ECON0072: Empirical Industrial Organisation

Lectures 1: Determinants of Market Outcomes

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[1] These lecture notes were kindly provided by Prof. Lars Nesheim who previously taught Empirical Industrial Organization at UCL. All errors are my own.

Introduction

- What is Empirical Industrial Organization?
- Aim to develop an empirical understanding of how firms and consumers interact in markets.

1. Firms.
2. Consumers.
3. Market structure.

Firms

What is a firm

- Technology, costs and contracts.
    - Technology determines cost structure of firm and to some degree what portfolio of products it will produce.
    - Cost functions are crucial for determining optimal operating size, optimal portfolio of products, and the number of firms in a market. They also influence pricing through marginal cost. Key components of the cost function are:
        - **marginal costs**, the magnitude and the nature(are they constant or not; are there economies of scale or scope and what is the minimum efficient scale).
        - **fixed costs**, the magnitude and the nature (are fixed costs sunk or recoverable),
        - **costs of entry** are crucial for determining the number of firms that enter the market.
        - **contracting costs** can affect the size of the firm, the extent of vertical and horizontal integration.
- The key firm outcomes empirical IO is concerned with are: firm's demand for inputs, prices, output quantities, revenues, profits, externalities.

Examples of firm data

- Summary statistics from industry trade body. E.g.,
  - Institute of Grocery Distribution
  - Global System for Mobile Communications
  - European Automobile Manufacturers' Association (ACEA)
- Detailed data on individual firms from management.
- Survey data from ONS such as Interdepartmental Business Register or Monthly Business Survey.
- Balance sheet data from AMADEUS or FAME (12m firms in the UK).

UBER LONDON LIMITED

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Profit & loss account

	31/12/2020	31/12/2019	31/12/2018	31/12/2017	31/12/2016	31/12/2015
	GBP	GBP	GBP	GBP	GBP	GBP
Original documents	PDF	PDF	PDF	PDF	PDF	PDF
	12 months	12 months	12 months	12 months	12 months	12 months
	Uncons.	Uncons.	Uncons.	Uncons.	Uncons.	Uncons.
	Unqualified	Unqualified	Unqualified	Unqualified	Unqualified	Unqualified
	UK GAAP	UK GAAP	UK GAAP	UK GAAP	UK GAAP	UK GAAP
∟ Turnover	50,956,000	82,525,000	68,431,000	59,517,983	36,942,160	23,304,148
∟ National Turnover	50,956,000	82,525,000	68,431,000	59,517,983	36,942,160	23,304,148
∟ Overseas Turnover						
∟ Cost of Sales						
∟ Exceptional Items pre GP						
∟ Other Income pre GP						
∟ Gross Profit				59,517,983		23,304,148
∟ Administration Expenses	-49,763,000	-76,203,000	-62,554,000	-54,855,744	-34,048,074	-21,478,477
∟ Other Operating Income/Costs pre OP						
∟ Exceptional Items pre OP						
∟ Operating Profit	1,193,000	6,322,000	5,877,000	4,662,239	2,894,086	1,825,671
∟ Other Income						
∟ Total Other Income & Int. Received					120,993	650
∟ Exceptional Items						
∟ Profit (Loss) on Sale of Operations						
∟ Costs of Reorganisation						
∟ Profit (Loss) on Disposal						
∟ Other Exceptional Items						
∟ Profit (Loss) before Interest paid	1,193,000	6,322,000	5,877,000	4,662,239	3,015,079	1,826,321
∟ Interest Received					120,993	650
∟ Interest Paid	-30,000	-87,000	-11,000	-39,637		-459

