In this analysis, I will be exploring procedures for estimating demand functions. A demand function shows the causal relationship between the quantity demanded for a product and various independent variables (i.e. factors which are believed to influence demand). More specifically, I will be exploring the causal relationship between price changes for a given product and its impact on demand. Economist theorize that holding everything else constant, when the price of a product falls, the quantity demanded of the product will increase. While when the price of a product rises, the quantity demanded of the product will decrease.

This means that there is an inverse relationship between price and quantity demanded;

*P* ↓ ⇒ *QD* ↑

*P* ↑ ⇒ *QD* ↓

Why might demand be downward sloping? There are a few reasons: (1) Intuitive reasoning; people would like to buy more units at lower prices and vice versa. (2) Diminishing marginal utility; consumer gets less and less additional satisfaction from consuming equal additional units of the same good. (3) Substitution effect; if the price of one good falls relative to its substitutes, then consumers will buy more of it. (4) Income effect; as the price of a good falls, the consumer can afford more units of that good, therefore their *purchasing power* increases.

Economists use *price elasticity* of demand to measure the responsiveness, or elasticity, of the quantity demanded of a good or service to a change in its price when nothing but the price changes. Therefore, the *price elasticity* of demand can be measured by;

Since, the *price elasticity* of demand is the percentage change in quantity demanded for a percentage change in price, moving along the demand curve. Equivalently, as above, *price elasticity* of demand can also be expressed as the slope of the relationship between the natural logs of *QD* and *P*. That is;

*Price elasticity* of demand will always be a negative number. As price increases, quantity demanded decreases and as price decreases, quantity demanded increases.

*Elastic* results occur when the percentage change in quantity demanded exceeds the percentage change in price. so that the *price elasticity* is greater than 1 in absolute terms;

*%*Δ*QD* > *%*Δ*P*  ⇒ || > 1

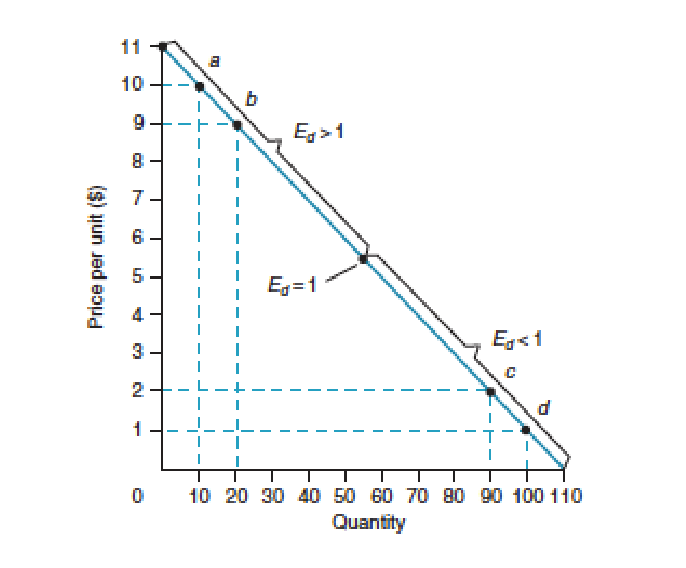
*Inelastic* results occur when the percentage change in quantity demanded is less than the percentage change in prices so that the *price elasticity* is less than 1 in absolute value;

*%*Δ*QD* < *%*Δ*P*  ⇒ || < 1

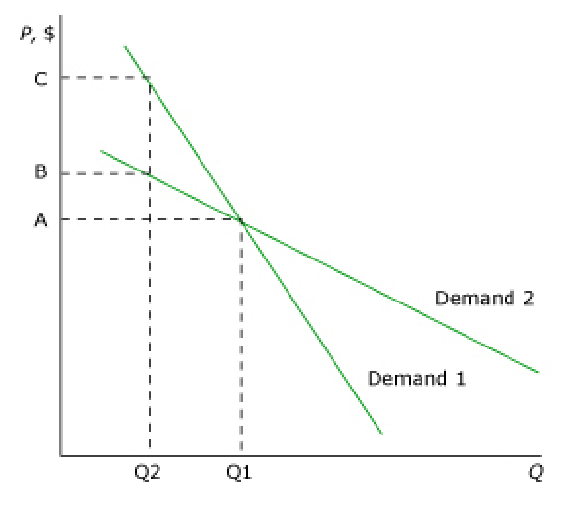
Some examples of *inelastic* goods are gas, salt, bread, tap water (necessary items), or cigarettes (addictive goods). Examples of *elastic* goods are shell gas (because consumers will shop at another gas stations), Apple (specific brands of some good), or a vacation plane ticket.

