Part 2 – Markets and Competition

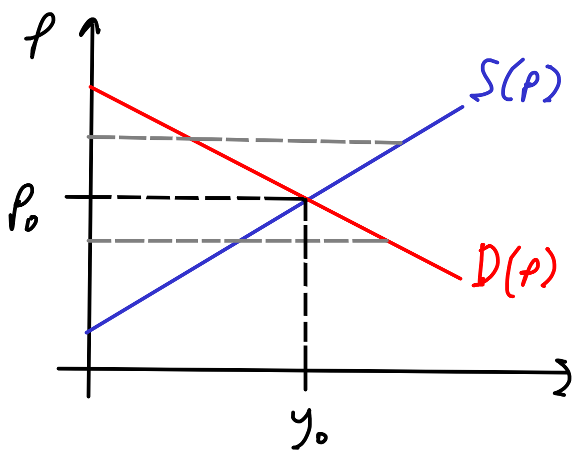
Markets – Demand, Supply, and Equilibrium

We define a market for a good or service to simply be the union of the individuals and firms that operate on both the supply and demand sides of a potential transaction. There are many different types of market that we should be aware of, some of which form rich areas of study themselves. We will continue to focus on markets for goods and services, however notable other markets include:

- stock market,
- labour market,
- capital market

The intentions and wishes of each side of a market are, of course, specified through the demand and supply curves, and we recall from the start of the course that (for a competitive market) the prices at which goods are sold is settled through the price mechanism.

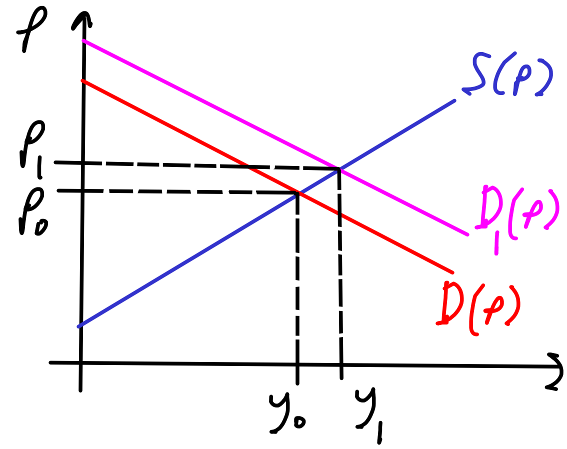
Recall that the price at which supply equals demand is referred to as the **equilibrium price**. Suppose that a market is settled at an equilibrium price p_0:



If $p < p_0$, then $D(p) > S(p)$ so p increases. Conversely, if $p > p_0$, then $D(p) < S(p)$ so p decreases

- If the demand for a good changes for some reason, then the demand curve will shift; demand and supply will no longer be equal at p_0.

- An increase in demand, or a decrease in supply, will lead to an ***excess in demand***.
- A decrease in demand, or an increase in supply, will lead to an ***excess in supply.***
- These excesses invoke the price mechanism, changing the equilibrium price. The speed at which this happens will vary between markets.



Excesses in demand or supply can be measured as long as we can express supply and demand in terms of the good's price.

- For an individual consumer, demand is measurable through the Marshallian demand function, under the assumption that they are maximising their utility. i.e., $x^*(\underline{p}, m)$, where $\underline{p}$ gives the prices of the goods and m is the consumer's budget.
- For an individual firm, we have the (short-run or long-run) supply curve (under profit-maximising assumptions), denoted by $y^*(\underline{p})$.

We want the **market demand** and **market supply** (also referred to as the industry demand and industry supply) i.e., the total demand for a good across the market and the total quantity of the good supplied. These are simply the sums of the individual demands/quantities, respectively.

