### Models

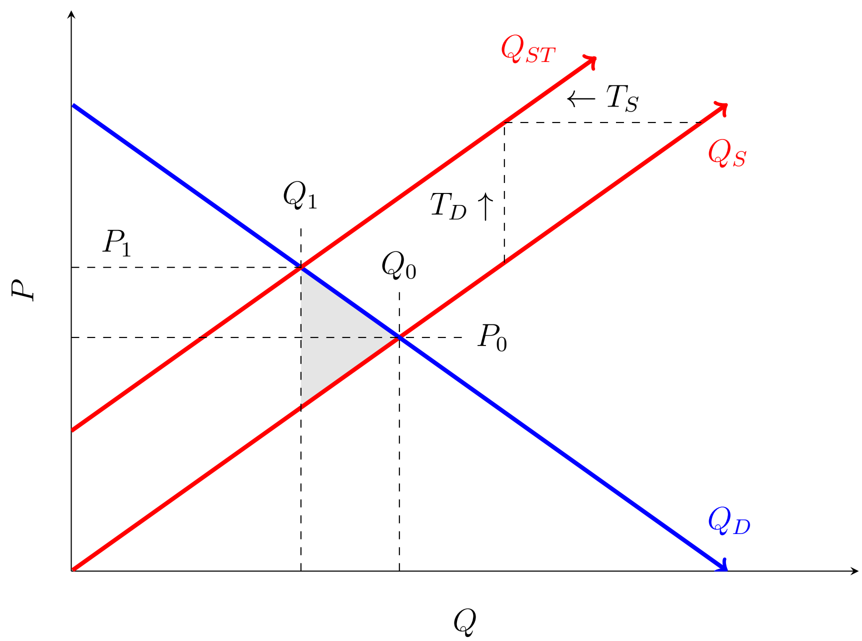
This subject deals with models; simplifications and idealisations of real world situations. While these might not be directly useful, they can help us gain an understanding as to how a more realistic situation might pan out.

## Supply and Demand

### Obesity

An example application of supply and demand can be observed in the rise of obesity among people in Australia in the recent past. This is a social problem which has implications for the economy and for government policy. A possible policy to counteract this issue is taxation of junk food.

The natural implication of taxation is that an increased price due to the tax will result in a lower equilibrium consumption quantity. We can consider the a model of supply in the junk food market to see the impacts. If we take a supply curve, which is upward sloping as a higher price implies a greater number of suppliers with incentive to produce such as $Q_S = P$ and a demand curve like $Q_D = c - P$ (negative, as higher price disincentivises purchase), we can plot the two to find an equilibrium price and quantity level.




If we want to desire the consumption level to some defined quantity $Q_1$, we need to increase the price by a relevant amount. If we charge a flat tax of some amount $T$, we will find that the price increases by exactly $T$. If this tax is applied on the supplier side, we will observe a reduction in quantity from $Q_S$ to $Q_ST$, as shown by $T_S$. If it is applied on the demand side, we will observe an increase in price presenting an effective supply curve of $Q_ST$, as shown by $T_D$. In either case, the gray shaded region represents a deadweight loss of welfare and the tax revenue is given by $T \times Q$.

While conceptually this makes sense to us, in reality studies have found that such taxes have a smaller effect than predicted on consumption of junk food. This suggests that junk food is actually highly price inelastic at current quantities; it is not strongly affected by the price.

### Price Elasticity of Demand

Price elasticity of demand is given by change in quantity per unit quantity divided by change in price per unit price. That is

$$E_P = \frac{\Delta Q/Q}{\Delta P/P} = \frac{\Delta Q}{\Delta P} \times \frac{P}{Q}$$

Which is simply the inverse of the slope of the demand curve multiplied by the ratio of price to quantity. This means that at low quantities, the ratio of price to quantity will be larger so the elasticity will be higher, as for a linear curve, the inverse of the slope is a constant. Generally elasticity is always negative, so we simply use the absolute value. Depending on the value of price elasticity we use certain terminology

- If $|E_P| > 1$ we say that demand is price elastic, which means that a given percentage change in price will lead to a greater percentage change in quantity.
- If $|E_P < 1|$ we say that demand is price inelastic, suggesting that a percentage change to price will produce a smaller percentage change in quantity.

