Aalto University
School of Business

Intermediate Microeconomics

Welfare analysis and market interventions, Exchange

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Welfare analysis

Total surplus or "welfare" generated in a market includes

- Consumer surplus CS
- Producer surplus PS
- Public sector ("Government") revenue T and spending G
- All components in money metric units

$$\mathrm{W} = \mathrm{CS} + \mathrm{PS} + \mathrm{T} - \mathrm{G}$$

Welfare analysis: What is the impact of the policy on W, both in total and by component? Does not take into account...

- Distributional impact within component
- MB of spending T elsewhere differ from one
- MC of obtaining funds G elsewhere to spend here differ from one

Market interventions

- Taxes and subsidies
- Incidence of taxes and subsidies
  (*verotuksen ja tukien kohtaanto*)
- Price regulation
  (*hintasäätely*)
- Production and consumption quotas
  (*tuotanto- ja kulutuskiintiöt*)
- Price support
  (*tukiostot*)

Taxation

With unit tax t buyers pay more than sellers get:

$P_b = P_s + t$ per unit

- Welfare effects of an increase in t:
  PS and CS decreased more than T can grow, so DWL>0
- Marginal Cost of Public Funds (MCPF):
  marginal welfare cost of marginal increase in T
- Laffer curve: relation of tax revenue and tax level

Proportional tax works the same, but graphs more complicated

$P_B = (1 + \tau)P_s$ or $P_S = (1 - \tau')P_b$

Incidence of Taxation

Price without tax is between buyer and seller prices, $P_s \leq P^* \leq P_b$

Incidence: who "really pays" the tax?

$t = (P_b - P^*) + (P^* - P_s)$

Depends on shapes of demand and supply curves

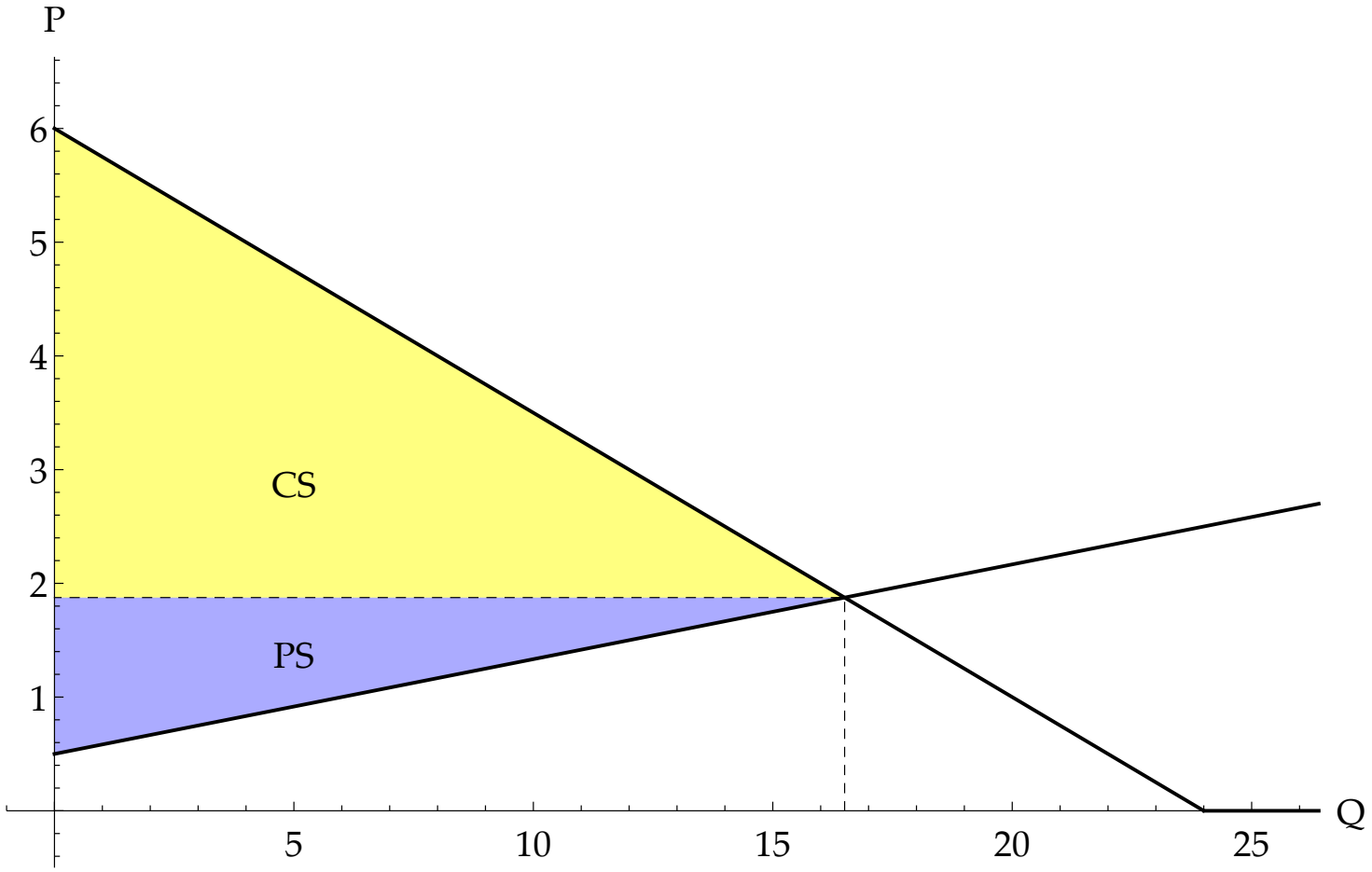
Less elastic side tends to pay more of the tax

Does not depend on the legal incidence of taxation in LR

Legal incidence matters in SR for surprise changes in taxation

LR impact includes entry and exit of producers

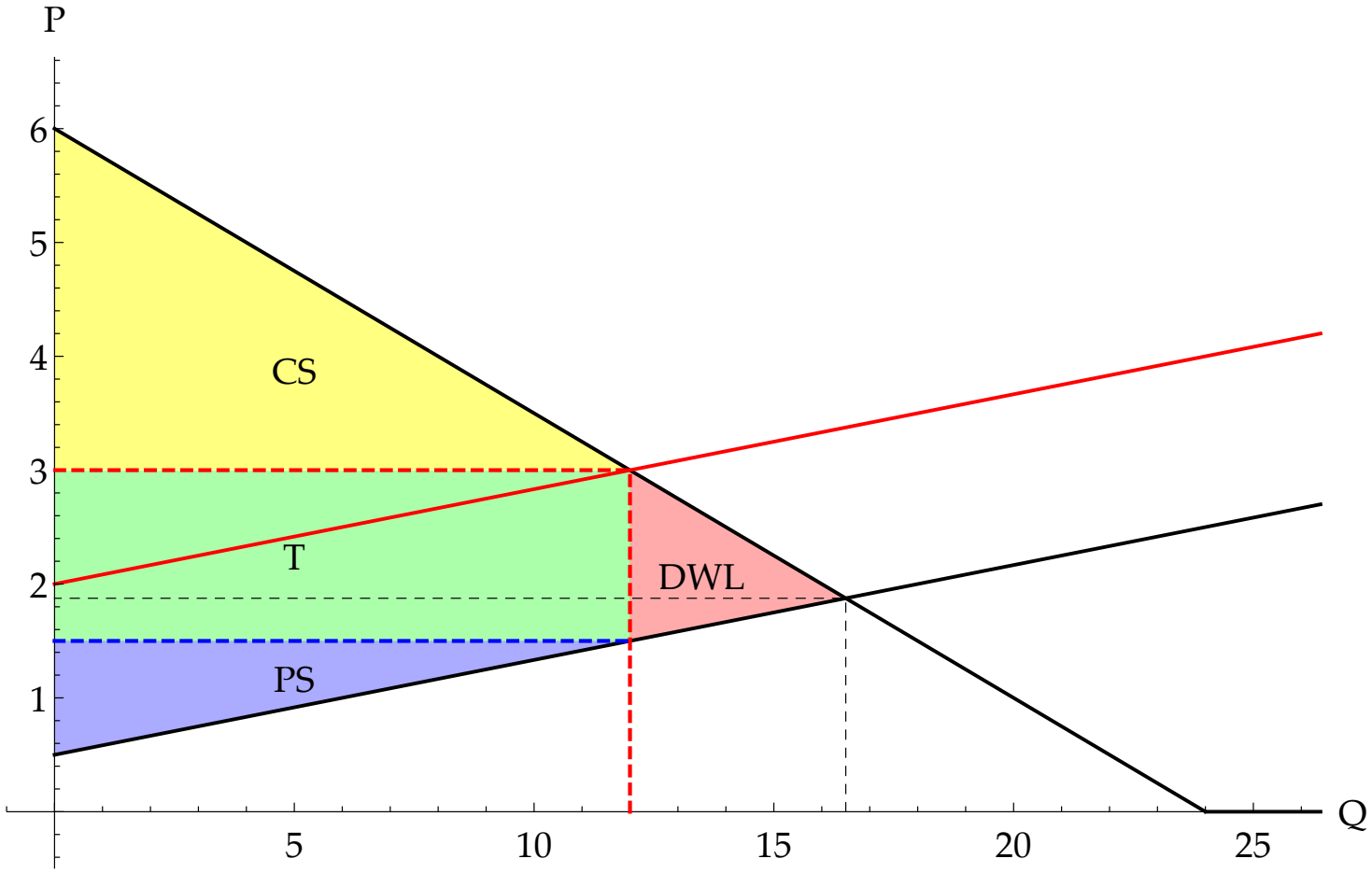
Unit tax: Example



$Q^d(p) = 24 - 4p \iff P^d(q) = 6 - \frac{q}{4}$ $\quad$ $Q^s(p) = 12p - 6 \iff P^s(q) = 0.5 + \frac{q}{12}$

No tax: $p^* = 1.875$, $q^* = 16.5$, CS ≈ 34.0, PS ≈ 11.3, W ≈ 45.4

Unit tax: Example

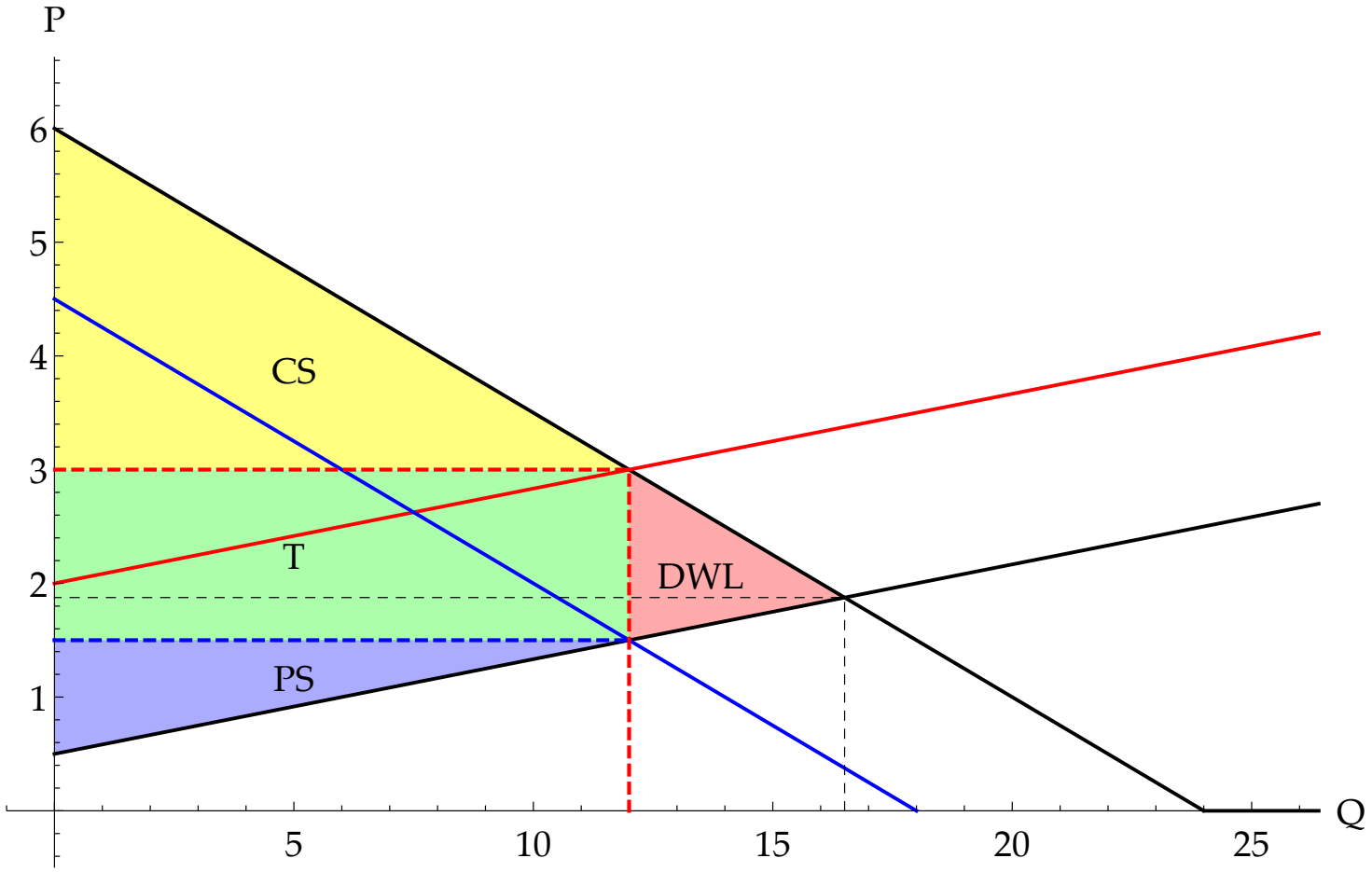


Unit tax $t = 1.5 \Longrightarrow p_b - p_s = 1.5$. In equilibrium $Q^d(p_s + t) = Q^s(p_s)$

$24 - 4(p_s + 1.5) = 12p_s - 6 \Longrightarrow p_s^t = 1.5 \Longrightarrow p_b^t = 1.5 + t = 3, q^t = 12$

$\mathrm{CS}^t = 18, \mathrm{PS}^t = 6, \mathrm{T} = tq^t = 18, \mathrm{W}^t = 42$

Unit tax: Example



Unit tax t can be interpreted as a negative supply shock $P^{s\prime}(q) = P^s(q) + t$, or as a negative demand shock $P^{d\prime}(q) = P^d(q) - t$.