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Original documents	31/12/2020 GBP PDF 12 months Uncons. Unqualified UK GAAP	31/12/2019 GBP PDF 12 months Uncons. Unqualified UK GAAP	31/12/2018 GBP PDF 12 months Uncons. Unqualified UK GAAP	31/12/2017 GBP PDF 12 months Uncons. Unqualified UK GAAP	31/12/2016 GBP PDF 12 months Uncons. Unqualified UK GAAP	31/12/2015 GBP PDF 12 months Uncons. Unqualified UK GAAP
∟ Paid to Bank				-26		
∟ Paid on Hire Purchase						
∟ Paid on Leasing						
∟ Other Interest Paid	-30,000	-87,000	-11,000	-39,611		-459
∟ Net Interest	-30,000	-87,000	-11,000	-39,637	120,993	191
∟ Profit (Loss) before Tax	1,163,000	6,235,000	5,866,000	4,622,602	3,015,079	1,825,862
∟ Taxation	-199,000	132,000	-751,000	-1,128,667	-551,174	-410,851
∟ Profit (Loss) after Tax	964,000	6,367,000	5,115,000	3,493,935	2,463,905	1,415,011
∟ Extraordinary Items						
∟ Minority Interests						
∟ Profit (Loss) for period [=Net income]	964,000	6,367,000	5,115,000	3,493,935	2,463,905	1,415,011
∟ Dividends						
∟ Retained Profit(Loss)	964,000	6,367,000	5,115,000	3,493,935	2,463,905	1,415,011

∟ Depreciation	655,000	1,271,000	2,069,000	1,390,332	767,938	424,800
∟ Depreciation Owned Assets	655,000	1,271,000				
∟ Depreciation Other Assets			2,069,000	1,390,332	767,938	424,800
∟ Impairment Tangibles						
∟ Audit Fee	46,000	31,000	31,000	62,587	41,600	38,313
∟ Non-Audit Fee						
∟ Tax Advice						
∟ Non-Tax Advisory Services						
∟ Other Auditors Services						
∟ Non-Audit Fees paid to Other Auditors						
∟ Total Amortization and Impairment						
∟ Amortisation						
∟ Impairment						
∟ Total Operating Lease Rentals	2,215,000	2,182,000	2,011,000	1,686,630	1,200,915	1,038,053

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∟ Hire of Plant & Machinery	2,215,000	2,182,000				
∟ Land & Building or Property Rents & Other						
∟ Research & Development						
∟ Foreign Exchange Gains/Losses					-180,124	-68,316
∟ Remuneration	19,961,000	25,605,000	19,530,000	15,735,913	11,432,809	7,161,851
∟ Wages & Salaries	12,935,000	16,224,000	14,262,000	13,650,097	10,092,118	6,270,479
∟ Social Security Costs	3,099,000	5,433,000	2,085,000	1,656,634	1,340,691	891,372
∟ Pension Costs						
∟ Other Staff Costs	3,927,000	3,948,000	3,183,000	429,182		
∟ Directors' Remuneration						
∟ Directors' Fees						
∟ Pension Contribution						
∟ Other Emoluments						
∟ Highest Paid Director						
∟ EBITDA	1,848,000	7,593,000	7,946,000	6,052,571	3,662,024	2,250,471
∟ Number of employees	174	249	269	282	199	105

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GOURMET BURGER KITCHEN (UK) LIMITED

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Private company
The Global Ultimate Owner of this controlled subsidiary is INVEST CO 1 LIMITED

Profit & loss account

	29/12/2019	30/12/2018	31/12/2017	01/01/2017	27/12/2015	28/12/2014
	GBP	GBP	GBP	GBP	GBP	GBP
Original documents	PDF	PDF	PDF	PDF	PDF	PDF
	12 months	12 months	12 months	12 months	12 months	12 months
	Uncons.	Uncons.	Uncons.	Uncons.	Uncons.	Uncons.
	Unqualified	Unqualified	Unqualified	Unqualified	Unqualified	Unqualified
	UK GAAP	UK GAAP	UK GAAP	UK GAAP	UK GAAP	UK GAAP
∟ Turnover	4,647,663	4,061,620	4,062,107	4,154,215	3,916,333	3,943,405
∟ National Turnover	4,647,663	4,061,620	4,062,107	4,154,215		3,943,405
∟ Overseas Turnover						
∟ Cost of Sales	-1,514,522	-1,084,899	-1,139,590	-2,253,326	-1,976,978	-2,046,989
∟ Exceptional Items pre GP						
∟ Other Income pre GP						
∟ Gross Profit	3,133,141	2,976,721	2,922,517	1,900,889	1,939,355	1,896,416
∟ Administration Expenses	-3,380,442	-3,006,711	-2,857,071	-1,631,060	-1,451,319	-1,372,137
∟ Other Operating Income/Costs pre OP	100,000	100,000	100,000	100,000	110,000	78,443
∟ Exceptional Items pre OP						
∟ Operating Profit	-147,301	70,010	165,446	369,829	598,036	602,722
∟ Other Income						
∟ Total Other Income & Int. Received		72		281		9,759
∟ Exceptional Items						
∟ Profit (Loss) on Sale of Operations						
∟ Costs of Reorganisation						
∟ Profit (Loss) on Disposal						
∟ Other Exceptional Items						
∟ Profit (Loss) before Interest paid	-147,301	70,082	165,446	370,110	598,036	612,481
∟ Interest Received		72		281		9,759
∟ Interest Paid	-466	-456	-346	-345	-343	-467