Suppose a market for a single good contains I consumers and J firms. Further, suppose that consumer i has demand given by

$$x_i^*(\underline{p}, m_i) \quad , i = 1, \dots, I$$

and that the supply curve for firm j is specified by

$$y_j^*(\underline{p}) \quad , j = 1, \dots, J$$

The market demand for the good is then defined as

$$X^*(\underline{p}, \underline{m}) = \sum_{i=1}^{I} x_i^*(\underline{p}, m_i)$$

and the corresponding market supply is defined as

$$Y^*(\underline{p}) = \sum_{j=1}^{J} y_j^*(\underline{p})$$

At equilibrium, $X^*(\underline{p}, \underline{m}) = Y^*(\underline{p})$

Example:

Suppose that the market for bananas contains 1000 utility-maximising consumers with demand functions

$$x_i^*(\underline{p}, m_i) = \frac{m_i \, p_B}{p_B^2 + p_A^2} \quad , \quad i = 1, \dots, 1000$$

which is dependent on the price p_B of bananas as well as the price p_A of apples.

Further, suppose the banana market comprises two suppliers, with supply curves

$$y_j^*(\underline{p}) = \frac{p_B}{2j} \quad , j = 1, 2.$$

What is the equilibrium price for bananas?

$$X^*(\underline{p}, \underline{m}) = \sum_{i=1}^{1000} x_i^*(\underline{p}, m_i)$$

$$= M \frac{p_B}{p_B^2 + p_A^2} \quad \text{where } M = \sum_{i=1}^{1000} m_i$$

and $$Y^*(\underline{p}) = y_1^*(\underline{p}) + y_2^*(\underline{p}) = \frac{p_B}{2} + \frac{p_B}{4} = \frac{3p_B}{4}$$

Then the equilibrium price of bananas is the value of p_B such that

$$X^*(\underline{p}, \underline{m}) = Y^*(\underline{p})$$

i.e.,

$$M \frac{p_B}{p_B^2 + p_A^2} = \frac{3p_B}{4}$$

$$\Rightarrow \quad p_B = \sqrt{\frac{4M}{3} - p_A^2}$$

Consumers' and Producers' Surplus – Social Welfare

To analyse the consequences of a change in prices or income – or more generally, a change in policy – it is useful to have a measure of social welfare. We will see that a handy such measure is the sum of ***consumers'*** and ***producers' surplus.*** It also gives rise to another characterization of the equilibrium price and equilibrium quantity, maximising this social welfare measure.

We put ourselves into the general framework of utility maximising consumers and profit maximising firms where the utility and production functions satisfy our usual assumptions. Suppose we have J firms with cost functions $c_j^*(\cdot)$, $j \in \{1, \dots, J\}$, and I consumers with respective utility functions $u_i(\cdot)$, $i \in \{1, \dots, I\}$, and corresponding quantities (i.e. indirect utility function v_i, expenditure function e_i, Marshallian demand x_i^*, and Hicksian demand $x_{H,i}^*$ as well as profit-maximising output y_j^*)

Consider fixed income levels $m_1, \dots, m_I$ and a price change from $\underline{p}^{(1)} \in \mathbb{R}^n_{\geq 0}$ to $\underline{p}^{(2)} \in \mathbb{R}^n_{\geq 0}$. Suppose that the price change affects only one single product and that w.l.o.g. the product gets more expensive. To save notation, we will only explicitly denote the variable with a price change, suppressing all the other ones. So in the specific good, we will consider a price change from $p^{(1)} > 0$ to $p^{(2)} > 0$ where we assume without loss of generality that $p^{(1)} < p^{(2)}$.

With $\pi_j^*(p) = p\, y_j^*(p) - c_j^*(y_j^*(p))$

(Note, we are effectively considering the case of a single product - just the one whose price is changing. Those products whose prices don't change will <u>not</u> affect $d\pi^*/dp$ - see below. Recall that here, the subscript j indicates the firm.)

