UNIVERSITY OF HULL | HULL UNIVERSITY BUSINESS SCHOOL

600541 APPLIED BUSINESS ECONOMICS

TRIMESTER 2, 2021–22

Scott McCracken

Module handbook

Contact details

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Introduction

This module will cover several topics in applied economics. We will begin by looking at strategies monopolies might use to increase their profits (price discrimination, versioning, bundling). Then we will introduce imperfect competition (in particular the Bertrand model of price competition), and study the effects on price competition of product differentiation, imperfect information, and switching costs. After this we will look at the effects of, and incentives for, various types of advertising under monopoly and price competition. Next we will look at innovation and the effects of public policy (e.g. patents). Finally we will study markets where the value of consuming a good or service depends on the number of other people consuming that good or service (e.g. the internet, Netflix, Microsoft Word).

We will use formal economics models, laying out the assumptions, and deriving the results using simple logic, diagrams, or mathematics (where necessary). Your focus should mostly be on learning the intuition or logic behind the model. However, I do expect you to be able to apply some basic mathematics such as manipulation of equations and inequalities. During some of the lecture sessions you will participate in several economic experiments or games to help you understand a number of the economic concepts and models we cover.

Module learning outcomes

(i) Apply economic models to a range of economic problems and derive results/predictions using logic, diagrams, and/or algebra.

(ii) Understand and explain the economic models and their results/predictions.

(iii) Identify which economic models or concepts apply to a given real-world problem and critically evaluate them.

(iv) Identify real-world problems to which a given economic model can be applied.

Topics

We will cover the following topics:

Price discrimination Types of price discrimination; nonlinear pricing; versioning; durable-goods pricing; bundling

PRICE COMPETITION Bertrand competition; horizontal and vertical differentiation, and the characteristics approach; Hotelling model of product differentiation; search and switching costs; price dispersion

ADVERTISING Informative and persuasive advertising; signalling; price competition and advertising

RESEARCH AND DEVELOPMENT Market structure and incentives for research and development; dynamics of research and development competition; public policy (patents, research and development agreements)

NETWORK EXTERNALITIES Network effects; compatibility and standards wars

READING

The core textbook (which is available online) is:

Cabral, Luís (2000) *Introduction to Industrial Organization*

Specific readings for each topic can be found through the Reading List menu item on Canvas as well as in the Canvas module for the topic.

SCHEDULED SESSIONS

LECTURES (WEEKS 22–31, 34–35)

Tuesday	9:00–10:50	Wilberforce Building LR11	(weeks 22, 25–26)
		Robert Blackburn Building LTC	(weeks 30–31)
	9:00–9:50	Larkin Building SR260	(weeks 23–24, 27–29, 34–35)

The lecture notes will be posted on Canvas and distributed to your OneNote Class Notebook on a regular basis. The lecture notes contain gaps that you will fill in while watching the videos provided on Canvas and embedded in your OneNote Class Notebook.

TUTORIALS (WEEKS 23–31, 34–35)

Wednesday 12:00–12:50 Cohen Building SR217

Weekly tutorials begin from the second week. Tutorial problems will be posted on Canvas and distributed to your OneNote Class Notebook before each tutorial.

Assessment

Assignment	100%	Due 4pm, 12th of May

The assignment will have a mix of computational and short essay questions covering all the topics.

Marking criteria

As well as being marked on whether or not you obtain the correct final answer to an assessed problem, consideration will be given to how clearly and precisely you explain the steps you used to obtain your answer. The following table provides grading descriptors (which are necessarily quite generic given the variety of the problems):

90%+ 1st	Exemplary response. Gives a complete response with a clear, coherent, unambiguous and elegant explanation; may include a clear and simplified diagram; communicates effectively; shows a complete understanding of the problem's economic concepts and processes; identifies all the important elements of the problem; presents strong supporting arguments.
70–89% 1st	Excellent response. Gives a nearly complete response with a clear explanation; may include a clear and simplified diagram; communicates effectively; shows a nearly complete understanding of the problem's economic concepts and processes; identifies all the important elements of the problem; presents strong supporting arguments.
60–69% 2:1	Good response. Gives a fairly complete response with reasonably clear explanations; may include an appropriate diagram; communicates effectively; shows a good understanding of the problem's economic concepts and processes; identifies the most important elements of the problem; presents solid supporting arguments.
50–59% 2:2	Minor Flaws But Satisfactory. Completes the problem satisfactorily, but the explanation may be muddled; argumentation may be incomplete; diagram may be inappropriate or unclear; understands the underlying economic concets; uses economic concepts effectively.
40–49% 3rd	Serious Flaws But Nearly Satisfactory. Begins the problem appropriately but may fail to complete or may omit significant parts of the problem; may fail to show full understanding of economic concepts and processes; may make major computational errors; may misuse or fail to use economics terms; response may reflect an inappropriate strategy for solving the problem.
10–39% Fail	Begins, But Fails to Complete Problem. Explanation is not understandable; diagram may be unclear; shows no understanding of the problem situation; may make major computational errors.
0–10% Fail	Unable to Begin Effectively: Words do not reflect the problem; drawings misrepresent the problem situation; copies parts of the problem but without attempting a solution; fails to indicate which information is appropriate to the problem.

CONTENTS

Price Discrimination

1.1 Introduction

Ticket Prices at HULL

TICKET PRICES

2D FILMS	STANDARD Mon-Fri After 5pm, all day Sat/Sun & Bank Holidays	15% SAVER Mon-Fri Before 5pm, except Bank Holidays
NEW PRICES EFFECTIVE FROM 06/02/15 REEL CINEMA HULL		
ADULT	£6.60	£5.60
STUDENT (SAVE 15% OFF ADULT)	£5.60	£4.75
TEEN (20% OFF ADULT)	£5.25	£4.45
CHILD / SENIOR (SAVE 25% OFF ADULT)	£4.95	£4.20
NHS / EMERGENCY SERVICES & ARMED FORCES ID REQUIRED	£4.95	£4.20
FAMILY GROUP 3 – ALL PAY CHILD PRICES	£14.85	£12.60
FAMILY GROUP 4 – ALL PAY CHILD PRICES	£19.80	£16.80

3D FILMS	STANDARD Mon-Fri After 5pm, all day Sat/Sun & Bank Holidays	15% SAVER Mon-Fri Before 5pm, except Bank Holidays
ADULT	£8.55	£7.25
STUDENT (SAVE 15% OFF ADULT)	£7.25	£6.15
TEEN (20% OFF ADULT)	£6.80	£5.75
CHILD / SENIOR (SAVE 25% OFF ADULT)	£6.40	£5.45
NHS / EMERGENCY SERVICES & ARMED FORCES ID REQUIRED	£6.40	£5.45
FAMILY GROUP 3 – ALL PAY CHILD PRICES	£19.20	£16.35
FAMILY GROUP 4 – ALL PAY CHILD PRICES	£25.60	£21.80

	2D FILMS	3D FILMS
REEL TUESDAYS & WEDNESDAYS*	£4.20	£5.45
KIDS CLUB**	£1.70	£2.70
CHILDREN'S PARTIES (INCLUDES KIDS COMBO)***	£6.20	£7.45
SENIORS CLUB****	£4.20	£5.45

ALTERNATIVE LIVE CONTENT	ADULT £15.00	CONCESSIONS £12.50

WE DO REEL TUESDAYS & WEDNESDAYS
ONE SUPER LOW TICKET PRICE
FOR EVERYONE

For more information please ask a member of our team, call us on 01482 223113 or visit www.reelcinemas.co.uk

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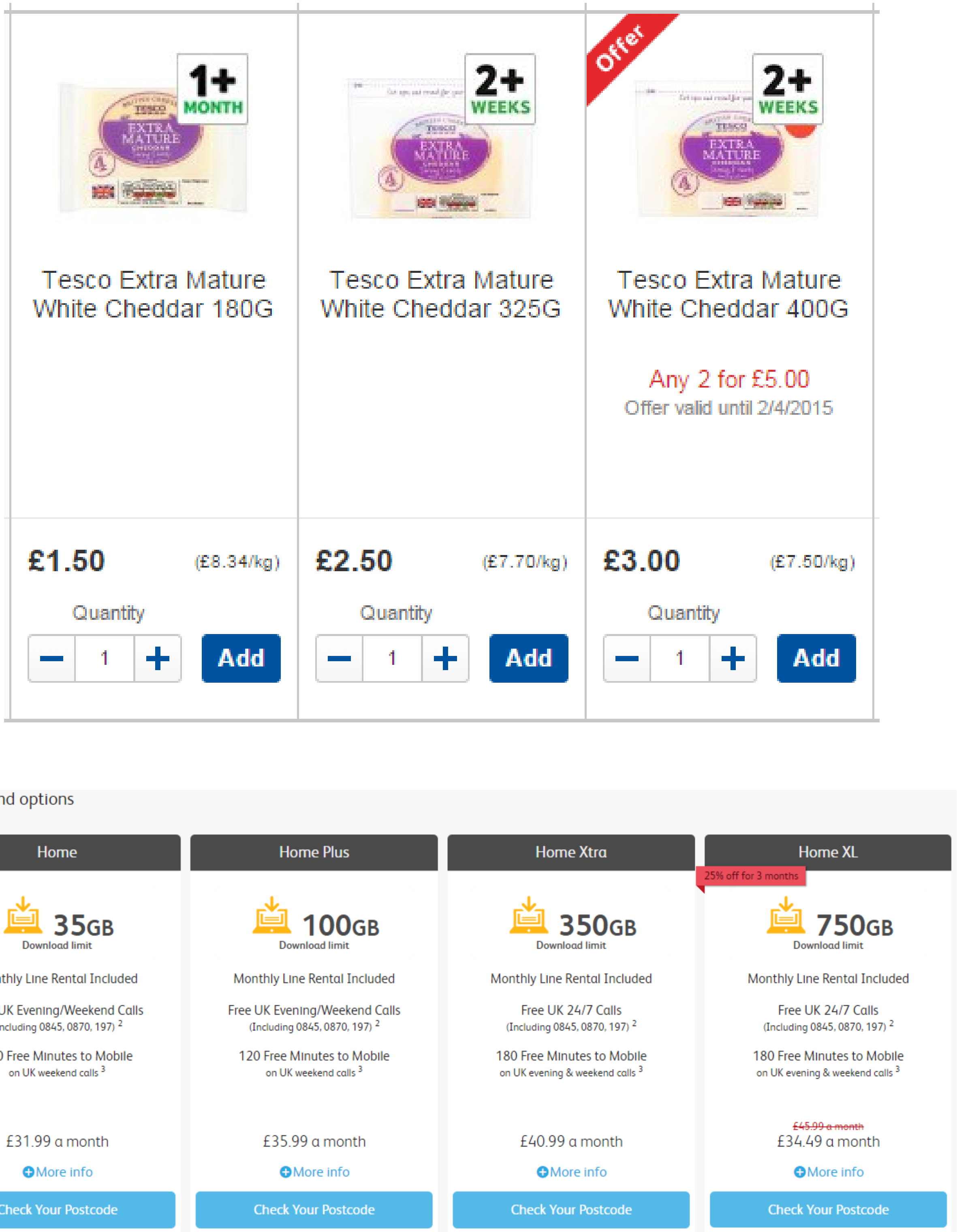
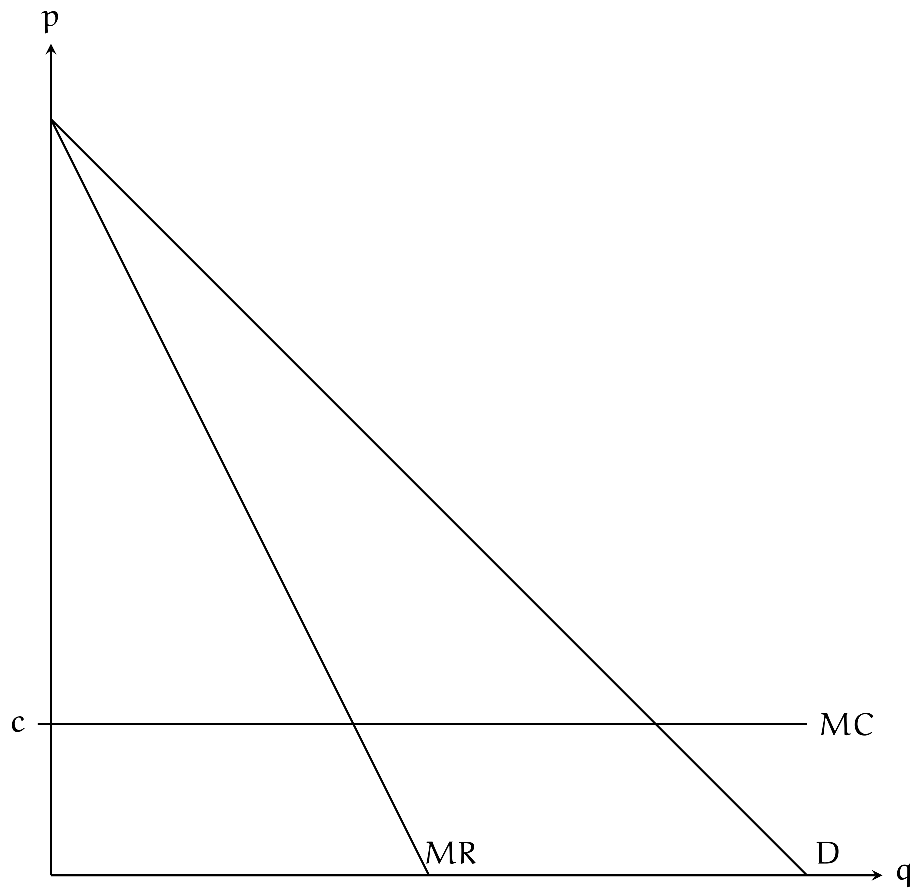


Figure 1.1: “Additional usage is just £2 per GB or part thereof.”

1.1.1 Motivation



A monopoly may be able to increase its profit over its uniform-pricing maximum profit by using non-uniform pricing (price discrimination).

1.1.2 Types of price discrimination

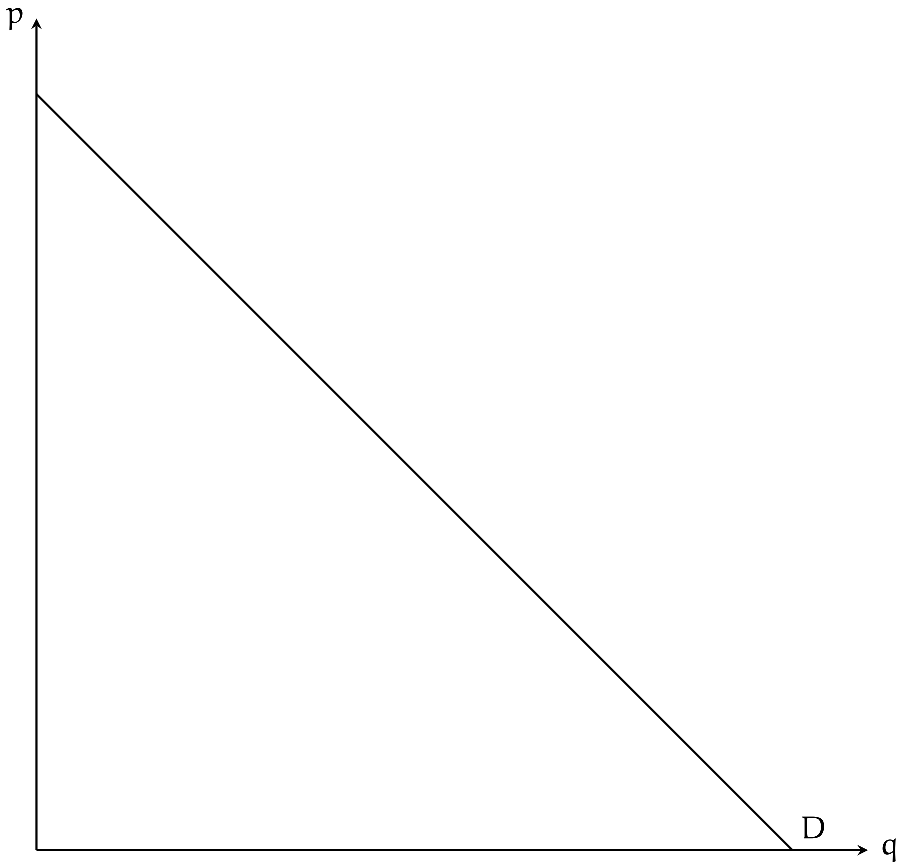
- Perfect (first-degree) price discrimination
- By indicators (third-degree): market segment can be directly identified
  - Example: geographical market segmentation
  - Example: special discounts (senior, student, etc)
  - Trick: apply elasticity rule to each market segment
- By self-selection (second-degree): market segment cannot be directly identified
  - Examples: broadband, phone plans
  - Many, many more examples
  - Trick: try to offer options such that each consumer will pay what they are willing to pay

All require no resale.

1.2 First-degree price discrimination

First-degree price discrimination is where the monopolist sells different units of output for different prices *and* these prices may differ from person to person. It is also known as *perfect price discrimination*.

To practice perfect price discrimination, the monopolist needs to be able to distinguish between consumers (and know their demand).



A perfectly price discriminating monopolist will produce the efficient output, and obtain all of the surplus as profit (the consumers get none).

1.3 Third-degree price discrimination

Third-degree price discrimination is where the monopolist sells output to different people at different prices, but every unit of output sold to a given person sells for the same price.

It is 'discrimination by indicators': different segments can be identified directly.

EXAMPLE

1.3.1 Elasticity formula for marginal revenue

Let P denote the inverse demand function. Marginal revenue can be written as:

$$MR(q) = P(q)\left(1 - \frac{1}{\varepsilon(q)}\right)$$

where $\varepsilon(q) > 0$ denotes the price elasticity of demand.

1.3.2 Optimal third-degree price discrimination

Suppose there are two submarkets, L and H. Profit maximization requires that

$$MR_L(q_L^d) = c \quad \text{and} \quad MR_H(q_H^d) = c.$$

This means that at the optimum $MR_L(q_L^d) = MR_H(q_H^d)$ or, using the elasticity formula,

$$p_L^d\left(1 - \frac{1}{\varepsilon_L(q_L^d)}\right) = p_H^d\left(1 - \frac{1}{\varepsilon_H(q_H^d)}\right).$$

So we have $p_L^d < p_H^d$ if and only if

At the optimum, a higher price will be charged in the market which has less elastic demand, i.e where demand is less price sensitive.

1.3.3 Welfare effects of third-degree price discrimination

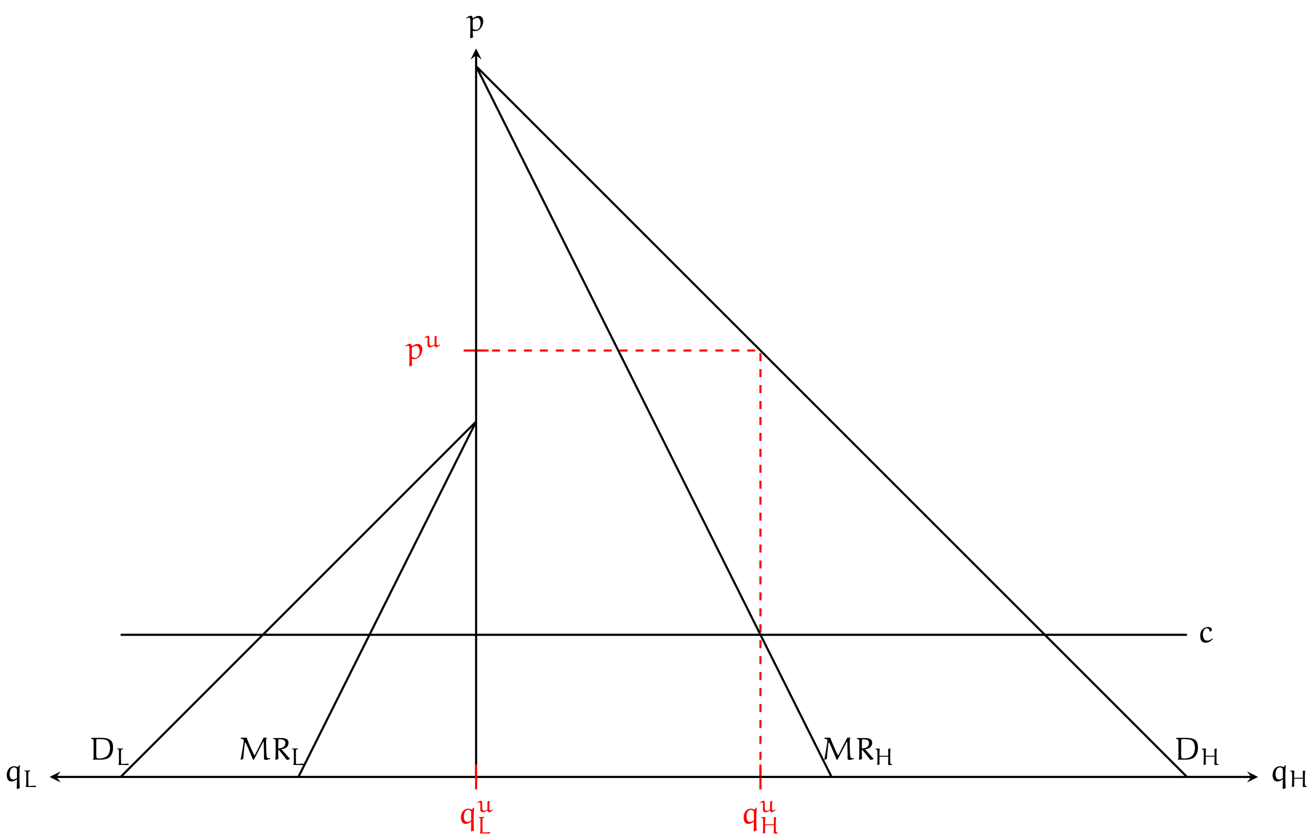
Does a move from uniform pricing to third-degree price discrimination increase, or reduce welfare? With two markets, there are two cases to consider:

1. One of the markets is not served under uniform pricing, but both are served under price discrimination (easy!)
2. Both markets are served under uniform pricing (more complicated)

Case 1

Consider the case where one of the markets is not served under uniform pricing, but both are served under price discrimination. Welfare will increase with price discrimination:

- The optimal uniform price is the same as the price in the high demand market under price discrimination.
- The ability to price discriminate makes it worthwhile for the monopoly to also sell in the low demand market, so that quantity in that market increases.
- This increase in quantity increases welfare; part of the increase is profit and part is consumer surplus.



Case 2

Now consider the case where both markets are served under uniform pricing. In this case a move to price discrimination has the following effects

	Market H	Market L	Overall
Price			
Quantity			
Welfare			
Profit			
Consumer surplus			

Price discrimination may increase the total quantity sold compared to uniform pricing. This might improve efficiency because a uniform pricing monopolist produces too little. But, a uniform price allocates any given quantity efficiently (the last unit is consumed by person with highest marginal value for it), whereas price discrimination means the last unit consumed in each market is valued differently (since $p_L^d < p_H^d$). As the next example shows, this means a redistribution could increase welfare.