Welfare effects: $\Delta\text{CS} \approx -16.0$, $\Delta\text{PS} \approx -5.3$, $\Delta\text{T} = 18$, $\Delta\text{W} \approx -3.4$ DWL=3.4

Incidence of a unit tax: the welfare effects

Welfare

$W = CS + PS + T - G$

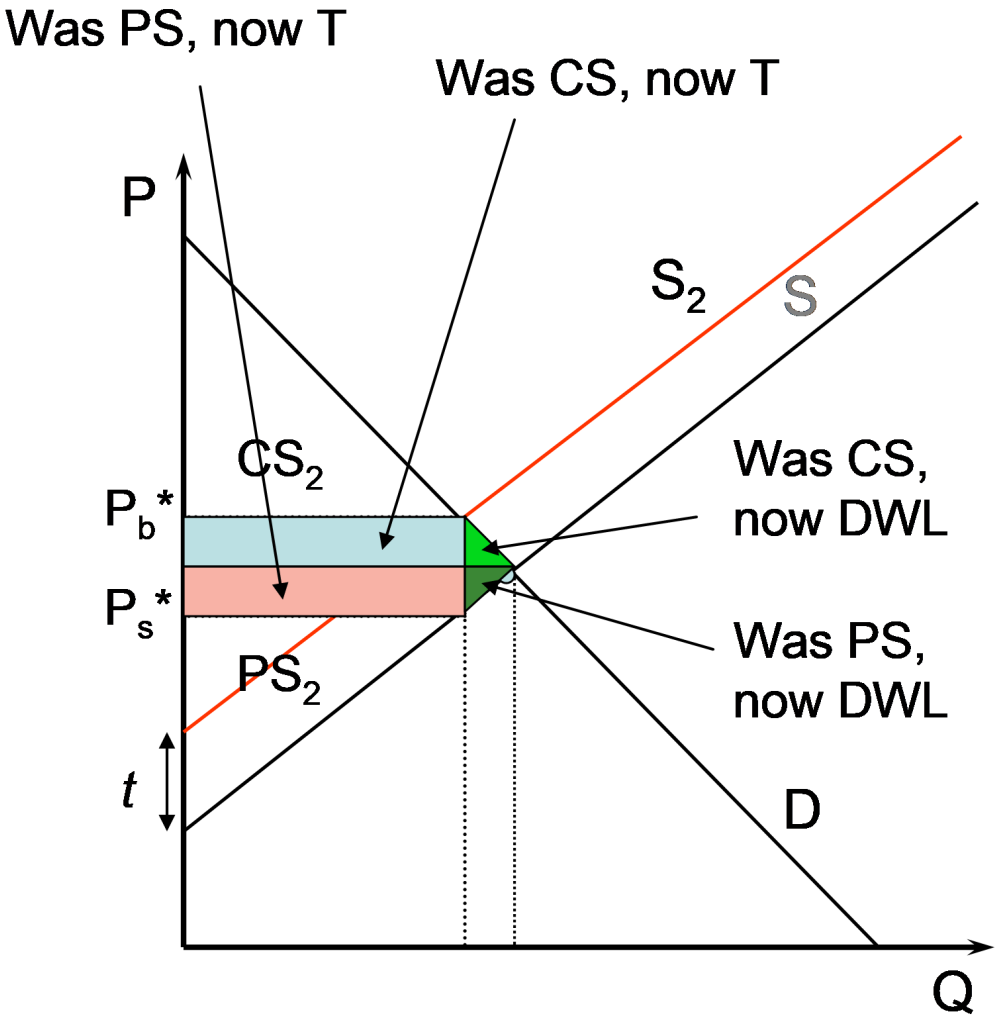
Welfare effects

$\Delta W = \Delta CS + \Delta PS + \Delta T - \Delta G$

DWL of a tax:

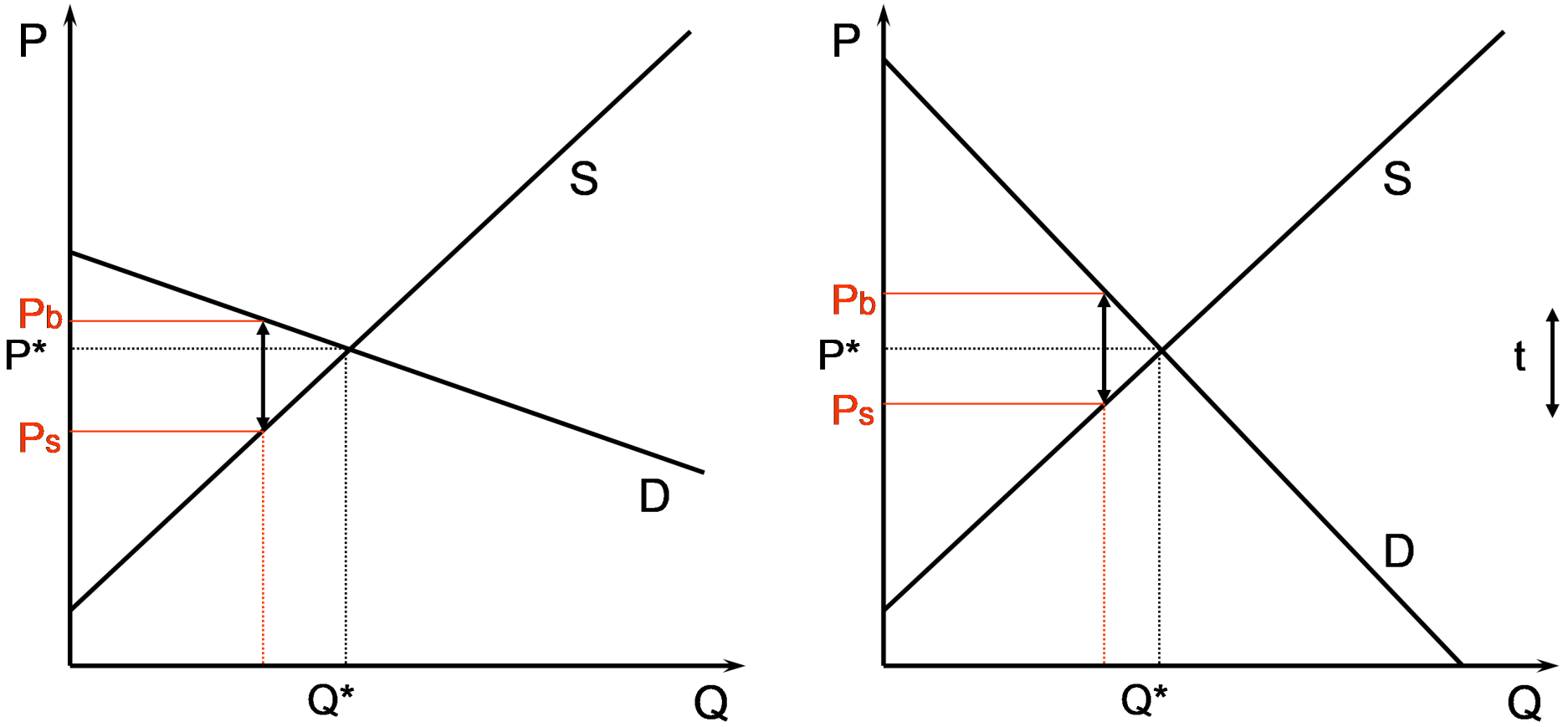
How much lower is W compared to if the tax were zero.

($\Delta W<0$ when a tax is introduced.)



With a unit tax of *t*, $P_b^* - P_s^* = t$

Incidence of Taxation and Elasticity



Two markets, same supply, same pre-tax equilibrium $\{Q^*, P^*\}$, same unit tax t imposed on both. Demand is more elastic in the left, and bears less of the tax burden.

How does DWL depend on elasticity? What kind of a tax would cause no DWL?

Tax rate and tax revenue

Laffer curve: relation between tax level (or rate) and tax revenue

Solve equilibrium and tax revenue as function of t

$$Q^d(p_s + t) = Q^s(p_s) \Longrightarrow P_s(t) \Longrightarrow Q^t(t) := Q^s(P_s(t))$$

$$T(t) = tQ^t(t)$$

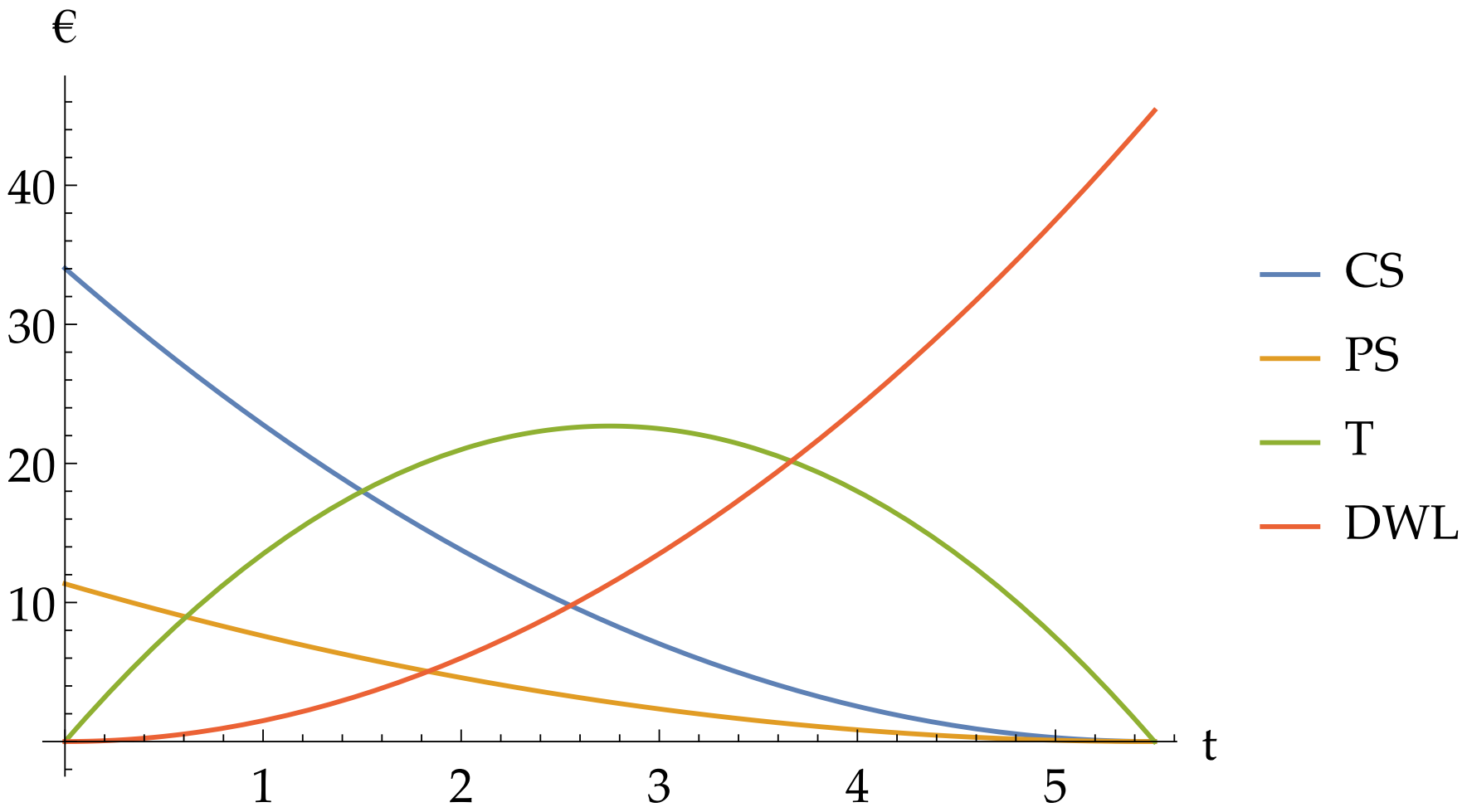
Example, continued

$$24 - 4(p_s + t) = 12p_s - 6 \Longrightarrow P_s(t) = \frac{30 - 4t}{16}$$

$$Q^t(t) = 12 \times \frac{30 - 4t}{16} - 6 = 16.5 - 3t$$

$$T(t) = t \times (16.5 - 3t) = 16.5t - 3t^2$$

Tax rate and welfare effects



Welfare burden of taxation increases faster at higher t.
Tax revenue would be maximized at $t = 2.75$, where $T'(t) = 0$.