we have

$$\sum_{j=1}^{J} \left(\pi_j^*(p^{(2)}) - \pi_j^*(p^{(1)})\right) = \sum_{j=1}^{J} \int_{p^{(1)}}^{p^{(2)}} \frac{d\pi_j^*(p)}{dp}\, dp$$

where

$$\frac{d\pi_j^*(p)}{dp} = y_j^*(p) + p\, y_j^{*\prime}(p) - c_j^{*\prime}(y_j^*(p)) \cdot y_j^{*\prime}(p)$$

$$= y_j^*(p) + y_j^{*\prime}(p)\left(p - c_j^{*\prime}(y_j^*(p))\right)$$

$$\left.\frac{d\left(p y_j - c_j^*(y_j)\right)}{d y_j}\right|_{y_j = y_j^*(p)} = 0$$

$$= y_j^*(p)$$

Thus,

$$\sum_{j=1}^{J}\left(\pi_j^*(p^{(2)}) - \pi_j^*(p^{(1)})\right) = \sum_{j=1}^{J}\int_{p^{(1)}}^{p^{(2)}} y_j^*(p)\,dp$$

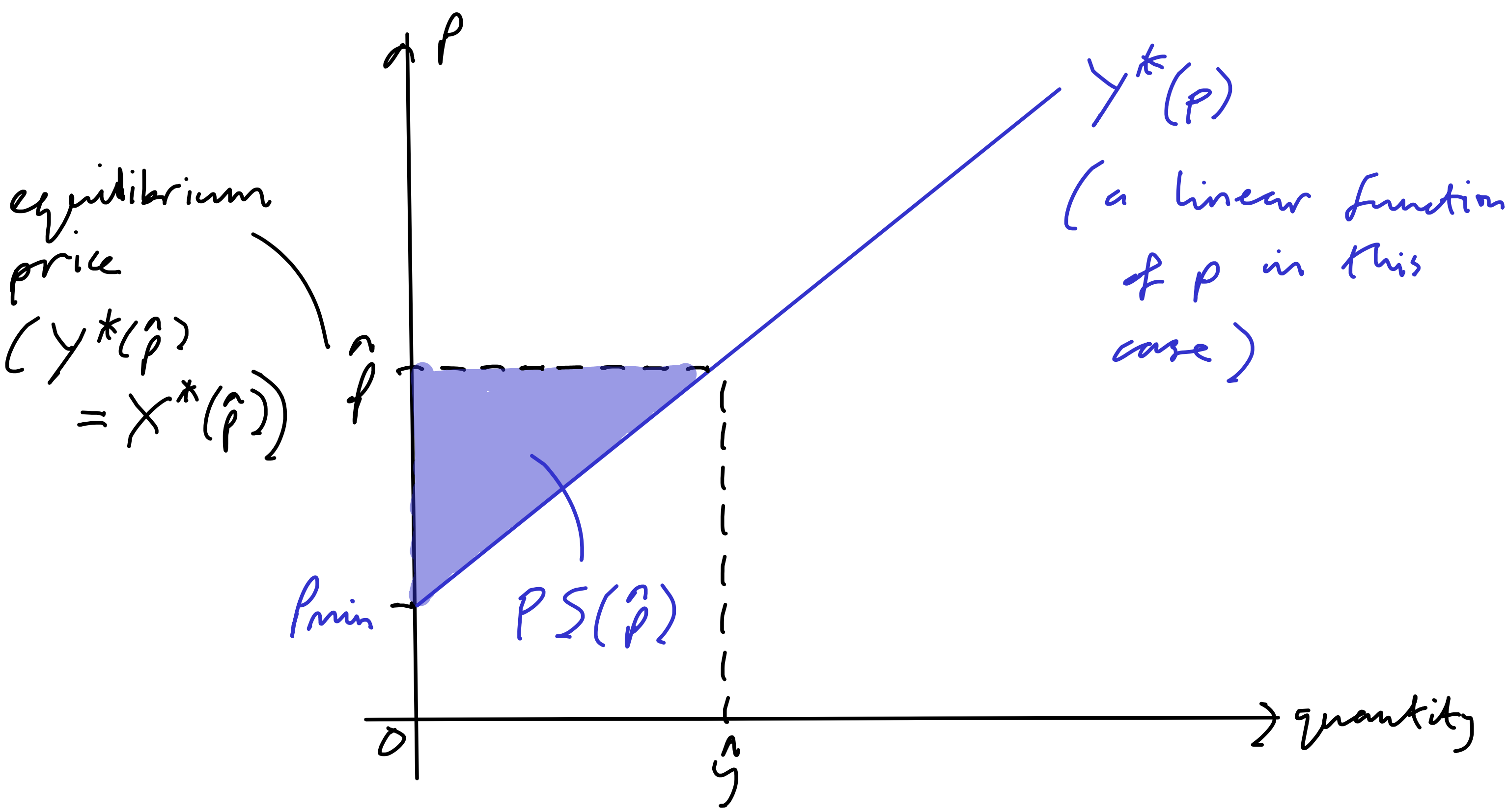
$$= \int_{p^{(1)}}^{p^{(2)}} Y^*(p)\,dp,$$