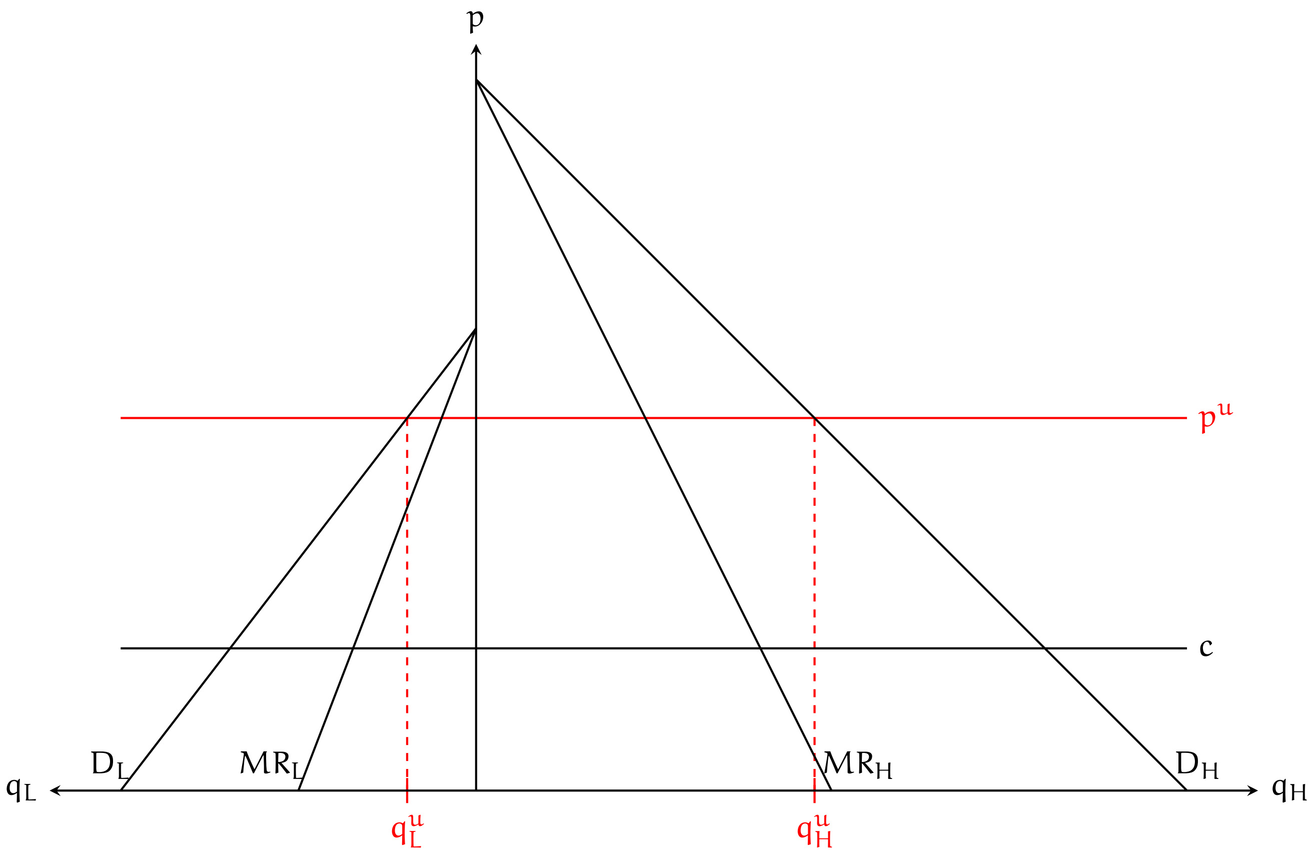
EXAMPLE

If $p_L^d = 5$ and $p_H^d = 8$, then if the last unit sold in market L is reallocated from market L to market H, there is a net gain of $8 - 5 = 3$. This £3 represents an increase in consumer surplus because the marginal benefit of consumption of that unit is higher in market H (£8) than in market L (£5).

Think of it another way: consumer H is willing to pay £8 for the last unit consumed in market L, but consumer L would be willing to sell it for £5. Thus there is a potential mutually beneficial trade (a potential Pareto improvement).

Uniform pricing: efficient distribution of a given quantity. Price discrimination: inefficient distribution of a given quantity. Price discrimination can only increase welfare if it increases quantity compared to uniform pricing.

1.3.4 Welfare effects: an upper bound



The change in welfare ΔW, as a result of a move *from* uniform pricing *to* price discrimination satisfies

$$\Delta W \leqslant (p^u - c)(q^d - q^u)$$

In particular, a sufficient condition for welfare to fall is that total quantity falls under discrimination:

$$q^d < q^u \Rightarrow W^d < W^u.$$

A necessary condition for welfare to rise is that total quantity rises:

$$W^d > W^u \Rightarrow q^d > q^u.$$

1.4 Second-degree price discrimination

Second-degree price discrimination is where the monopolist sells different units of output for different prices, but every individual who buys the same quantity of the good pays the same price. Prices differ across units but not across people.

The monopoly knows there are different types of consumers, but cannot identify them.[1]

1.4.1 Linear vs nonlinear pricing

With *linear pricing*, a constant average price p is charged regardless of quantity, and the buyer's total outlay $T(q)$ is

$$T(q) = pq.$$

In this case T is a linear function of q. If, instead T is a nonlinear function, then there is *nonlinear pricing*.

1.4.2 Two-part tariffs

One form of non-linear pricing is the two-part tariff. A *two-part tariff* (f, p) consists of an access fee f and a unit price p:

$$T(q) = f + pq.$$

Linear pricing corresponds to $f = 0$. If $f > 0$ there is nonlinear pricing.[2] The monopoly may offer a number of such tariffs.

EXAMPLE (Gulliver's)

Ticket Prices - Warrington

Below are standard entry prices.

*Remember you'll always get the best prices by booking online at least 2 days before arrival!

Standard Tickets

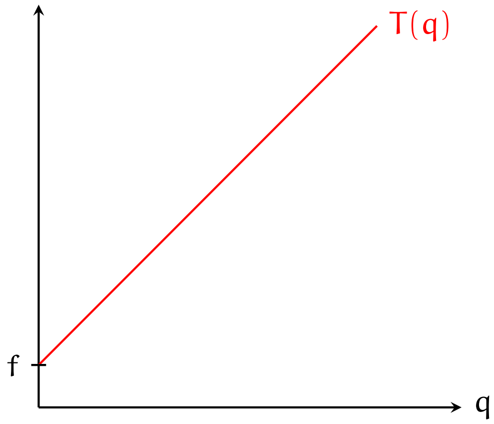
	Adult		Child		OAP		Under 90cm	Fully Inclusive		
	Online (2 days in advance)	Gate	Online (2 days in advance)	Gate	Online (2 days in advance)	Gate		Online (2 days in advance)	Gate	
GULLIVER'S Warrington	£15	£17	£15	£17	£14	£16	FREE	£22	£26	BOOK ONLINE

In this example, for adults paying at the gate the access fee is   while the per-unit price is   .

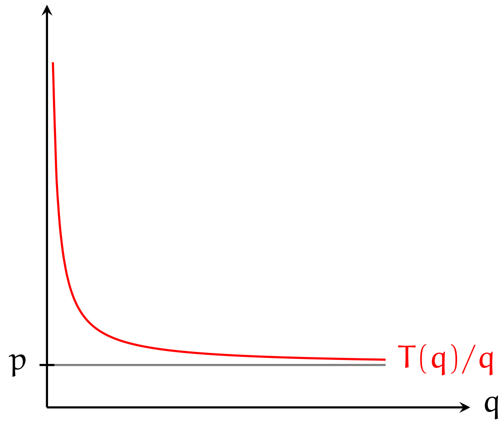
[1] If there is only one type of consumer, then first and second-degree price discrimination are the same.

[2] When $f \neq 0$, T is *not* a linear function. It is an affine function.

Notice that if $f > 0$ then a two-part tariff involves bulk discounting: the average outlay is decreasing in q.



Total outlay, $T(q) = f + pq$



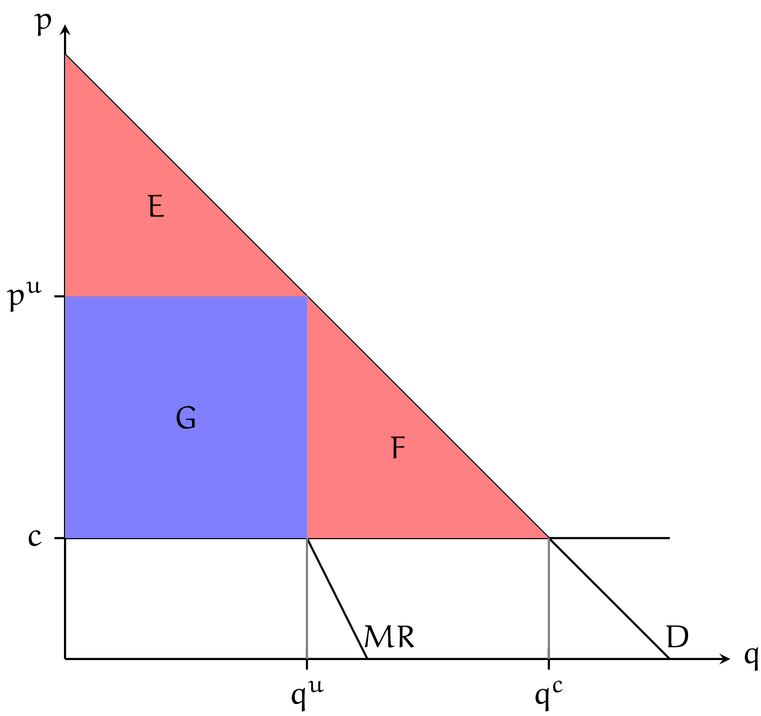
Average outlay, $\frac{T(q)}{q} = \frac{f}{q} + p$

A consumer will purchase up to the point that the marginal cost of an extra unit equals the marginal benefit:

- The marginal cost (i.e. marginal outlay) is $T'(q) = p$ (same as for linear pricing)
- The marginal benefit (i.e. the marginal utility) is equal to the height of the standard demand curve at q.

Thus, under nonlinear pricing, the quantity demanded is just the point on the standard demand curve corresponding to the unit price p.

1.4.3 Optimal two-part tariff: identical consumers



A uniform-pricing monopoly sells q^u units at price p^u. The monopoly could continue to sell q^u units and capture more surplus with a two-part tariff

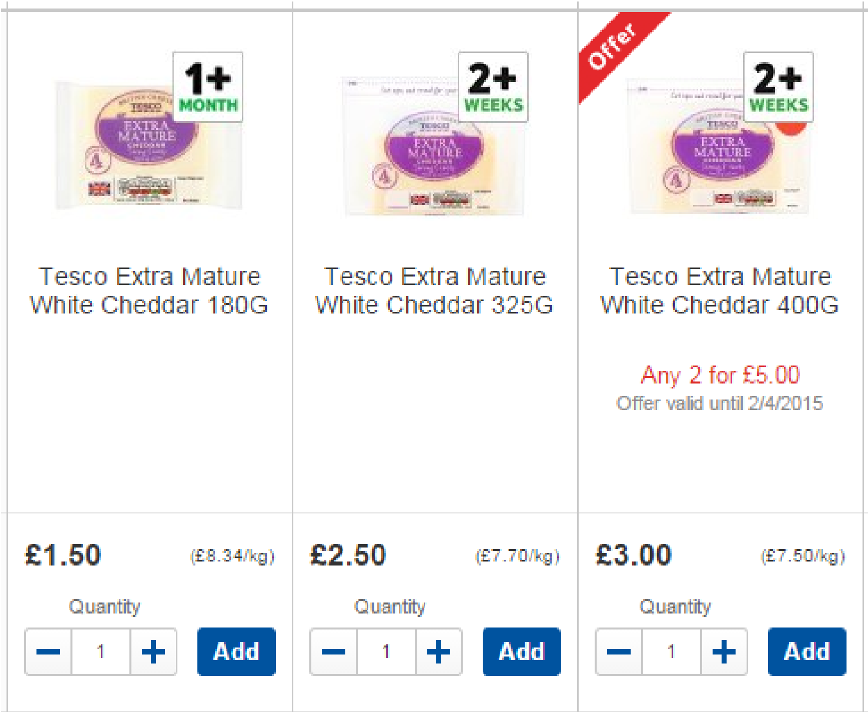
But it can do better. The optimal two-part tariff is

The monopoly sells units and extracts all the surplus from the (identical) consumer(s).

1.4.4 Price-quantity pairs

Instead of offering a whole schedule giving a price $T(q)$ for each $q \geqslant 0$, the monopoly may offer only a finite number of different prices and quantities. A *price-quantity* pair (T, q) consists of a price T and a quantity q.

EXAMPLE (Tesco Extra Mature White Cheddar)



Three of the price-quantity pairs offered are: (£1.50, 180g), (£2.50, 325g), (£3.00, 400g). But consumers can purchase any combination of these too.

EXAMPLE (KC broadband)

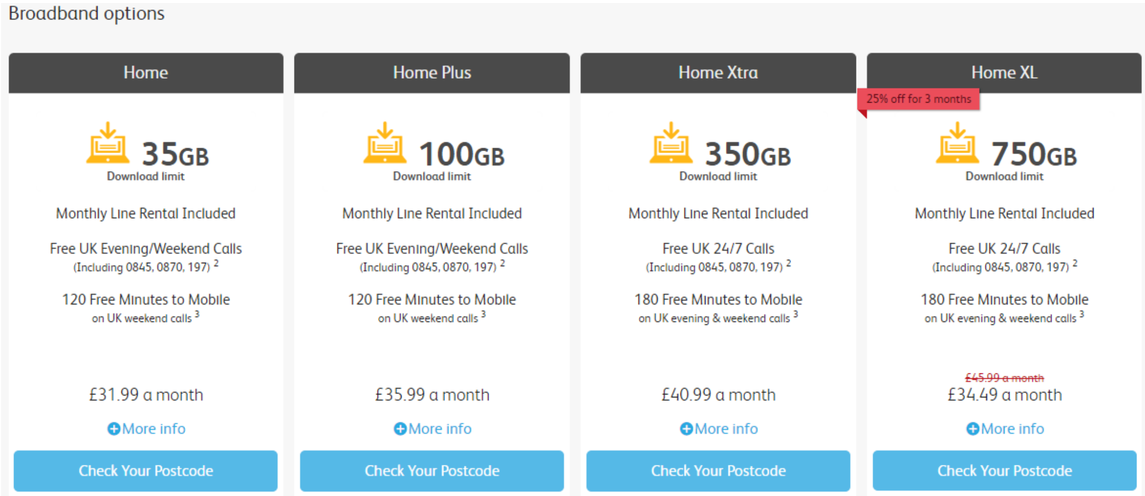
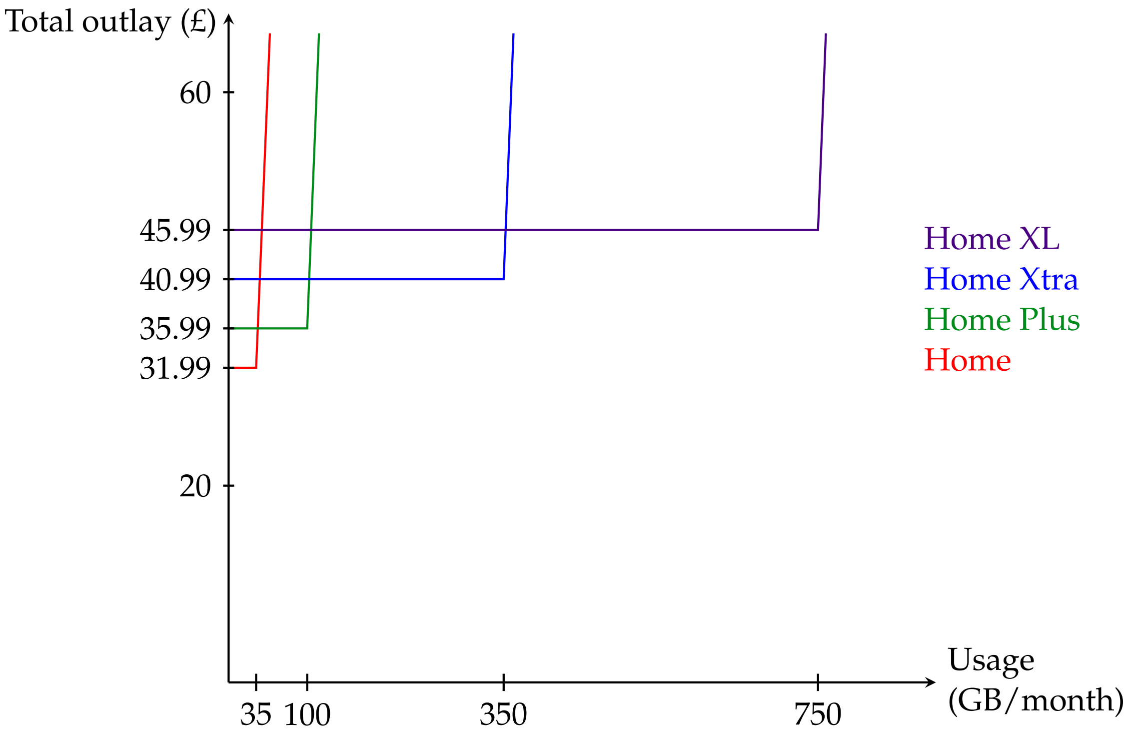


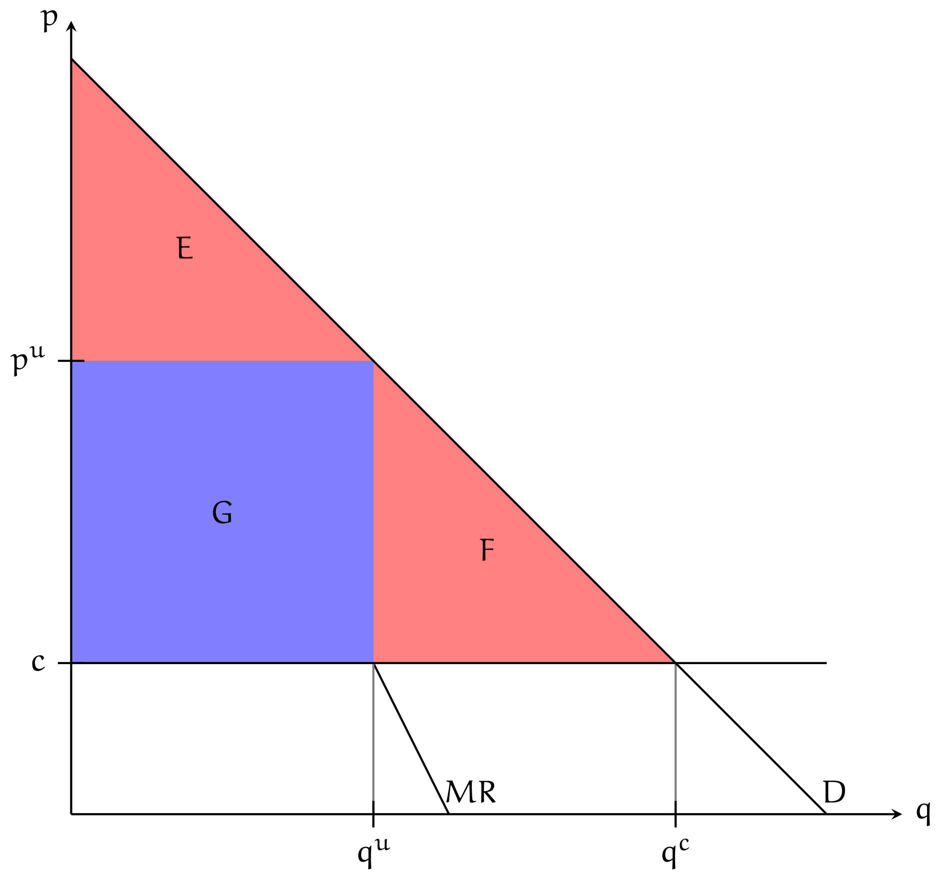
Figure 1.2: "Additional usage is just £2 per GB or part thereof."



KC is effectively offering a menu of just four price-quantity pairs:

- Home: (£31.99, 35GB)
- Home Plus: (£35.99, 100GB)
- Home Xtra: (£40.99, 350GB)
- Home XL: (£45.99, 750GB)

1.4.5 Optimal price-quantity pair: identical consumers



A uniform-pricing monopoly sells q^u units at price p^u. The monopoly could continue to sell q^u units and capture more surplus by offering the price-quantity pair

But it can do better.The optimal price-quantity pair is

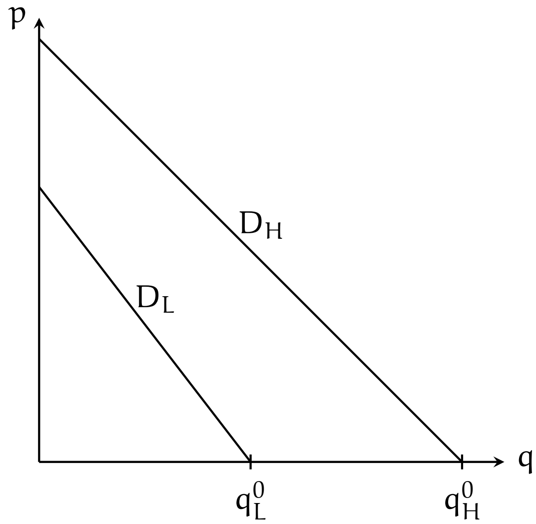
As with a two-part tariff, the monopoly sells units and extracts all the surplus.

1.4.6 Optimal menu of price-quantity pairs: two types of consumer

Suppose there are only two consumers (or two equal-sized groups of consumers):

- a low demand type L, and
- a high demand type H.

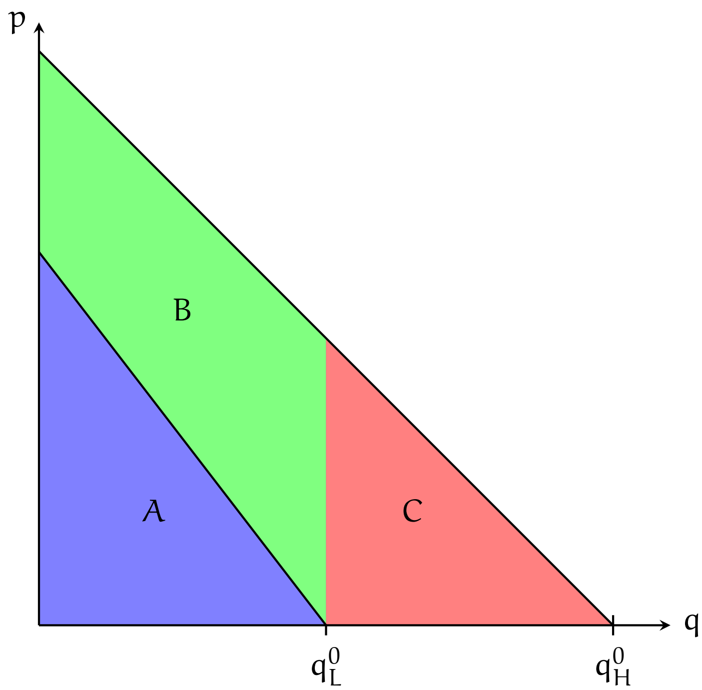
Also, suppose that marginal cost is constant at 0 (this just makes the diagrams neater).



What menu of price-quantity pairs maximizes profit?

Observable types (first-degree price discrimination)

Suppose the monopoly can observe types. What price-quantity pair should it offer L (H)?