Marginal Cost of Public Funds

MCF (aka MCPF) needed in cost-benefit analysis of public projects, to be compared with project MB

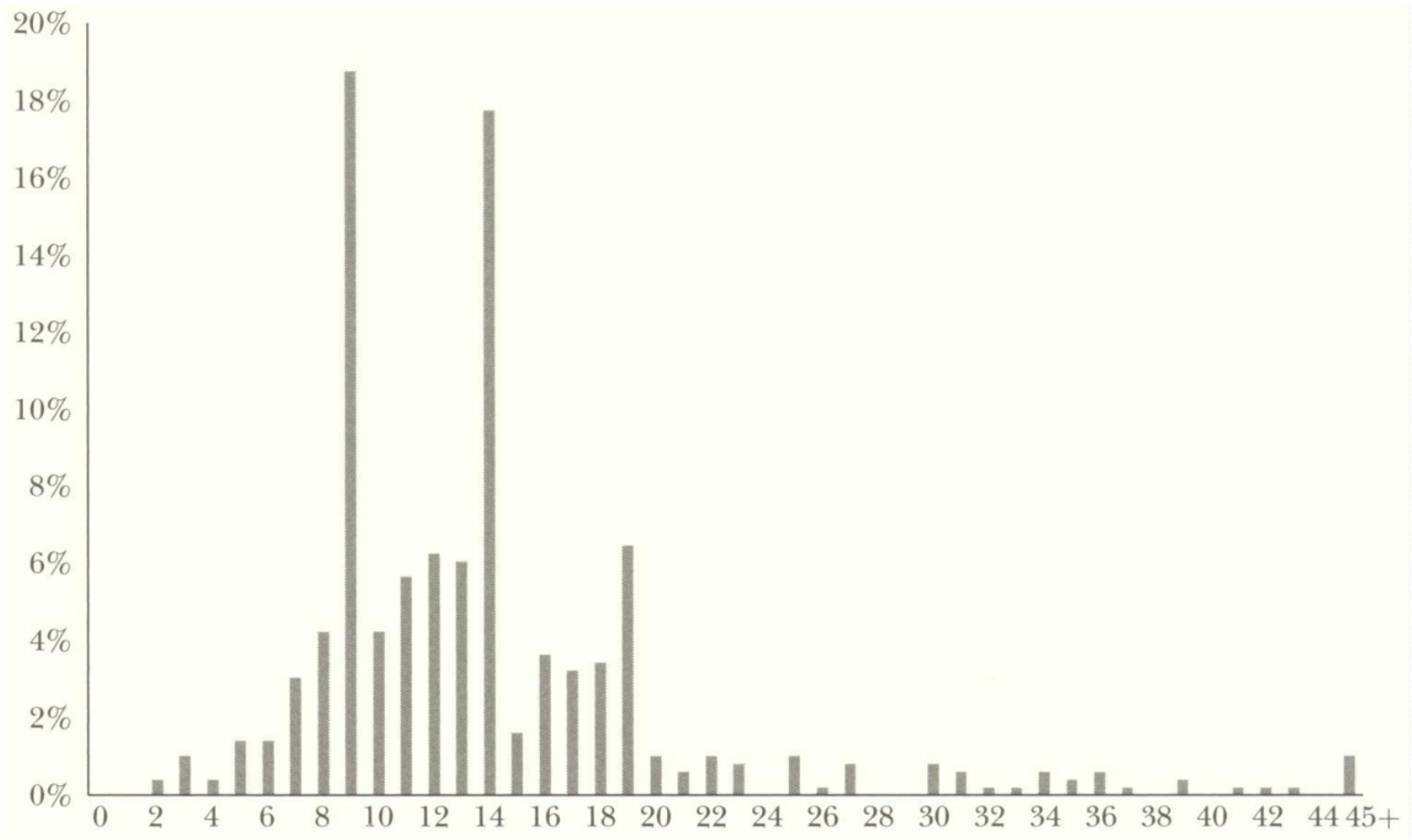
At the margin, a small increase in tax revenue will cost MCF € for each (tax revenue) € raised

$$\text{MCF}(t) = -\frac{\text{W}'(t)}{\text{T}'(t)}$$

Estimates of MCF for labor taxes at current levels ~1.5–2.5 in EU

MCF can be negative for undertaxed negative externalities

Example: impact of a tax on windows

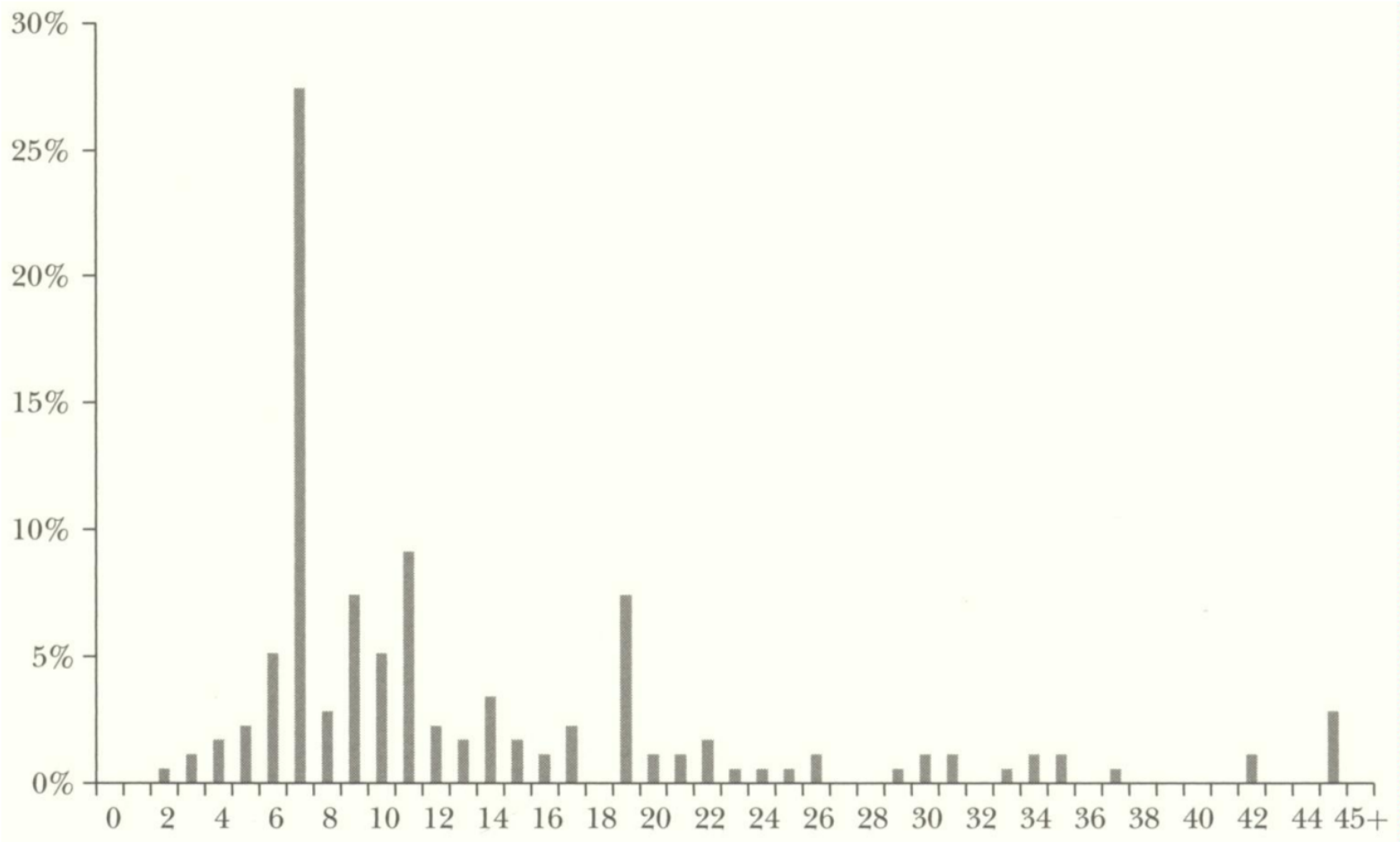


Oates and Schwab (2015) The window tax: a case study.

https://www.jstor.org/stable/43194700

Example: impact of a tax on windows

Distribution of Number of Windows, 1761–65 Sample



Oates and Schwab (2015) The window tax: a case study.

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Subsidies

With unit subsidy s buyers pay less than sellers get:

$P_b = P_s - s$ per unit

Subsidy is like a negative tax, now $\mathrm{G} > 0$ and $\mathrm{T} = 0$

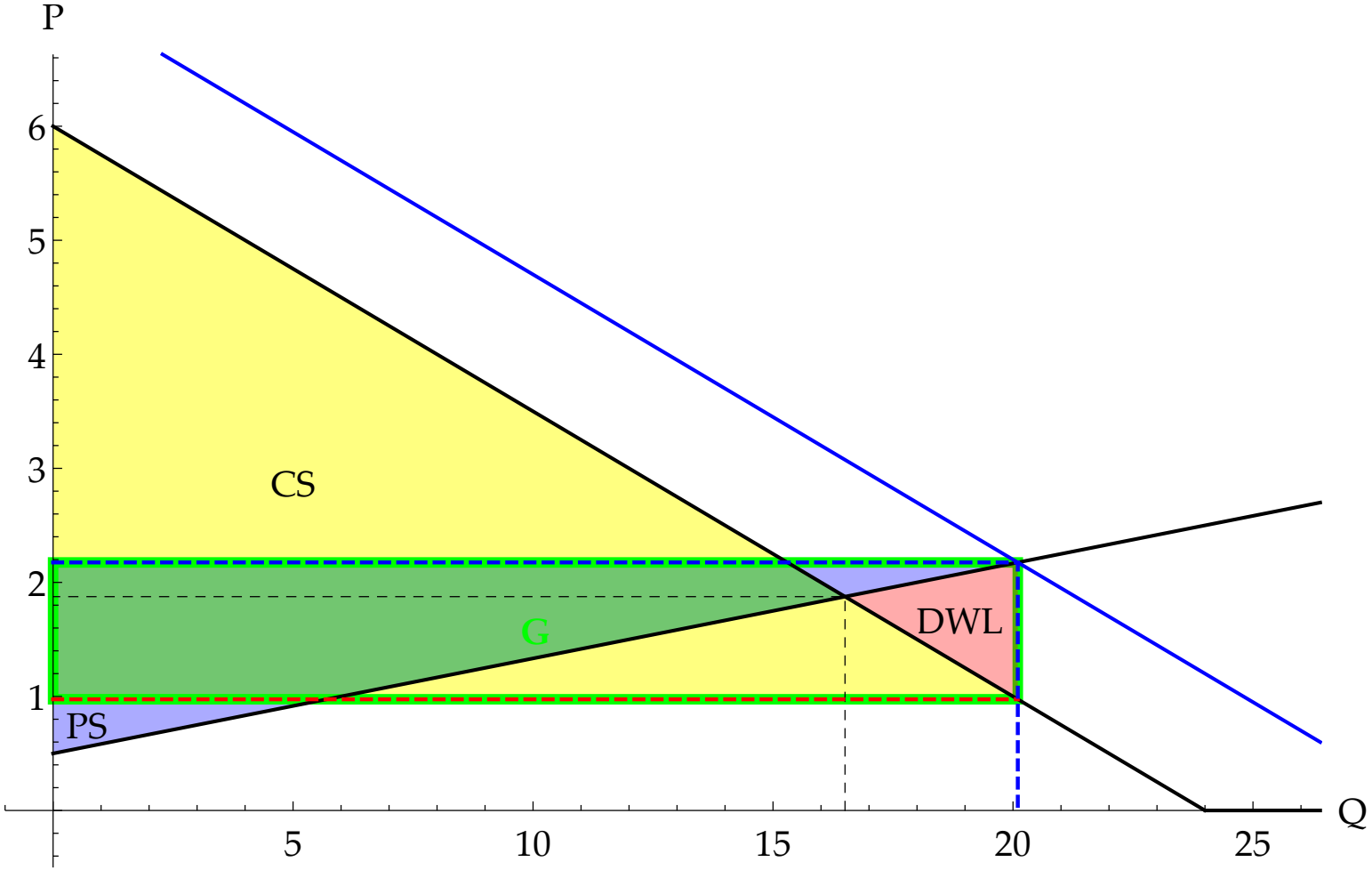
Incidence of subsidies analogous to taxation

- Less elastic side benefits more from a subsidy
- Legal incidence only matters in SR

Welfare effects of an increase in s:

PS grows, CS grows, G grows more than PS + CS, so DWL>0

Unit subsidy: Example



Unit subsidy $s = 1.2 \implies p_s - p_b = 1.2$

$24 - 4(p_s - 1.2) = 12p_s - 6 \implies p_s^s = 2.175 \implies p_b^s = 0.975, q^s \approx 20.1$

$\mathrm{CS}^s \approx 50.5, \mathrm{PS}^s \approx 16.8, \mathrm{G} = sq^s \approx 24.1, \mathrm{W}^s \approx 43.2$

$\Delta\mathrm{CS} \approx 16.5, \Delta\mathrm{PS} \approx 5.5, \Delta\mathrm{G} \approx 24.1, \Delta\mathrm{W} \approx -2.2$

Price control

Regulated price ceiling or price floor

Suppose regulator sets price ceiling $\bar{p} < p^*$ (or price floor $\underline{p} > p^*$)
(Non-binding price control has no effect)

This results in a shortage: $Q^d(\bar{p}) > Q^s(\bar{p})$
Who gets to buy?