i.e., the area bounded by the market supply curve $Y^*(p)$ for $p^{(1)} < p < p^{(2)}$

Consequently, we introduce the ***producers' surplus at price*** $\hat{\mathbf{p}}$ as one part of the measure for social welfare measure:

$$PS(\hat{p}) = \int_0^{\hat{p}} Y^*(p)\,dp$$

This is the additional (aggregated) profit made by the producers by selling the product at the (equilibrium) market price $\hat{p}$ rather than at the minimum price p_{min}, say, at which they would be prepared to sell it. E.g.,



Note:

$$PS(\hat{p}) = \int_0^{\hat{p}} y^*(p)\,dp = \int_{p_{min}}^{\hat{p}} y^*(p)\,dp$$

The consumer side is a bit trickier. Following the utility maximisation rationale of the lecture, each individual consumer cares about the difference in their individual indirect utility, that is

$$V_i(p^{(2)}, m_i) - V_i(p^{(1)}, m_i)$$

However, this approach is problematic since

- it doesn't make sense to aggregate <u>ordinal</u> utilities,
- we would like to compare the effect on consumers to that on producers.

$\longrightarrow$ We instead seek a monetary measure.

A natural possibility is to consider the difference of the individual expenditure functions, keeping the initial (indirect) utility fixed. This quantity is known as ***compensating variation*** :

$$CV_i(p^{(1)}, p^{(2)}, m_i)$$

$$= e_i(p^{(2)}, v_i(p^{(1)}, m_i)) - e_i(p^{(1)}, v_i(p^{(1)}, m_i))$$

" m_i "

$$= \int_{p^{(1)}}^{p^{(2)}} \frac{d}{dp} e_i(p, v_i(p^{(1)}, m_i))\, dp$$

$$= \int_{p^{(1)}}^{p^{(2)}} \frac{d}{dp} e_i(p, v_i(p^{(1)}, m_i))\, dp$$

by Shephard's Lemma

$$= \int_{p^{(1)}}^{p^{(2)}} x^*_{H,i}\left(p, v_i(p^{(1)}, m_i)\right) dp$$

Note that here, this subscript i indicates the consumer rather than a product.

But this is problematic for the reason that Hicksian demand is not observable – only Marshallian demand is observable.

Furthermore it is somewhat inelegant that compensated variation is in general not anti-symmetric, i.e.,

$$CV_i(p^{(2)}, p^{(1)}, m_i) \neq - CV_i(p^{(1)}, p^{(2)}, m_i),$$

whereas the change in profit on the producer side is:

$$\sum_{j=1}^{J} \left(\Pi_j^*(p^{(2)}) - \Pi_j^*(p^{(1)})\right) = - \sum_{j=1}^{J} \left(\Pi_j^*(p^{(1)}) - \Pi_j^*(p^{(2)})\right).$$

We prefer to work with a quantity that relies on Marshallian demand only and that is anti-symmetric.

Thus, we consider:

$$\int_{p^{(1)}}^{p^{(2)}} x_i^*(p, m_i)\,dp$$

Recall,

$$CV_i(p^{(1)}, p^{(2)}, m_i) = \int_{p^{(1)}}^{p^{(2)}} x_{H,i}^*(p, v_i(p^{(1)}, m_i))\,dp$$

And $\quad x_{H,i}^*(p, v(p,m)) = x_i^*(p,m)$

so $\quad x_{H,i}^*(p^{(1)}, v_i(p^{(1)}, m_i)) = x_i^*(p^{(1)}, m_i)$

and $\quad x_{H,i}^*(p^{(2)}, v_i(p^{(2)}, m_i)) = x_i^*(p^{(2)}, m_i)$.