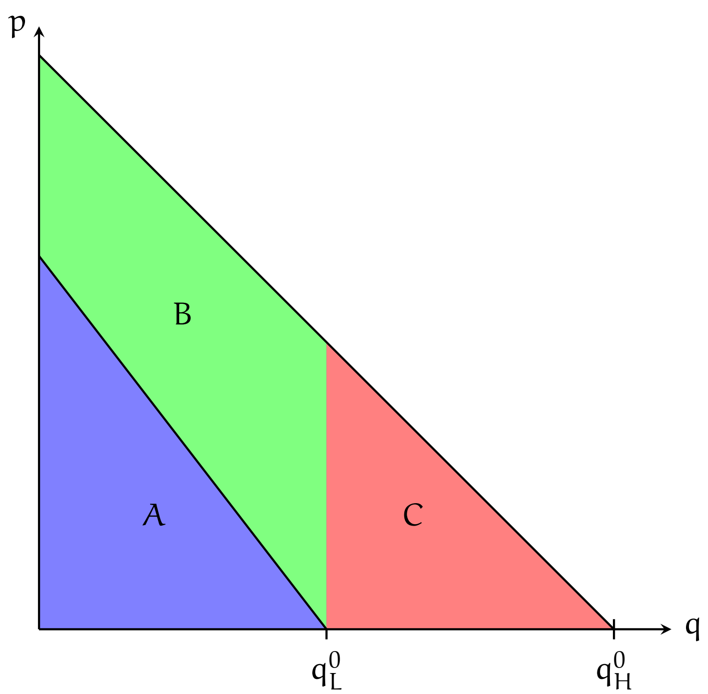


If types were observable, monopoly would offer L the price-quantity pair

and offer H

Both consumers get surplus. Profit would be $2A + B + C$.

Unobservable types (second-degree price discrimination)



But if types are unobservable and the monopoly offers

$$(T_L, q_L) = (A, q_L^0)$$
$$(T_H, q_H) = (A + B + C, q_H^0).$$

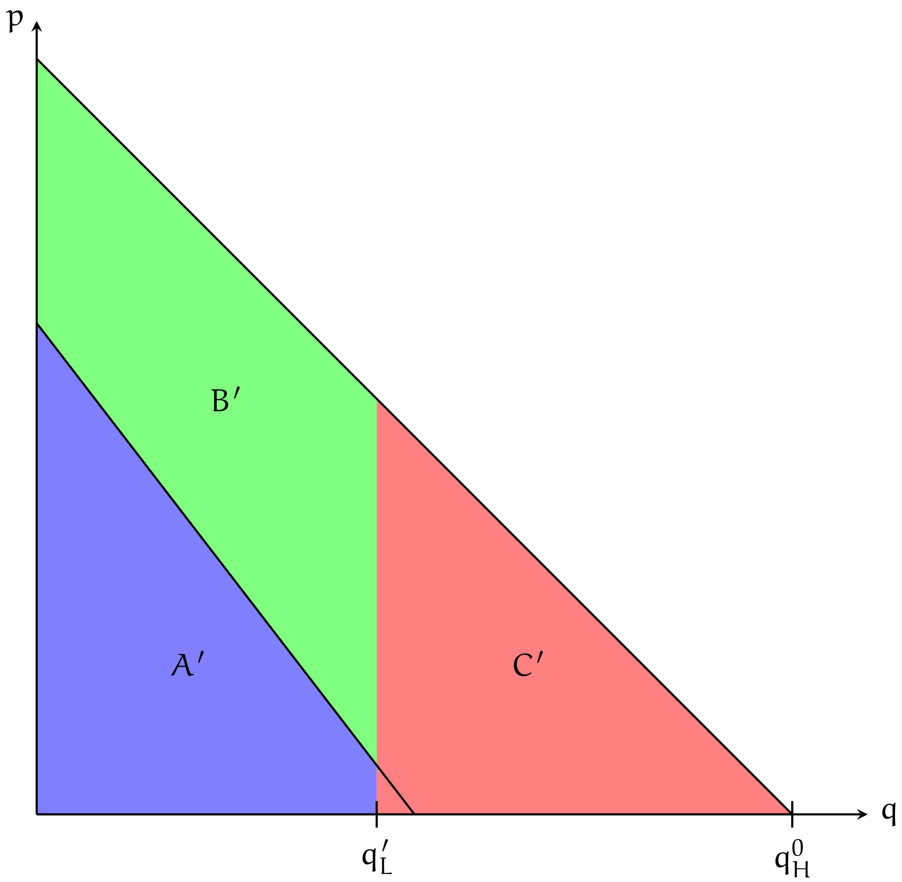
then H would prefer pair meant for L, as gets $B > 0$ surplus. Profit would be only $2A$.

But can do better…Decrease T_H until H is indifferent between the two price-quantity pairs:

H gets a surplus of B from both price-quantity pairs and chooses the pair meant for him. Profit is now $2A + C$. This is larger than with the previous menu:

$$2A + C > 2A.$$

Figure 1.3: Can do still better...



Decrease q_L, decrease T_L, increase T_H, keeping H indifferent between the two price-quantity pairs:

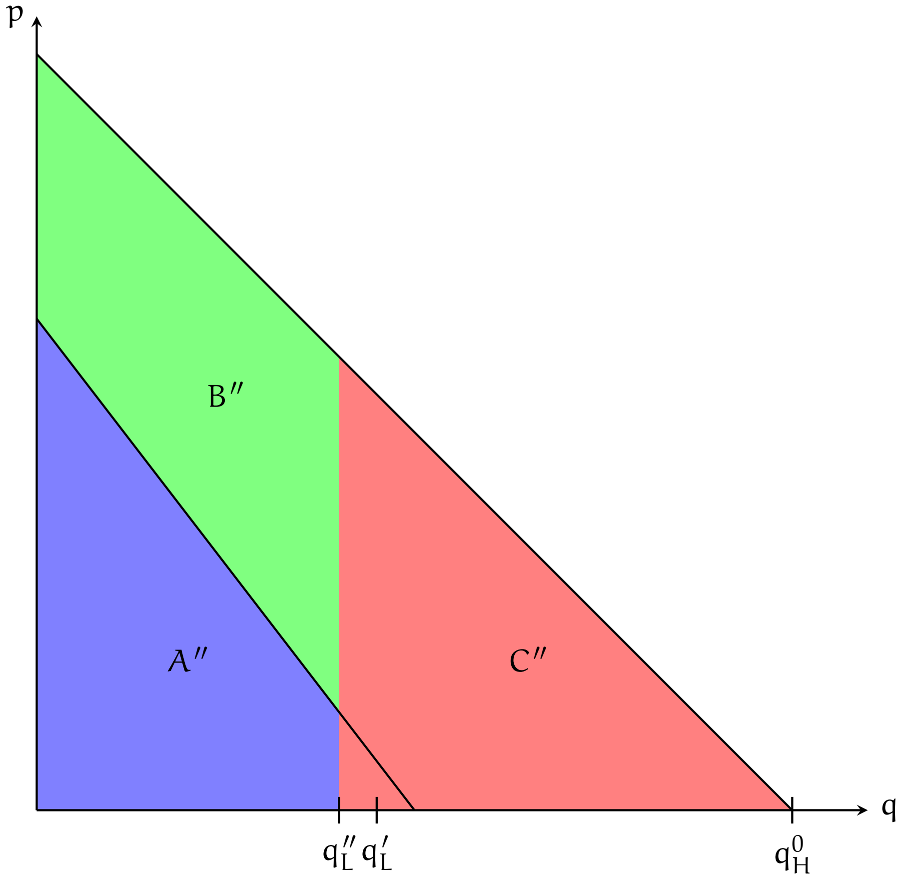
H gets B' surplus from both. Profit is now

$$\begin{aligned} 2A' + C' &= 2(A - a) + (C + a + c) \\ &= (2A + C) + (c - a) \end{aligned}$$

The marginal gain in profit is c, the marginal loss is a. Since $c > a$, profit is higher than with the previous menu:

$$2A' + C' > 2A + C$$

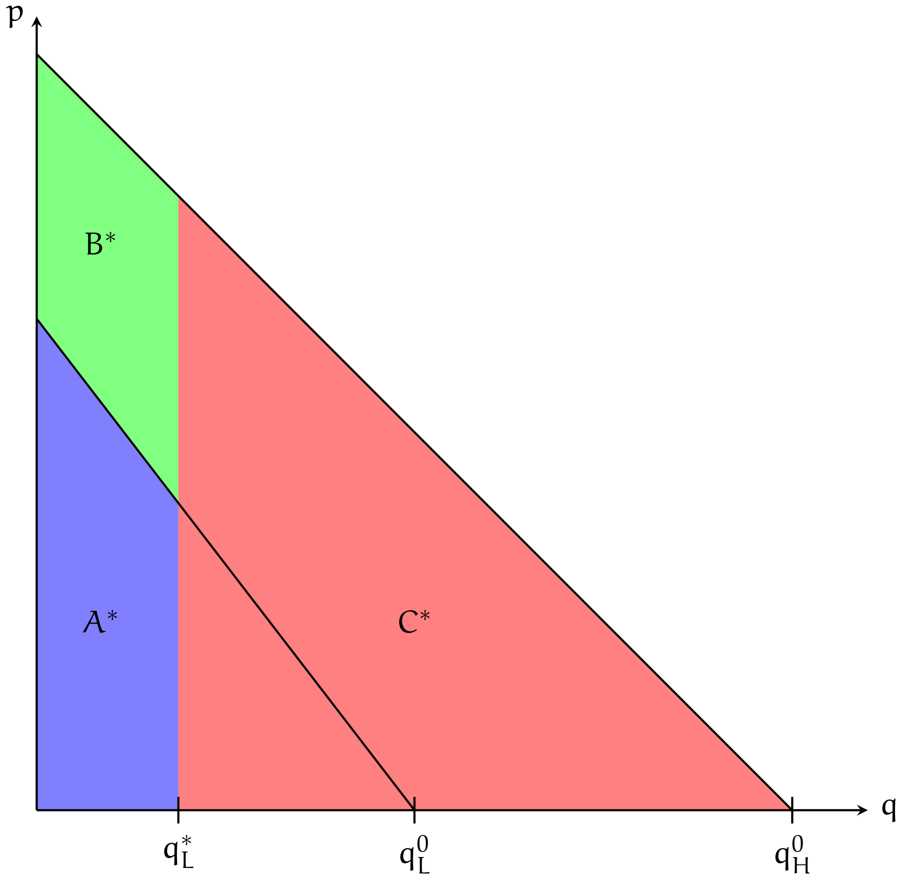
Figure 1.4: Keep decreasing $q_L \ldots$



Decrease q_L a little more to q_L''. Decrease T_L to A''. Increase T_H to $A'' + C''$. Profit rises

$$\underbrace{\text{marginal gain}}_{\text{red outlined area}} > \underbrace{\text{marginal loss}}_{\text{blue outlined area}}$$

Figure 1.5: Optimal price-quantity menu



Keep going until the red outlined area (marginal gain) is equal to the blue outlined area (marginal loss). This is at q_L^* where height of H's demand curve is twice that of L's. The optimal price-quantity menu is

$$(T_L, q_L) = (A^*, q_L^*)$$
$$(T_H, q_H) = (A^* + C^*, q_H^0)$$

Properties of the optimal price-quantity menu:

- Downward distortion of quantity for low type ($q_L < q_L^0$)
- No distortion of quantity for high type ($q_H = q_H^0$)
- Low type gets zero surplus ($T_L = u_L(q_L)$)
- High type gets positive surplus ($T_H < u_H(q_H)$)

Profit is lower than under perfect price discrimination because:

- H gets some surplus and
- the monopoly has to distort L's quantity downwards.

1.5 Versioning

The practice of offer different price-*quality* pairs is known as *versioning*.

EXAMPLE

Nothing new! Can reinterpret everything we did with quantities in terms of qualities:

- Assume consumers buy one unit or none
- q now stands for quality instead of quantity
- The demand curve is now over quality
- Demand is downward sloping with respect to quality because a consumer's willingness to pay for an increase in quality decreases with quality

EXAMPLE (486)

Intel produced the 486DX chip—at the time the most powerful chip widely available. It also produced a budget version, the 486SX.

- The 486SX was produced my disabling the integrated maths coprocessor of a

486DX.

- The maths coprocessor greatly speeds up the handling of floating-point numerical computations.
- Disabling the coprocessor was costly, so the 486SX actually cost more to produce!
- The 486SX sold for $333 compared to the 486DX for $588.

The 486SX is an example of a *damaged good*, a particular case of versioning where differences in products are obtained by 'damaging' the basic product.

EXAMPLE (486, continued)

Type	No.	Willingness to pay 486DX	486 SX
High-value	3	600	300
Low-value	1	400	350

Assume a zero marginal cost for both versions.

In the example above, if Intel did not also offer the 'damaged good' (i.e. the 486SX) then they would have chosen to sell only to those with a high demand for processing power. Those consumers with a low value for processing power would have been priced out of the market. By introducing the 'damaged' 486SX Intel was able to charge a high price for the 486DX, and a low price for the damaged good.

When there are consumers who differ by their willingness to pay for quality, versioning allows the firm to charge a higher price to consumers with a higher willingness to pay than the price charged to consumers with a lower willingness to pay.

EXAMPLE (Other examples of damaged goods)

Sony MiniDiscs came in two sizes: 60 minute and 74 minute.

- Physically identical but 60 minute version has encoded instruction that limits quantity of recorded material.

IBM introduced the IBM LaserPrinter E, a low-cost alternative to its LaserPrinter

- Apparently identical, but LaserPrinter E had firmware whose function was to slow down the printing speed.

Plastic molding powder methyl methacrylate (MM) was sold to industrial users at $0.85 per pound and dental manufacturers at $22 per pound.

- Arbitragers begin buying MM at the industrial price and reselling to dental manufacturers.
- One of the suppliers considered mixing arsenic with the MM sold for industrial use.

1.6 Durable goods

1.6.1 Introduction

A good that is not used up over time is called a *durable good*. A good that is consumed in one use or several uses is called a *non-durable good*

EXAMPLE

Durable goods:

Non-durable goods:

1.6.2 Durable goods curse

By setting different prices now and in the future, a monopolist may be able to engage in profitable price discrimination: to sell both to high-valuation buyers at a high price and to low-valuation buyers at a low price.

- Suppose that Samsung launches a new smartphone today and prices it at £600 and then lowers the price to £100 six months from now.
- Hopefully, this pricing pattern will lead high-valuation buyers to buy now and lower valuation consumers to wait for six months.
- Unfortunately, a rational buyer will realize that it will be in the Samsung's interest to lower prices in the future. Since even high-valuation buyers prefer to pay low prices, the outcome of the high-price-today-and-low-price-tomorrow strategy may turn out to be that most buyers prefer to wait for the future low price.
- Samsung's price discrimination strategy will then have backfired. Compared to the case where Samsung set the monopoly price in both periods: sales are much slower; and average price is much lower.

In other words, the possibility of setting different prices in each period—at first sight an advantage to the seller—may turn out to be its 'curse', for total profits are then lower.

EXAMPLE (Durable goods curse)

Type	Proportion	Willingness to pay Today	 Tomorrow
High-value	1/2	600	300
Low-value	1/2	200	100

Assume a zero marginal cost, and that their is a continuum of consumers of mass one. Half the consumers are willing to pay 300 per period, half are willing to pay 100.

In the example given, the ability to price discriminate over time leads to a lower profit than if the seller were able to commit to keeping prices high. This is the *durable-goods curse*. Note that this is simply an example of unprofitable 'versioning' (the versions differ by date). Of course, we can easily come up with examples where the ability to discriminate over time is profitable (e.g. using the numbers from the 486 example)

1.6.3 Solutions to the curse

Potential solutions to the curse:

- Commit not to lower price
- Lease the good rather than selling it
- Limit the durability of the product through planned obsolescence
- Introduce product differentiation
- Develop a reputation for not lowering prices

Commit not to lower price

A firm could take some action that makes it costly to lower the price in the future.

- Chrysler (apparently) offered a 'lowest-price guarantee': If it were to lower the price of a given car model, it would have to refund all previous buyers the difference
- The guarantee means that Chrysler *cannot* offer a higher price today and a lower price in the future

Lease the good

A firm could lease the good rather than sell it.

- Xerox leased its photocopiers in the late 60s and early 70s.
- Leasing effectively turns a durable good into a non-durable one: the good is no longer a photocopier, but the use of the photocopier for a specified time period.

EXAMPLE (Leasing the good)

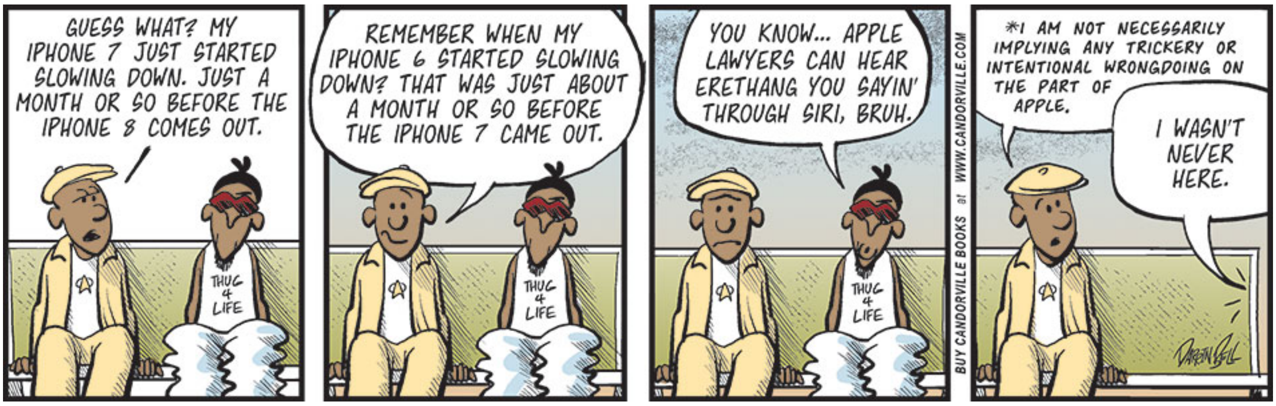
If the good from the previous example were leased, then the high-value consumer would be willing to pay up to 300 to lease the good for one period, while the low-value consumer would be willing to pay up to 100 to lease the good for one period.

		Willingness to pay	
Type	Proportion	Today	Tomorrow
High-value	1/2	300	300
Low-value	1/2	100	100

Planned obsolescence

The monopolist might be able to limit the durability of its product by hastening its obsolescence. This strategy of planned obsolescence might be achieved:

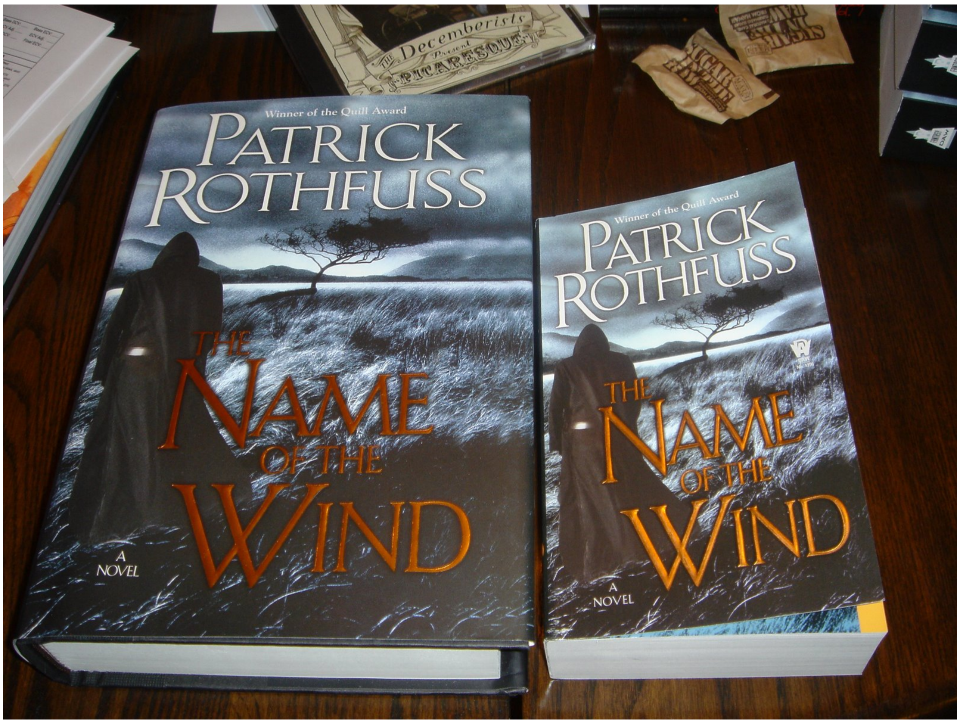
- directly, by shortening the useful life of the product; or
- indirectly, by introducing new versions of the product over time.



Introduce product differentiation

A firm could offer different versions of the good over time.