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∟ Paid to Bank		-109				
∟ Paid on Hire Purchase						
∟ Paid on Leasing						
∟ Other Interest Paid	-466	-347	-346	-345	-343	-467
∟ Net Interest	-466	-384	-346	-64	-343	9,292
∟ Profit (Loss) before Tax	-147,767	69,626	165,100	369,765	597,693	612,014
∟ Taxation	27,825	-17,658	-37,653	-74,594	-131,154	-134,816
∟ Profit (Loss) after Tax	-119,942	51,968	127,447	295,171	466,539	477,198
∟ Extraordinary Items						
∟ Minority Interests						
∟ Profit (Loss) for period [=Net income]	-119,942	51,968	127,447	295,171	466,539	477,198
∟ Dividends	-2,683,001					
∟ Retained Profit(Loss)	-2,802,943	51,968	127,447	295,171	466,539	477,198

∟ Depreciation	81,642	83,387	72,075	68,135	75,427	74,234
∟ Depreciation Owned Assets	81,642				75,427	74,234
∟ Depreciation Other Assets		83,387	72,075	68,135		
∟ Impairment Tangibles						
∟ Audit Fee	14,500	3,300				
∟ Non-Audit Fee						
∟ Tax Advice						
∟ Non-Tax Advisory Services						
∟ Other Auditors Services						
∟ Non-Audit Fees paid to Other Auditors						
∟ Total Amortization and Impairment	43,727	42,582	36,728	36,727	36,242	38,769
∟ Amortisation	43,727	42,582	36,728	36,727	36,242	38,769
∟ Impairment						

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Original documents	29/12/2019 GBP PDF 12 months Uncons. Unqualified UK GAAP	30/12/2018 GBP PDF 12 months Uncons. Unqualified UK GAAP	31/12/2017 GBP PDF 12 months Uncons. Unqualified UK GAAP	01/01/2017 GBP PDF 12 months Uncons. Unqualified UK GAAP	27/12/2015 GBP PDF 12 months Uncons. Unqualified UK GAAP	28/12/2014 GBP PDF 12 months Uncons. Unqualified UK GAAP
∟ Total Operating Lease Rentals	655,754	396,334	407,917	445,241		
∟ Hire of Plant & Machinery	655,754					
∟ Land & Building or Property Rents & Other						
∟ Research & Development					346	
∟ Foreign Exchange Gains/Losses						
∟ Remuneration	1,292,890	1,455,970	1,390,965	1,358,242		
∟ Wages & Salaries	1,157,599	1,359,946	1,305,515	1,278,656		
∟ Social Security Costs	111,820	81,329	76,624	71,864		
∟ Pension Costs	23,471		8,826	7,722		
∟ Other Staff Costs		14,695				
∟ Directors' Remuneration						
∟ Directors' Fees						
∟ Pension Contribution						
∟ Other Emoluments						
∟ Highest Paid Director						
∟ EBITDA	-21,932	195,979	274,249	474,691	709,705	715,725
∟ Number of employees	77	58	60	61	59	