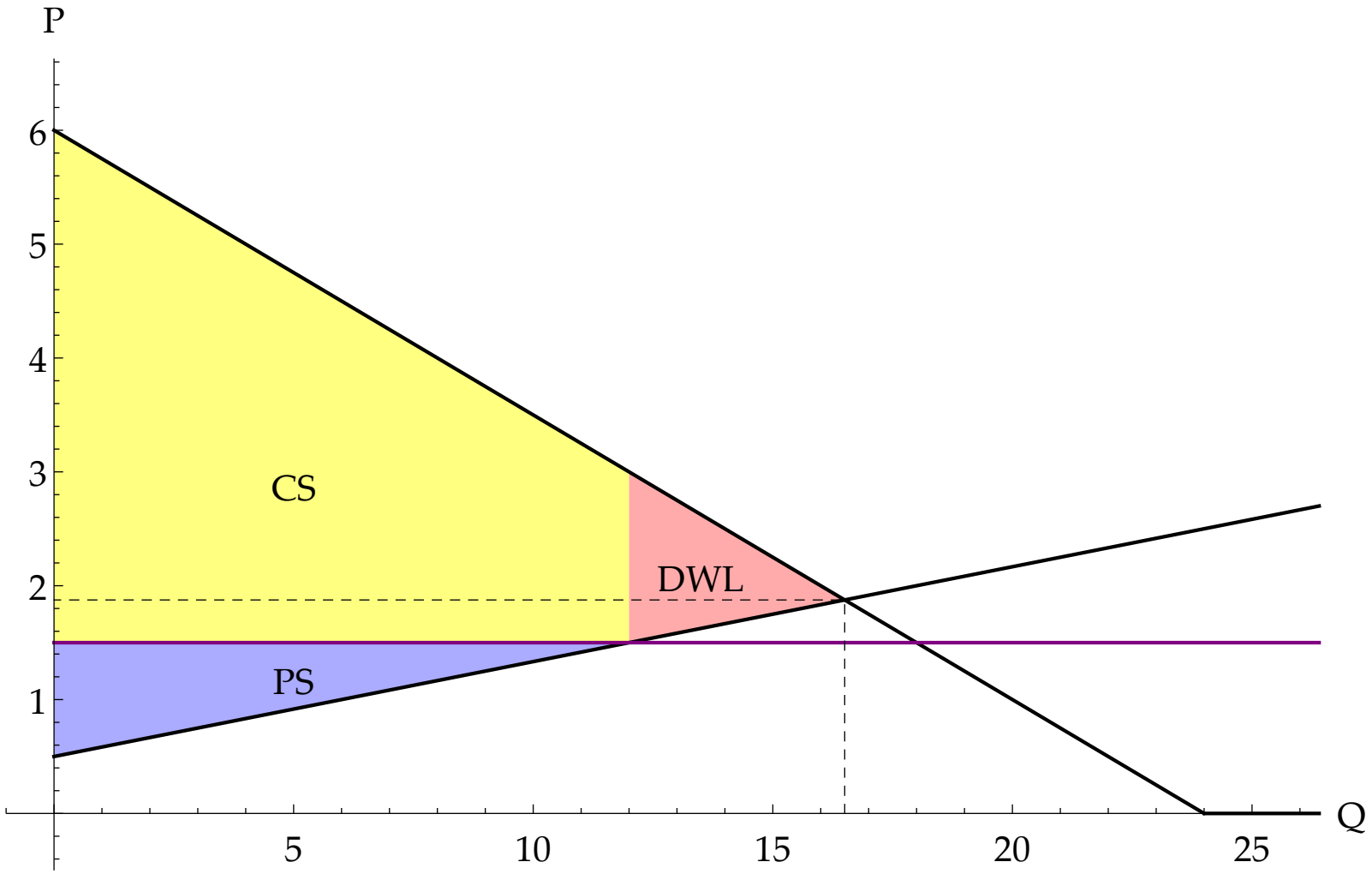
Welfare effects of a price ceiling: $\mathrm{PS} \downarrow$, CS depends on elasticities and on who gets to buy, $\mathrm{W} \downarrow$

Welfare effects of a price floor: $\mathrm{CS} \downarrow$, PS depends on elasticities and on who gets to sell, $\mathrm{W} \downarrow$

Additional reading: Jännittävät sähkömarkkinat (in Finnish)

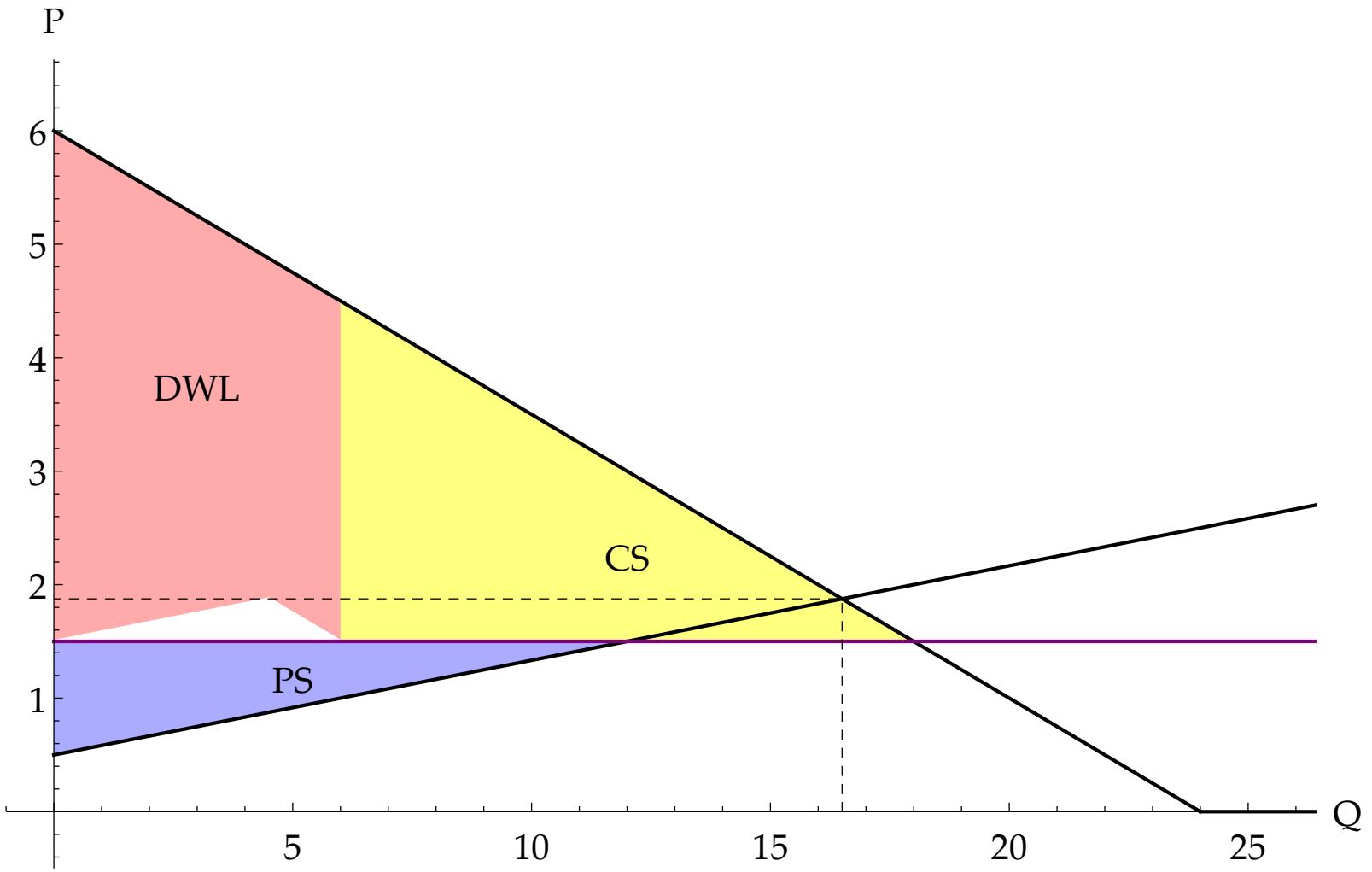
https://blog.hse-econ.fi/?p=9562

Price ceiling



Price ceiling $\bar{p} = 1.5 < p^*$. Under best case scenario for efficiency, purchases with highest valuations get to be made. How would a black market affect things?

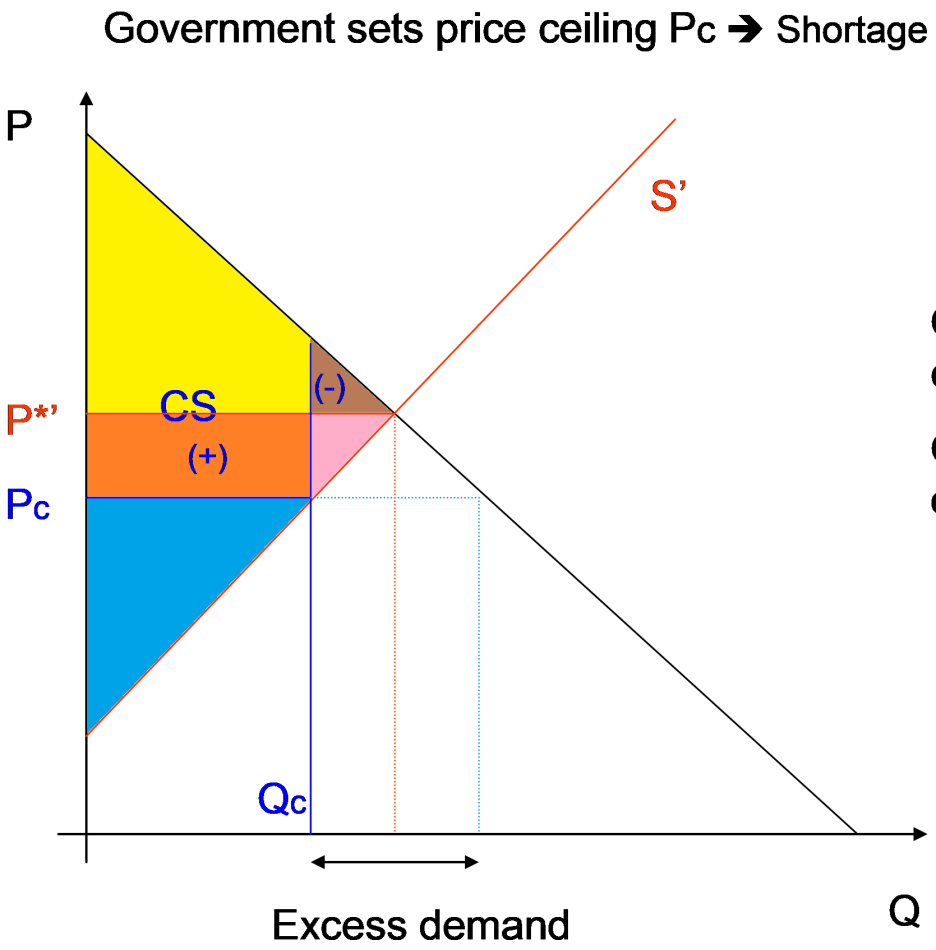
Price ceiling



Price ceiling $\bar{p} = 1.5 < p^*$. Under worst case scenario for efficiency, purchases with lowest valuations get to be made. How would a black market affect things?

Example: Price ceiling with less elastic supply

Best case scenario for CS (e.g., frictionless black market)

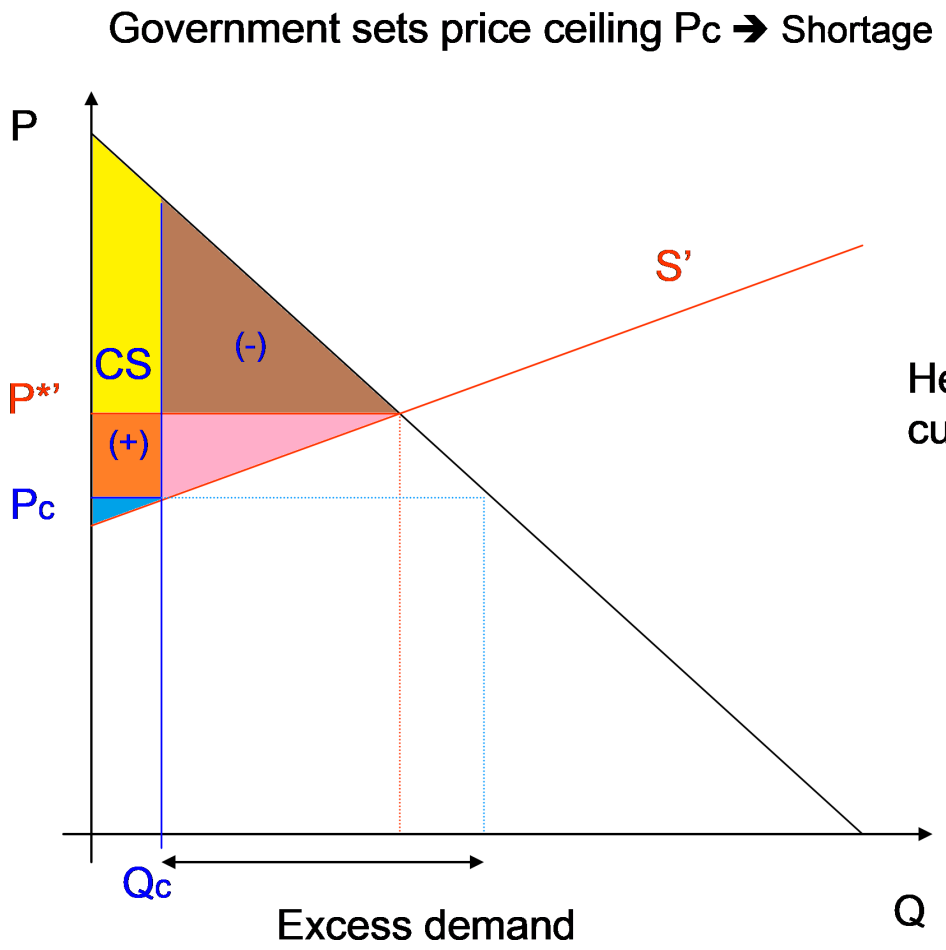


Q. What is the effect of price ceiling on CS?

Q. Does the answer depend on shape of the curves?

Example: Price ceiling with more elastic supply

Best case scenario for CS (e.g., frictionless black market)