- Book publishers usually—at least they used to—offer a hardback (high price) and then a paperback version (low price)

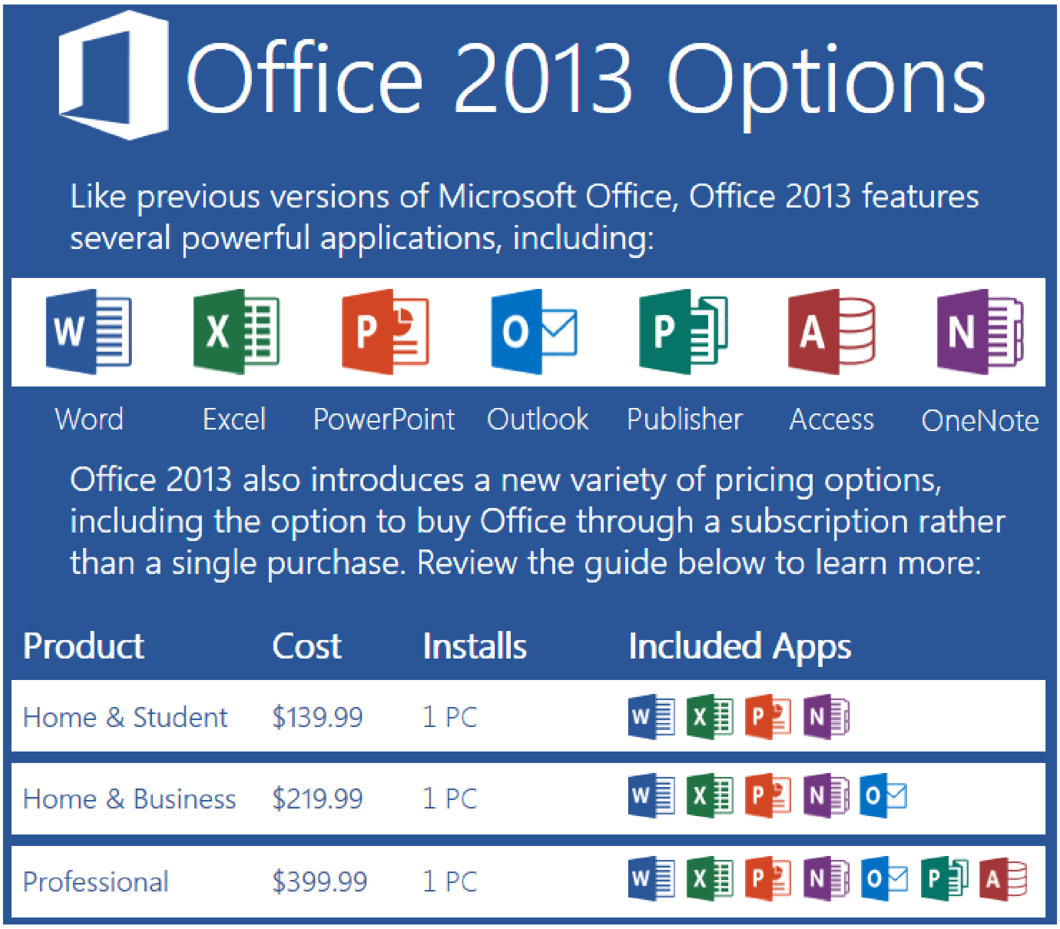


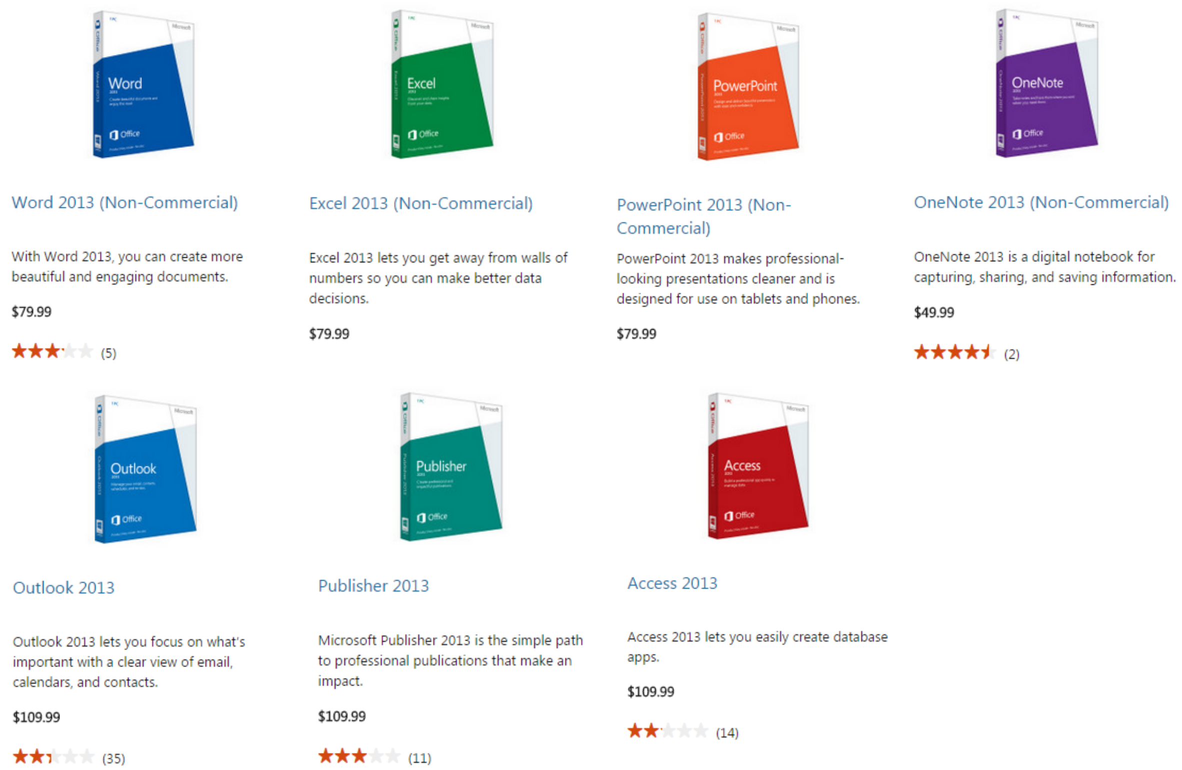
Reputation

A firm may wish to build a reputation for not lowering its price over time

- Consider a firm that produces a series of different durable products
- In the short run (i.e. considering one of the products in isolation) a firm may have an incentive to cut its price for any one product
- However, in the long run, the firm has to consider the long run cost of lost reputation
- After observing a price cut for one product consumers will now expect the firm to lower the price for all its future products over time
- This long-run cost can be enough to outweigh the short-run gain and deter price cuts

1.7 Bundling


Office 2013 Options
Like previous versions of Microsoft Office, Office 2013 features several powerful applications, including:
Word
Excel
PowerPoint
Outlook
Publisher
Access
OneNote
Office 2013 also introduces a new variety of pricing options, including the option to buy Office through a subscription rather than a single purchase. Review the guide below to learn more:
Product
Cost
Installs
Included Apps
Home & Student
$139.99
1 PC
Home & Business
$219.99
1 PC
Professional
$399.99
1 PC


Word 2013 (Non-Commercial)
With Word 2013, you can create more beautiful and engaging documents.
$79.99
(5)
Excel 2013 (Non-Commercial)
Excel 2013 lets you get away from walls of numbers so you can make better data decisions.
$79.99
PowerPoint 2013 (Non-Commercial)
PowerPoint 2013 makes professional-looking presentations cleaner and is designed for use on tablets and phones.
$79.99
OneNote 2013 (Non-Commercial)
OneNote 2013 is a digital notebook for capturing, sharing, and saving information.
$49.99
(2)
Outlook 2013
Outlook 2013 lets you focus on what's important with a clear view of email, calendars, and contacts.
$109.99
(35)
Publisher 2013
Microsoft Publisher 2013 is the simple path to professional publications that make an impact.
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Access 2013
Access 2013 lets you easily create database apps.
$109.99
(14)

1.7.1 Introduction

Consider a multiproduct monopoly producing two goods, A and B.[3]

- *Pure bundling*: buyers have choice between bundle of A and B, or nothing.
- *Mixed bundling*: choice between bundle of A and B, or buying A or B separately, or nothing.

More generally, if there are more than two parts, monopoly may offer a range of different bundles (where each bundle is made up of a different subset of the goods it produces).

1.7.2 Pure bundling

EXAMPLE (Profitable pure bundling)

		Willingness to pay	
Type	A	B	Together
1	900	300	1200
2	300	900	1200

Assume zero marginal cost and one of each type.

-
-

[3]Note that in contrast to versioning, where the consumer would wish to purchase at most one unit of one of the versions/qualities, here the consumer may wish to purchase one unit of each of A and B.

By bundling, monopoly can effectively charge type 1 and type 2 customers different prices for each product. Effectively, monopoly charges each type as follows:

- Type 1 customers: 900 for A and 300 for B
- Type 2 customers: 300 for A and 900 for B

Bundling may give a strictly higher profit than selling separately. It can act as a form of price discrimination where the monopoly can effectively charge different prices to different customers for the same product.

EXAMPLE (Unprofitable pure bundling)

	Willingness to pay		
Type	A	B	Together
1	900	100	1000
2	900	300	1200

Assume zero marginal cost and one of each type.

-
-

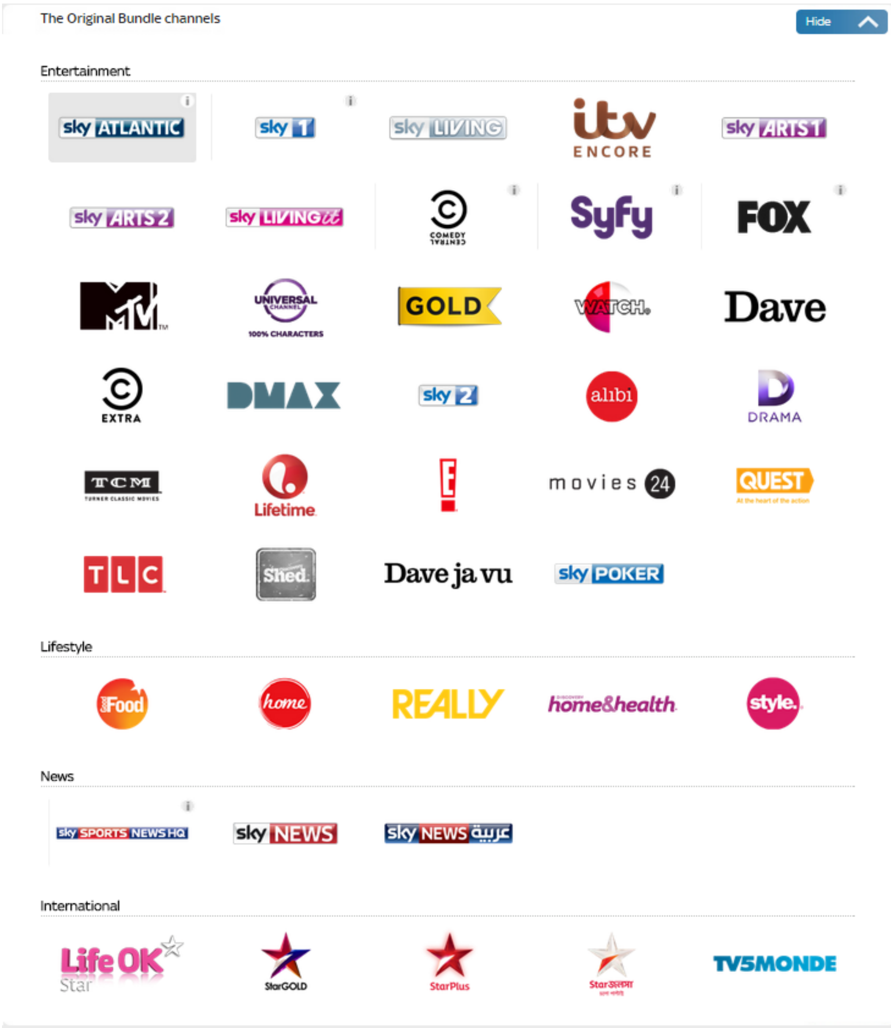
In the first example, there was a (perfect) negative correlation between willingness to for each good.

- Type 1 put a high value on good A and a low value on good B.
- Type 2 put a low value on good A and a high value on good B.

This meant there was more heterogeneity between the consumer types in their valuations of individual products, and less heterogeneity in their valuation of the bundle.

In the second example both consumers put the (same) higher value on A, so there was a positive correlation between the willingness to pay for each good. Additionally, when selling separately, it was optimal to sell B to only one of the consumers.

Pure bundling may be strictly less profitable than selling separately.



EXAMPLE (Profitable pure bundling without negative correlation)

	Willingness to pay		
Type	A	B	Together
1	7	7	14
2	7	13	20
3	13	7	20
4	13	13	26

Assume zero marginal cost and one of each type.

If there are more than two types of consumer, then pure bundling can be strictly more profitable than selling separately even if there is no correlation between the willingness to pay for each good.

1.7.3 Mixed bundling

If there are more than two types of consumers, then mixed bundling may give a strictly higher profit than selling separately or pure bundling.

EXAMPLE (Profitable mixed bundling)

		Willingness to pay	
Type	Mozart	Rammstein	Together
Classical	50	0	50
Industrial	0	50	50
Eclectic	30	30	60

Assume zero marginal cost and one of each type.

Price Competition 2

2.1 Bertrand competition

2.1.1 Introduction

Most real world firms are between the extremes of monopoly and perfect competition. How do we model markets with few firms (oligopolies)? When there are multiple firms, each firm has to worry about how its decisions (of quantity, price, etc) affect other firms, and how other firms react. Game theory allows us to model such situations where decisions are interdependent. It turns out that, in contrast to the case with a single decision maker (monopoly), the decision variable (price or quantity) matters. We will first look at the Bertrand model of price competition, where the strategic variable is price. In Microeconomics, you saw the Cournot model where the strategic variable is quantity. We will not cover the Cournot model in this module.

2.1.2 Model

- Two firms, A and B
- Homogeneous good
- Consumers buy from the firm with the lower price
- If prices are equal, total demand is shared equally
- Total demand for the good is $D(p)$ where p is the lower price
- Each firm has constant marginal cost c
- Firms set prices p_A and p_B simultaneously.
- Each firm's goal is to maximize its profits

A *best response* of a player to the other players' strategies is a strategy which gives at least as high a payoff as any other strategy

- In the Bertrand game each player's (i.e. firm's) strategy is a price
- A best response of firm A to some price chosen p_B by B is a price that gives A at least as a high a profit as any other price

A *Nash equilibrium* is where each player is playing a best response to the other players' strategies. In a Nash equilibrium, there is no incentive for any player to deviate given the other players strategies, i.e. no player has a strictly profitable unilateral deviation

- In the Bertrand game a Nash equilibrium is a pair of prices (p_A^*, p_B^*) such that each price is a best response to the other.
- In the Bertrand game (p_A^*, p_B^*) is a Nash equilibrium if, given firm B's choice of price p_B^*, there is no price p_A which gives a strictly higher profit than p_A^*

EXAMPLE (Bertrand game with three price levels)

Firm B

		$p_B = 5$	$p_B = 4$	$p_B = 3$
	$p_A = 5$	9, 9	0, 14	0, 8
Firm A	$p_A = 4$	14, 0	7, 7	0, 8
	$p_A = 3$	8, 0	8, 0	4, 4

Firms typically do not just set prices of 3, 4 or 5. Suppose now that firms can choose any prices $p_A \geqslant 0$ and $p_B \geqslant 0$. Now we cannot represent the game using a payoff matrix. Instead payoffs represented by profit functions π_A and π_B over pairs of prices. In the game with three prices, we had, for example:

$$\pi_A(4,5) = 14 \qquad \pi_B(4,5) = 0.$$

In the general case, A's profits are

$$\pi_A(p_A, p_B) = (p_A - c)D_A(p_A, p_B)$$

where

$$D_A(p_A, p_B) = \begin{cases} D(p_A) & \text{if } p_A < p_B \\ \frac{1}{2}D(p_B) & \text{if } p_A = p_B \\ 0 & \text{if } p_A > p_B \end{cases}$$

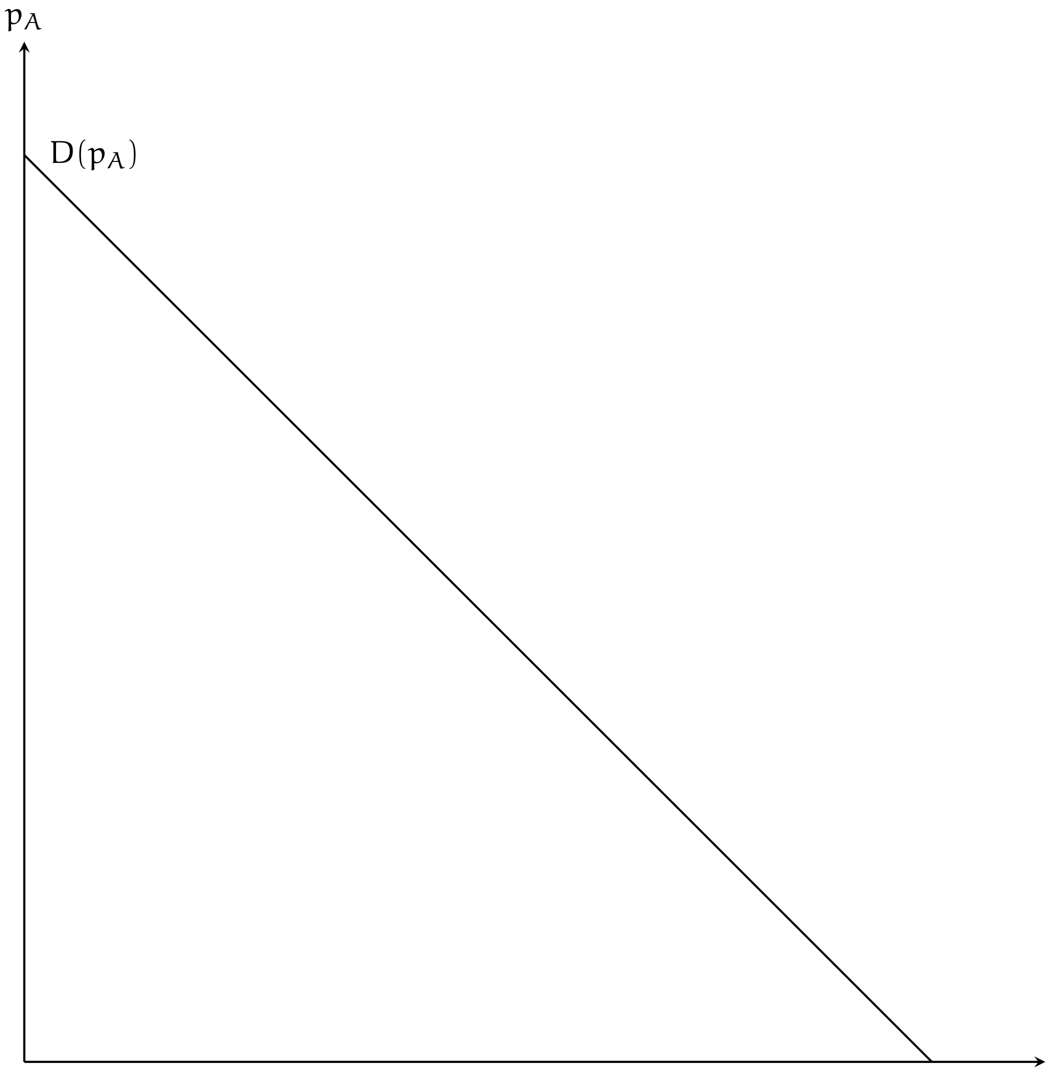


Figure 2.1: A's demand

2.1.3 Nash equilibrium

Recall there are two ways to find all Nash equilibria:

(i) Derive the full best responses and find their intersection(s).

(ii) Look at pairs of prices and find those where there is no unilateral incentive to deviate.

We will use the second method.

CLAIM

The *unique* Nash equilibrium is $p_A = p_B = c$. Each firm gets demand $\frac{1}{2}D(c)$ and makes zero profit.

There are two parts to the proof:

(i) Show there is no incentive for either firm to deviate from $p_A = p_B = c$

(ii) Show that for any other pair of prices (p_A, p_B), there *is* an incentive to deviate.

Proof.

(i) There is no incentive for either firm to deviate from $p_A = p_B = c$.

- At these prices, both firms get zero profit.
- Suppose A raises her price: she gets zero demand ($p_A > p_B$) and so makes zero profit.
- Suppose A lowers her price: she gets all the demand ($p_A < p_B$), but makes negative profit ($p_A < c$).
- Neither deviation makes her strictly better off.
- The same argument applies for B.

(ii) For any other pair of prices (p_A, p_B), other than $p_A = p_B = c$ there *is* an incentive for at least one firm to deviate.

- If $p_A < c$ or $p_B < c$, then one firm is making a negative profit. They are strictly better off raising their price to c and making zero profit.
- If $p_B > p_A = c$ or $p_A > p_B = c$, then the firm with the lower price is making zero profit. They are strictly better off raising their price a bit and making a positive profit.
- If $p_A \geqslant p_B > c$ and $p_B \geqslant p_A > c$, then at least one firm has an incentive to deviate, as we show in the next diagram. In particular we show in the diagram that if $p_B > c$ then firm A is strictly better off undercutting B by a small amount than charging $p_A \geqslant p_B$. ■

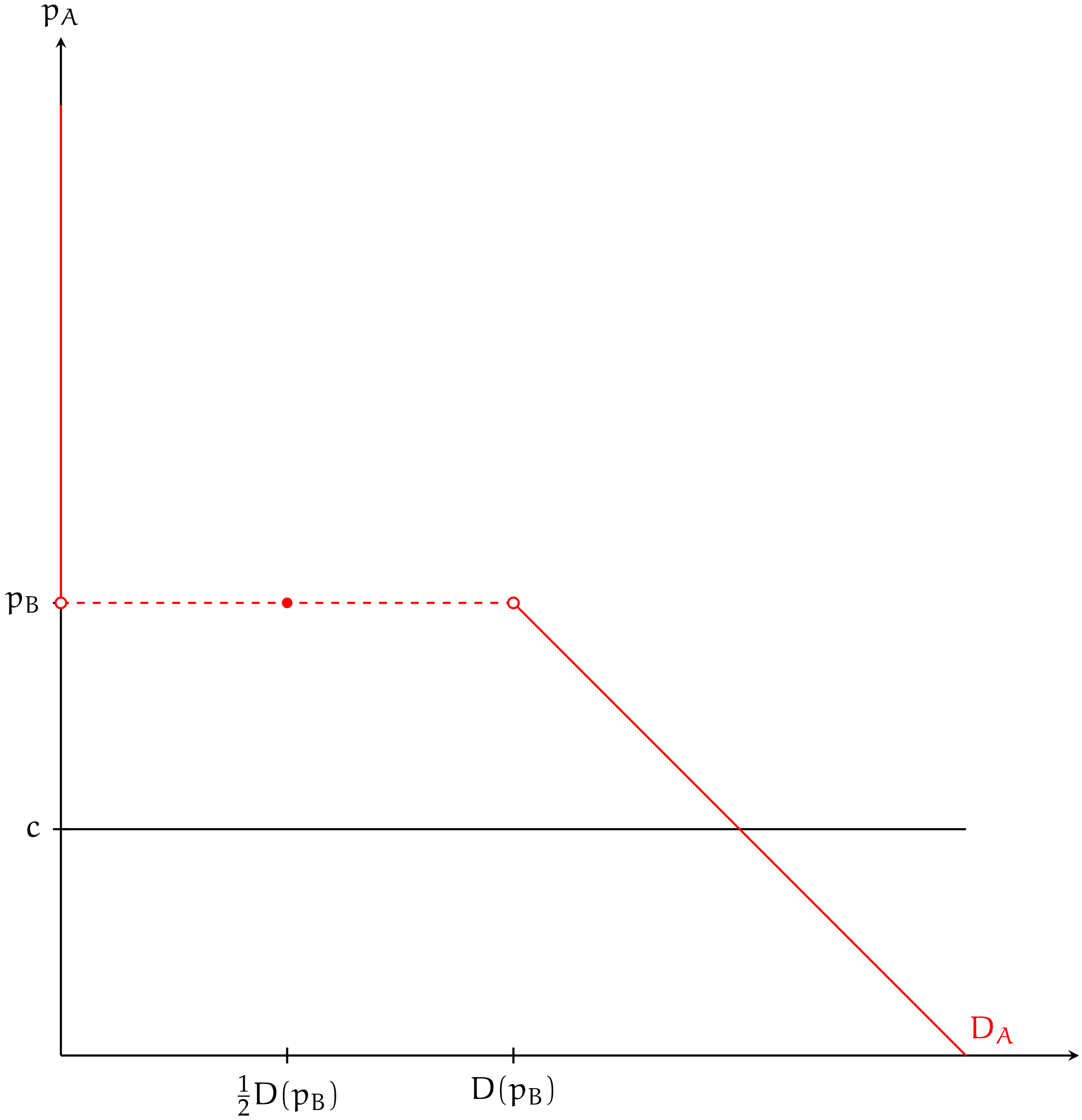


Figure 2.2: Is there an equilibrium with $p_A \geqslant p_B > c$?

p_A	π_A
$> p_B$	0
$= p_B$	
$= p_B - \varepsilon$	

2.1.4 Bertrand paradox

This is a striking result—with only two firms we get the perfectly competitive outcome. Under price competition with homogeneous products and constant, identical marginal cost, all firms price at marginal cost. Each firm faces an infinitely elastic demand curve at the price charged by its rival, so that there is a strong incentive to undercut. The proof above extends easily to more firms.

2.1.5 'Solutions' to the Bertrand paradox

Generally industries with two firms have positive profits. Also, in reality an increase in the number of oligopolistic firms usually leads to a decrease in prices, whereas the Bertrand model predicts none. How can we alter the assumptions of the model to improve its match with reality?

- Product differentiation, switching costs
  - Idea: Make consumers less price sensitive
- Search costs
  - Idea: Consumers may not observe price cuts
- Capacity constraints
  - Idea: Cannot satisfy all demand (at price equal to marginal cost)
- Dynamic competition
  - Idea: Undercutting today has negative consequences in the future

In the Bertrand model there is a large incentive to undercut any price above marginal cost. Each change above reduces this incentive and can lead to equilibrium prices above marginal cost.

2.1.6 Dynamic competition

When firms interact repeatedly, it is possible to sustain higher prices.

- Consider an infinitely repeated game where each stage is as in the game considered earlier.
- If a firm cheats, and undercuts, then they are punished by the other firm playing a low price (e.g. marginal cost) forever.
- If firms are sufficiently patient, then the threat of punishment ensures that it as an equilibrium outcome for firms to play the monopoly price and share the monopoly profit in every period.
- The short-run gain (one period of monopoly profit) is outweighed by the long-run loss (zero profits thereafter).

2.1.7 Capacity constraints

If a firm is subject to a capacity constraint, then it cannot produce (and hence sell) more than its capacity.

CLAIM

If a firm has a capacity constraint of $k < D(c)$ then $p_A = p_B = c$ (pricing at marginal cost) is no longer a Nash equilibrium.

