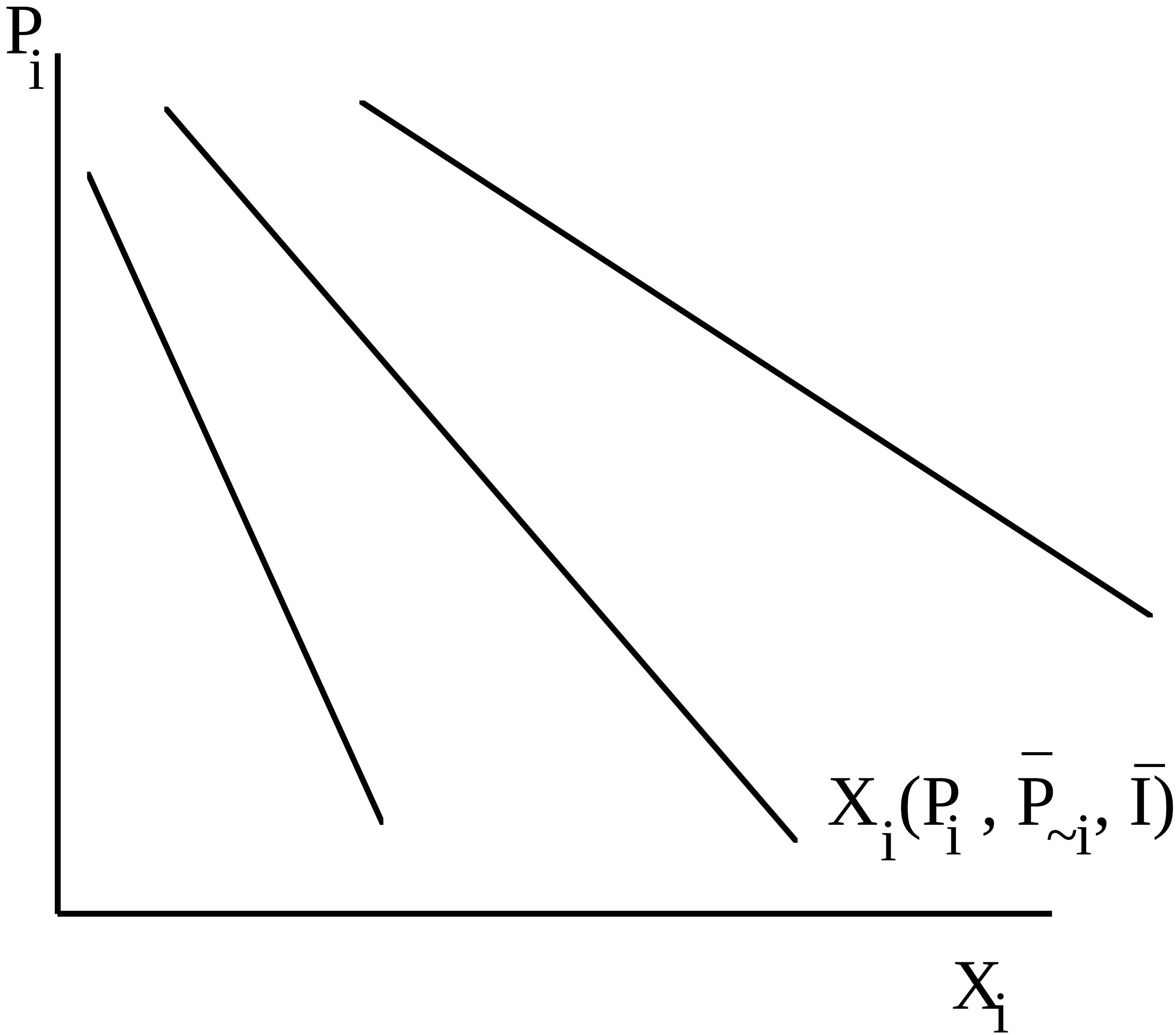
Market or Industry Demand

We have seen how the demand for one good can be affected when the price of another good changes. This also works for situation where there is more than 2 goods. The i^{th} good depends on the prices of all goods and income x_i (p, I). Since there are too many variables (n prices and income) I will assume that except for the price of the i^{th} good, all prices and income are kept constant. We can now draw a familiar demand curve (see figure below). To find the market demand curve, I add up horizontally all the demand curves of different people.