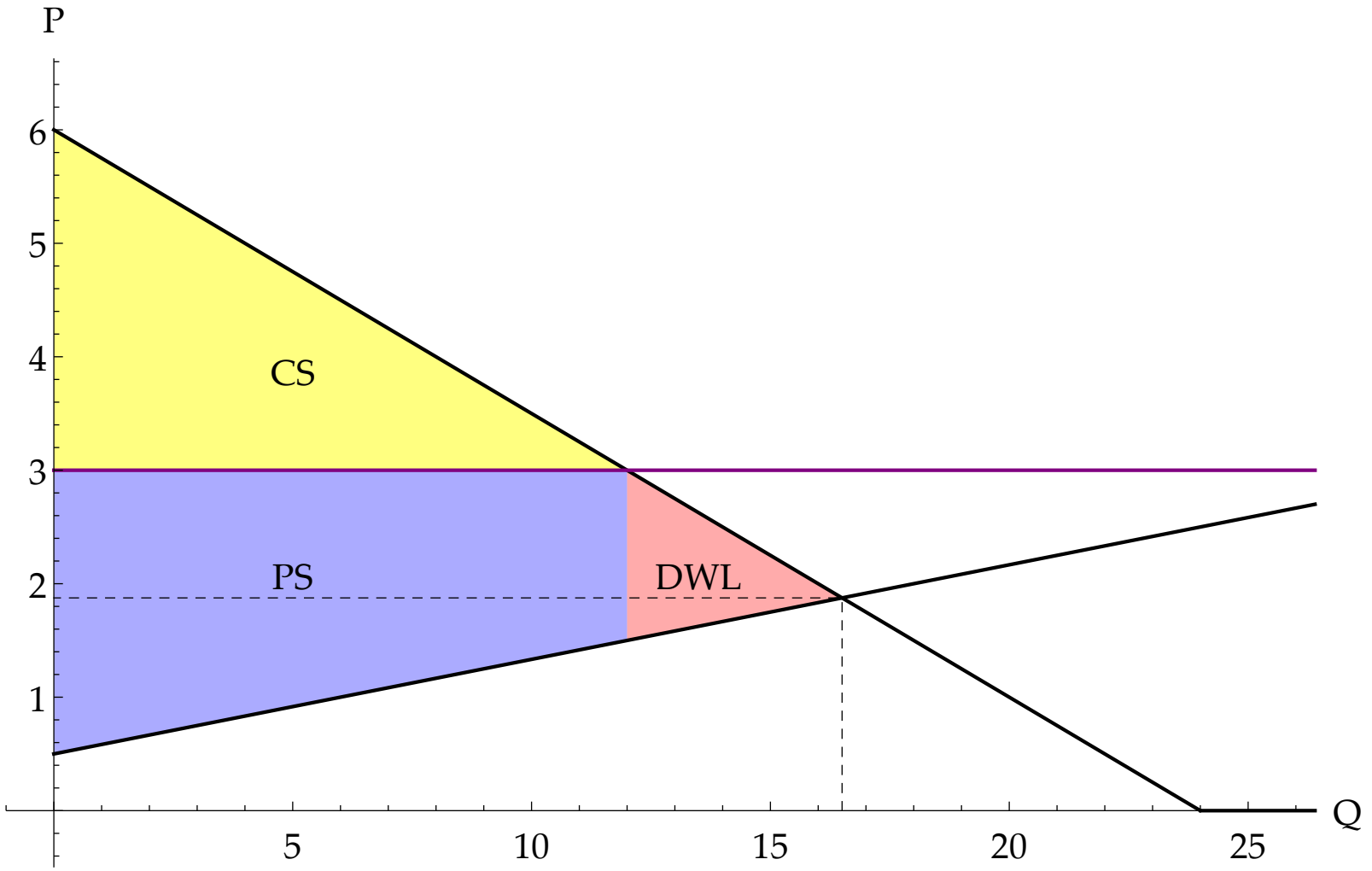


Here the new supply curve is more elastic

Now CS goes down

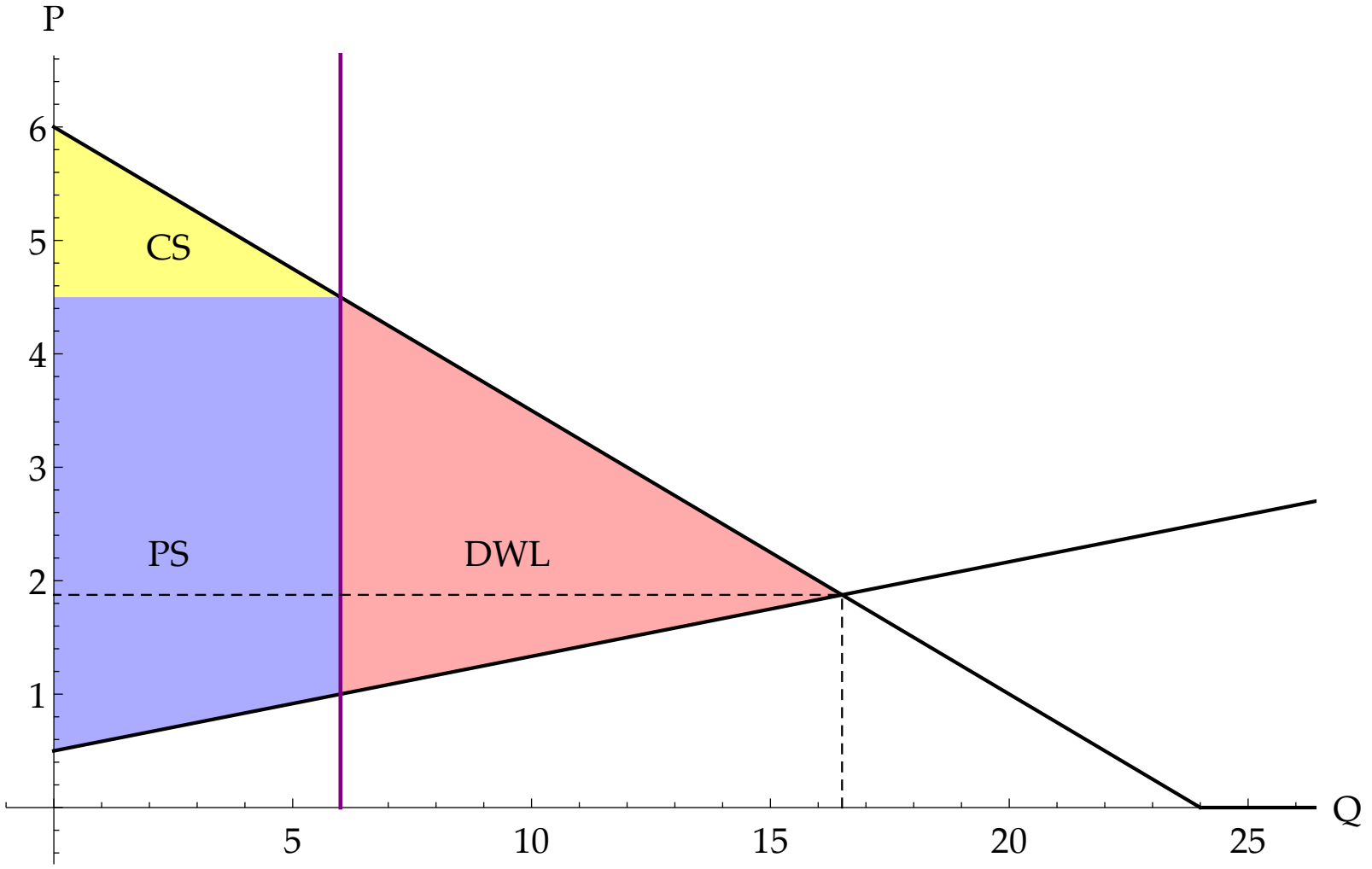
As a result of the price ceiling, because price-elastic supply reacts a lot.

Price floor



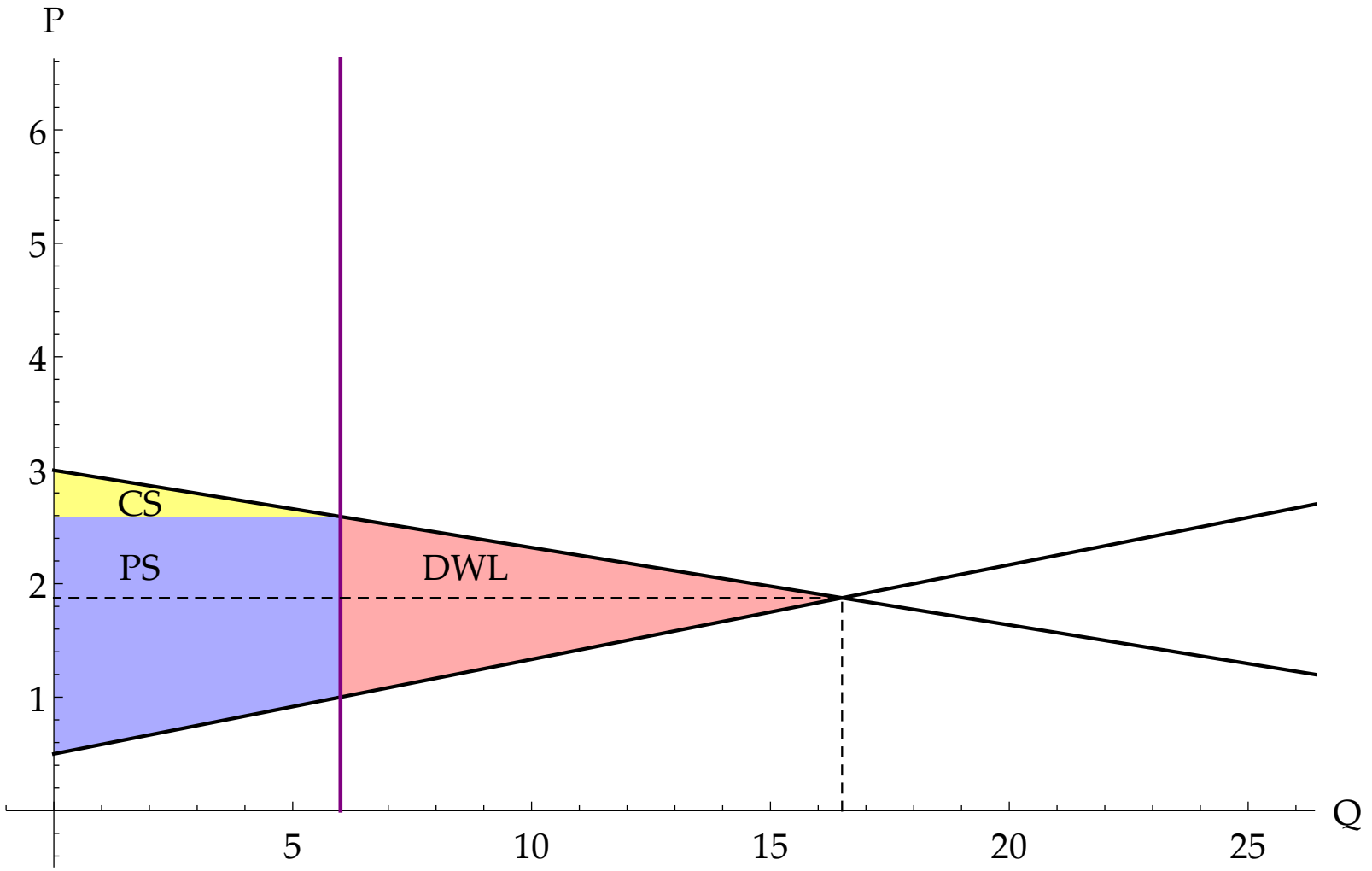
Price floor $\underline{p} = 3 > p^*$. Under best case scenario for efficiency, sales with lowest production costs (seller valuations) get to be made.

Supply quota



Supply quota $\bar{q} = 6 < q^*$. Under best case scenario for efficiency, sales with lowest production costs (seller valuations) get to be made.

Supply quota



Same supply quota as on p. 24 but "more elastic" demand $P^{d\prime}(q) = 3 - 0.068q$.
Now PS is reduced by the quota, even in the best case scenario.