Proof. Suppose B has a capacity constraint $k < D(c)$. We show that if $p_A = p_B = c$, then there is an incentive for firm A to deviate:

- Suppose A raises her price by a small amount
- B cannot satisfy a demand of $D(c)$
- So, even though $p_A > p_B = c$, A gets a positive demand $D(p_A) - k$
- A makes a positive profit and so is strictly better off ∎

When products are homogeneous, there is perfect information, firms interact only once (or a finite number of times), and there are no capacity constraints then the only Nash equilibrium is marginal cost pricing. The discontinuity in demand (the large jump in demand for an infinitesimal cut in price) gives each firm a strong incentive to undercut its rival(s).

- If firms interact infinitely many times (or an uncertain number of times), then the threat of future punishment may be enough to deter undercutting
- If firms faces a capacity constraint, then they may not be able to satisfy all the demand they receive, so a firm pricing at a higher level than its rival(s) may still sell some units

2.2 The characteristics approach to product differentiation

The *characteristics approach* is to treat goods as being made up of various characteristics; a consumer's valuation of a good is an aggregate of their valuations of the characteristics.

2.2.1 Vertical vs horizontal characteristics

Products can be differentiated along two dimensions: *Vertical (quality) characteristics* are those attributes for which consumers agree on the ranking, i.e. there is an objective ranking of quality from highest to lowest. *Horizontal characteristics* are those attributes for which consumers disagree on the ranking, i.e. there is no objective ranking.

EXAMPLE (Cars)

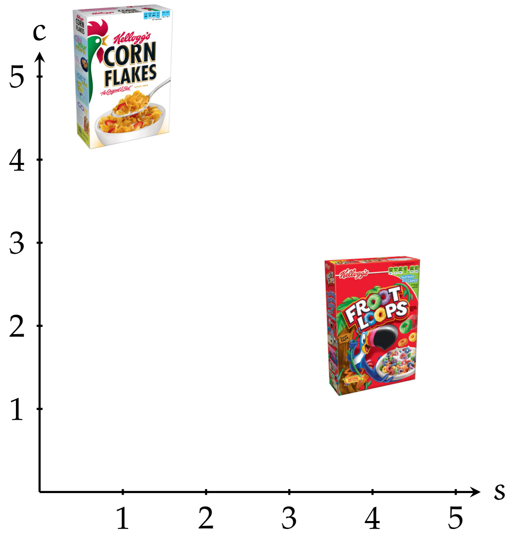
- Vertical:
- Horizontal:

2.2.2 Vertical characteristics; horizontal product differentiation

Consider a good made up of multiple characteristics. Consumers agree that more of each characteristic is better (the characteristics are vertical). If consumers value characteristics differently, then the good may be horizontally differentiated (i.e. consumers may disagree about which variety of the good is better).

EXAMPLE

Suppose cereal is made up of two characteristics: sweetness, s, and crunch, c.



Willingness to pay for each characteristic and for a general cereal:

Buyer	sweetness, s	crunch, c	cereal, (s, c)
A	s	$2c$	
B	$2s$	c	

Willingness to pay for each cereal:

Buyer	Corn Flakes $(s, c) = (1, 5)$	Froot Loops $(s, c) = (4, 2)$
A		
B		

More generally, a good may be made up of n characteristics. We can describe a good using a vector:

$$(c_1, \ldots, c_n),$$

where c_j denotes how much the quantity of characteristic j. We might assume that a consumer's valuation v for the good is given by

$$v = \beta_1 c_1 + \cdots + \beta_n c_n$$

where β_j is the consumer's valuation of a unit of characteristic j.

- Vertical characteristics: $\beta_j \geqslant 0$ for everybody
- Horizontal characteristics: β_j has a different sign

EXAMPLE (Willingness to pay for car characteristics)

Berry, Levinsohn and Pakes (1995) estimated the distributions of willingness to pay for various car characteristics:[1]

Characteristic	Average	Standard deviation
Power to weight ratio (HP/10lb)	2.883	4.628*
Air conditioning	1.521*	1.818
Fuel efficiency (10miles/$)	−0.122	1.050*
Size (length × width)	3.460*	2.056*

* indicates statistical significance. All values are in thousands of dollars.

Results show, for example, that having air conditioning is worth as much as an additional $1.521/3.460 = 0.44$ units of size (about the difference between a small and a medium-sized car)

[1]These estimates are reported in Table IV on page 63 of Berry, Steven, James Levinsohn and Ariel Pakes (1995), "Automobile prices in market equilibrium" , *Econometrica* 63, pp. 841–890.

2.3 Hotelling model of product differentiation

2.3.1 Introduction

We saw that in the standard Bertrand model with homogeneous products firms priced at marginal cost. In order to illustrate the effects of the degree of product differentiation on competition, we will concentrate on a model of *horizontal* differentiation.[2]

Breakfast cereal is a differentiated product. Suppose it is differentiated along only one dimension (sweetness) and that consumers have different ideal levels of sweetness.

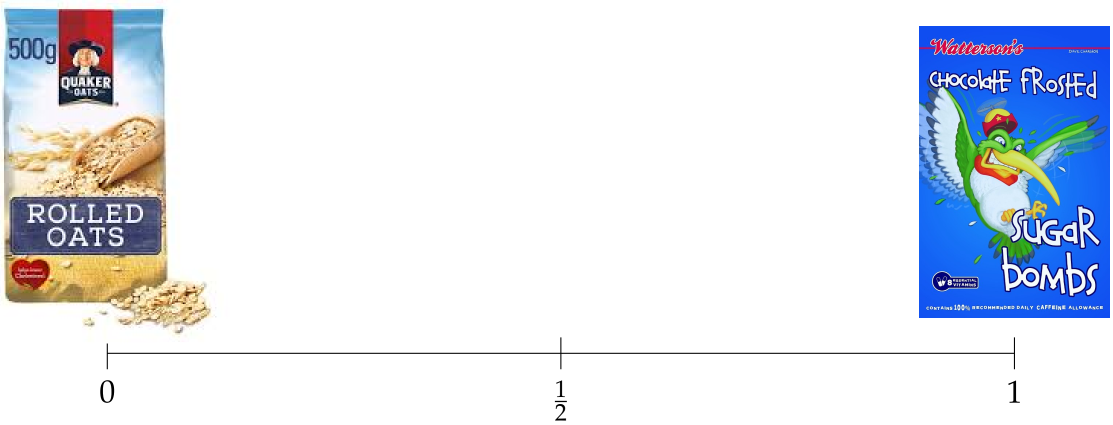


Figure 2.3: The Hotelling line: the sweetness of a variety of cereal is represented as a point along a line from zero to one: higher numbers represent sweeter cereals.

Above we have used a line to represent the possible varieties of cereal. We can use the same idea to represent geographical differentiation with homogenous products. In this case the line represents a street and points along the line are different locations along the street. It will be useful to keep this interpretation/analogy in mind as we go through the model.

[2]Common models of vertical (quality) differentiation have similar predictions.

Firms

- Two firms, A and B
- Differentiated good: located at L_A and L_B
- Each firm has constant marginal cost (assumed zero in the diagrams)
- Firms set prices p_A and p_B simultaneously
- Each firm's goal is to maximize its profit

Consumers

- A continuum of consumers (of mass one) is distributed uniformly along the line,[3]
- A consumer's location represents their ideal variety:
  - Consumers are willing to pay v for their ideal variety
  - There is a 'travel cost' (or disutility) of $t > 0$ for each unit of distance a variety deviates from the consumer's ideal variety, so that consumers are willing to pay:

$$v - t \times (\text{distance from ideal variety})$$

  - In the non-geographical interpretation, a greater t means consumers care more about deviations from their ideal variety
- Each consumer's goal is to maximize surplus.

2.3.2 Demands

For now, suppose that A is at zero and B is at one. Consider a consumer at position x on the line. They must 'travel' a distance x to buy from A, or a distance $1 - x$ to buy from B and so are willing to pay

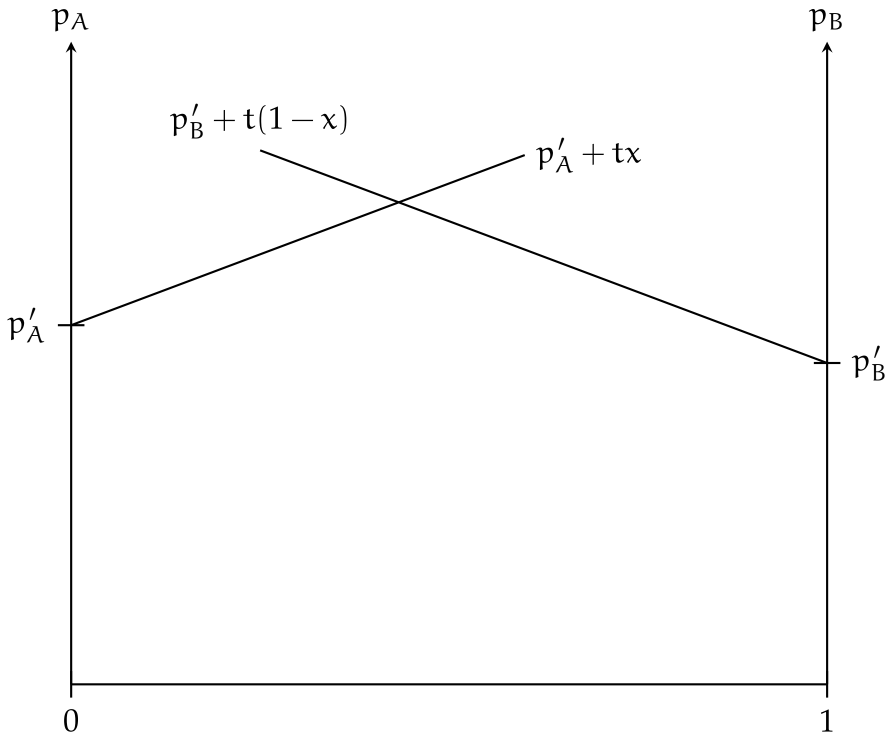
- $v - tx$ for A's product
- $v - t(1 - x)$ for B's product.

They will purchase from A if

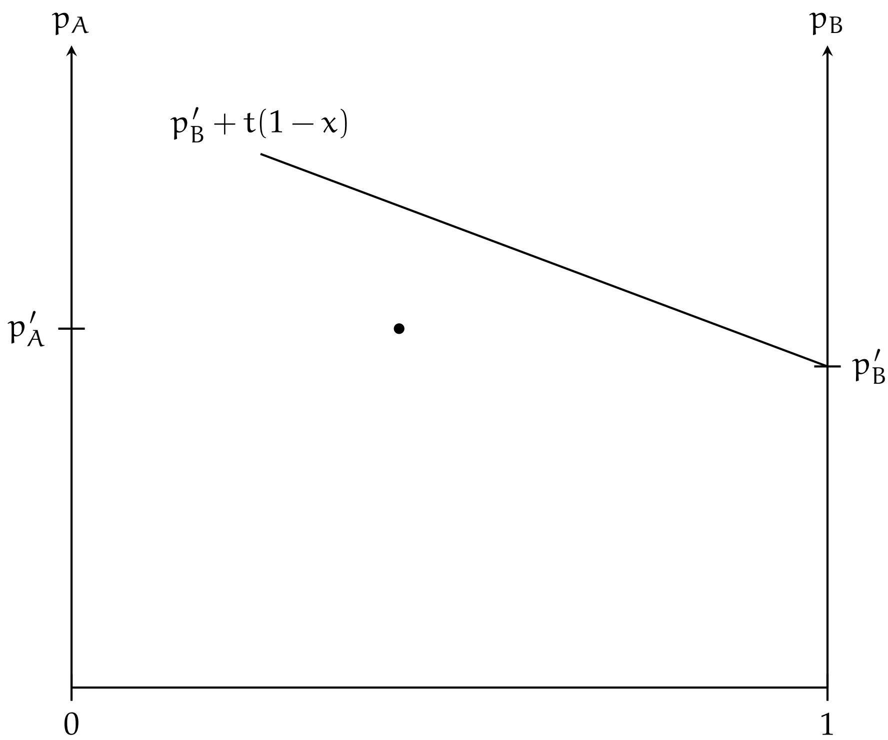
$$v - tx - p_A > v - t(1 - x) - p_B$$

That is, if the 'delivered cost' of A is less than that of B.

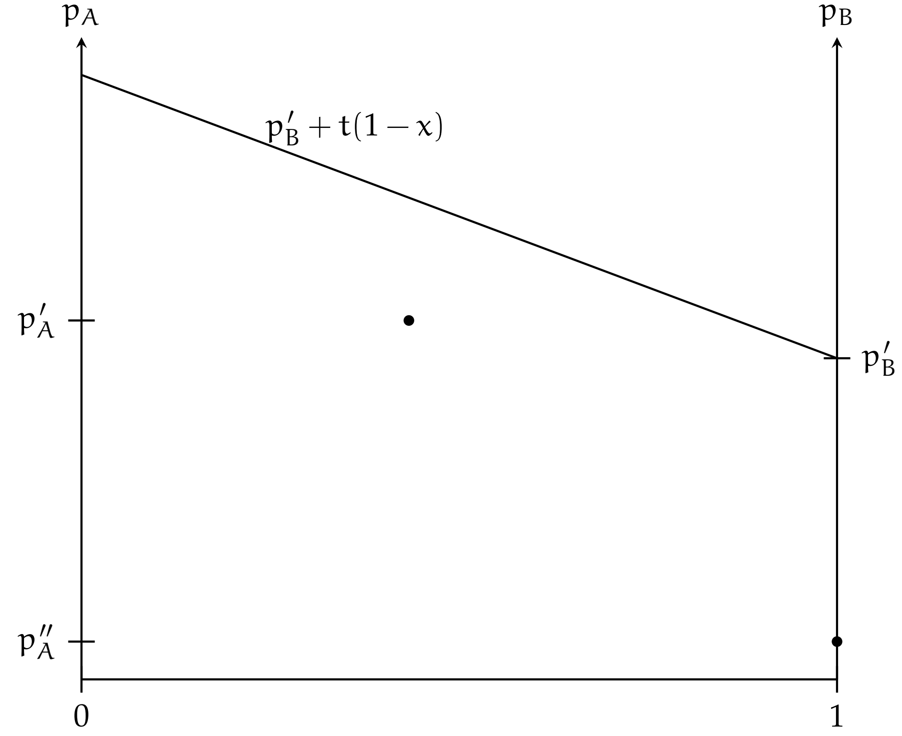
[3] That is, for any position x along the line, x of the consumers are to the left of x (and $1 - x$ to the right). For example half the consumers are to the left of $1/2$ and half to the right.



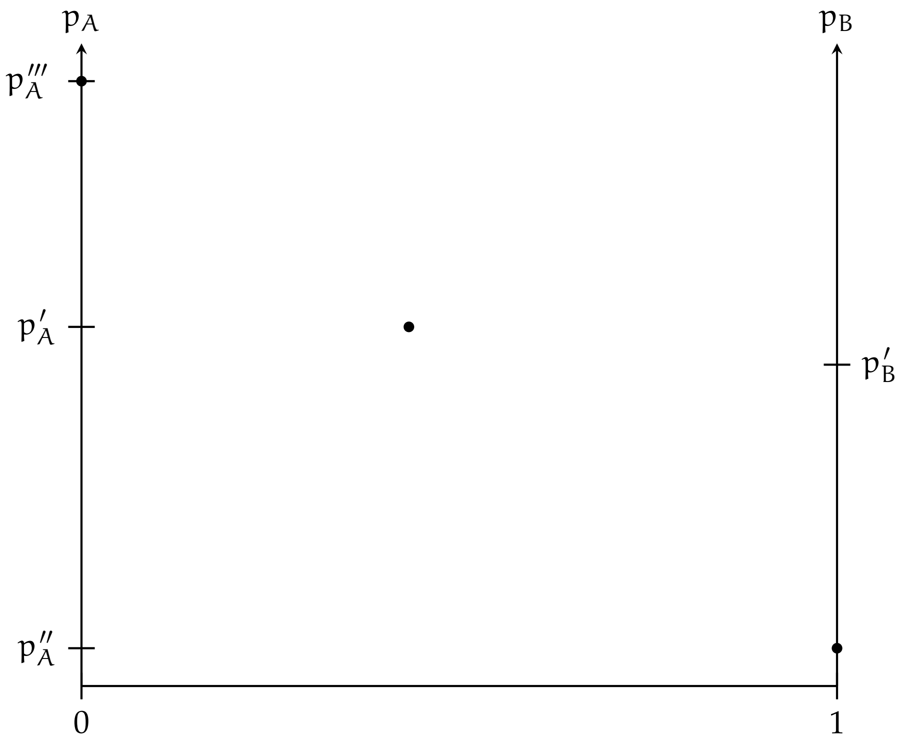
A's demand when $(p_A, p_B) = (p'_A, p'_B)$



A's demand when $(p_A, p_B) = (p''_A, p'_B)$

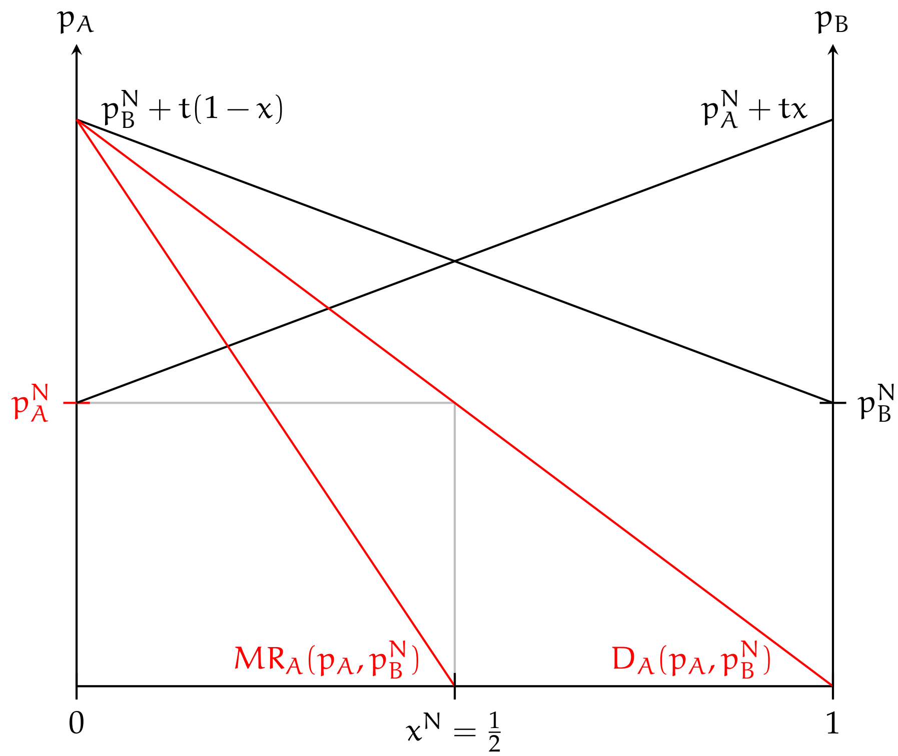


A's demand when $(p_A, p_B) = (p'''_A, p'_B)$

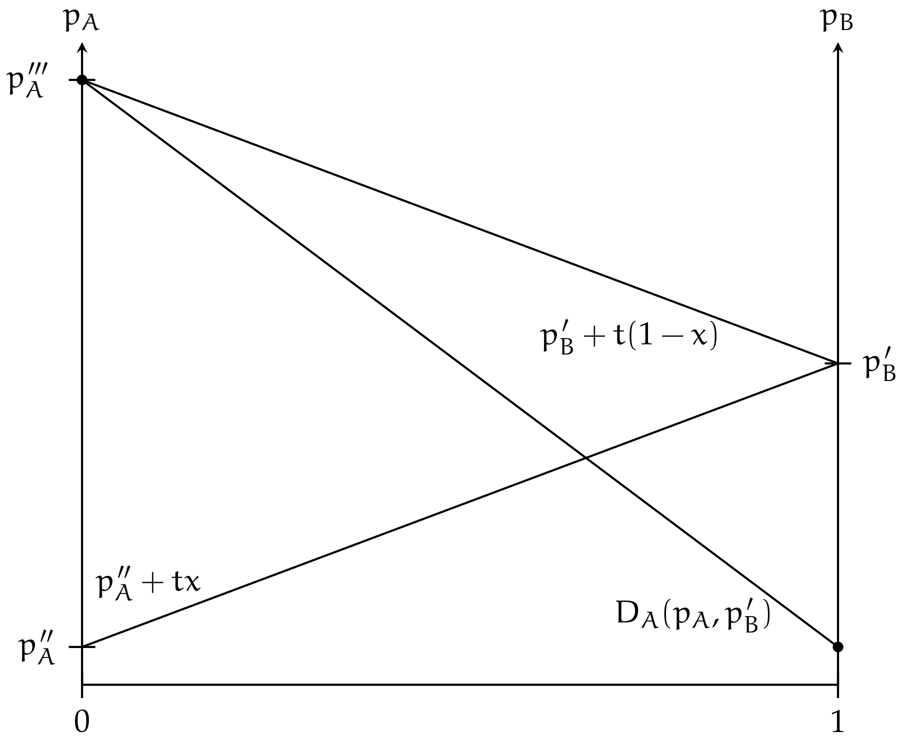


A's best response to p'_B is $b_A(p'_B)$

2.3.3 Nash equilibrium



In the Hotelling model (with $t > 0$), the Nash equilibrium prices are above marginal cost. Each firm has some market power.



The effect of an increase in t

When the firms' locations are fixed at zero and one, we can interpret t as the degree of product differentiation.

- If products were more differentiated (t higher), the demand curve would be .
- If products were less differentiated (t lower), the demand curve would be .
- In the extreme where $t = 0$, the demand curve would be the same as in the standard Bertrand model.

> The greater the degree of product differentiation (the higher t) the greater the degree of market power and the higher the Nash equilibrium prices.

2.3.4 Product positioning

So far we assumed that firms were located at either end of the line. If we allow firms to choose their location:

- How will they position their product?
- Will they locate close together or far apart?