## Individual Choice

In reality, individuals might maximise welfare through different means, different quantities of junk food, etc. In microeconomics, agents need to make decisions between goods. Here, we will consider how agents will find an optimal basket of two goods. We can consider an example of how many hours one should study. If the benefit derived from $h$ study hours is

$$B = \omega h$$

Where $\omega$ is some constant. Then our marginal benefit of studying is

$$\frac{\mathrm{d}B}{\mathrm{d}h} = \omega$$

If this was the only information we had, then it would be optimal to spend all time studying. However, we must also consider the costs involved in studying some amount, which we can model as

$$C = \frac{h^2}{4} \Rightarrow MC = \frac{\mathrm{d}C}{\mathrm{d}h} = \frac{1}{2}h$$

The net benefit of one hour of study is then $B - C = B_N = \omega h - \frac{h^2}{4}$. We can find the point to maximise benefit by setting the derivative of net benefit equal to zero.

$$\frac{\mathrm{d}B_N}{\mathrm{d}h} = 0 \Rightarrow \omega - \frac{1}{2}h = 0 \Rightarrow h = 2\omega$$

This is equivalent to finding $B' = C'$ or $MB = MC$.

This can be generally applied; if we want to incentivise an action, we should lower the marginal cost of this action and increase its marginal benefit.

### Short-Termism

In some settings, we find that people consistently fail to make decisions which maximise their welfare. For example, in Africa governments often heavily subsidise mosquito nets and yet adoption is still fairly lower, because people don't consider the future benefit sufficiently.

We can model this as a *discount factor*, $V$ which influences our evaluation of future benefit from a present investment. For a future benefit of magnitude $G$, at a present price of $F$, an individual will only make the transaction if for them

$$\frac{G}{V} \geq F$$

Thus, individuals with higher discount factors are likely to be disincentivised from making decisions that may appear to lead to a large increase in welfare for them in the future.

## Consumer Preferences

In Australia, we have a flat 10% GST across most goods and services, with some exemptions for food, health, education, etc. Some probolems exist with this system, with parties arguing that it can be complex and distortionary. A proposed reform is the removal of exemptions, with the suggestion for compensation of disproportionately affected poor person by transfer payment.

To determine an appropriate magnitude for such a payment, we would need to realistically estimate the basket of goods consumed by such a recipient. The problem being solved here is a constrained maximisation exercise.

We can consider a consumer trying to find an optimal composition of goods between food and other goods.

| Basket | Other | Food |
|---|---|---|
| $A$ | $4$ | $8$ |
| $B$ | $8$ | $2$ |
| $C$ | $6$ | $5$ |
| $D$ | $4$ | $5$ |
| $E$ | $7$ | $6$ |

In the above example, it is obvious that basket $E$ is strictly than $C$ which in turn is strictly greater than $D$. We can say that there should be a *strict preference* for $E > C > D$. It is not obvious however how $E$ should be compared to $A$ or $B$.

For this problem, we introduce some special notation for comparison of various baskets.

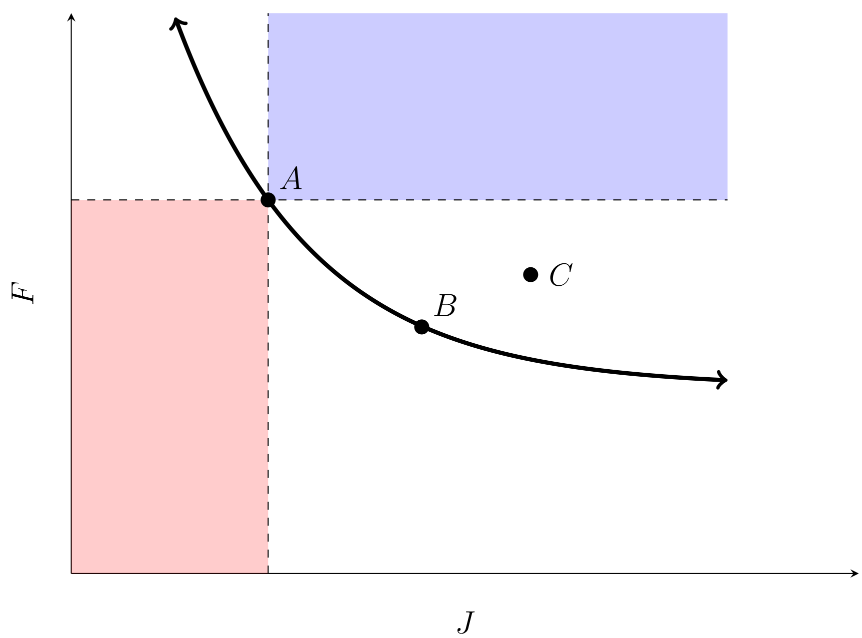
- The statement $A \succ B$ indicates a preference for $A$ over $B$. In the above case, this means that the agent would happily sacrifice $4$ units of other goods for $6$ units of food.
- The statement $A \sim B$ means that there is no strong preference between $A$ and $B$.
- $A \succsim B$ suggests that $A$ is as good or better than $B$. In this case $B \not\succ A$. The symbol behaves similarly to $\geq$.