P_i
$X_i(P_i, \bar{P}_{\sim i}, \bar{I})$
X_i

A market demand curve, X_i, depends on the i^{th} price, on the price of all other goods and on the whole distribution of income (if I change the distribution of income, even if I keep total income constant and all prices constant, demand will change). The aggregate demand depends not only on total income but also on who has it.

$$X(P_i, P_{\sim i}, I^1, I^2, \ldots\ldots I^n)$$

Slope. To characterize a demand curve we look at the slope. The slope tells me how sensitive the quantity demanded is to changes in prices. The slope tells me what is the change in demand with respect to a change in price.

$$\frac{\partial x_i}{\partial p_i}$$

For example, if a demand curve is very flat, a small change in price will result in a big change in demand.

The problem with the slope is that it is not unit independent. We obtain a different number if we measure, for instance, in pounds per Dollar than if we measure it in grams per Yen. If we want to get a measure of sensitivity with respect to price that is unit free we look at percentages. Instead of looking at,

$$\frac{\Delta x_i}{\Delta p_i}$$

Elasticity

Elasticity- The percentage change in a dependent variable resulting from a 1% change in another variable.

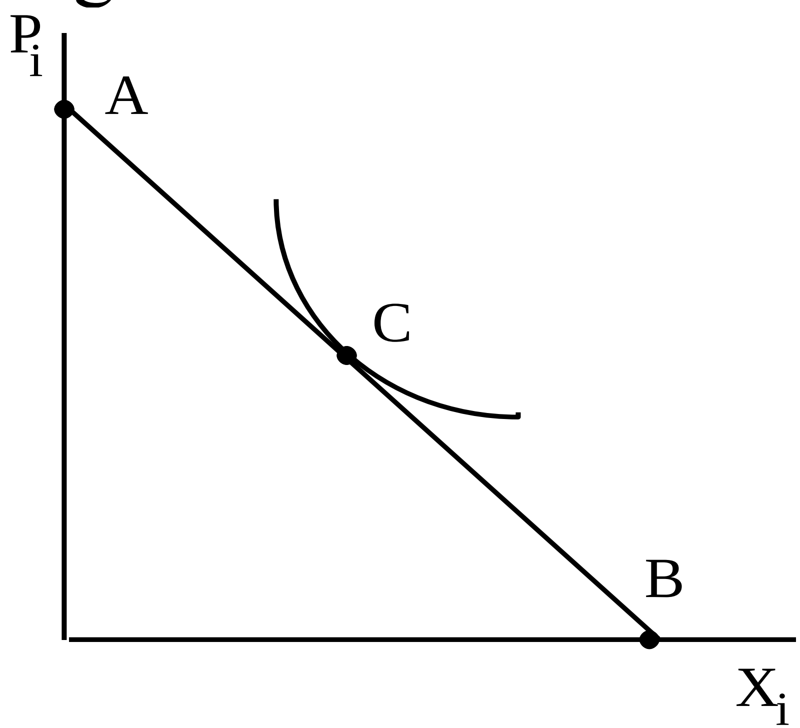
We look at,

$$\frac{\%\Delta x_i}{\%\Delta p_i} \quad \text{or} \quad \frac{\Delta x_i / x_i}{\Delta p_i / p_i}$$

which will be unit free. It will say something like a 1% change in price will result in a 3% change in demand. Since we expect demand curves to be downward sloping the price elasticity will be negative. The elasticity is the absolute value of the previous expression

$$\left| \frac{p_i}{x_i} \frac{\partial x_i}{\partial p_i} \right| = \text{elasticity}$$

Suppose we have a demand curve that is a straight line (see figure below). The elasticity of this demand curve at point A is very high because a small percentage change in price leads to an infinite percentage change in demand. The elasticity at point B is zero because a big percentage change in price results in a small percentage change in demand.