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Demand

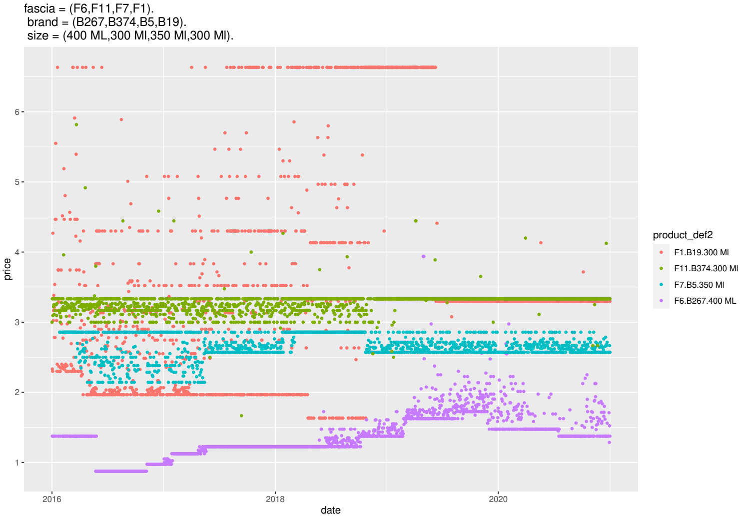
Demand

- What is demand structure?
    - Who are the customers?
        - households,
        - downstream firms,
        - government, etc.
    - What is the nature of the product?
        - service,
        - perishable,
        - storable,
        - durable, etc.

Examples of demand data

- ONS Living Cost and Food Survey (UK), BLS Consumer Expenditure Surveys (USA), etc.
- Kantar scanner data on grocery purchases.
- Department of transport sample of airline ticket sales
- Aggregate data on car sales and prices by make and model.

Shampoo prices



Market structure

- Define market.
  - Which products?
    - new cars only
    - new and used cars
    - petrol and electric cars
  - Other considerations:
    - lease, loans and purchases
    - private cars, company cars and rentals
    - locally produced or imported, etc.
  - Location and scope
  - Time period/duration
- Number and type of competitors. Competitors might be differentiated by size, quality, cost, etc.
- Nature of competition.
  - Compete in prices, quantities, quality, or in some other dimension.
  - Static vs. dynamic competition. Competition related to who enters or after entry about prices or other outcomes?

Market structure: other factors

Other factors are also important in shaping market structure. However, this course will not discuss them in much detail. Examples include:

- Role of regulation. In some markets like railways, utilities, communications, airlines, regulation plays an important role influencing market outcomes.
- Role of information. What firms know about their customers and their competitors plays an important role in influencing market outcomes. Does firm 1 know the the marginal cost of firm 2? Does firm 1 know the quality of the product of firm 2? Does firm 1 know only the aggregate demand elasticity or does it have information about the demand elasticities for different groups in the population?

Empirical IO outcomes of interest

Outcomes: what measurable quantities is empirical IO interested in?

1. Prices and quantities: demand.
2. Consumer welfare.
3. Revenues, profits and costs.
4. Types of products.
5. Entry and exit.

Demand

Demand

1. Measurement.
   1. Prices.
   2. Quantities.
   3. Characteristics.
2. Demand functions.
   1. Examples: linear, log-linear, discrete choice.
   2. Individual vs market.
   3. Market demand function is aggregate of individual demand. That is, it is the sum over all customers.

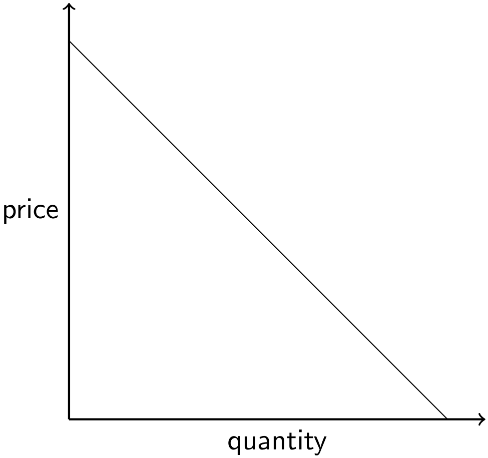
Linear demand

One common assumption is the demand is linear with demand q related to price p by the linear relation

$$\begin{aligned} q &= a - bp \qquad (1) \\ p &= \frac{a}{b} - \frac{1}{b}q \end{aligned}$$

where $a > 0$, $b > 0$ and $p \leq \frac{a}{b}$. See the figure on the next page.