And Slutsky's equation gives:

$$\frac{\partial x_i^*(p,m_i)}{\partial p} = \partial_1 x_{H,i}^*(p, v_i(p,m_i)) - \left(\frac{\partial x_i^*(p,m_i)}{\partial m_i}\right) \cdot x_i^*(p,m_i)$$

$$\geq \partial_1 x_{H,i}^*(p, v_i(p,m_i)) \quad (1)$$

Note that here, as above, the subscript i indicates the consumer.

if we assume the good is normal $\left(\text{i.e., } \frac{\partial x_i^*(p,m_i)}{\partial m_i} \geq 0\right)$.

But

$$\partial_1 x^*_{H,i}(p, v_i(p, m_i)) = \left(\frac{\partial}{\partial p} x^*_{H,i}(p, u) \right) \Bigg|_{u = v_i(p, m_i)}$$

$$= \frac{\partial}{\partial p} x^*_{H,i}(p, v_i(p^{(1)}, m_i)) \quad \text{at } p = p^{(1)}$$

So, recalling (1), we have

$$\frac{\partial x_i^*(p, m_i)}{\partial p} \geq \frac{\partial}{\partial p} x^*_{H,i}(p, v_i(p^{(1)}, m_i)) \quad \text{at } p = p^{(1)}.$$

So at $p = p^{(1)}$, the gradient of the $x_i^*(p, m_i)$ curve is greater than that of the $x^*_{H,i}(p, v_i(p^{(1)}, m_i))$ curve.

Similarly, one can show that

$$\frac{\partial x_i^*(p, m_i)}{\partial p} \geq \frac{\partial}{\partial p} x^*_{H,i}(p, v_i(p^{(2)}, m_i)) \quad \text{at } p = p^{(2)}.$$

And note that since $p^{(1)} < p^{(2)}$ then

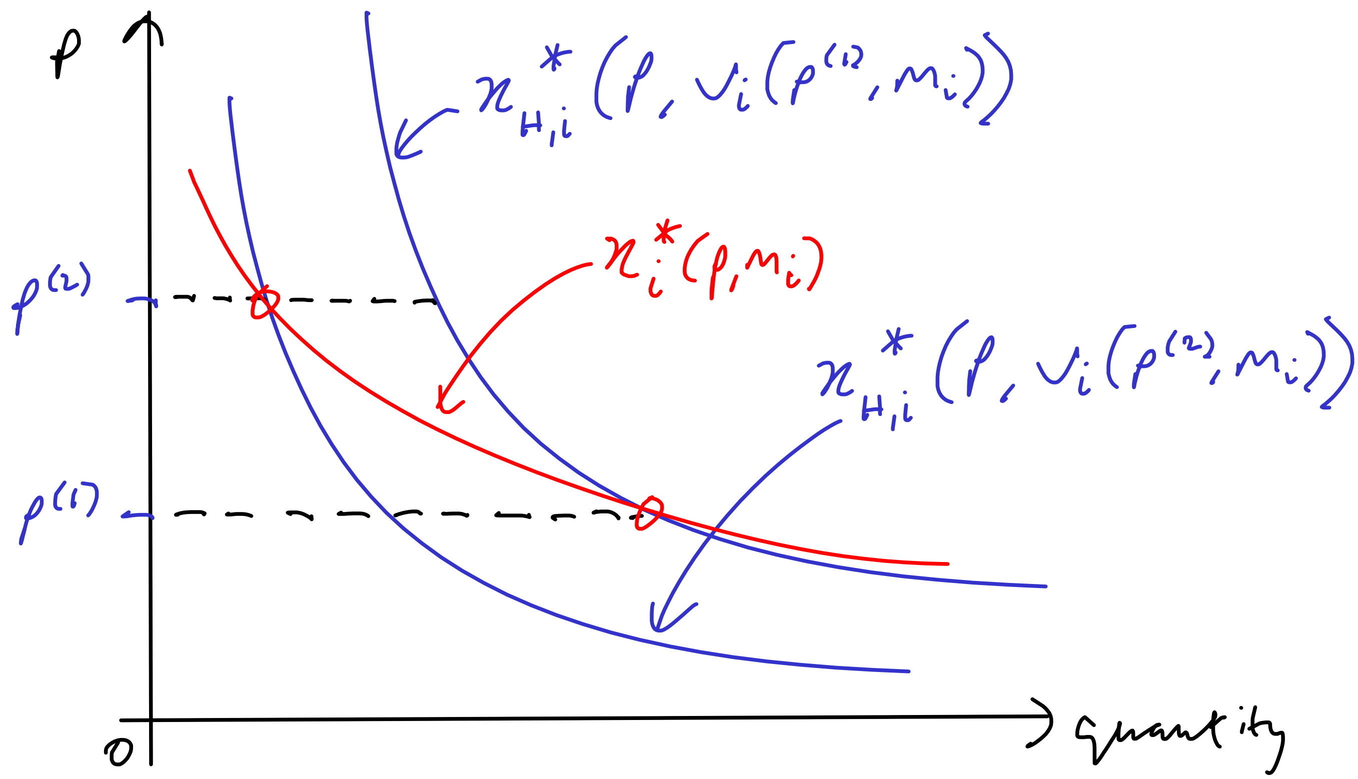
$$v_i(p^{(1)}, m_i) > v_i(p^{(2)}, m_i)$$