In general

Elasticity = (%Δ Y) / (%Δ X)

$$= (\Delta Y / \Delta X) * (X / Y)$$

This applies to demand as well as supply and applies to any dependnt variable that is affected by an independent variable as per the definition at the beginning of this lecture.

Point Elasticity = Elasticity at a given point on a function.

$$\text{Point Elasticity} = (\%\Delta Y) / (\%\Delta X)$$

$$= (\Delta Y/Y) / (\Delta X/X)$$

$$= (\Delta Y / \Delta X) * (X / Y)$$

$$= (\partial Y / \partial X) * (X / Y)$$

Arc Elasticity = Elasticity over a given range of a function.

Arc Elasticity
= [(Change in Y)/(Average Y)] /[(Change in X)/(Average X)]

= [(Y2-Y1)/(Y2+Y1)/2}] /[(X2-X1)/ (X2+X1)/2]
= (ΔY / ΔX) * [(X2+X1) / (Y2+Y1)]

We will concentrate on point elasticity for the rest of this lecture.

Price elasticity of demand - Responsiveness of the quantity demanded to changes in the price of the product, holding constant the values of all other variables in the demand function.

Remember ε_p is negative since demand curve downward sloping.

Price elasticity terminology.

$|\varepsilon_p| > 1$ is defined as elastic demand

$|\varepsilon_p| = 1$ is defined as unitary demand

$|\varepsilon_p| < 1$ is defined as inelastic demand

With Elastic demand the change in price changes quantity demanded by a larger percentage that the change in price. This means every time you increase price by 1%, quantity will decrease by more than 1%. Therefore revenue (P*Q) will decrease since $\uparrow P < \downarrow Q$.

The opposite happens with inelastic demand. With unitary elastic demand revenue remains unchanged.

Optimal pricing policies.

Total revenue (TR) equal (P*Q).

We can define Marginal Revenue as

$$MR = (\Delta TR/\Delta Q)$$

$$MR = [(P*\Delta Q) + (\Delta P*Q)]/ \Delta Q$$

After some manipulation we can wr
MR in terms of price elasticity.

$$MR = P + (\Delta P / \Delta Q) * Q$$
$$= P + (\Delta P / \Delta Q) * (Q/P) * P$$
$$= P[1 + \{(\Delta P / \Delta Q) * (Q/P)\}]$$
$$= P[1 + \{1/(\Delta Q / \Delta P) * (P/Q)\}$$
$$MR = P[1 + (1/\varepsilon_p)]$$

$MR = P[1 + (1/\varepsilon_p)]$

Given this we can see what happens to Marginal Revenue as prices change. When demand is Elastic (<-1, so MR<0), Inelastic (>-1 so MR>0) and Unitary Elastic (=-1, so MR=0).

Notice elasticity here needs to be measured in real terms and not absolute terms.

Note: We will learn that profit is maximized when marginal cost equals marginal revenue.

MC=MR

Therefore the profit maximizing price can be written as a function of the elasticity.

$MR = MC = P[1 + (1/\varepsilon_p)]$

$P^* = MC/[1 + (1/\varepsilon_p)]$

$$P^{*}=MC/[1+(1/\varepsilon_p)]$$

This is known as markup above marginal cost. As can be seen how much above MC a firm can charge depends on there price elasticity of demand.

Different types of Elasticity of Demand

Own Price Elasticity of Demand

$$\frac{\%\Delta x_i}{\%\Delta p_i}$$

Cross Price Elasticity of Demand

$$\frac{\%\Delta x_i}{\%\Delta p_J}$$

Income Elasticity

$$\frac{\%\Delta x_i}{\%\Delta I}$$

Cross Price Elasticity of Demand

$$\frac{\%\Delta x_i}{\%\Delta p_J}$$

Cross elasticity of demand
Responsiveness of demand for one product when the price of another product changes.

$$\varepsilon_{px} = (\%\Delta \text{ in } X_i) / (\%\Delta P_j)$$
$$= (\Delta X_i / X_i) / (\Delta P_j / P_j)$$
$$= (\Delta X_i / \Delta P_j) * (P_j / X_i)$$
$$\Rightarrow (\partial X_i / \partial P_j) * (P_j / X_i)$$

Substitutes - Related products for which a price increase for one leads to an increase in demand for the other.
Complements- Related products for which a price increase for one leads to a reduction in demand for the other.