Price support

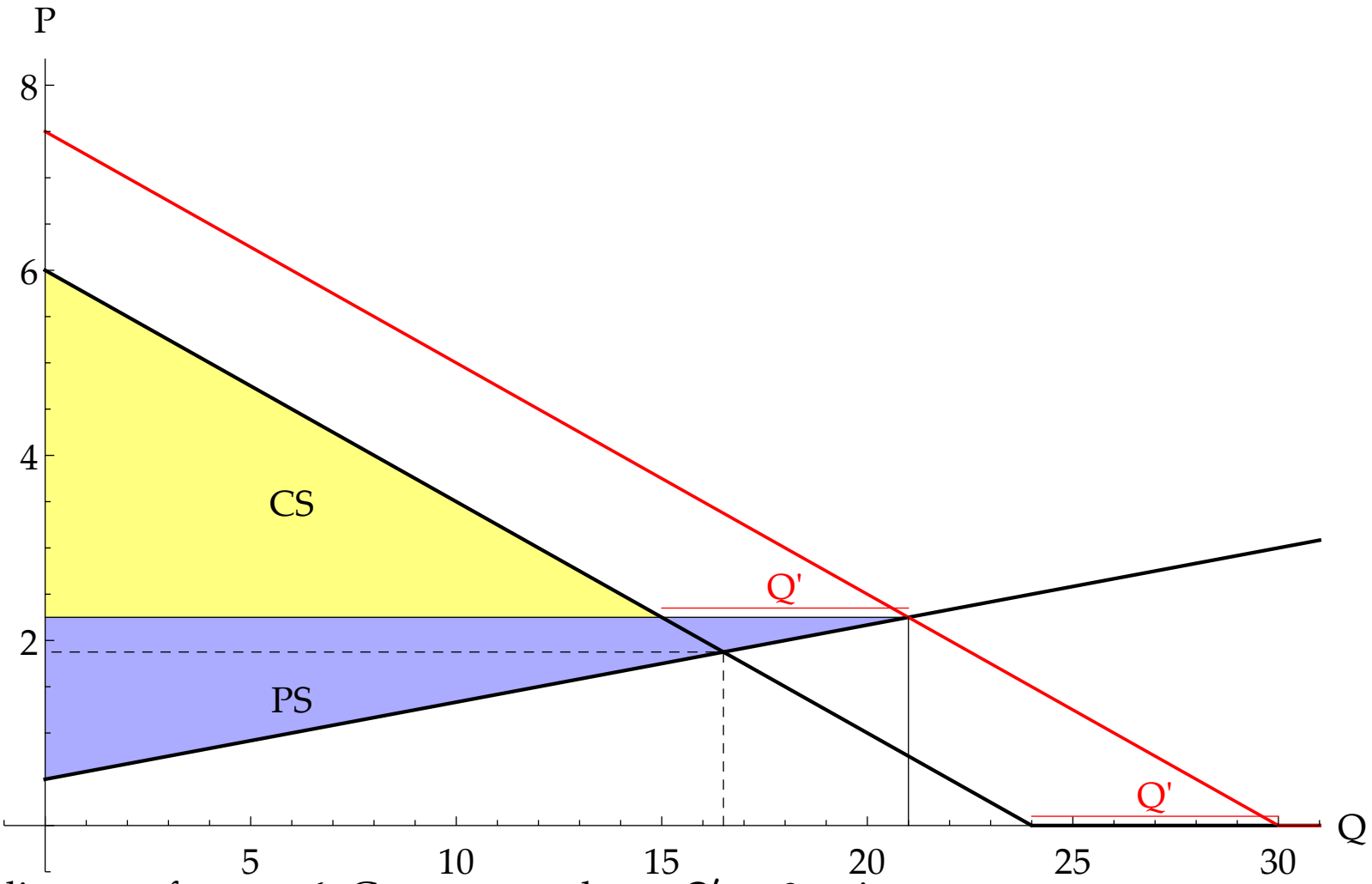
Government buys from the market, and uses it in a way that does not decrease market demand.

Government purchase Q' shifts demand curve to the right

New price $P' > P^*$
Market consumption $Q^d(P') < Q^*$
Total demand $Q^d(P') + Q' > Q^*$
Government expenditure $\mathrm{G} = P'Q'$

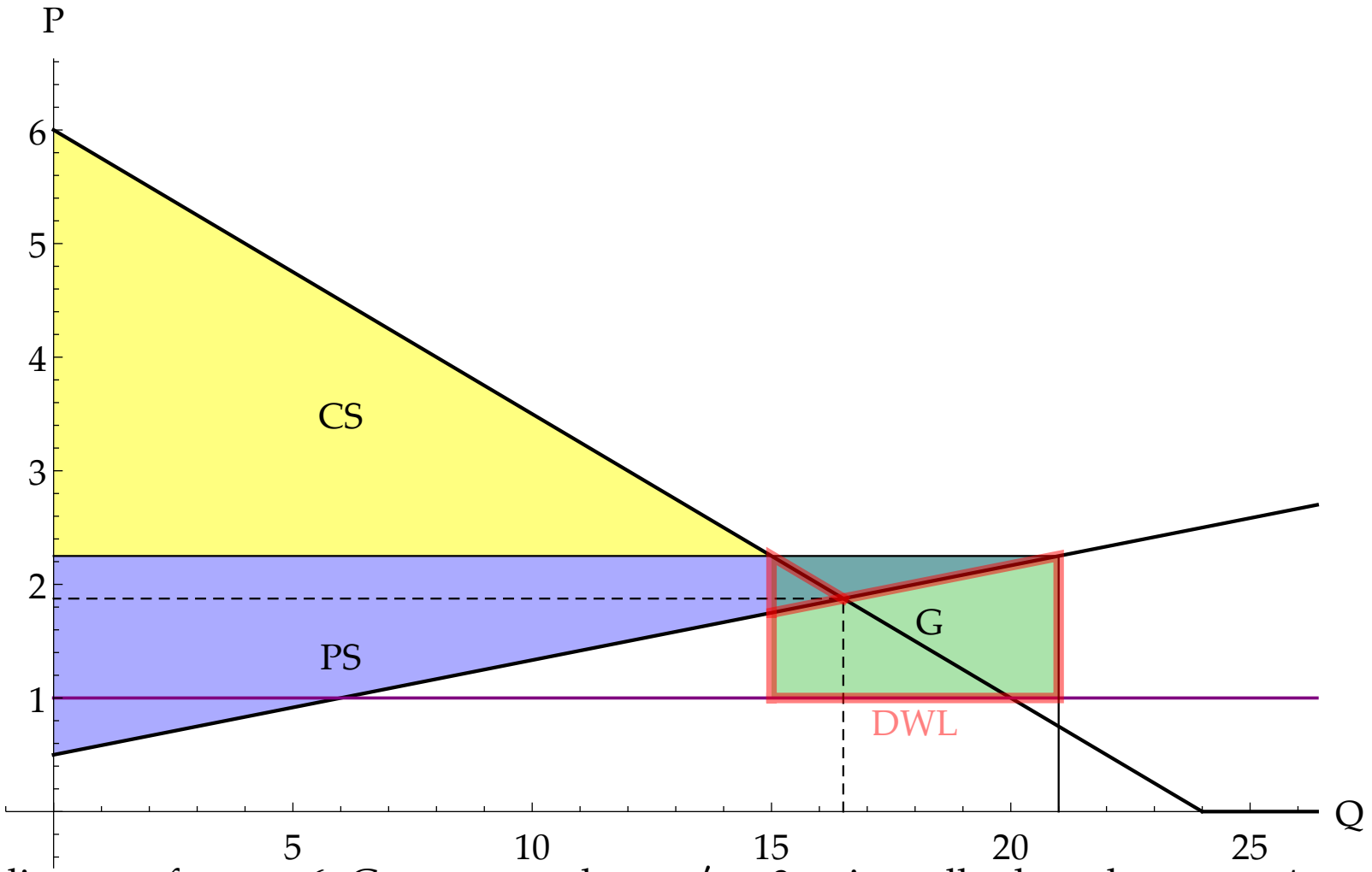
If the support purchase can be sold in the world market at price P_W then $\mathrm{G} = (P' - P_W)Q'$ is an export subsidy

Price support



Baseline case from p. 6. Government buys $Q' = 6$ units.
In equilibrium $Q^d(p) + Q' = Q^s(p) \Longrightarrow p' = 2.25$. Total output $Q^d(p') + Q' = 21$.

Price support



Baseline case from p. 6. Government buys $q' = 6$ units, sells abroad at $p_W = 1$.
In equilibrium $Q^d(p) + q' = Q^s(p) \Longrightarrow p' = 2.25$. Total output $Q^d(p') + q' = 21$.
$\mathrm{G} = q'(p' - p_W) = 7.5$, $\mathrm{CS} \approx 28.1$, $\mathrm{PS} \approx 18.4$, $\Delta\mathrm{W} \approx -6.4$.

Welfare analysis: Key skills

Map the impact of a policy change to D-S framework.
What are the areas in D-S framework that represent changes in surpluses and government finances affected by a policy change?

Qualitative results (directions of changes)
Which changes are general results, and which depend on specifics (shapes of D&S curves, magnitude of policy change)?

Quantitative results (size of changes)
Starting from specific (numerical) assumptions or data, obtain the magnitudes of changes by calculating relevant areas

Welfare analysis and distribution

Since u is ordinal, aggregating utilities requires the use of a subjective, e.g., researchers' stated social welfare function (SWF)

For example $U(\mathbf{v}) = \sum_i u(v_i)$ for a stated u

Declining MU of wealth v implies that a more even distribution of the same average v increases U. Analogy with risk aversion

Rawlsian SWF: $U(\mathbf{v}) = \min_i\{v_1, \ldots, v_n\}$

Fundamental theorems of welfare economics (competitive market)
1st: Equilibrium allocation is Pareto-efficient
2nd: Any Pareto-efficient allocation can be achieved with wealth transfers (and no other intervention) *if better-than sets convex

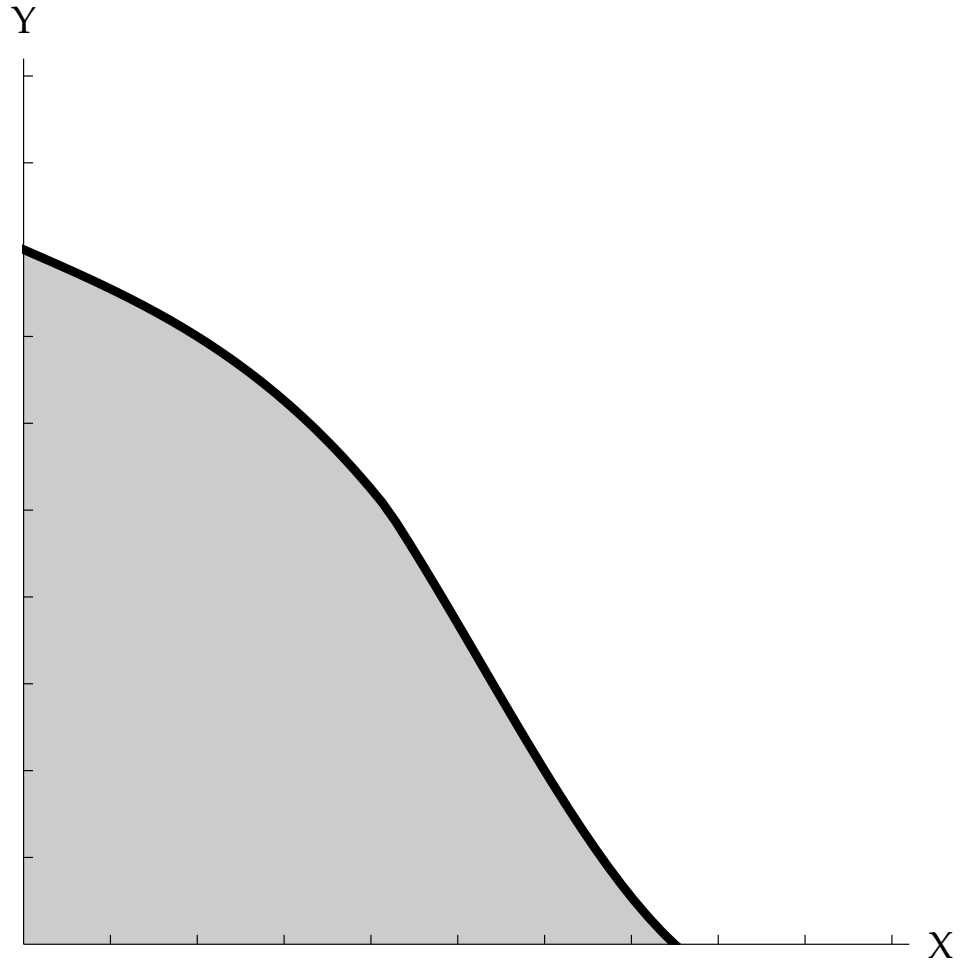
Exchange

- Production Possibilities Frontier / Set
  (*Tuotantomahdollisuuksien käyrä / joukko*)
- Autarky vs gains from trade
- Comparative advantage
  (*Suhteellinen etu*)

Production possibilities set: Given the available resources to the economy (labor, capital, land,...) which combinations of outputs could be produced?