Linear inverse demand



Linear demand: implications (1)

1. Impact of price (slope) is same regardless of whether price is low or high.
    1. Do we expect the sensitivity of demand for petrol to be the same when the price is £1 per litre as when the price is £10 per litre?
2. No non-linear pricing. For example, there are no quantity discounts.
3. In many cases, when goods are homogenous, the linear demand model is a good approximation for small changes in p. Suppose the true demand relationship is

$$q = f(p).$$

Then, if the demand function is analytic, Taylor's theorem yields an approximation of q for p close to p_0:

$$q \approx f(p_0) + \frac{\partial f(p_0)}{\partial p}(p - p_0).$$

Linear demand: implications (2)

1. Model (1) ignores product differentiation. In reality, product differentiation is important. Characteristics such as quality, time of day, pack size, day of week, season, etc. In practice, empirical analysis of a model such as (1) relies on data that has been aggregated across similar but differentiated products. For example, suppose total quantity of coffee is the sum of q_H, demand for high quality coffee, and q_L, demand for low quality coffee,

$$q = q_L + q_H$$

and the price is

$$p = \left(\frac{q_L}{q_L + q_H}\right) p_L + \left(\frac{q_H}{q_L + q_H}\right) p_H.$$

Does analysis of demand for q and p provide an accurate picture of demand for coffee?

Log-linear demand

An alternative demand model that is commonly employed is the log-linear demand model in which

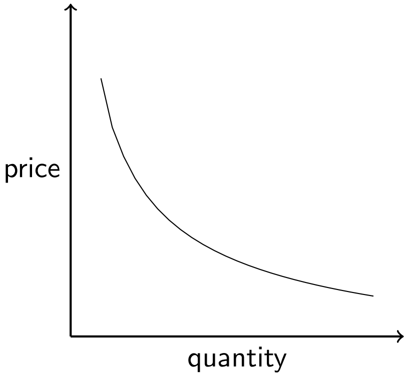
$$\begin{aligned} \ln q &= a - b \ln p \\ q &= e^a p^{-b}. \end{aligned}$$

For this model, the inverse demand relationship is

$$\ln p = \frac{a}{b} - \frac{1}{b} \ln q.$$

See the figure on the next page.

Log-linear inverse demand



Log-linear demand: implications

1. Elasticity of demand with respect to price is constant

$$\varepsilon = \frac{p}{q}\frac{\partial q}{\partial p} = -b.$$

2. Goods are homogenous (as in linear demand case) and pricing is linear (that is there are no quantity discounts).
3. Both price and quantity must be strictly positive.

Discrete choice demand (1)

In many case, a model that assumes homogenous goods is not adequate because product differentiation is important. In these cases, it is important to understand not only how much people buy but which products they buy. Suppose there are $J + 1$ distinct products (or options) in a market and index each product by $j = 0, 1, ..., J$. Let option $j = 0$ be the option not to buy anything. Let each option $j > 0$ be an option to buy one specific product.

Discrete choice demand (2)

1. **Example 1.** When choosing a restaurant, there might be 5 restaurants to choose from: 1) Wasabi, 2) Pret a Manger, 3) Leon, 4) Great Nepalese, 5) Pitted Olive
2. **Example 2.** Suppose you are building a new factory in Europe for batteries for electric cars and need to choose a location. You can choose from: 1) UK, 2) Sweden, 3) Germany, 4) Poland

Discrete choice demand (3)

A discrete choice model can be used to model these settings. In the consumer demand case, suppose consumer i can choose at most one from $J+1$ options. Assume utility u_{ij} from purchasing product $j \in \{0, 1, ..., J\}$ is given by

$$\begin{aligned} u_{ij} &= \alpha x_j + \beta p_j + \varepsilon_{ij} \\ &= v_{ij} + \varepsilon_{ij} \end{aligned} \tag{2}$$

where p_j is the price of product j, x_j is a vector of (observable) product characteristics (for example, brand, quality, departure time, etc.), and ε_{ij} is an unobserved demand shock. In discrete choice demand estimation, one assumes that one has data on (x_j, p_j) for all j (assume that $p_0 = x_0 = 0$) and on which product was purchased by each consumer.