and so

$$x^*_{H,i}(p, v_i(p^{(1)}, m_i)) > x^*_{H,i}(p, v_i(p^{(2)}, m_i))$$

And as p increases, so both $x^*_{H,i}(p, v_i(p^{(1)}, m_i))$ and $x^*_{H,i}(p, v_i(p^{(2)}, m_i))$ decrease.

So we have



So

$$-CV_i(p^{(2)}, p^{(1)}, m_i) \leq \int_{p^{(1)}}^{p^{(2)}} x^*_i(p, m_i)\,dp \leq CV_i(p^{(1)}, p^{(2)}, m_i)$$

$$\| $$

$$\int_{p^{(1)}}^{p^{(2)}} x^*_{H,i}(p, v_i(p^{(1)}, m_i))\,dp$$

(Compare areas in sketch above.)

We define the consumers' surplus at price $\hat{p}$ by:

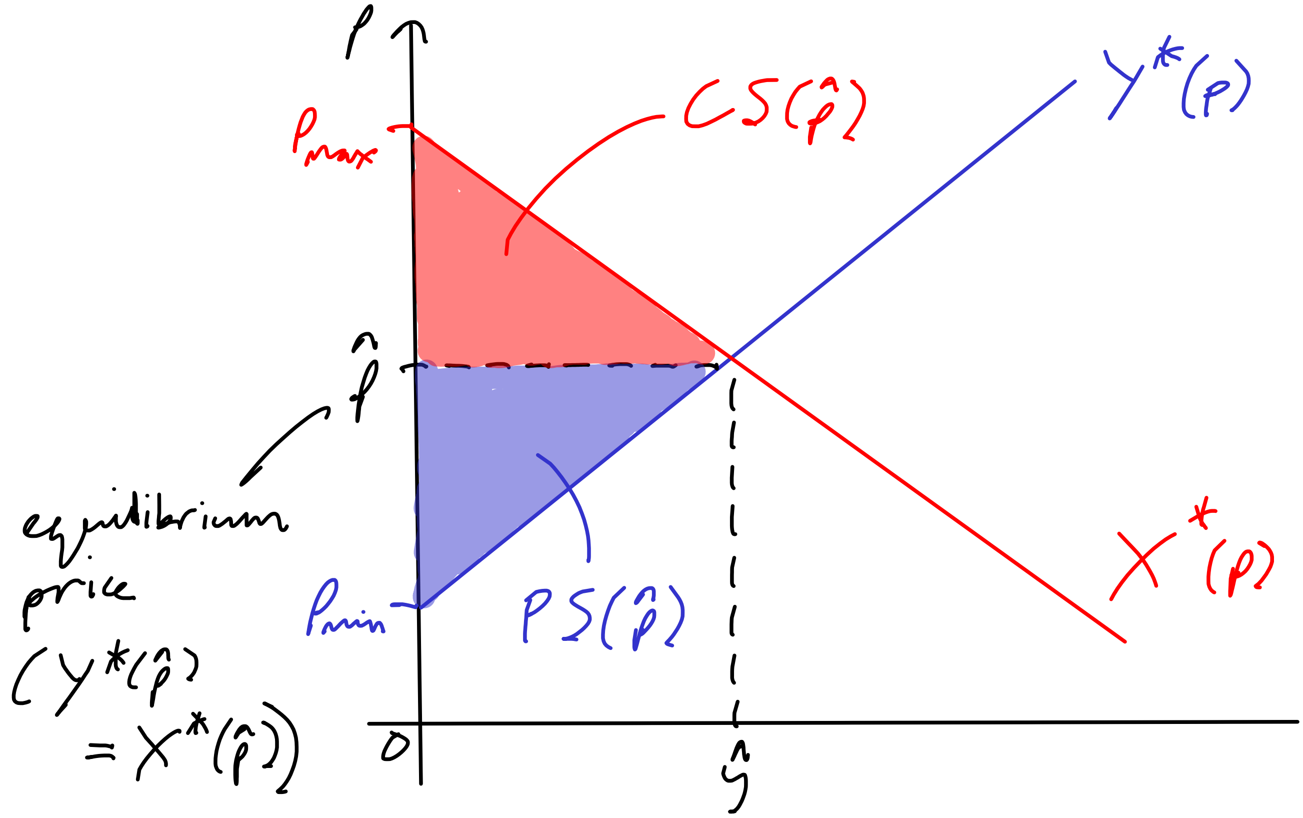
$$CS(\hat{p}) = \int_{\hat{p}}^{\infty} \sum_{i=1}^{I} x_i^*(p, m_i)\, dp$$

$$= \int_{\hat{p}}^{\infty} X^*(p, \underline{m})\, dp$$

$$= \int_{\hat{p}}^{p_{max}} X^*(p, \underline{m})\, dp$$

where p_{max} is the maximum price the consumers would be prepared to pay for the product.

So we have:



Finally, the sum of consumers' surplus and producers' surplus, the ***community surplus***, can be considered as a measure of social welfare.