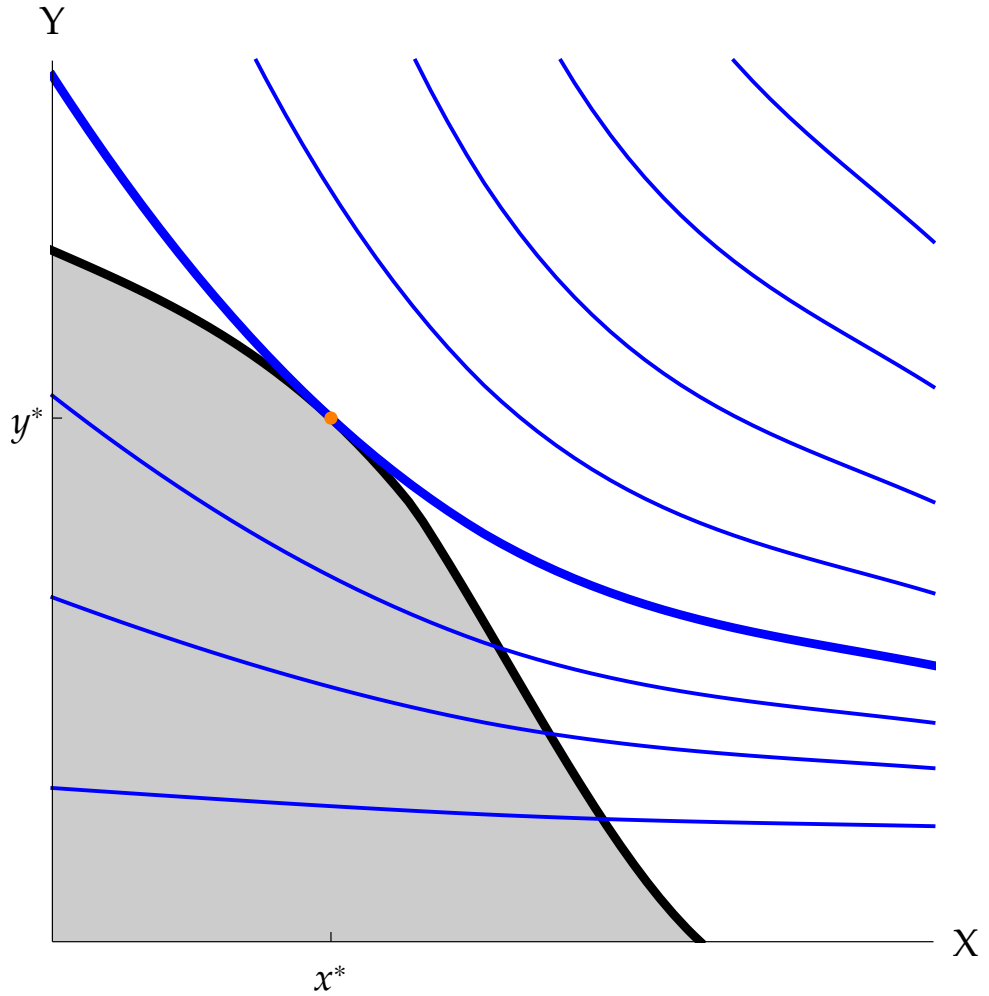
PPF is the frontier of the set, where it is not possible to increase the output of any good without reducing some other output

Production Possibilities Frontier



Which combinations of goods $\{X, Y\}$ are feasible to produce, given the resources

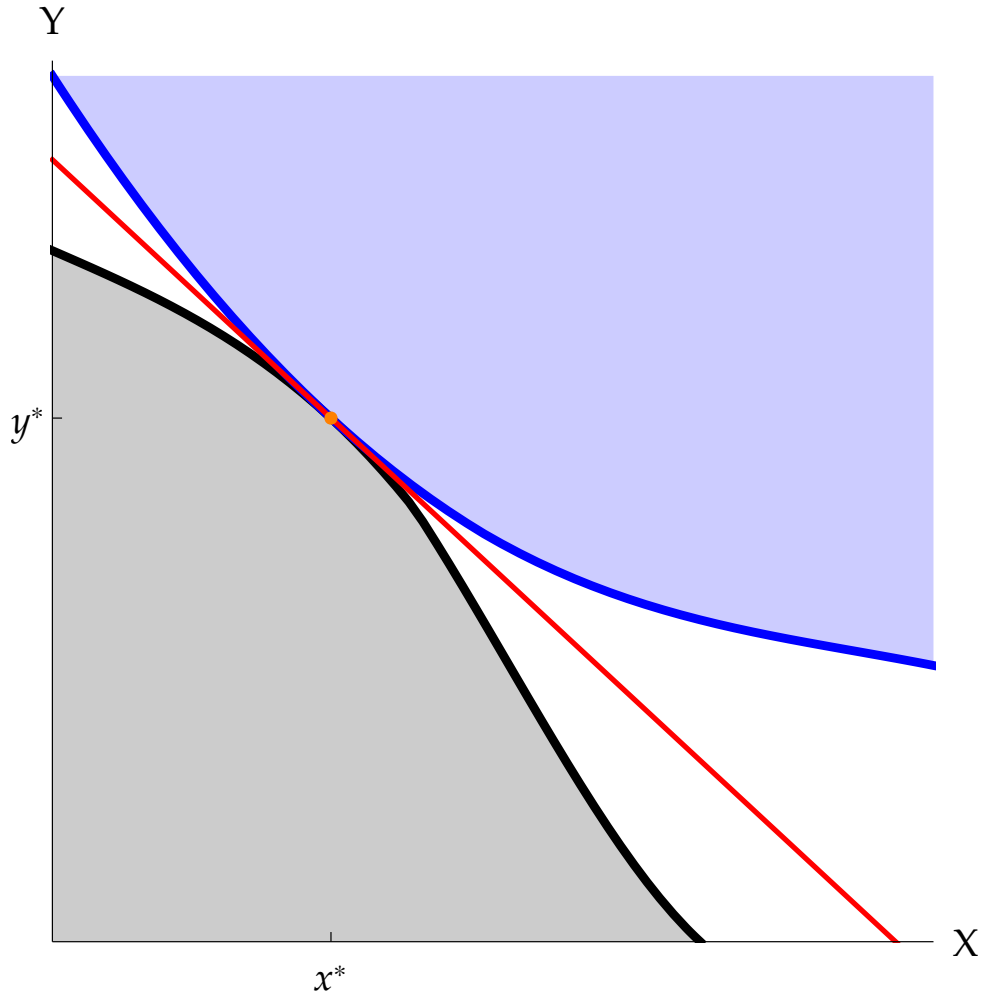
Production Possibilities Frontier and Utility



Indifference curves of a representative consumer or "social planner".

Optimal bundle $\{x^*, y^*\}$ gives highest feasible utility.

PPF, Utility, Equilibrium



PPF and the highest achievable indifference curve are tangent at the optimum $\{x^*, y^*\}$.
The slope of the tangency gives the MRT and MRS at $\{x^*, y^*\}$,
and the ratio of equilibrium prices in autarky $-p_x/p_y$. $y = y^* - \frac{p_x}{p_y}(x - x^*)$

Trade and Comparative Advantage

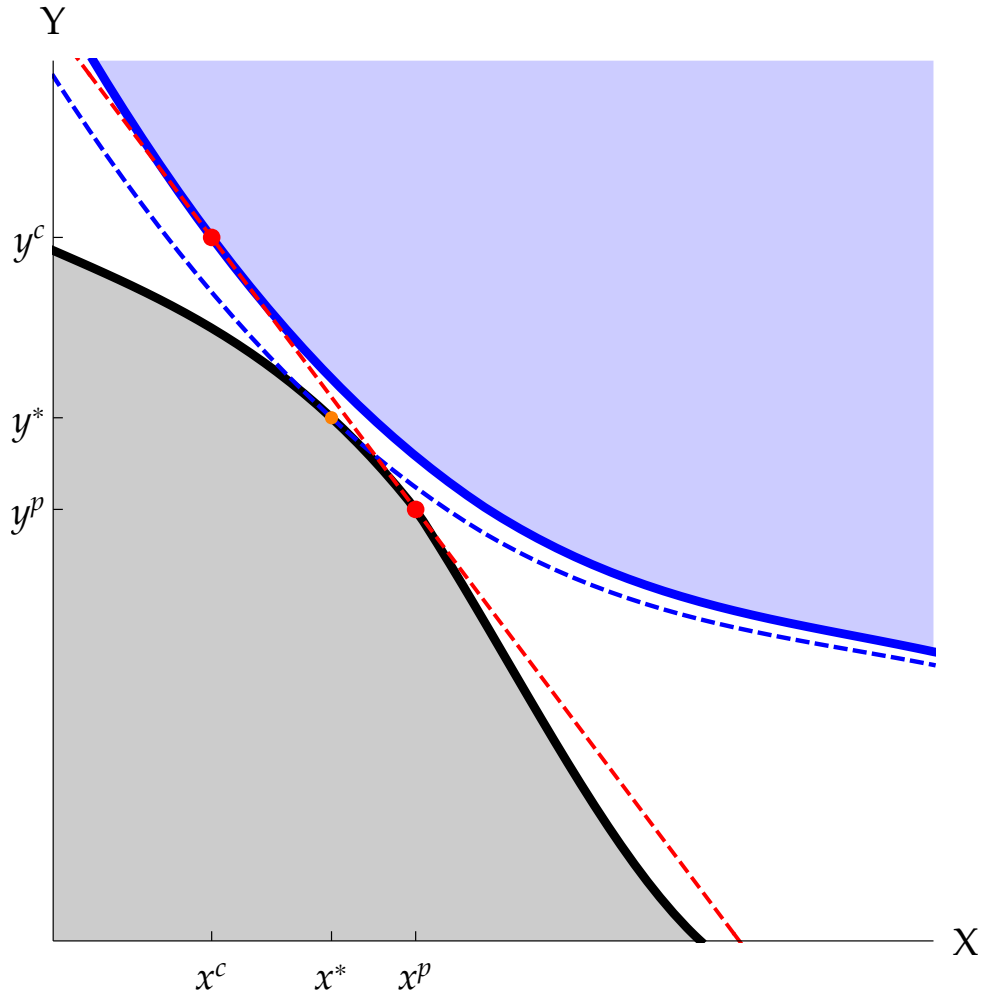
There are gains from trade if world price ratio is different from domestic autarky price ratio (for any pair of goods)

With trade, consumption and production bundles are different. Country exports the good in which it has comparative advantage, imports the other good

If $p_x^w/p_y^w > p_x/p_y$ then we have a comparative advantage in producing X (vice versa, in Y)

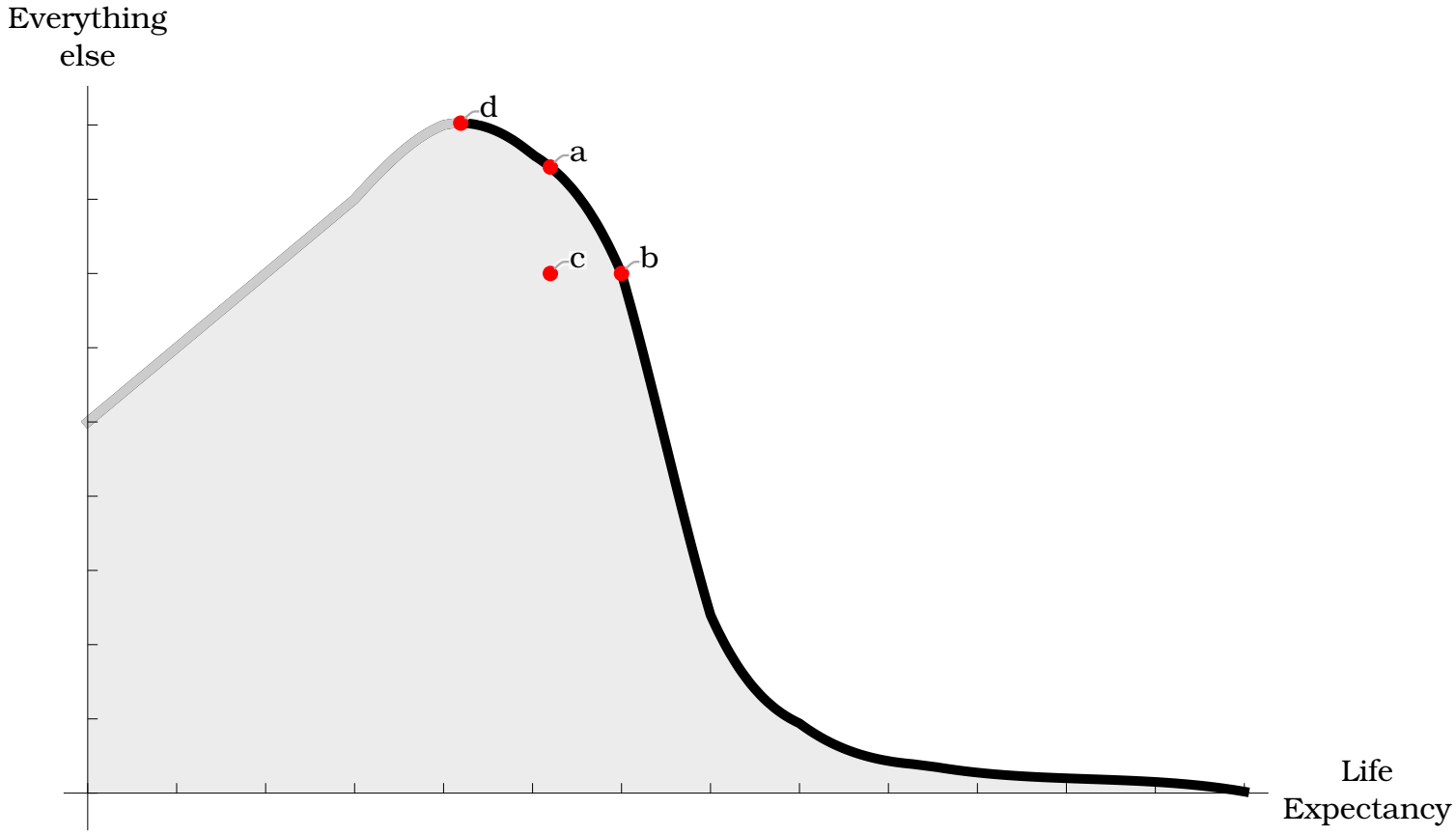
Suppose $p_x > p_x^w, p_y > p_y^w$, so that World has absolute advantage in every good. What are the implications for trade?