Discrete choice demand (4)

Each consumer purchases one product but the model implies (when ε_{ij} is assumed to be a logit demand shock) that the probability that consumer i purchases product j is

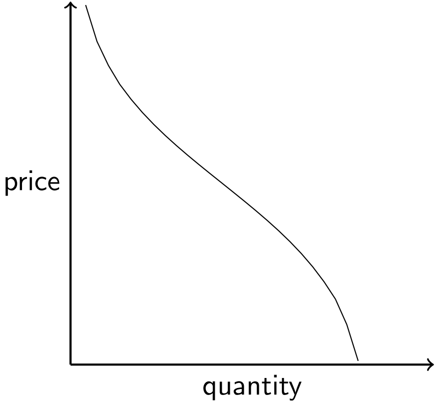
$$s_{ij} = \frac{\exp\left(v_{ij}\right)}{\sum_{k=0}^{J} \exp\left(v_{ik}\right)}$$

If the total population is N and the fraction of the population of type i is w_i this implies that the demand for product j is

$$q_j = N \sum_i w_i \left(\frac{\exp\left(v_{ij}\right)}{\sum_{k=0}^{J} \exp\left(v_{ik}\right)} \right).$$

See figure on the next page.

Logit inverse demand



Logit demand: implications

1. Each consumer chooses only one option and conditional on choosing j only buys one unit.
   1. Model can be extended to account for simultaneous purchase of 2 or more options.
   2. Model can be extended to account for purchase of more than one unit of quantity.
2. Substitution patterns.
   1. Simple model implies very restrictive substitution patterns across goods.
   2. Alternative assumptions about unobserved shocks ε_{ij} are less restrictive.
3. Number of goods.
   1. Do we always know what the right J is?
   2. Do we always know what the correct set of characteristics x to consider are?
4. Functional form.
   1. Utility function is linear in price and demand curve is convex. This will have important implications for analysis of mergers.

Utility functions (1)

Consumer demand function is derived from consumer utility maximisation. Assume that the consumer solves

$$\max_{\{q\}} \left\{ u\left(q, x, \theta\right) \text{ subject to } \sum_i p_i q_i \leq y \right\}$$

where x is a vector of observable household demographics and θ is a vector of parameters. This model implies that demand has the form

$$q = d\left(p, y, x, \theta\right).$$

That is, demand is a function of prices, income, demographics x, and parameters θ.

Utility functions (2)

For example, suppose the consumer problem is

$$\max_q \left\{\theta x \ln q_1 + (1 - \theta x) \ln q_2 \text{ subject to } p_1 q_1 + p_2 q_2 \leq y\right\}$$

where $0 < \theta x < 1$. Then, the demand functions are

$$\begin{aligned} q_1 &= \frac{\theta x y}{p_1} \\ q_2 &= \frac{(1 - \theta x)\, y}{p_2}. \end{aligned}$$

Utility functions (3)

This simple example imposes many important restrictions including:

1. $0 < \theta x < 1$.
2. Demand is linear in income.
3. Expenditure share of each good i is a constant, with

$$\begin{aligned} s_1 &= \frac{p_1 q_1}{y} = \theta x \\ s_2 &= \frac{p_2 q_2}{y} = 1 - \theta x \end{aligned}$$

   independent of price and income.
4. Demand for good i is independent of the price of good $j \neq i$.
5. Price elasticity is $\varepsilon = 1$.

Aggregate demand

- Aggregate demand is

$$Q = \sum_i d_i \left(p, y_i, x_i, \theta_i\right) w_i$$

  where w_i is a weight.
- Is aggregate demand linear? No. But, as an approximation?
- Aggregate demand approximation

$$\begin{aligned} Q &= \sum d\left(p_0, y_0\right) + \frac{\partial d}{\partial p}\left(p - p_0\right) \\ &\quad + \frac{\partial d}{\partial y}\left(y - y_0\right). \end{aligned}$$

Indirect utility

In many cases, one is interested in the indirect utility function $v(p, y)$. This function describes the maximum utility attainable given prices p and income y. The indirect utility function is defined by

$$v(p, y) = \max_q \{u(q) \text{ subject to } p \cdot q \leq y\}.$$

Equivalently, if

$$q^* = d(p, y)$$

is the optimal level of demand, then

$$\begin{aligned} v(p, y) &= u(q^*) \\ &= u(d(p, y)). \end{aligned}$$

It often proves useful in demand analysis. For example, it is used to compute consumer welfare.