Substitutes - 2 good are substitutes if $\varepsilon_{pY} > 0$
Complements -2 good are complements if $\varepsilon_{pY} < 0$
Two good are independent if $\varepsilon_{pY} = 0$

Income Elasticity

$$\frac{\%\Delta x_i}{\%\Delta I}$$

Income elasticity of Demand- Responsiveness of demand to changes in income, holding all other variables constant.

$$\varepsilon_I = (\%\Delta \text{ in } X_i) / (\%\Delta \text{ in } I),$$
$$= (\Delta X_i / X_i) / (\Delta I/I)$$
$$= (\Delta X_i / \Delta I)^* (I / X_i)$$
$$\Rightarrow (\partial X_i / \partial I)^* (I / X_i)$$

noncyclical, countercyclical, procyclical.

inferior goods- Products for which consumer demand declines as income rises.

inferior goods or countercyclical $\varepsilon_I < 0$

normal and superior (luxury) goods- Products for which consumer demand increases as income rises.

normal good or noncyclical $1 > \varepsilon_I > 0$

superior (luxury) good or procyclical $\varepsilon_I > 1$

Other measure of Elasticity

Advertising elasticity., weather elasticity (utilities), interest rate elasticity.

$$X = \frac{I}{(1+\frac{.75}{.25})P_x}$$

Own Price Elasticity of Demand

$$\frac{\%\Delta X}{\%\Delta P_X} = \frac{\frac{\Delta X}{X}}{\frac{\Delta P_X}{P_X}} = \frac{\Delta X}{\Delta P_X}\frac{P_X}{X} \Rightarrow \varepsilon_{P_X} = \frac{\partial X}{\partial P_X}\frac{P_X}{X}$$

$$\varepsilon_{P_X} = \frac{\partial X}{\partial P_X}\frac{P_X}{X} = -\frac{I}{(1+3)P_X^2}\frac{P_X}{X} = -\frac{I}{(4)P_X X}$$

Income Elasticity

$$\frac{\%\Delta x_i}{\%\Delta I} \Rightarrow \varepsilon_{I=} \frac{\partial X}{\partial I}\frac{I}{X} = \frac{1}{(1+3)P_x}\frac{I}{X} = \frac{I}{(4)P_X X}$$

Cross Price Elasticity of Demand

$$\frac{\%\Delta X}{\%\Delta P_Y} \Rightarrow \frac{\partial X}{\partial P_Y}\frac{P_Y}{X} = 0 \times \frac{P_Y}{X} = 0$$

Find the Own Price Elasticity of Demand, the Income Elasticity and the Cross Price Elasticity of Demand for the following Marshallian demand function.

$$X = 2 - 6P_X + 3P_Y + 2I^2$$

Own Price Elasticity of Demand

$$\frac{\%\Delta X}{\%\Delta P_X} = \frac{\frac{\Delta X}{X}}{\frac{\Delta P_X}{P_X}} = \frac{\Delta X}{\Delta P_X}\frac{P_X}{X} \Rightarrow \varepsilon_{P_X} = \frac{\partial X}{\partial P_X}\frac{P_X}{X}$$

$$\varepsilon_{P_X} = \frac{\partial X}{\partial P_X}\frac{P_X}{X} = -6\frac{P_X}{X}$$

Income Elasticity

$$\frac{\%\Delta x_i}{\%\Delta I} \Rightarrow \varepsilon_{I=} \frac{\partial X}{\partial I}\frac{I}{X} = 2(2)\frac{I}{X} = 4\frac{I}{X}$$

If d>0 then normal or superior good

Cross Price Elasticity of Demand

$$\frac{\%\Delta X}{\%\Delta P_Y} \Rightarrow \frac{\partial X}{\partial P_Y}\frac{P_Y}{X} = 3\frac{P_Y}{X}$$

if c>0 the Y is a substitute if c<0 then Y is a complement.