Trade and Comparative Advantage



World market value of domestic production maximized at $\{x^p, y^p\}$
Utility from domestic consumption maximized at $\{x^c, y^c\}$
Exports $x^p - x^c$ and imports $y^c - y^p$ have equal world market value.

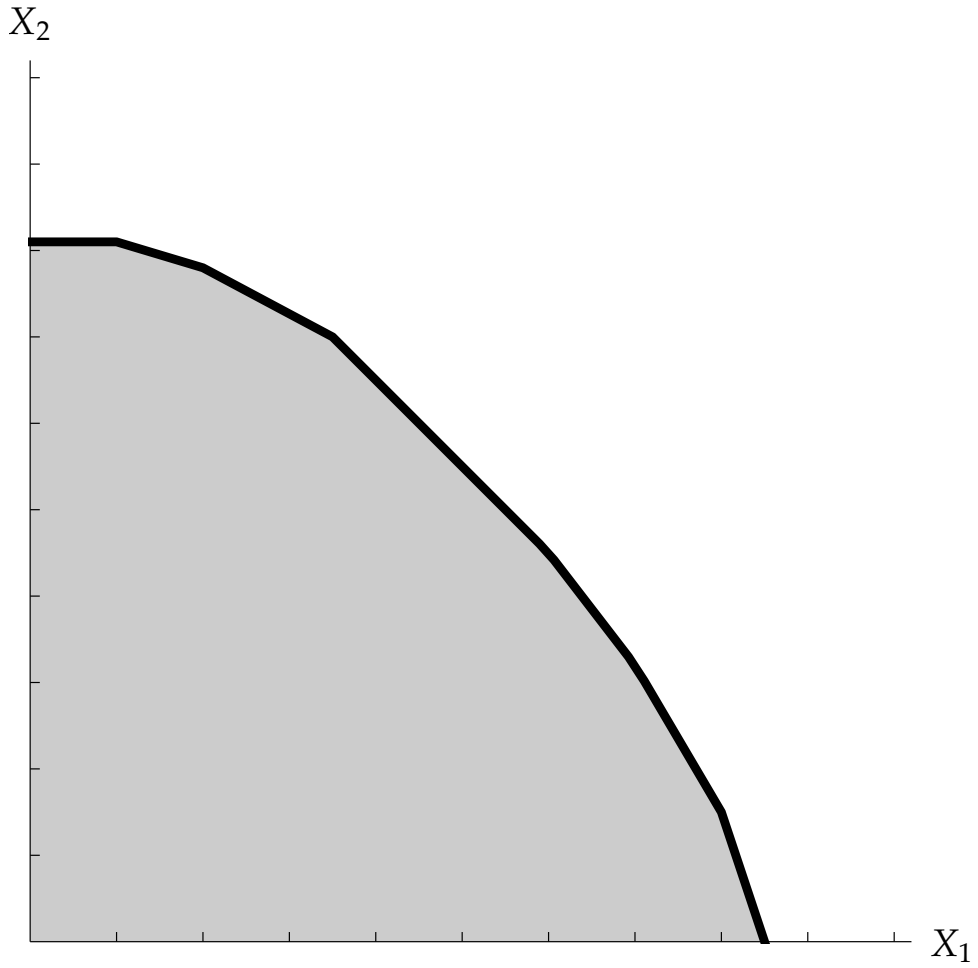
PPF application: life expectancy and everything



a) and b) are feasible combinations, optimal for different preferences. c) Inefficient point. d) "Free lunch" if LE less than here.

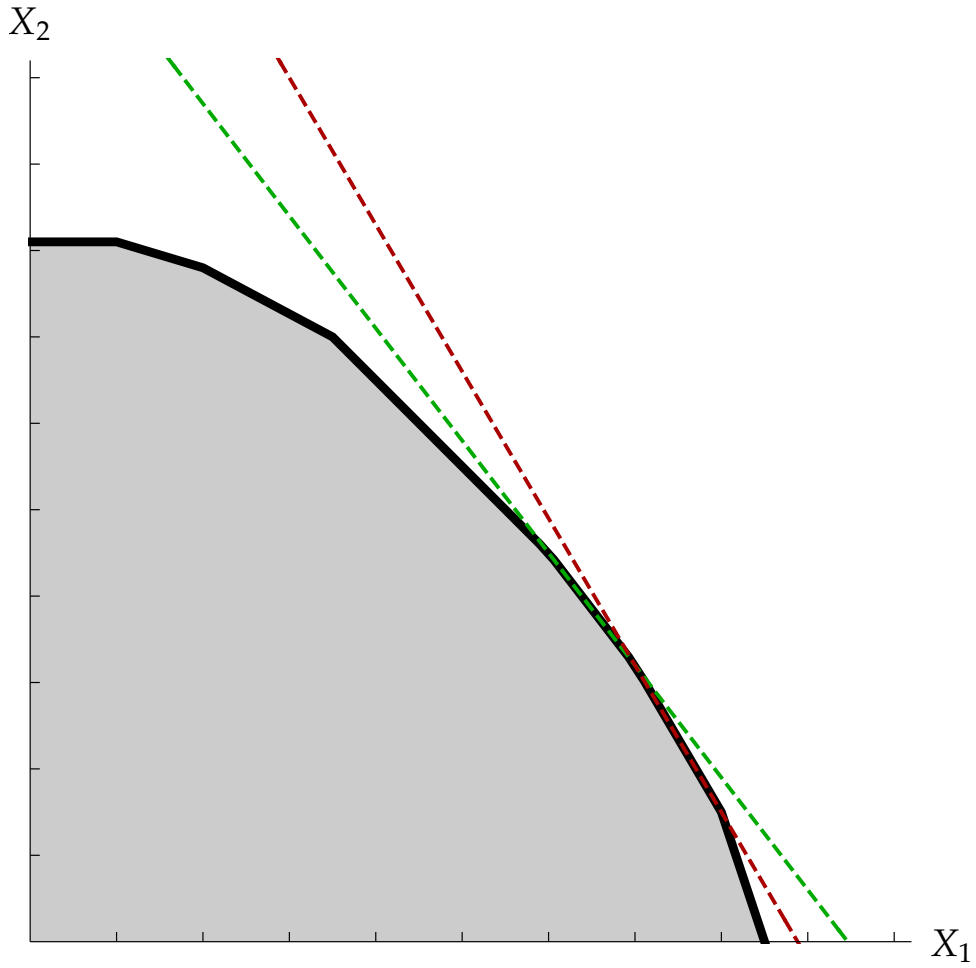
Extra reading here (in Finnish) `https://blog.hse-econ.fi/?p=3077`

Application: sign of the real interest rate



Lower consumption in first period X_1 can be transformed to more in the second X_2.
Best investment projects used first, so the Production Possibilities Set is convex.

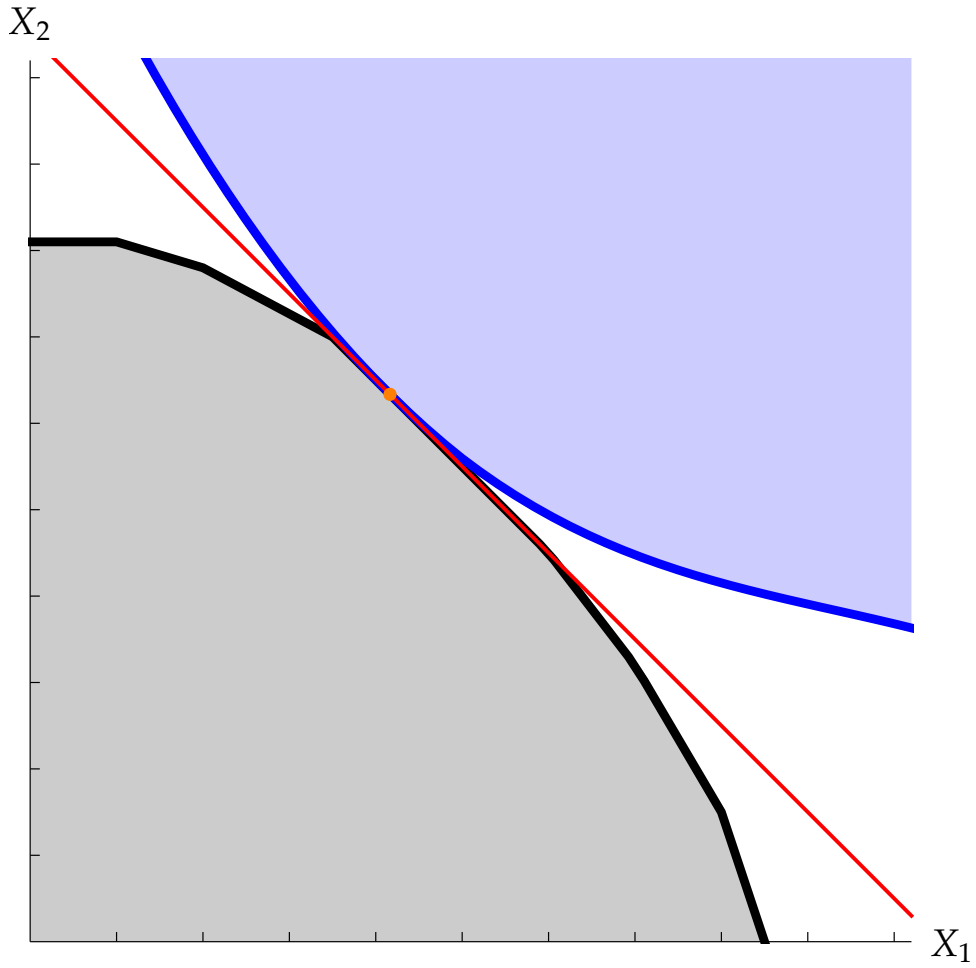
Application: the real interest rate



By giving up one unit of X_1 we can get $\frac{p_1}{p_2}$ more units of X_2. We can define "real return" as r such that with one unit of X_1 we get $(1 + r)$ units of X_2.

Intertemporal transformation has slope: $\frac{dX_2}{dX_1} = -\frac{p_1}{p_2} = -(1 + r)$.

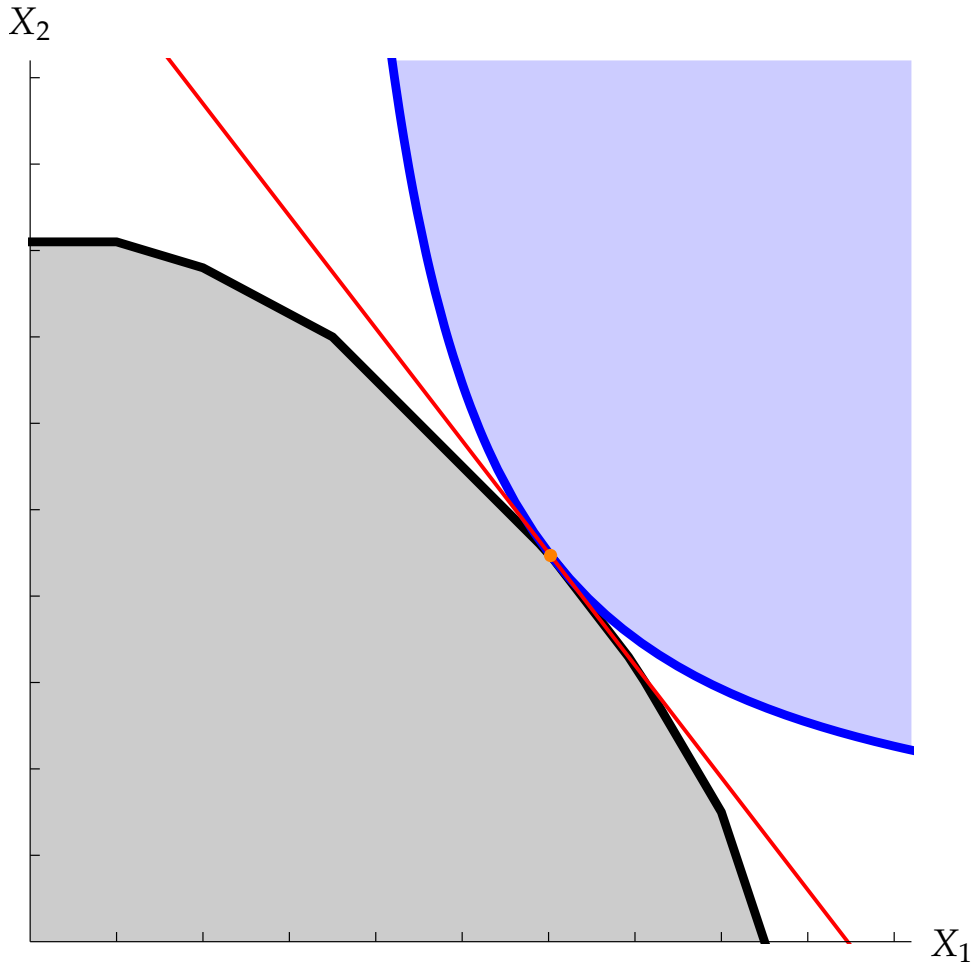
Application: the real interest rate



In equilibrium the real interest rate r is such that the time profile of consumption $\{x_1, x_2\}$ that yields highest utility is produced.

Convex better-than-sets imply decreasing marginal utility of consumption each period.

Application: the real interest rate



There is no fundamental reason why real interest rate would have to be positive. With sufficiently patient consumers or lack of high-return projects the equilibrium slope $-\frac{p_1}{p_2}$ can be so shallow that the implied $r < 0$.