Elasticities

1. The elasticity of demand with respect to price is defined as

$$\varepsilon = \frac{p}{q}\frac{\partial q}{\partial p}.$$

2. For example, when demand is linear, $q = a - bp$, the elasticity is

$$\varepsilon = -b\frac{p}{q}.$$

3. Properties
    1. When $\varepsilon > 1$, demand is elastic.
    2. The elasticity does not depend on the units of measurement making it useful for comparison across different markets and in different environments.
    3. It plays an important role in calculating/approximating welfare effects, profit effects, market definition, etc.

Cross-price elasticity

1. The elasticity of demand for product i with respect to the price of product j is
$$\varepsilon_{ij} = \frac{p_j}{q_i}\frac{\partial q_i}{\partial p_j}.$$
2. Examples
    1. When $\varepsilon_{ij} > 0$, then i and j are often called substitutes.
    2. When $\varepsilon_{ij} < 0$, they are often called complements.

Dynamics (1)

When goods are durable or utility is influenced by some form of habit formation (marginal utility of consumption in period $t+1$ is affected by quantity consumed in period t). Then the dynamics of consumption and demand can be very important. For example, let q_1 be consumption in period 1 and q_2 be consumption in period 2, let (p_1, p_2) be the corresponding prices, and let (y_1, y_2) be income in periods 1 and 2. Suppose consumers can borrow or lend and the interest rate is zero. Suppose consumer's maximise utility of the form

$$u(q_1, q_2) = \alpha \ln q_1 + \beta \ln(\delta q_1 + q_2)$$

subject to the budget constraint

$$p_1 q_1 + p_2 q_2 = y_1 + y_2.$$

The quantity purchased and consumed in period 1 impacts utility in period 2 through the term δq_2.

Dynamics (2)

Examples in which this type of “durable goods” or “habits” model might apply include:

1. demand for soap powder,
2. automobiles,
3. houses,
4. alcohol, cigarettes.

In these cases, if demand is estimated while ignoring the dynamics, then estimates of demand elasticities may be biased.

Consumer welfare: consumer surplus

One measure of consumer welfare is consumer surplus. It is defined to be

$$\begin{aligned} CS &= \int_0^{q_0} \left(p\left(x\right) - p_0\right) dx \qquad (3) \\ &= \int_0^{q_0} p\left(x\right) dx - p_0 q_0. \end{aligned}$$

When the marginal utility of income is a constant it measures the difference between what consumers are willing to pay and what they pay. When the marginal utility of income is not constant, consumer surplus is an approximate measure of welfare.

Consumer welfare: compensating variation

Compensating variation measures how much money is required to compensate a consumer for a price change. For example, suppose initial prices are p_0 and the consumer obtains utility u_0. That is,

$$\begin{aligned} u_0 &= v\left(y, p_0\right) \\ &= \max_q \left\{ u\left(q\right) \text{ subject to } \sum_j p_{0j} q_j \leq y \right\}. \end{aligned}$$

The cost of obtaining the utility level is

$$c\left(p_0, u_0\right) = \min_q \left\{ \sum_j p_{0j} q_j \text{ subject to } u\left(q\right) \geq u_0 \right\}$$

If prices increase to p_1 , then the compensating variation is

$$CV = c\left(p_1, u_0\right) - c\left(p_0, u_0\right).$$

Equivalently, CV satisfies the equation

$$v\left(p_0, y\right) = v\left(p_1, y + CV\right).$$

Consumer welfare: equivalent variation

A second exact measure of welfare is the equivalent variation. It is defined by

$$EV = c\left(p_1, u_1\right) - c\left(p_0, u_1\right).$$

In contrast, to CV it is measured at the new utility level u_1.

Market structure

Market structure

1. Monopoly
2. Cournot
3. Bertrand

Why do monopolies exist? Increasing returns to scale?