These assumptions have the following assumptions

- Completeness; a consumer can always assign an operator to compare two baskets. They can pick and choose between all available baskets.
- Transitivity; $A \succ B$ and $B \succ C$ means $A \succ C$.
- More is better (ceteris paribus)
- Convexity; consumers prefer a combination of goods over an equivalent value of a single good. This is enforced through a diminishing marginal rate of substitution.

**Indifference Curves**

An indifference curve is a curve drawn on a plot of two different goods that describes the set of good baskets that the consumer is indifferent between.




In the above plot, the black line indicates the possible baskets of the goods $J$ and $F$ that a hypothetical consumer is indifferent between. Because $A$ and $B$ lie on this line, we know $A \sim B$. The blue shaded region indicates baskets of goods $\succ A$, as they have more of both goods than $A$ does. The red shaded region is the baskets $\not\succ A$. If we considered the equivalent regions for $B$, we see that $C$ can never lie on the indifference curve as $C \succ B$.

For the same reason that $C \succ B$, we know that two indifference curves can never intersect as all indifference curves must be at different value levels. Thus, we can view a set of indifference curves as a kind of welfare topographic map for the consumer, known as an *indifference map*.

### Marginal Rate of Substitution

An indifference curve shows us that to gain more of one good at the same level of satisfaction, the consumer must give up some of the other good. To generalise this concept we use the marginal rate of substitution, $MRS$. So for a curve of $F$ and $J$,

$$MRS_{FJ} = -\frac{\mathrm{d}F}{\mathrm{d}J}$$

Note that this is in terms of the amount of the vertical axis good $F$ a consumer is willing to sacrifice for a unit of horizontal good $J$. As we move to higher $J$ values, the consumer is willing to give up less $F$ for more $J$.

This system works well for most goods, however for some goods which are *perfect complements* like left and right shoes, a consumer always wants an exactly equal quantity of the two goods.

Another variety of goods is "bads"; goods which have negative value. If these goods are plotted against a positive good, the curves will increase as we move to the top left. We also have neutral goods, where quantity of the good is unrelated to welfare.

### Utility Functions

A convenient way to universally determine preferences between baskets of goods is through utility functions. An example might be

$$u(J, F) = 2J + F$$

For this function to accurately represent preferences it must have the properties

- $u(A) > u(B) \Leftrightarrow A \succ B$
- $u(A) = u(B) \Leftrightarrow A \sim B$

Any order preserving transformation can be applied to a utility function without changing the ranking it produces.

Utility functions yield a concept of marginal utility, the utility obtained from consuming an additional unit of a good.

$$MU_F = \frac{\mathrm{d}u}{\mathrm{d}F} = \frac{\partial u}{\partial F}$$

Our assumption of convexity means that we know that

$$\left.\frac{\partial u}{\partial F}\right|_{F=x} \downarrow \text{ as } x \uparrow$$

An indifference curve is described by a line where $\Delta u = 0$.

$$-\frac{\Delta F}{\Delta J} = \frac{MU_J}{MU_F}$$

As the magnitude of the derivative of $F$ with respect to $J$ is $MRS$, we have found

$$MRS_{FJ} = \frac{MU_J}{MU_F}$$

The marginal rate of substitution is given by the ratio of marginal utilities.

### Budgets

In reality, a consumer has some budget to spend. If that amount is a budget $I$ to be spent on two goods $F$ and $J$ then we find

$$P_J J + P_F F = I$$

Where $P$ is price. Rearranging, this looks like

$$F = \frac{I}{P_F} - \left(\frac{P_J}{P_F}\right) J$$

If plotted, this yields a graph of $F$ against $J$ with slope

$$-\frac{P_J}{P_F}$$

The area under this graph is the set of all baskets the consumer can afford.

An increase in income $I$ will cause a shift up and out of the budget line. The slope will remain constant.

A change in price of one of the goods will cause the intercept of that good to change. The other intercept will remain constant. For instance if $J$ becomes cheaper, the horinzontal $J$ intercept will move inward to a lower value, while the vertical $F$ intercept remains constant, resulting in a steeper curve, incentivising higher consumption of $J$.

If both goods are increased in price by some factor $k$, the effect is to reduce income by factor $\frac{1}{k}$ while maintaining the ratio of goods.