To answer these questions, we consider a two stage game:

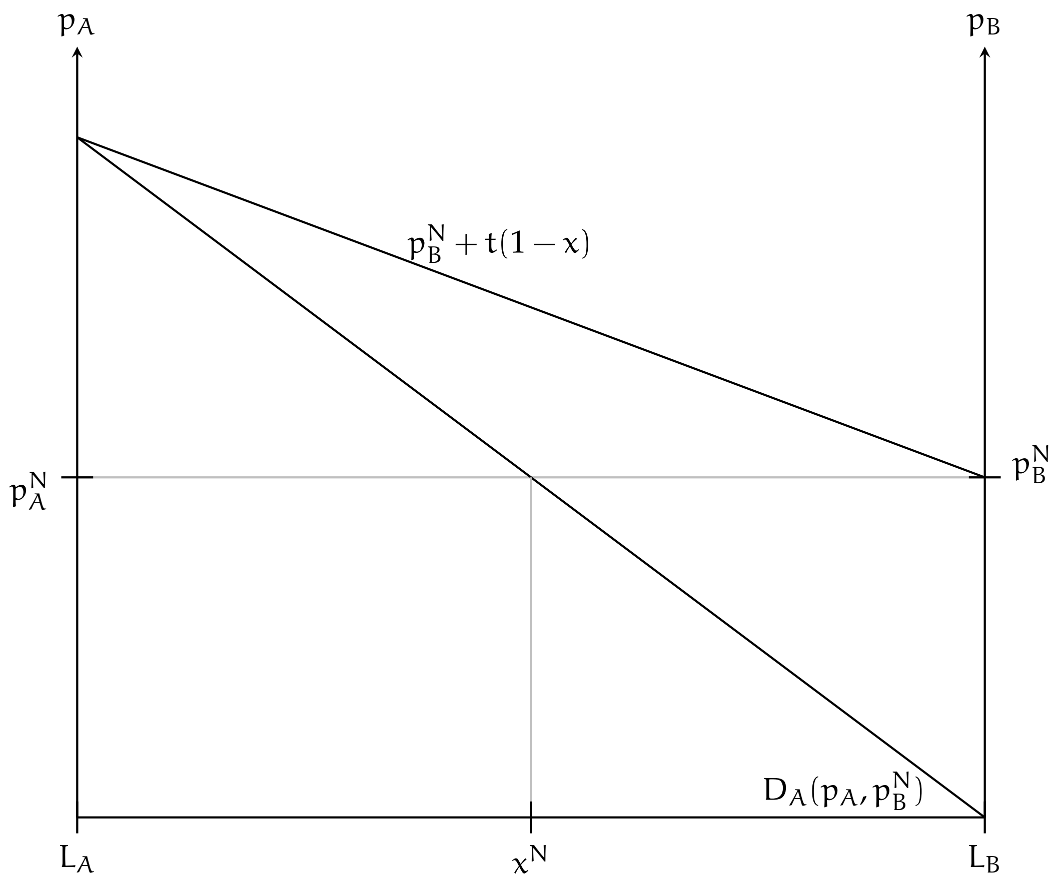
Stage 1: Firms simultaneously choose locations L_A and L_B
Stage 2: Firms simultaneously choose prices p_A and p_B

We will split up the effect of a change in location on profits into two parts:

- *Direct effect*: fixing prices, a change in a firm's location affects its demand
- *Strategic effect*: a change in a firm's location affects the second-stage price competition (in particular its rival's equilibrium price), which affects its demand

Direct effect (fixed prices)

Fix the prices of the firms at p_A^N and p_B^N (the Nash equilibrium prices when firms are located at each end of the line) and consider a small change in location of firm A from $L_A = 0$ to $L'_A > 0$. What is the effect on demand (and hence profit)?



The direct effect is positive: If prices are fixed, then any move of A towards B increases its demand, and hence profits.

CLAIM

If consumers are distributed uniformly, and prices are fixed and equal, then the only Nash equilibrium is for both firms to located at the centre.

Proof.

- Suppose that $L_A = L_B = 1/2$. There is no incentive to deviate, because it lowers demand from 1/2.
- For all other locations firm A or B could increase demand by locating right next to the other firm on the side nearer the centre. ■

Strategic effect

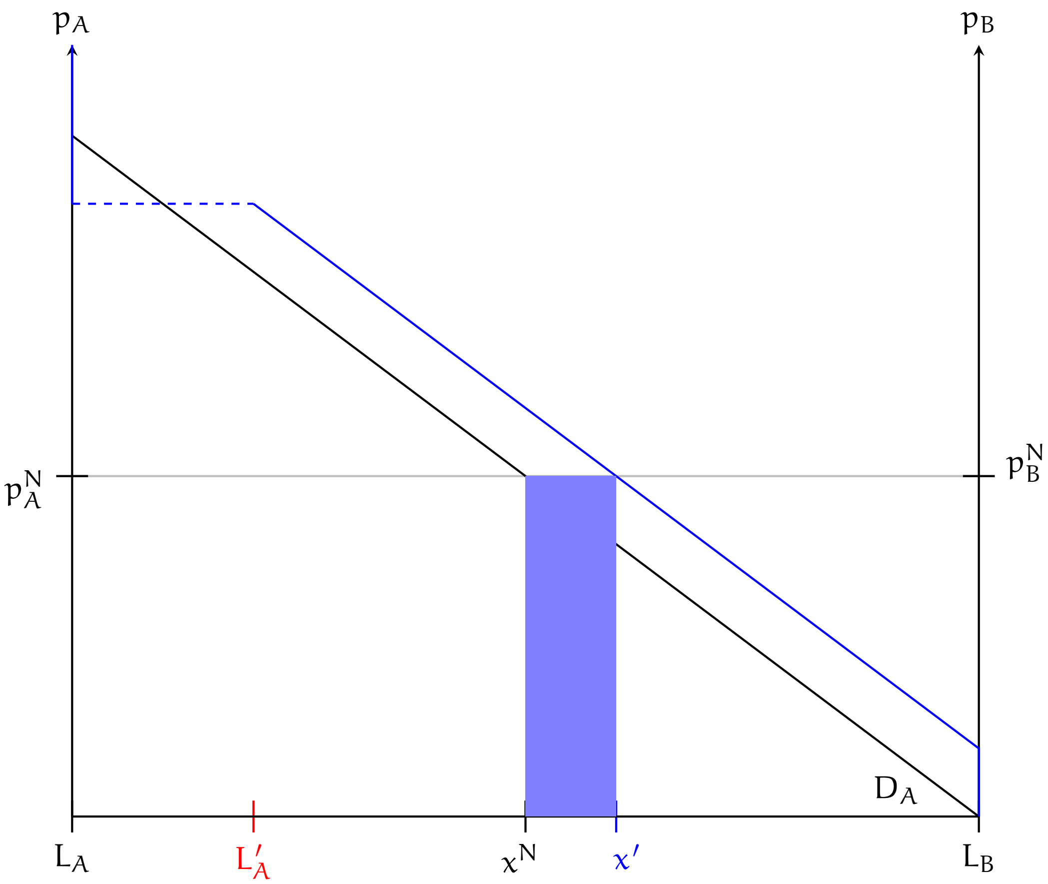
However, prices are not fixed. The price chosen by B in the second stage is a function of A's location choice in the first stage. A change in L_A will cause firm B's price to change. The resulting change in A's profit is the *strategic effect*

The strategic effect is negative: Any move towards the other firm increases price competition.

As an extreme case, consider what happens when A moves all the way to 1:

- When $L_A = 0$ and $L_B = 1$, both firms priced above marginal cost.
- When A moves all the way to 1 (i.e. $L_A = L_B = 1$), we have the standard Bertrand model and firms price at marginal cost.

In the diagram, a small move to the right by A causes B's price to fall and this reduces A's demand and hence profit.



There are two effects of changing position:

- The direct effect gives an incentive to locate close to each other
- The strategic effect gives an incentive to move apart (differentiate)

The relative size of the two effects will depend on the transport costs and the distribution of consumers. The balance of the two effects will determine whether the firms locate close together or far apart

2.4 Switching costs

To see what effect switching costs have, take the standard Bertrand model and:

- Suppose that initially consumers are split equally between firms A and B
- If a consumer goes to a new firm they incur a *switching cost* s

For simplicity, assume that there is a continuum of consumers of mass one, and that each consumer is willing to pay up to v (so that the monopoly price is v).[4]

CLAIM

For any switching cost $s > 0$ there is no (pure-strategy) Nash equilibrium where a firm prices below the monopoly price.

Proof.

- We show that if at least one firm is pricing below the monopoly price, then the firm with the lower price firm has a profitable deviation
- Suppose $p_A \leqslant p_B$ and $p_A < v$
- Then A has at least half the consumers
- If A raises her price by less than the switching cost, then she will not lose any consumers and her profit will rise ∎

[4] This model should be familiar! It is the same as the model in the pricing game with shopping costs.

CLAIM

For sufficiently large switching costs the unique Nash equilibrium is $p_A = p_B = v$

Proof.

- Each firm has profit
- Suppose A raises her price: she gets zero demand ($p_A > v$)
- Suppose A lowers her price: in order to attract any of B's customers, she must choose a price
- The deviation is not profitable if

So $p_A = p_B = v$ is a Nash equilibrium if

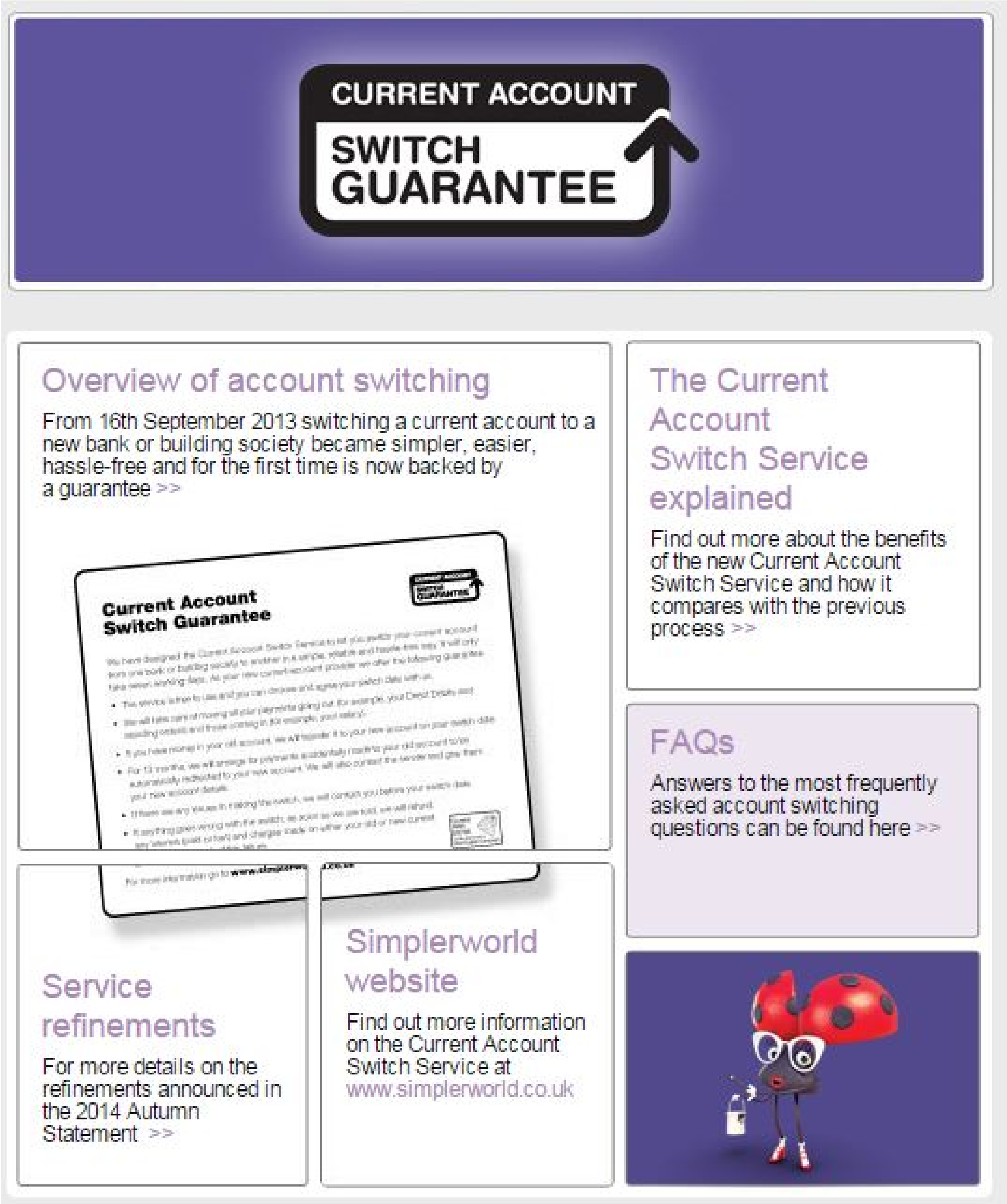
When switching costs s are introduced into the Bertrand model:

- For any $s > 0$, pricing at marginal cost is no longer an equilibrium
- If s is sufficiently large then monopoly pricing is an equilibrium

Relaxing an assumption

We assumed that each firm initially had half the consumers. Suppose our model now has two stages:

- Firms have an incentive to offer relatively low prices/discounts in the first stage in order to attract an installed base of consumers
- In the second stage they can then raise prices as we showed
- Still, switching costs tend to raise profits


CURRENT ACCOUNT
SWITCH GUARANTEE
Overview of account switching
From 16th September 2013 switching a current account to a new bank or building society became simpler, easier, hassle-free and for the first time is now backed by a guarantee >>
Current Account Switch Guarantee
The Current Account Switch Service explained
Find out more about the benefits of the new Current Account Switch Service and how it compares with the previous process >>
FAQs
Answers to the most frequently asked account switching questions can be found here >>
Service refinements
For more details on the refinements announced in the 2014 Autumn Statement >>
Simplerworld website
Find out more information on the Current Account Switch Service at www.simplerworld.co.uk

2.5 Search costs

Consider the standard Bertrand model with the following modifications:

- Consumers know only the prices of the stores they visit
- Each consumer starts at one store
- In order to find out the price set by another store, a consumer must visit that store
- Each visit incurs a *search cost* s

CLAIM

For any search cost $s > 0$ it is not an equilibrium for firms to set $p_A = p_B = c$.

Proof.

- We show A has a profitable deviation.
- Suppose A raises her price slightly (i.e. to some $p_A < c + s$).
- None of those who visit A first will also visit B (as they know that the least they can pay is $c + s$)
- Some of those who visit A will purchase, and so A makes a positive profit ■

We now show that when the search cost is positive, it is an equilibrium for both firms to price at the monopoly level. Assume each consumer is willing to pay up to v.

CLAIM

For *any* search cost $s > 0$ there exists an equilibrium where $p_A = p_B = v$ and all consumers believe that any store they visit will offer this price.

Proof.

- We show A has no profitable deviation.
- Suppose A raises her price: Then A's price is above v, and so her demand and profit are zero.
- Suppose A lowers her price: This will not attract any consumers away from B, since those consumers do not visit A and so do not observe the price cut (and expect every store to charge v) ■

This startling result is known as the *Diamond paradox*. It suggests that the perfectly competitive result is a 'knife-edge' case. Even with the tiniest search cost imperfect information about prices breaks the marginal-cost pricing equilibrium Instead, there is now an equilibrium at the other extreme: monopoly pricing.[5]

When search costs s are introduced into the Bertrand model:

- For any $s > 0$, pricing at marginal costs is no longer an equilibrium
- For any positive search costs—*no matter how small*—it is an equilibrium for firms to price at the monopoly level

[5] The ability to advertise price may change this result because a firm has an incentive to advertise a price that undercuts the other firm(s).

2.6 Price dispersion

Xbox One S 500GB Console
by Microsoft
46 customer reviews

Media: Video Game
Platform: Xbox One

Price + Delivery	Condition	Seller Information	Delivery
£209.95 FREE Delivery	New	Level99Games 99% positive over the past 12 months. (10,927 total ratings)	• In stock. • Dispatched from United Kingdom. • Delivery rates and return policy.
£210.02 prime	New	amazon.co.uk	• In stock. • £4.49 Express Delivery (next business day before 1 pm): Get it Monday, 12 March • +0.00 Premium Shipping: Get it Sunday, 11 March (order within) . • Nominated Day Delivery available. • Delivery rates and return policy.
£214.99 prime	New	Bargain Games UK 99% positive over the past 12 months. (27,020 total ratings)	FULFILLED BY AMAZON • Back-ordered. Due in stock March 18 -- order now to reserve yours • Free Expedited Delivery • Nominated Day Delivery available. • Delivery rates and return policy.
£220.00 FREE Delivery	New	Arancia Eoutlet 100% positive over the past 12 months. (1,915 total ratings)	• In stock. • Dispatched from United Kingdom. • Delivery rates and return policy.
£249.98 FREE Delivery	New	TheGamery 98% positive over the past 12 months. (884 total ratings)	• In stock. • Dispatched from United Kingdom. • Delivery rates and return policy.
£249.99 prime	New	iBuytech 96% positive over the past 12 months. (137 total ratings)	FULFILLED BY AMAZON • In stock. • Free Expedited Delivery • Nominated Day Delivery available. • Delivery rates and return policy.
£265.98 FREE Delivery	New	Gameseek 88% positive over the past 12 months. (54,725 total ratings)	• In stock. Is usually dispatched within 4 - 5 working days. • Dispatched from United Kingdom. • Delivery rates and return policy.

In the Bertrand model, all firms priced at marginal cost. In our model of search, all firms priced at the monopoly price. However, we often observe price dispersion, i.e. different prices being charged for exactly the same product. How can we explain this? One explanation is that consumers have different costs of search.

Idea:

- Consumers with low (zero) search cost find out all the prices and therefore buy from the firm(s) with the lowest price
- Consumers with high search cost do not search and choose a firm randomly

It can be an equilibrium for firms to charge different prices because both low and high-price firms can make sales:

- Low-price firms sell to both types of consumers
- High-price firms sell only to consumers with high search costs (and so sell less than low-price firms)
- If the average cost of selling to just high-search cost consumers is higher than from selling to both types, then both low and high-price firms can make the same profit

2.6.1 Tourists and natives model (Carlton and Perloff pp. 481–487)

Large number of potential entrants with identical U-shaped average-cost curves

- The equilibrium number of firms n is determined by free entry (so that each firm must have zero profit in equilibrium)

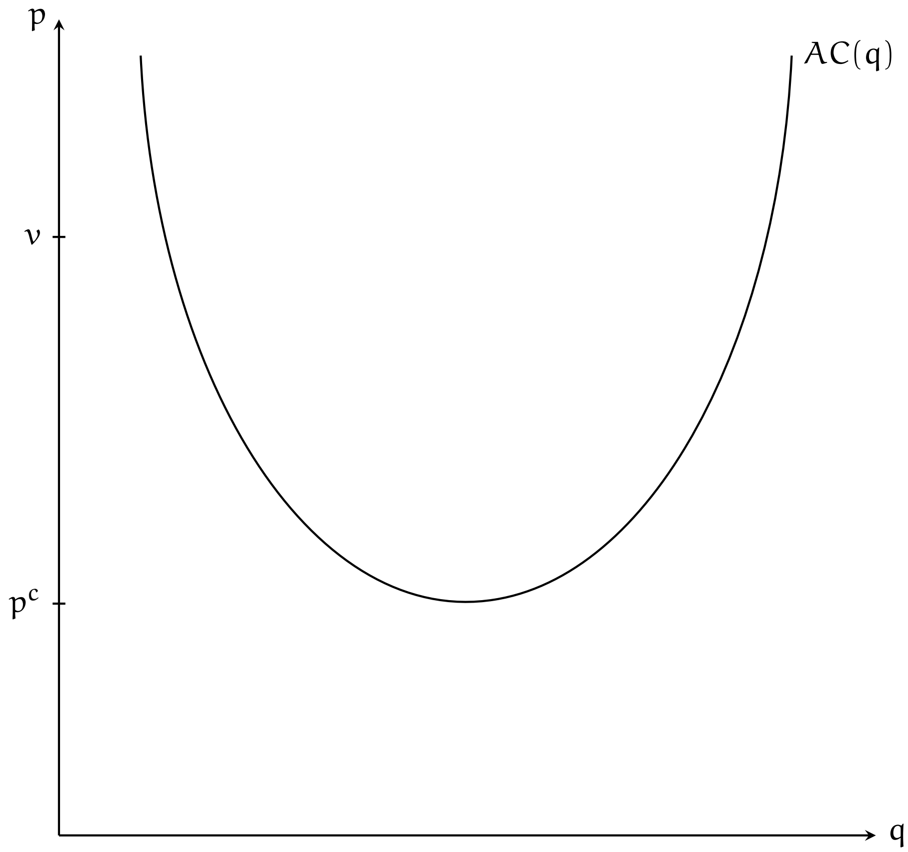


Figure 2.4: q^c is the quantity that minimizes average cost, q^v is the quantity which would give zero profit at the monopoly price v

L consumers each consumer willing to pay up to v for the good:

- Fraction α are *natives*: informed consumers (zero search costs)
- Fraction $1 - \alpha$ are *tourists*: uninformed consumers (large search costs)

Informed consumers know lowest price being charged, so visit and purchase from a store with the lowest price

- Firms with lowest price get equal share of informed consumers

Uninformed consumers do not know prices, so simply choose a store at random

- Each store gets equal share of uninformed consumers

2.6.2 $\alpha = 0$ (ALL CONSUMERS ARE TOURISTS/UNINFORMED)

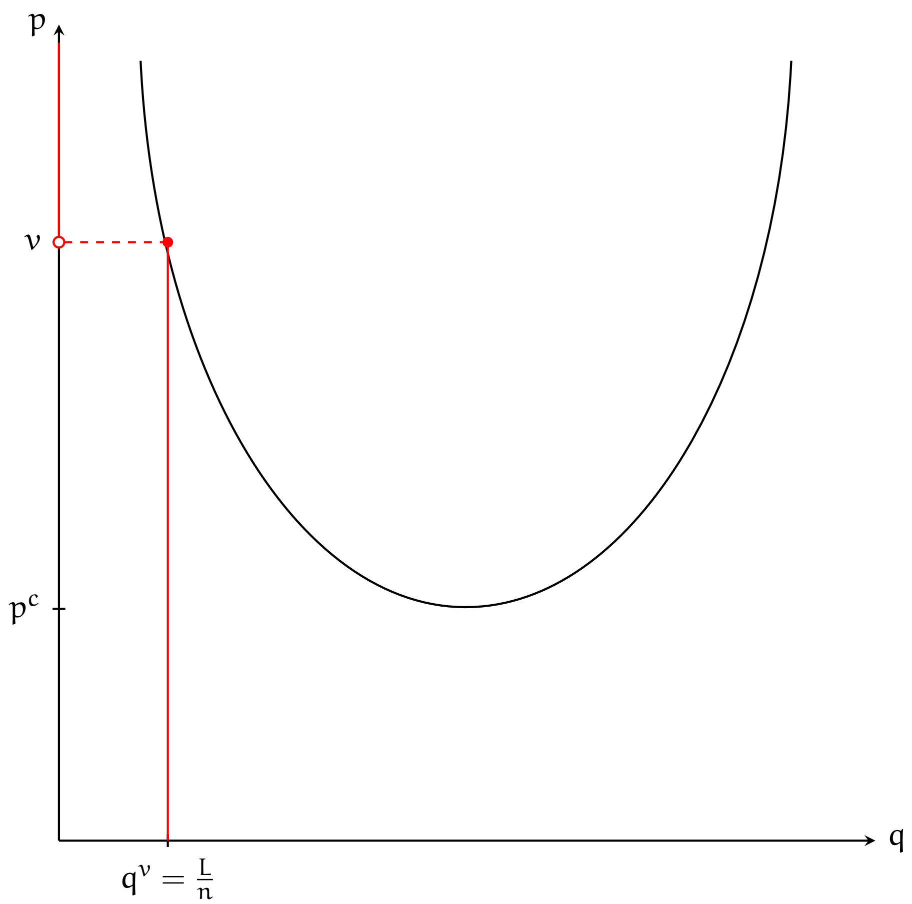
All consumers choose store at random just like in the model with search costs.

CLAIM

When all the consumers are uninformed ($\alpha = 0$), then it is an equilibrium for all firms to price at v. The equilibrium number of firms is $\frac{L}{q^v}$.

Proof. In the proposed equilibrium each active firm sells q^v units and makes zero profit.

