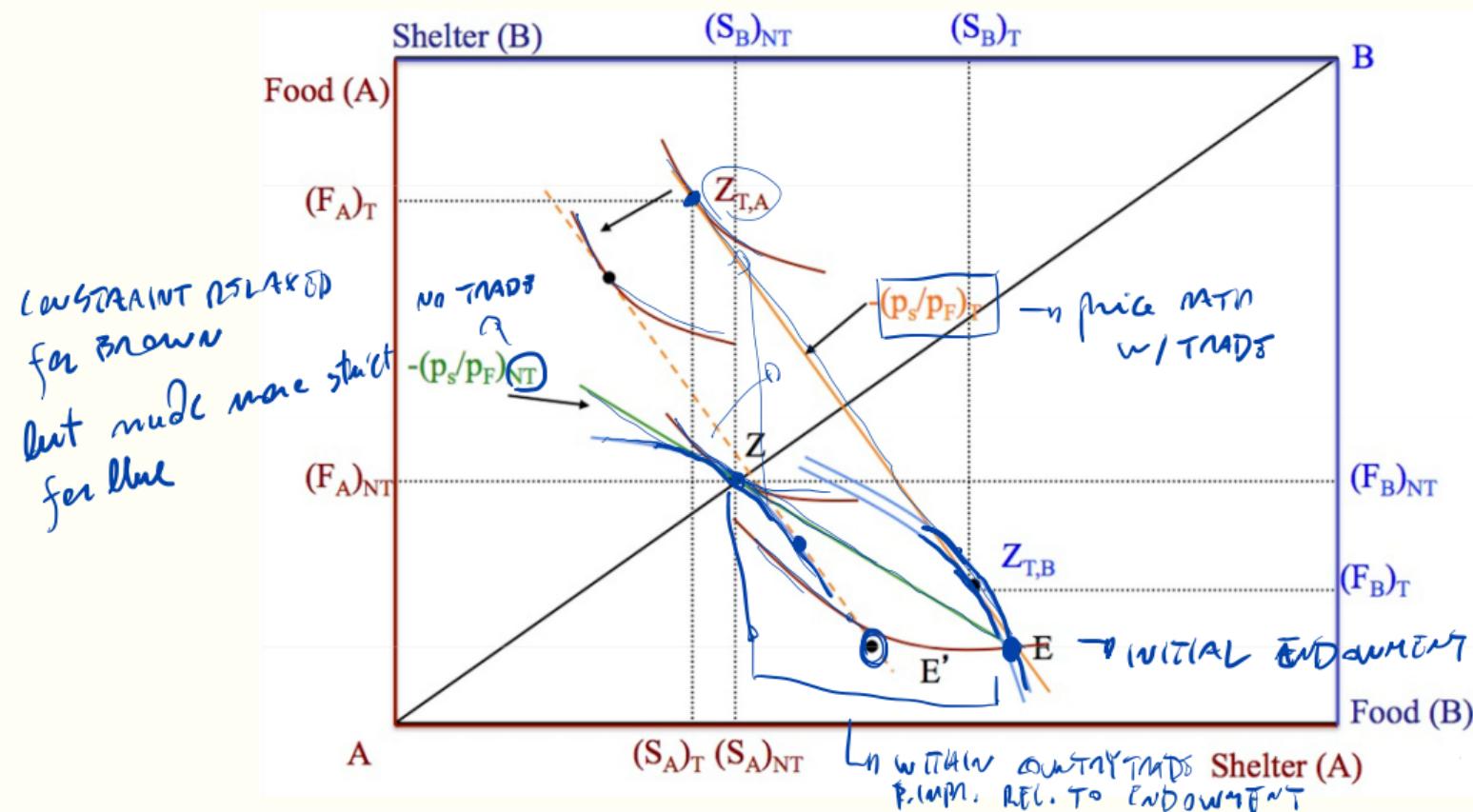
Gains arise if the country has comparative advantage relative to abroad. That is,

$$\left(\frac{p^A}{p^B} \right)_{\text{Autarky}} \neq \left(\frac{p^A}{p^B} \right)_{\text{Trade}}.$$

International versus Within-Country Trade



International versus Within-Country Trade II



May Léon Walras be with you...