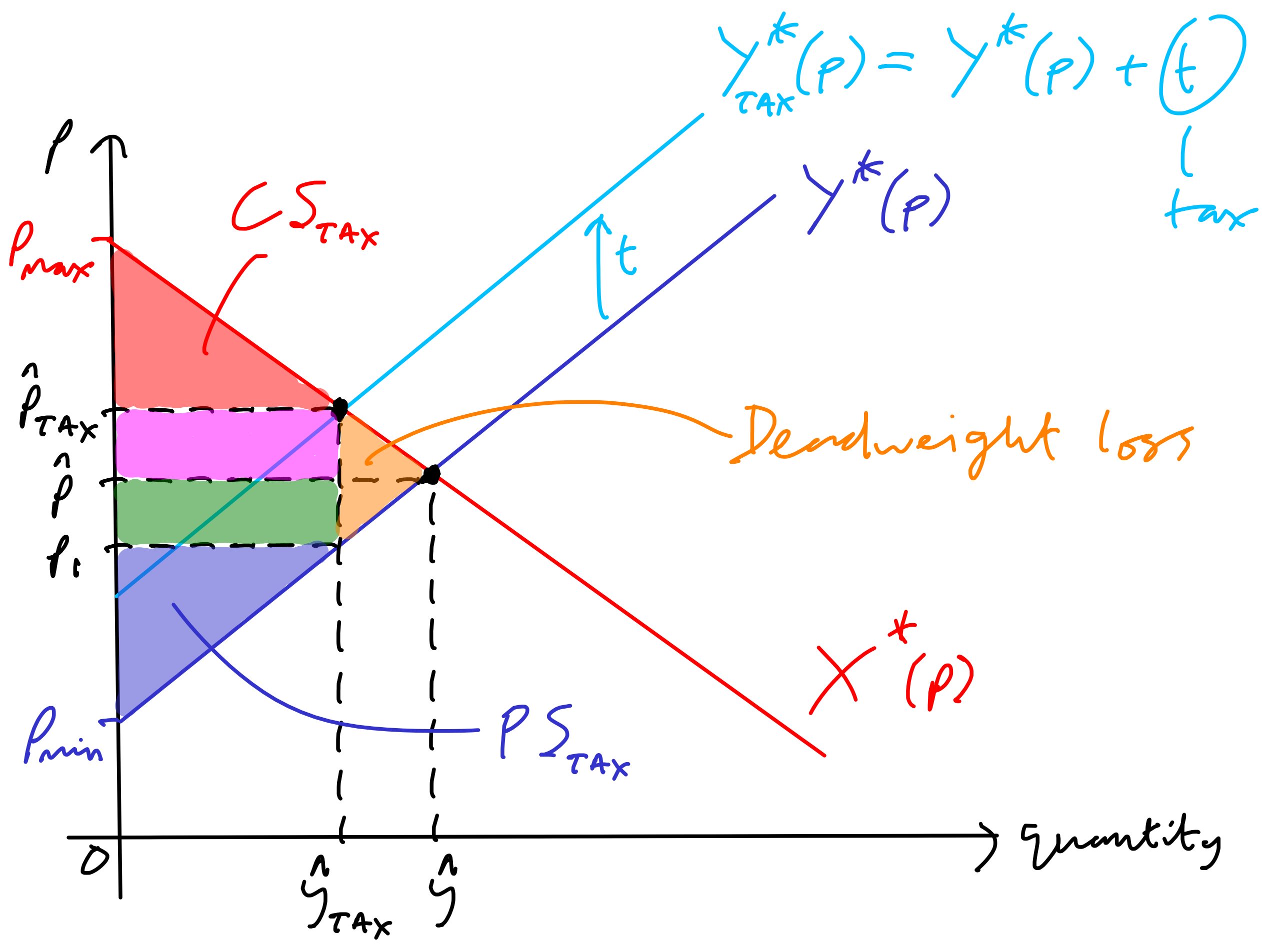
i.e., $CS(\hat{p}) + PS(\hat{p})$

Changes in the market demand or industry supply of a good will lead to a change in its equilibrium price. Taxes and subsidies are an interesting example of factors that lead to such a change.

Indirect Taxes and Equilibrium:

An indirect tax is one that can be passed on to another party. In the context of providing goods and services, an indirect tax on producers is one that is passed on to consumers. In general, a tax that is dependent on the quantity of good being produced can be treated as an indirect tax.

How much of an indirect tax is passed on to consumers?



The new supply function $y^*_{TAX}(p)$ accounts for a tax that the producer passes on to the consumer. The new equilibrium price and quantity traded are $\hat{p}_{TAX}$ and $\hat{y}_{TAX}$, respectively. Now, because of this tax, the consumer pays an additional

$$(\hat{p}_{TAX} - \hat{p})\hat{y}_{TAX} \qquad ①$$

for the amount $\hat{y}_{TAX}$ of the product while the producer earns

$$(\hat{p} - p_1)\hat{y}_{TAX} \qquad ②$$

less on selling that amount (the producer is now selling an amount $\hat{y}_{TAX}$ at a price $\hat{p}_{TAX}$, but after deducting tax, only earns $p_1 \hat{y}_{TAX}$ from the sale). ① and ② are the cost of the tax to the consumer and the producer, respectively (also referred to as the tax incidence or burden on them).

After accounting for these tax costs, the consumer and producer are left with surpluses of CS_{TAX} and PS_{TAX} as indicated in sketch the above.

Finally, the 'deadweight loss' is the difference

$$(CS + PS) - (CS_{TAX} + PS_{TAX})$$

i.e., the loss in community surplus due to the tax.