Now without number ☺

Find the Own Price Elasticity of Demand, the Income Elasticity and the Cross Price Elasticity of Demand for the following Marshallian demand function.

$$X = a - bP_X + cP_Y + dI$$

Own Price Elasticity of Demand

$$\frac{\%\Delta X}{\%\Delta P_X} = \frac{\frac{\Delta X}{X}}{\frac{\Delta P_X}{P_X}} = \frac{\Delta X}{\Delta P_X}\frac{P_X}{X} \Rightarrow \varepsilon_{P_X} = \frac{\partial X}{\partial P_X}\frac{P_X}{X}$$

$$\varepsilon_{P_X} = \frac{\partial X}{\partial P_X}\frac{P_X}{X} = -b\frac{P_X}{X}$$

Income Elasticity

$$\frac{\%\Delta x_i}{\%\Delta I} \Rightarrow \varepsilon_I = \frac{\partial X}{\partial I}\frac{I}{X} = d\,\frac{I}{X}$$

If d>0 then normal or superior good

Cross Price Elasticity of Demand

$$\frac{\%\Delta X}{\%\Delta P_Y} \Rightarrow \frac{\partial X}{\partial P_Y}\frac{P_Y}{X} = c\,\frac{P_Y}{X}$$

if c>0 the Y is a substitute if c<0 then Y is a complement.

Which products do you believe are inelastic with respect to its own price?

Which product do you believe are elastic with respect to its own price?

Write out 2 columns one with list elastic products another with inelastic products.

What factors might affect a product’s price elasticity?

Determinants of price elasticity of Demand

1. Degree to which it is a necessity
2. Availability of substitutes
3. The proportion of income spent on the product.

What advantage does a manager have by knowing how elastic a product is with respect to its own price?

What about other types of Elasticity?

What advantage might a manager have by knowing the cross price elasticity with respect to other products?

What advantage might a manager have by knowing income elasticity of a product? Advertising Elasticity? Weather Elasticity?

Short vs Long Term Elasticity

It may be that the price elasticity of a product is inelastic in the short run, but as people are able to change their behavior the price elasticity becomes more elastic.

Can you think of such a product?

Now consider the following example:

A microbrewery sells only beer and initially sells 8000 pints per months at \$4.50 per pint. The average cost (including overhead) to the microbrewery is constant at \$4.00 a pint

After some consideration the owner raises the price to \$4.95 per pint. Average cost remains constant at \$4.00 a pint.

After the price increase the quantity of pints sold decreases to 7600.

Did the microbrewery make the correct decision by increasing the price of a pint?

What is the point price elasticity of Beer in this example?

Is Beer elastic, inelastic or unitary elastic?

How has total revenue changed?

Should the owner raise prices again?