- If an active firm raises their price, then their demand is zero, so they are no better off.
- If an active firm lowers their price, their demand is unchanged (consumers do not observe the price cut) and so they make negative profit.
- There is no incentive for another firm to enter (they would make a negative profit)
- There is no incentive for a firm to exit (they still make zero profit) ■



2.6.3 $\alpha = 1$ (ALL CONSUMERS ARE NATIVES/INFORMED)

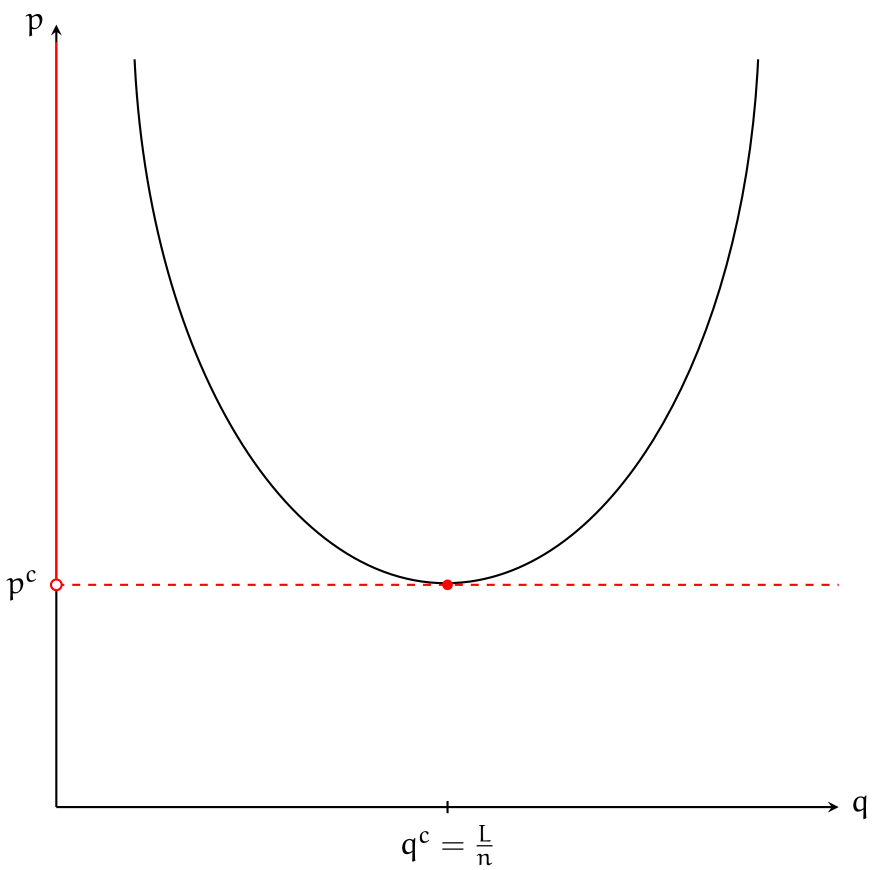
All consumers visit lowest price store(s) just like in the standard Bertrand model.

CLAIM

When all the consumers are informed ($\alpha = 1$), then the equilibrium is for all firms to price at p^c. The equilibrium number of firms is $\frac{L}{q^c}$.

Proof. In the proposed equilibrium each active firm sells q^c units and makes zero profit.

- If an active firm raises their price, then their demand is zero, so they are no better off.
- If an active firm lowers their price, they get all the consumers, but their price is less than their average cost and so they make negative profit.
- There is no incentive for another firm to enter (they would make a negative profit)
- There is no incentive for a firm to exit (they still make zero profit) ■



2.6.4 $0 < \alpha < 1$ (SOME CONSUMERS ARE TOURISTS, SOME NATIVES)

Let β be the fraction of firms that charge the lowest price. When there are n active firms:

- Each of the βn firms with lowest price get an equal share $\frac{1}{\beta n}$ of the αL informed consumers
- Each of the n firms gets an equal share $\frac{1}{n}$ of the $(1-\alpha)L$ uninformed consumers

Single-price equilibrium (large α)

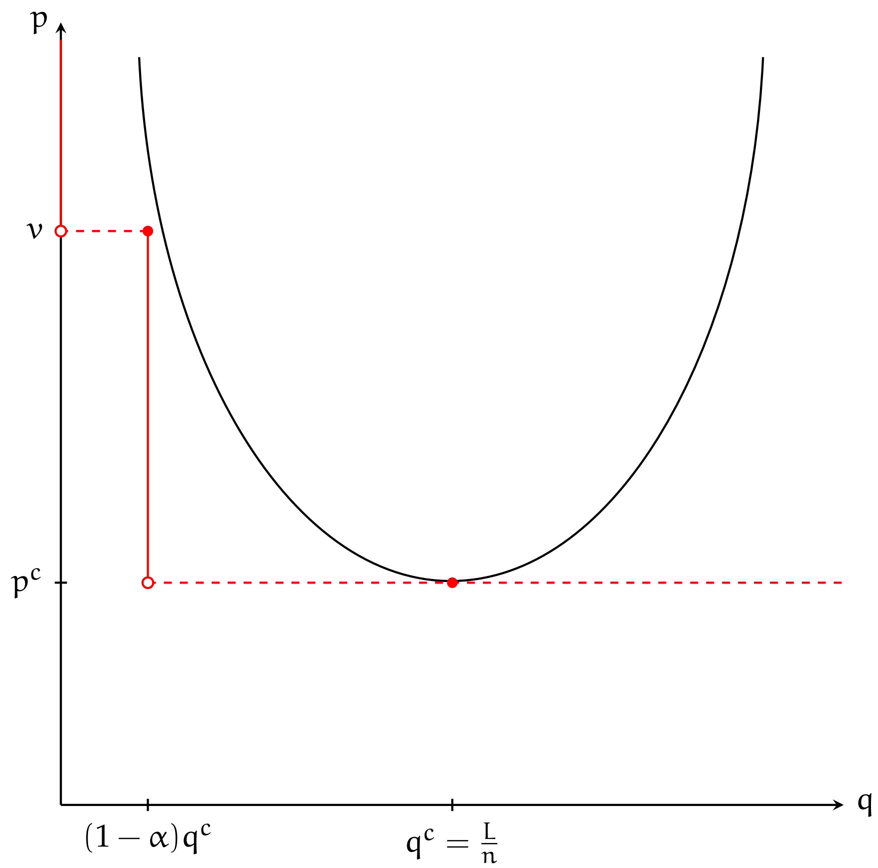
Idea: If there are not many tourists (uninformed consumers) then the the average cost from selling just to the tourists will be more than the monopoly price.

CLAIM

If there are a sufficiently large number of informed consumers (α is large enough), then the equilibrium is for all firms to price at p^c. The equilibrium number of firms is $\frac{L}{q^c}$.

Proof. In the proposed equilibrium each active firm sells q^c units and makes zero profit.

- If an active firm raises their price, then:
  - their demand is $\frac{(1-\alpha)L}{n} = (1-\alpha)q^c$ for any price less than or equal to v
  - the best they can do is raise their price to v
  - profit is negative because α is large enough that $AC\left((1-\alpha)q^c\right) > v$
- The rest of the argument is the same as for $\alpha = 1$. ∎



No single-price equilibrium (small α)

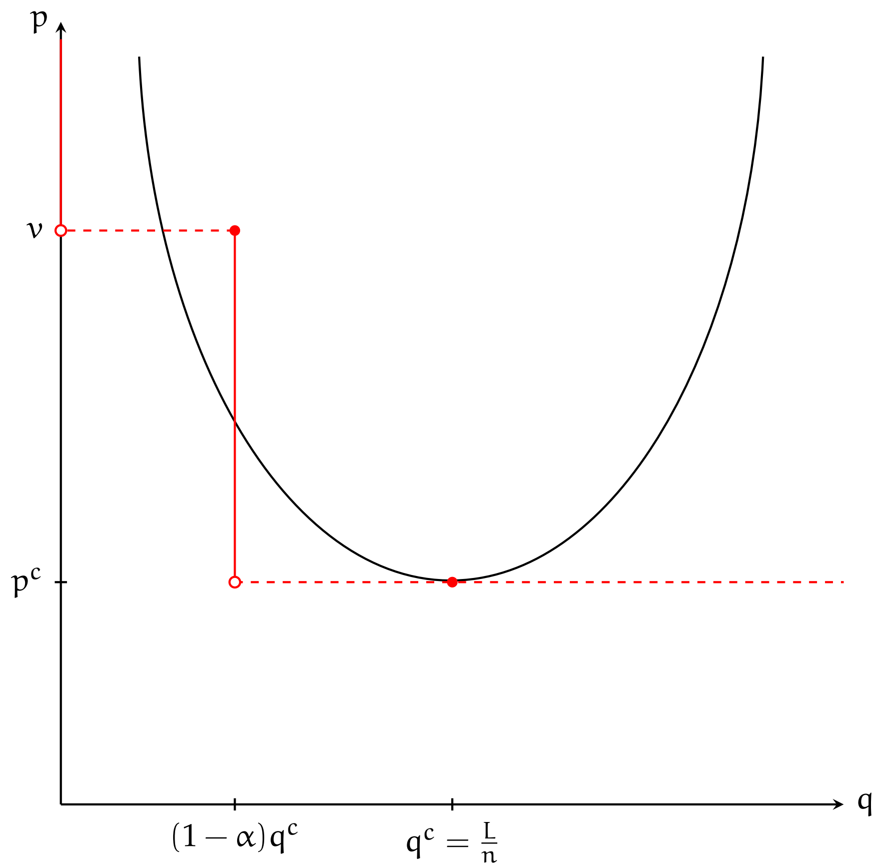
Idea: If there are enough tourists (uninformed consumers) then the the average cost from selling just to the tourists will be *less* than the monopoly price.

CLAIM

If there are sufficiently small number of informed consumers (α is small enough), then it is *not* an equilibrium for all firms to charge the competitive price, p^c, or for all to price at the monopoly level, v.

Proof.

- It is not an equilibrium for there to be $\frac{L}{q^c}$ firms charging p^c:
  - It is now profitable for any firm to deviate to the monopoly price v
  - Since the fraction of uninformed consumers is now larger, a deviation no longer results in such a large drop in demand that average cost rises above v



- It is not an equilibrium for there to be $\frac{L}{q^v}$ firms charging v:
  - It is profitable for a firm to deviate to a price slightly less than v
  - Given a sufficiently small fraction of informed consumers this will reduce its average cost below v ■

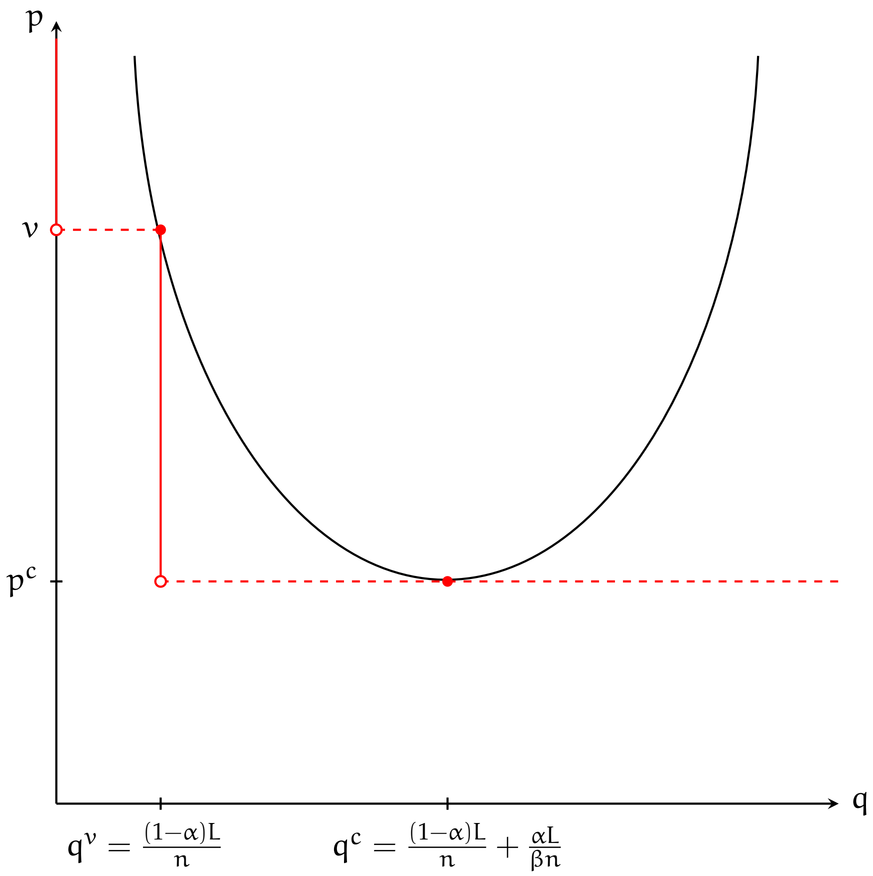
Two-price equilibrium (small α)

CLAIM

If there are a sufficiently small number of informed consumers (α is small enough), then the equilibrium is for some firms to price at p^c and some to price at v. The equilibrium number of firms is $\frac{(1-\alpha)L}{q^v}$, the equilibrium fraction of low-price firms is $\frac{\alpha q^v}{(1-\alpha)(q^c-q^v)}$.[6]

Proof. In the proposed equilibrium each active low-price firm sells q^c units and makes zero profit, while each active high-price firm sells q^v units and makes zero profit.

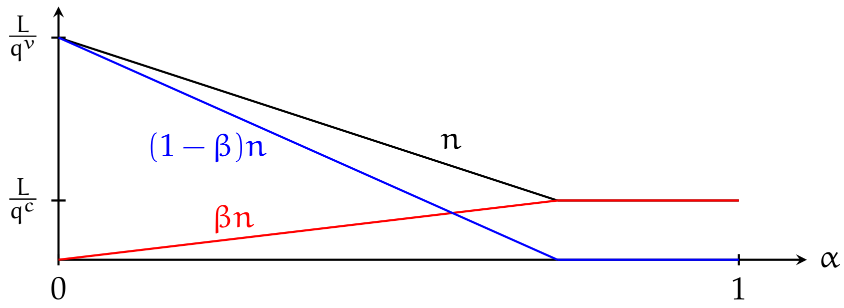
- If a low-price firm:
  - raises its price, then it can make at most zero profit (by pricing at v or above)
  - lowers its price, then it makes negative profit
- If a high-price firm:
  - raises its price, then it gets zero demand and makes zero profit
  - lowers its price enough to increase demand, then it makes negative profit
- There is also no incentive for a firm to exit or enter. ∎



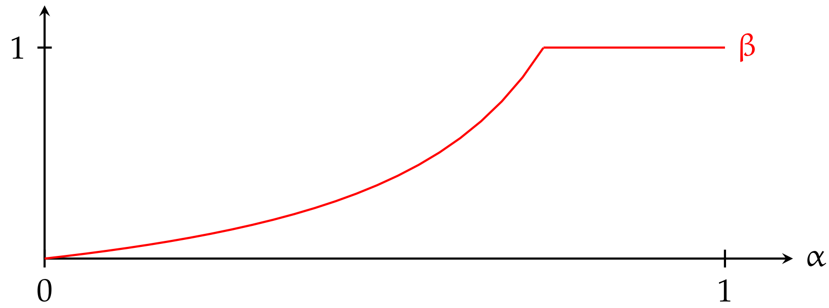
[6] In equilibrium, we need $q^v = \frac{(1-\alpha)L}{n}$ (pricing at v gives zero profit) and $q^c = \frac{(1-\alpha)L}{n} + \frac{\alpha L}{\beta n}$ (pricing at p^c gives zero profit). The first equation gives the equilibrium value of n. Substituting this into the second equation and solving gives the equilibrium value of β.

The type of equilibrium depends on the size of α

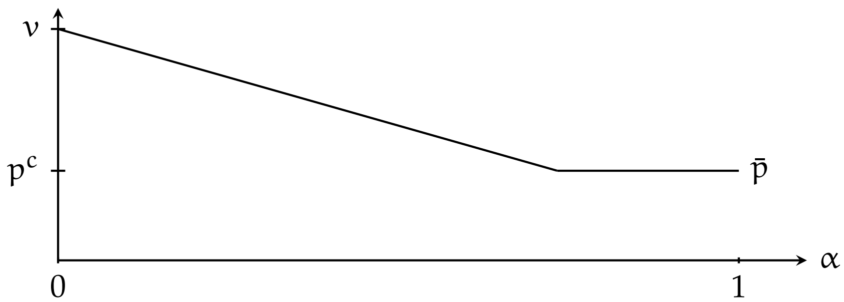
- With no informed consumers ($\alpha = 0$), we get monopoly pricing.
- With a large fraction α of informed consumers, we get competitive pricing.
- With an intermediate fraction of informed consumers, we get price dispersion:
  - A fraction β are low-price firms and sell quantity q^c (to both types of consumers)
  - A fraction $1-\beta$ are high-price firms and sell quantity $q^v < q^c$ (to uninformed consumers)
  - All firms make zero profit



Equilibrium numbers of low-price, βn, and high-price firms, $(1-\beta)n$



Equilibrium fraction of low-price firms, β



Mean equilibrium price, $\bar{p} = \beta p^c + (1-\beta)v$

ADVERTISING 3

3.1 INTRODUCTION

3.1.1 SEARCH VS EXPERIENCE CHARACTERISTICS

Consumers might be uninformed about price, quality, or horizontal attributes of products (particularly in the case of new products). We have seen the case where consumers may be uninformed about prices, but may choose to incur a search cost to find out about them.

Search characteristics are those attributes of a product that can be determined by inspection prior to purchase, usually through visual or tactile inspection. *Experience characteristics* are those attributes of a product that can only be determined by consuming the product.

EXAMPLE (Clothing)

- Search:

- Experience:

3.1.2 Types of advertising

Advertising may:

- Present hard facts about a product
- Make vague claims
- Create a favourable impression of the product
- List prices
- Reveal or signal quality—higher demand (consumers willing to pay more for high quality)
- Differentiate—higher or less elastic demand (reduces price competition)

3.1.3 Informative vs persuasive advertising

Informative advertising describes a products objective characteristics. For example:

- Price
- Features
- Uses
- Existence

Persuasive advertising is designed to shift consumers' tastes by making the product seem cool or desirable.

- Search characteristics: advertising usually provides direct information—photographs, specifications, descriptions.
- Experience characteristics: advertising often provides no direct information, but the presence and level of advertising may be able to signal the quality of a good.

3.1.4 Goal of advertising

The goal of advertising, whether persuasive or informative, is to change the demand for a firm's product or other competing firms' products in a favourable way.

- If advertising shifts demand out, then the firm can sell the same quantity at higher prices (but will generally change its quantity) and is clearly better off.
- If advertising makes a rival's demand curve more inelastic, then it will raise its price, shifting the firm's own demand curve out.

3.2 Burning money model of advertising

3.2.1 Introduction

Consider a firm producing a new product. Consumers may not know whether the product is high or low quality. If this is the case then consumers will be willing to pay less for the product than if they knew the product were high quality. The firm will make lower profits than in the case where consumers are sure of the quality.

Idea: Advertising might provide no direct information but could indirectly signal quality.

- Requires that the seller of a high-quality product spends enough on advertising so that the investment could only be recouped by a high-quality firm from sales in subsequent periods when the true quality of the product has become known.
- A low quality (or 'fly-by-night') firm would not imitate by advertising because after the first period their sales will only be at the level of a low-quality product, and so they cannot recoup the investment in advertising.

3.2.2 Model

There are two periods.

One firm:

- Produces either high quality good low quality good at unit cost c (and knows which one it is)[1]

Continuum of consumers of mass one:

- Willing to pay 1 for the high quality good and nothing for the low quality good.
- Initially believe that firm is high quality with probability λ
- For simplicity, assume consumers will not buy a product they believe (with probability one) is low quality.
- Cannot observe quality in first period but after the first period quality becomes known (quality is an experience good).

[1] For simplicity, we assume a firm cannot change its quality.

3.2.3 No advertising

Without advertising, there is no way for consumers to distinguish between low-quality and high-quality firms in the first period and so, in the first period, consumers are willing to pay

Over the two periods, a high-quality firm could only make the profit

On the other hand, if the firm's quality were known in the first period, it could make profit

So if an advertising expenditure of less than can signal quality then this will increase a high-quality firms profits relative to not advertising.

3.2.4 An equilibrium where advertising signals quality

Advertising may be able to signal quality. We will construct a separating equilibrium where a high-quality firm spends A on advertising, and low-quality firms do not. In such an equilibrium, consumers believe in the first period that:

- a firm spending A on advertising produces high quality.
- a firm spending anything other than A produces low quality;

For these beliefs to be correct, it must be that, given the beliefs:

- a high quality firm prefers to spend A on advertising
- a low quality firm prefers not to spend A on advertising;

In such an equilibrium, if a firm does not advertise, then:

- Consumers believe it is a low-quality firm and so are not willing to purchase its product in the first period.
- Since no-one purchases the product in the first period, they continue to believe it is low quality in the second period and so the firm makes no sales in the second period.
- Hence (whether or not the firm is actually high or low quality) a firm that does not advertise makes no profit (in either period).

Condition for high-quality firm to prefer to advertise

If a high quality firm advertises, it is believed to be high quality in the first period, and gets first-period profit

In the second period it is known to be a high-quality firm and therefore makes a profit of $1 - c$. In total its profit from advertising is

A high-quality firm will want to advertise if:

Condition for low-quality firm to prefer not to advertise

If a low-quality firm advertises, it is believed to be high quality in the first period, and gets a profit of

In the second period it is known to be low-quality and therefore makes zero profit and so its profit from advertising is

A low-quality firm would not want to pretend to be a high-quality firm by advertising if:

Equilibrium condition on advertising expenditure

Putting together the two inequalities, for a separating equilibrium where only a high-quality firm advertises, we need:

- Advertising had no directly informative or persuasive content
- Instead, advertising provided information *indirectly*
- The mere act of spending money (and it being observed through advertising) was enough to signal quality
- A low-quality firm gains less from advertising (the first-period gain in profits) compared to a high-quality firm (two periods of higher profits)
- Thus, there is some level of advertising that is sufficient to signal high-quality

3.3 Informative advertising

3.3.1 Introduction

Consumers can be informed about search characteristics by the firm in a number of ways:

- Advertising with information content
- Demonstration
- Trial version
- Money back guarantee

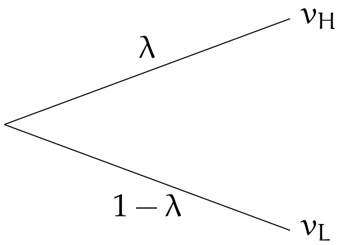
Figure 3.1: Infomercial / product demonstration

Figure 3.2: Trial version / shareware

3.3.2 A model of informative advertising

Continuum of Connie the consumers (of mass one)

A Connie's willingness to pay for the cake is either v_L or v_H, with $v_H > v_L \geqslant 0$



If a Connie is uninformed then her willingness to pay is her expected valuation:

One cake stall, owned by Alice

Alice first chooses a level of advertising in $\{0, 1\}$ then she chooses her price p.

- 0 represents no advertising: Connie is uninformed
- 1 represents perfectly informative advertising: Connie learns her valuation

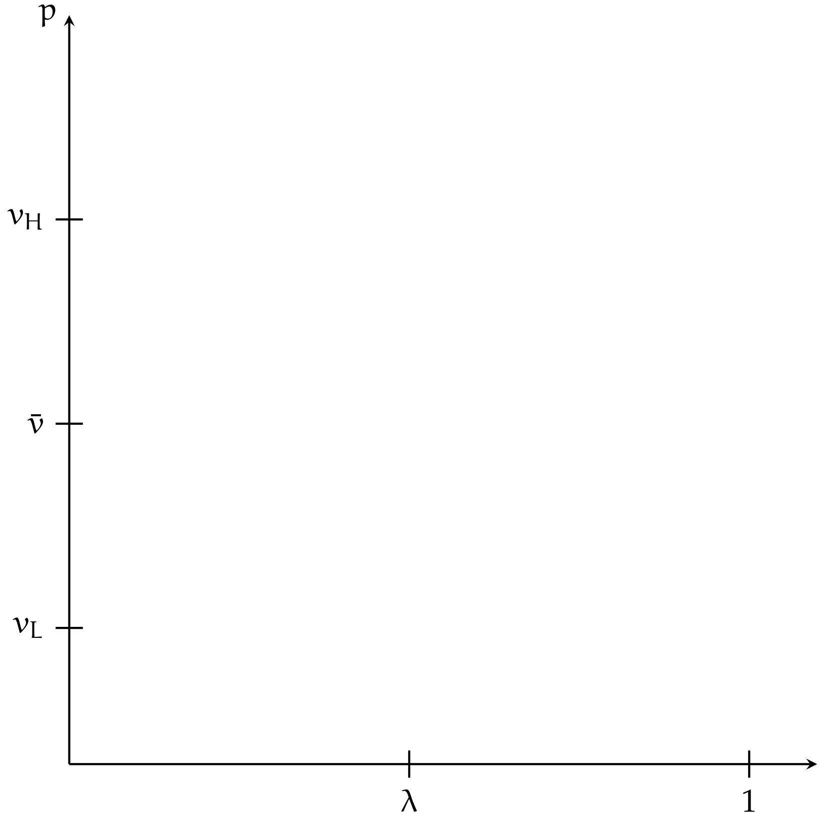
Advertising and production are costless.