1. Some industries require high capital investment or large up front costs. Suppose costs are
$$c(q) = F + c_1 q + c_2 q^2.$$
2. Then, average costs are
$$AC = \frac{F}{q} + c_1 + c_2 q$$
and marginal costs are
$$MC = c_1 + 2c_2 q.$$
3. There are increasing returns to scale for all $q \leq \sqrt{\frac{F}{c_2}}$ and decreasing returns to scale for $q > \sqrt{\frac{F}{c_2}}$.

Why do monopolies exist? Increasing returns to scale?

1. Under what conditions will this market be captured by a monopoly?
2. If total demand is less than $\sqrt{\frac{F}{c_2}}$ when price equals the monopoly price, then the monopolist can produce the good more cheaply than multiple firms. In this case it may be efficient to have a monopolist (possibly with regulation) supply the market.
3. If demand is a little bit greater than $\sqrt{\frac{F}{c_2}}$ it may be efficient to have an oligopoly supplying the market.
4. If demand is a great deal larger than $\sqrt{\frac{F}{c_2}}$ then the market outcome might be approximately competitive with many firms supplying the good, each producing $q_i = \sqrt{\frac{F}{c_2}}$.

Why do monopolies exist? Other reasons?

1. Network effects. Monopoly may result from network effects on the demand side. In markets with important network effects, the benefits to consumers from a product depend on the number of other consumers using the product. As a result, a single producer serving the entire market has an advantage over many small producers serving parts of the market. Examples include Microsoft, Google, Facebook, airline networks.
2. May result from barriers to entry (natural or otherwise).
3. Natural barriers such as transport costs or quality hurdles may prevent entry of competitors.
4. Regulatory barriers such as patent and copyright law or planning law may prevent entry.

Monopoly

1. Now we begin our study of monopoly by reviewing the simple **single product monopoly model in a static market environment with anonymous linear pricing.**
2. Pay careful attention to all of the assumptions embedded in the previous sentence.

Monopoly

1. **First**, the monopolist produces **a single product**. Both costs and revenues depend only on the price and quantity of this single product. If you allow either costs or revenues to depend on production of other products, the implications of the analysis can change.
2. **Second**, there is **only one firm**. There are no strategic interactions with other firms.
3. **Third**, the environment is **static**. Choices about current quantities or prices do not impact future profits, demand or consumer welfare.
4. **Fourth**, pricing is **anonymous and linear**. The model assumes that the monopolist cannot identify its customers. As a result, the monopolist cannot price discriminate nor charge a non-linear price.

Monopoly pricing (1)

There is one firm in a market producing output q and selling this output at price p.

The market demand curve is $q = D\left(p\right)$ with $\frac{\partial D}{\partial p} < 0$

The inverse demand curve is $p = D^{-1}\left(q\right) = p\left(q\right)$.

The cost function of the firm is $c\left(q\right)$ with $\frac{\partial c(q)}{\partial q} > 0$.

Monopoly pricing (2)

The monopolist solves

$$\max_{q} \left\{ p\left(q\right) q - c\left(q\right) \right\}. \tag{4}$$

The first order conditions (FOC) are

$$p\left(q^m\right) + \frac{\partial p\left(q^m\right)}{\partial q} q^m - \frac{\partial c\left(q^m\right)}{\partial q} = 0 \tag{5}$$

which can be re-written as

$$-\frac{q^m}{p^m} \frac{\partial p\left(q^m\right)}{\partial q} = \frac{p\left(q^m\right) - \frac{\partial c\left(q^m\right)}{\partial q}}{p\left(q^m\right)}$$

or

$$-\frac{1}{\varepsilon} = \frac{p\left(q^m\right) - \frac{\partial c\left(q^m\right)}{\partial q}}{p\left(q^m\right)} \tag{6}$$

where $\frac{1}{\varepsilon} = \frac{q^m}{p^m} \frac{\partial p\left(q^m\right)}{\partial q}$ is the inverse of the elasticity of demand.

Monopoly pricing (3)

The monopolist equates marginal revenue to marginal cost. The "markup" over marginal cost $\left(\frac{p(q^m)-\frac{\partial c(q^m)}{\partial q}}{p(q^m)}\right)$ (also known as the "Lerner index") is inversely related to the elasticity of demand.