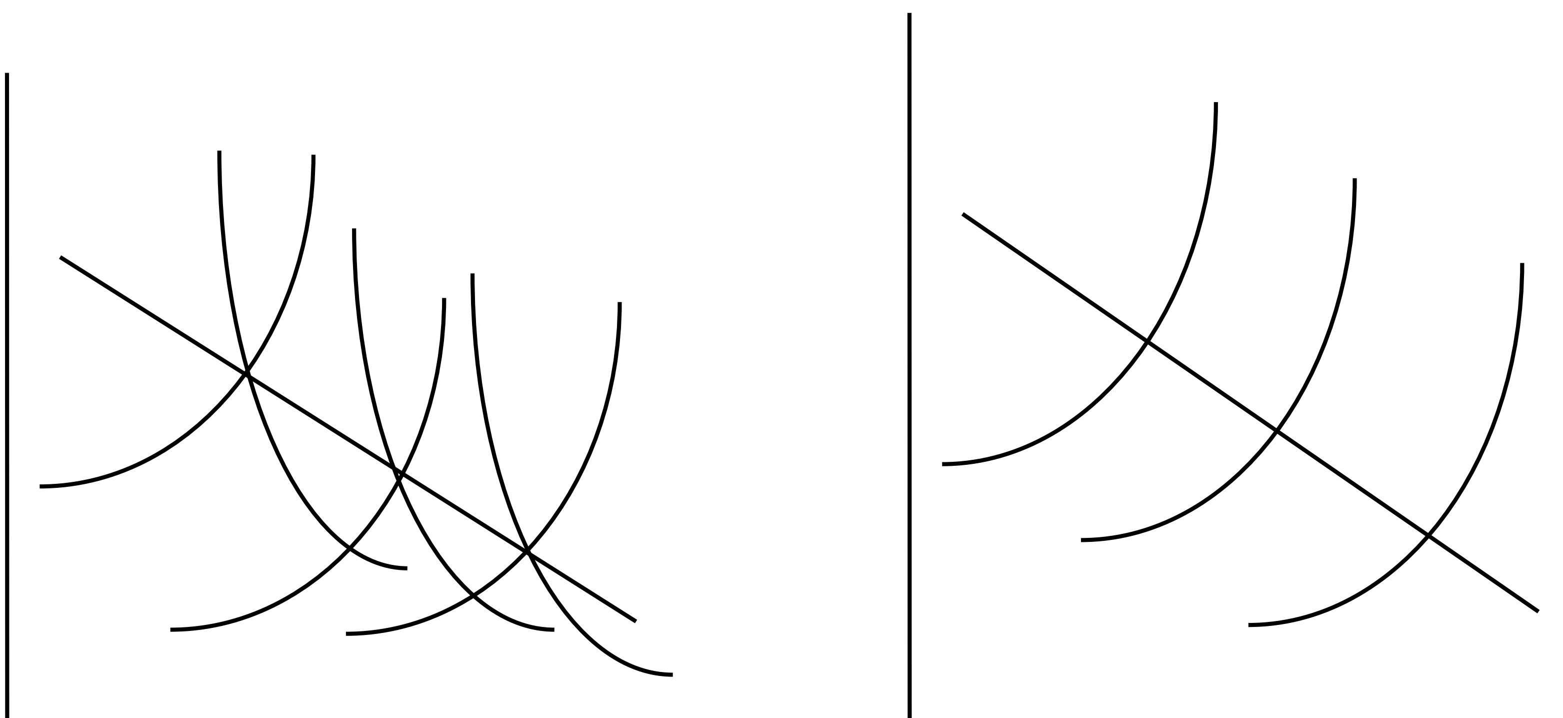
Demand Estimation

Identification Problem- For our purposes this is the problem incurred by including independent variables that do not effect the dependent variable or exclude independent variables that are relevant.

Difficulties in estimating Demand

It is difficult to estimate all of the variables that may affect demand.

In addition, the interaction of demand and supply can distort any estimate of demand.



Simultaneous relation

Concurrent association. In our example the supply and demand determines the quantity and price of the product. We therefore must estimate supply and demand simultaneously.

This of course make the identification problem even harder since we have to correctly predict which factor affects supply and demand. In addition, we have to deal with factors that may affect both supply and demand.

Interview and Experimental Methods

Consumer Interviews - Questioning customers to estimate demand relations.

Many times customers are unable or unwilling to provide correct answers to surveys.

This is why a market experiment may be a better option.

It can involve the manipulation of prices or different types of advertisement in certain test markets. This way they can see how consumers actually respond to changes in these variables. One problem is that the tester can not control environmental factor that can exogenously effect the demand for the product.

Another method is a laboratory experiment. Participants are given monetary units to buy certain products. Researcher can then manipulate the environment to test how certain change will affect demand.

One problem with type of study is that participants are likely to act differently in the experiment, than they might in the real world. Another problem is the high cost of such experiments.

Using both these methods we can estimate point or arc price elasticity. We can also measure cross elasticity. We do however have to be aware of the limitations to estimations of demand.