The determinants of demand elasticity are: (1) substitutability; products with close substitutes have more elastic demand (e.g. price of orange juice goes up, consumers substitute apple juice, cranberry juice, etc.). (2) generality; price elasticity for narrowly defined specific brands of products is greater than that for broadly defined product categories (e.g. demand elasticity of coke > demand elasticity of colas > demand elasticity of soft drinks). (3) proportion of income; the higher the price of the good relative to income, the greater the elasticity and vice versa. (4) degree of need; price elasticity of luxury goods is greater than that of necessity goods (e.g. demand elasticity for vitamins > demand elasticity for insulin). (5) complementarity; products with many complements have less elastic demand. (6) time; the more time that passes, the greater the demand elasticity of the product (e.g. demand elasticity for gas in the long run > demand elasticity for gas in the short run).

Something that might not be as obvious is that price elasticity of demand must be measured at a particular point on the demand curve;



Looking at a linear demand curve, as we move along the curve, is constant, but *P* and *Q* will change. Note, that the steeper the demand curve, the more inelastic the demand for the good.



The flatter the demand curve, the more elastic the demand for the good. Thus, Demand 2 (from below) is relatively more elastic than demand 1.

One reason why *elasticity* is important is that it tells us how much revenue changes as you change price. Suppose there is elastic demand (*|| > 1*); Therefore, when price increases revenue decreases (decrease in *Q* is bigger than increase in *P*). However, when price decreases revenue increases (increase in *Q* is bigger than decrease in *P*). Suppose now that there is inelastic demand (*|| < 1*); Therefore, when price increases revenue increases (decrease in *Q* is smaller than increase in *P*). However, when price decreases revenue decreases (increase in *Q* is smaller than decrease in *P*).

For the remainder of this analysis I will be covering the *logit model* for estimating demand. I will then be discussing the use of *Instrumental variables* (*IV*) to deal with the endogeneity problems in our demand function– namely, when the price regressor is correlated with the error term (*ε*).

The reason why I have decided to use the *logit model* in estimating demand is because it is the most popular model by economic researchers. The *logit model* is the most popular model because the formula for the choice probabilities takes a closed form and is easily interpretable.

I will begin by first expressing that a consumer’s indirect utility function is assumed to have the form;

– + +

Where each consumer *i* can choose from *j* products and where markets are indexed by *t* and *pjt* denotes the price of the product. Thus, each consumer chooses one of the following *J + 1* mutually exclusive alternative products indexed by *j = 0, 1, …, J*. The *0* choice is called the *outside option*—it means that you choose none of the above. Each *J* alternative is associated with a *K x 1* vector of observed characteristics (*xjt* = [*xjt1… xjtK*]). Each product-market *jt* is also associated with some unobserved product characteristics, *ξjt*. The idiosyncratic heterogeneity vector, *εit*, is distributed *iid* across *i*, *t* (Note, this model assumes that everyone has the same taste for quality but different idiosyncratic tastes for the product).

The *ε’*s are distributed according to the extreme value type 2 distribution:

*F(ε)*

This is a very helpful assumption, as it allows for the aggregate shares to have an analytical form.

Therefore, the type 2 extreme value distribution gives me the market share for product *j* in market *t*;

*sjt*()

Where *sjt* is the market share for each product-market *jt*. I can derive cross price derivatives as *sj \* sk*, and own price derivative as *sj \** (*1 - sj*).

If I normalize the mean utility associated with the outside option to 0, I get;

Then the probability of choosing the outside good is;

*sjt*()

And the probability of choosing any other good *j* is;

*sjt*()

By taking the log odds ratio, I can get the following linear equation;

*–*  – +

Therefore, I can estimate this via linear regression.

As mentioned earlier, *ξjt* are unobserved product-market level characteristics in the model. This means that there could be a list of product attributes that are unobserved in the estimation of my model (e.g. quality or prestige characteristics). *ξjt* can also be in the form of measurement error in prices (often prices are averages). Since the unobserved characteristics are not independent from price, most often prices are always endogenous.

There are a couple methods to achieve identification with endogenous prices: (1) *Fixed Effects*, and (2) *Instrument Variables*. Since *Instrument Variables* are preferred, I will be using an *IV* to achieve identification with my endogenous prices data.