No advertising

Each Connie is willing to pay up to her expected valuation $\bar{v}$. Thus demand with no advertising is

$$D^0(p) = \begin{cases} 1 & p \leqslant \bar{v} \\ 0 & p > \bar{v} \end{cases}$$

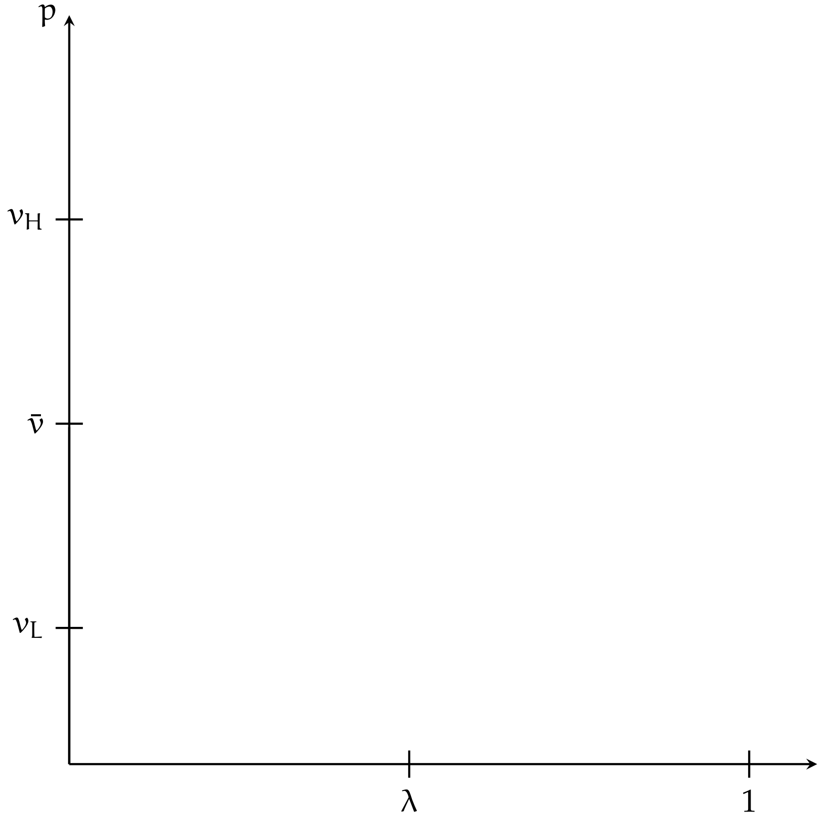
where p is the price Alice charges



Alice advertises

If Alice advertises, then λ of the Connies learn their valuation is v_H and $1-\lambda$ learn their valuation is v_L, so demand is

$$D^1(p) = \begin{cases} 1 & p \leqslant v_L \\ \lambda & v_L < p \leqslant v_H \\ 0 & p > v_H \end{cases}$$


p
v_H
$\bar{v}$
v_L
λ
1

Should Alice advertise?

Profit from not advertising

Profit from advertising:

When Alice does not advertise she can effectively perfectly price discriminate: If the Connies knew their valuations, and Alice could perfectly price discriminate, then she would charge each Connie her exact valuation, earning profit

which is the same profit as without advertising. This result generalizes to any number of valuations and to continuous distributions.

A monopoly may prefer to keep buyers ignorant in order to be able to effectively perfectly price discriminate.

Welfare

Not advertising maximizes welfare (but consumer surplus is zero):

- By not informing, Alice can effectively practise perfect price discrimination (which we know maximizes welfare)

Two reasons advertising might improve welfare are:

- Advertising prevents those who value the good below marginal cost from buying.
  - But we assumed all the Connies' valuations are above marginal cost (zero)
- Advertising allows consumers to chose the product that actually gives them the higher surplus.
  - But we assumed there was only one product

Important differences between this model and models with quality:

Initially in the quality case, the firm knew the quality while consumers did not (asymmetric information).

- Advertising may indirectly inform consumers about quality, i.e. make information symmetric
- Informing either decreases or increases the valuations of all consumers (as they are all willing to pay more for higher quality)

Initially, in this model of informative advertising, the firm and consumers only know the distribution of valuations (symmetric information)

- Now advertising informs consumers about their valuations, but the firm does not learn them: information becomes asymmetric
- Informing decreases the valuations of a consumer with true valuation v_L, and increases the valuation of a consumer with true valuation v_H

Relaxing assumptions

Assumed that marginal cost of production was zero.

- If $c > \bar{v}$ it will certainly pay to advertise
- In fact, with two valuations, it pays to advertise if the cost is greater than the lower valuation: $c > v_L$ (advertising allows the firm to screen out those willing to pay less than marginal cost and charge the other consumers v_H)

Assumed monopoly could choose no information or perfect information

- But consumers might already have some information
- Monopoly may want to choose partial information (tutorial)

Assumed consumers not able to search

- If the firm does not advertise, consumers might choose to expend effort finding out about a product

Assumed consumes risk neutral

- If sufficiently risk averse, may be profitable to advertise
- For example, if infinitely risk averse, prepared to pay only v_L if uninformed—can do at least as well by informing

3.3.3 Informative advertising under duopoly

What if there are two firms? Apply Hotelling model of product differentiation:

- A firm is located at 0 and other at 1 (consumers know this)
- If firms do not advertise, then consumers do not know which firm is located where

If neither firm advertises its location:

- Consumers act as if the two goods are identical
- There is Bertrand competition and prices are equal to marginal cost in equilibrium

If either firm advertises its location,

- Consumers know where each firm is located
- Price competition is softened

> Informative advertising may reveal product differentiation and reduce price competition.

3.3.4 Advertising prices

Consider the model of search costs (section 2.5)

- When firms do not advertise, it is an equilibrium for firms to price at the monopoly level (Diamond paradox)
- When both firms advertise, effectively search costs are zero, and the equilibrium is marginal cost pricing (Bertrand paradox)

> Advertising prices may increase price competition.

3.4 Persuasive Advertising

Advertising convinces many consumers that bottled water tastes better, or is better for them, and thus results in more sales at a higher price. But are consumers better off? The price is higher, but some consumers are receiving more pleasure from using bottled water than before (and profits have risen). Is there too much advertising of bottled water?

3.4.1 Dixit and Norman (1978)

A paper called 'Advertising and Welfare'. If advertising is purely persuasive then:

> Monopolies, oligopolies, and monopolistically competitive industries all advertise too much in equilibrium.

'Too much' is relative to the amount that would maximize welfare, given the equilibrium output choices of the firm(s). The result is not obvious, because under imperfect competition firms usually produce too little. If advertising causes consumers to buy more, this increases welfare.

We consider only the monopoly case.[2] The monopolist's decision can be split into two stages:

(i) The monopolist chooses a level of advertising expenditure, $\alpha \geqslant 0$.

(ii) Given the chosen level of α, the monopolist chooses how much to produce.

There is *excessive advertising* if the monopoly firm would choose a higher level of advertising expenditure in the first stage than would a welfare-maximizer.

An increase in advertising

Let us consider an increase E in advertising expenditure from α^0 to α^1 that shifts demand from D^0 to D^1:

- D^0 is the pre-advertising demand curve;
- D^1 is the post-advertising demand curve.

Advertising is only profitable if it increases equilibrium output, price or both. Also, advertising can only increase welfare if it causes the equilibrium output to rise.[3] So let us assume that the increase in advertising increases the equilibrium output and price.

[2]This case is discussed on pp. 507–510 of Carlton and Perloff (diagram is on p. 503), and in section 17.1 of Church and Ware.

[3]This is assuming that the welfare standard is fixed, i.e. we do not use the pre-advertising demand curve to measure pre-advertising welfare and the post-advertising demand curve to measure post-advertising welfare. In some situations, it does make sense to do this (e.g. if the advertising is informative—we will look at this case in a tutorial problem).

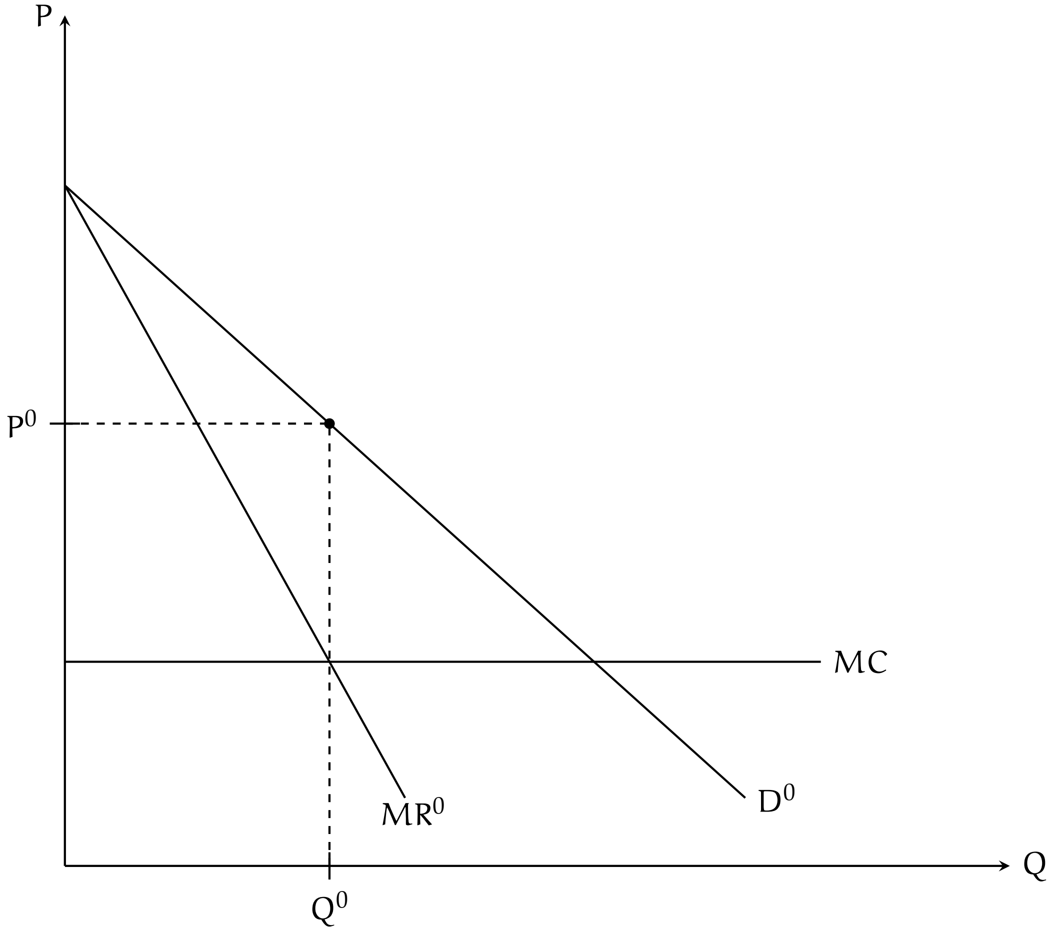


Figure 3.3: Pre and post-advertising equilibrium

Measuring welfare

Welfare is the consumption benefits less the production and advertising costs:[4]

$$W = \text{consumption benefits} - \text{production costs} - \alpha$$

The welfare can be measured using either pre or post-advertising preferences, i.e. to measure the consumption benefits we could use either

- the pre-advertising demand curve D^0, or
- the post-advertising demand curve D^1.

Some argue advertising only causes consumers to 'think they are better off' and so pre-advertising tastes should be used. Others argue that consumers are the best judges of their own tastes, so should use post-advertising tastes. Which preferences should be used as the standard for measuring welfare changes?

[4] Alternatively, we can write welfare as the sum of consumer surplus and profits because the consumer surplus is consumption benefits less expenditure, while profits are revenue (expenditure) less production costs and the advertising expenditure.

To get around the problem of a changing standard for welfare comparisons, Dixit and Norman (1978) do the following:

- First, they compare welfare using pre-advertising preferences as their standard.
- Then they repeat this comparison using post-advertising preferences.
- Finally, they conclude that one gets the same result in both cases.

Change in welfare

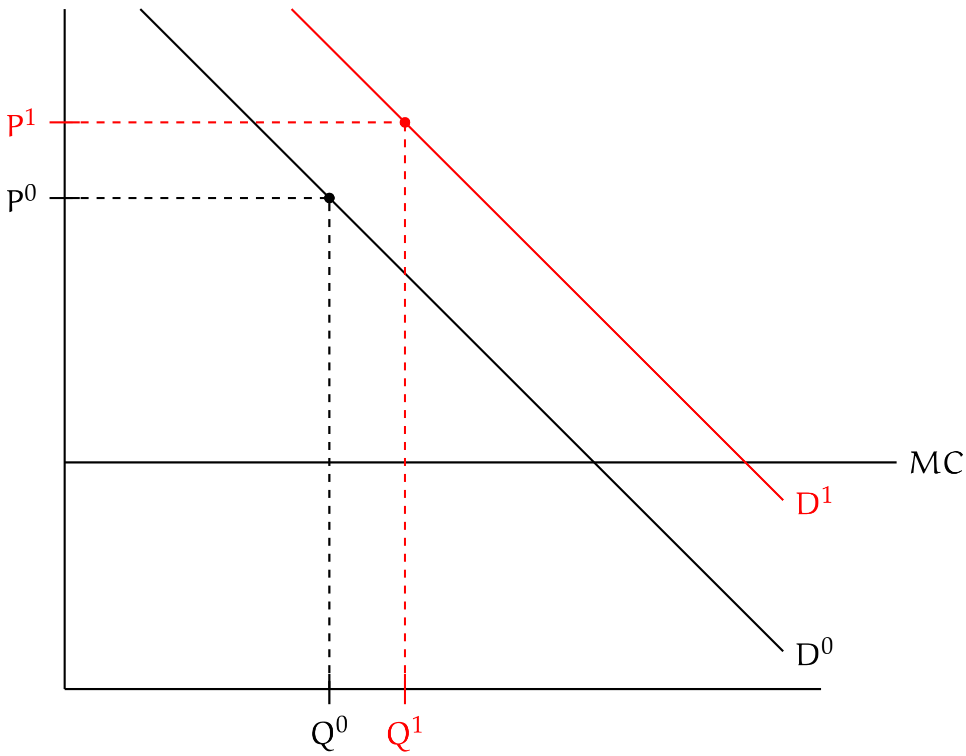


Figure 3.4: Pre-advertising (ΔW^0) vs post-advertising measure (ΔW^1) of welfare change

The area under a demand curve represents consumption benefits, and the area under the marginal cost curve represents production costs, so the change in welfare (gross of the change in advertising expenditure) is

- area B using pre-advertising preferences (i.e. demand curve D^0);
- area $B + C + D$ using post-advertising preferences (i.e demand curve D^1).

For a discrete change in advertising, post-advertising preferences give a larger measure of the change in welfare ($\Delta W^1 > \Delta W^0$). Hence any discrete change in advertising that

- increases welfare according to pre-advertising preferences will necessarily be beneficial according to post-advertising preferences;
- decreases welfare according to post-advertising preferences will also be harmful according to pre-advertising preferences.

For marginal changes in advertising (infinitesimal E) it does not matter which preferences we use: $\Delta W_0 = \Delta W_1$ because areas C and D are of 'second order':

- areas A and B are of first order because they are infinitesimal changes (in P and Q respectively) multiplied by discrete amounts;
- areas C and D are of second order because they are infinitesimal amounts multiplied by infinitesimal amounts.

Change in profits vs change in welfare

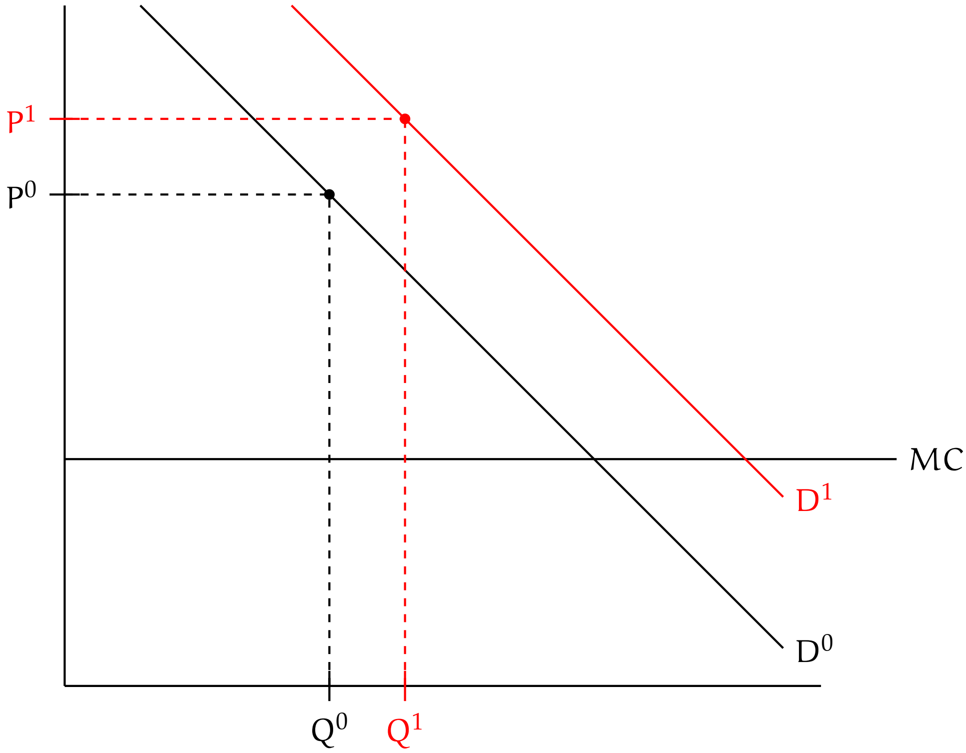


Figure 3.5: Relationship between change in welfare and profit (using pre-advertising tastes)

The diagram shows that for a marginal change in advertising from α^0 we have

The welfare gain from a marginal increase in advertising is:

- the increase in monopoly profits caused by advertising,
- less the increase in expenditure the consumers incur in buying the initial quantity at the higher price.

Excessive advertising

The monopoly will choose to advertise up to where the marginal effect on profit is zero ($\Delta\Pi = 0$). So, at the monopoly's optimal level of advertising α^*,

where Q^* is the optimal output corresponding to α^*. Thus welfare is decreasing in α at monopoly's choice of advertising α^*. Welfare could be increased by reducing advertising. Thus there is *excessive advertising*.

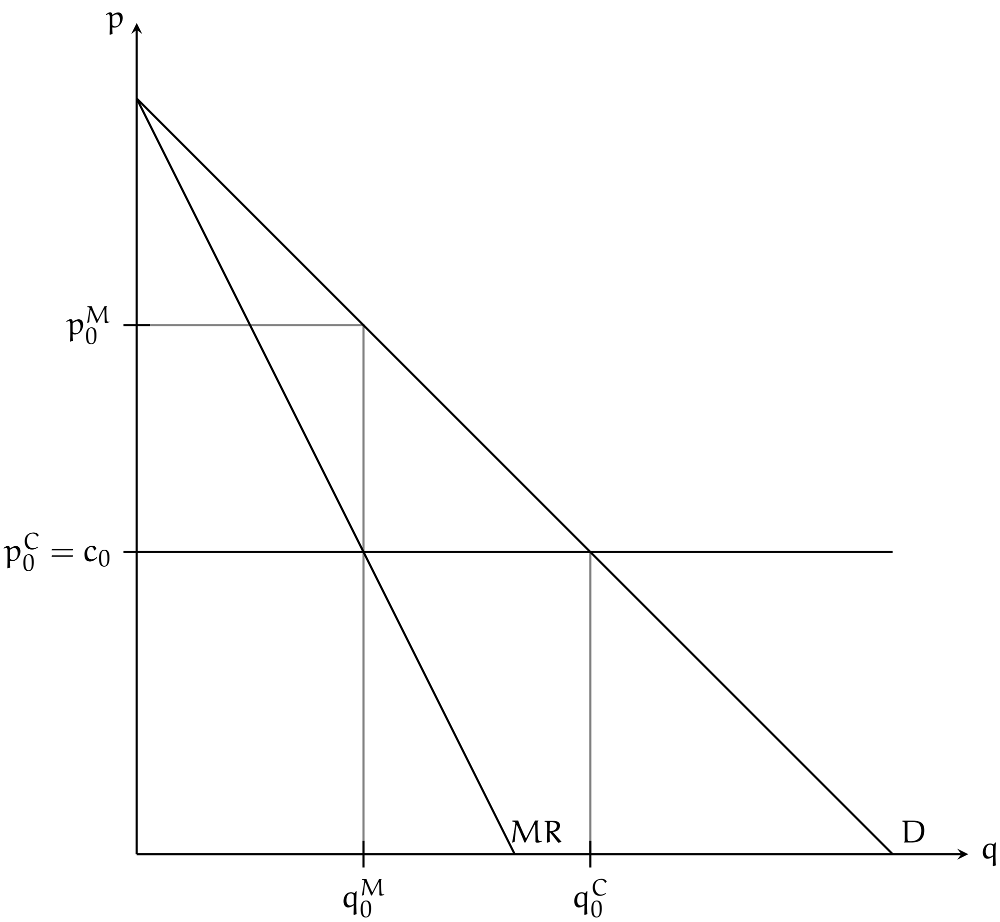
When advertising is purely persuasive, a monopoly will advertise too much in equilibrium:

- The monopoly takes account of the increase in its profits from the 'pre-advertising consumers' paying a higher price post advertising
  - Consumption is Q^0 before the increase in advertising.
  - After advertising, the price increases by ΔP per unit.
  - This increases profit by $Q^0 \Delta P$.
- This gain in profit is not a gain in welfare because it is just a transfer from consumers to the monopoly:
  - The monopoly gains $Q^0 \Delta P$ in revenue, but consumers lose $Q^0 \Delta P$ in expenditure.

4 Research and Development

4.1 Market Structure and Incentive to Innovate

Consider a *process innovation* that reduces unit cost from c_0 to c_1 ; only the innovating firm can use the innovation. Does a monopoly or a competitive firm have more incentive to carry out such an innovation?



What is the post-innovation equilibrium in the competitive market?

- After innovation the firms play a Bertrand game where the innovating firm has marginal cost c_1 and its competitors have marginal cost c_0.
- Assume that consumers buy from the low-cost firm if its price is the same as the lowest-price high-cost firm.

- Any Nash equilibrium of this game involves the low-cost firm pricing at c_0 and obtaining all the demand (i.e. q_0^C) at that price.[1]

> A competitive firm has a greater incentive to carry out a process innovation than a monopoly.

The monopoly has a positive pre-innovation profit; the competitive firm does not. The result is explained by the *replacement effect*: the innovation allows the monopoly to 'replace' its initial profit by a somewhat higher profit, whereas the competitive firm creates a brand new profit opportunity. The monopoly benefits less from the cost reduction because it is over a smaller number of units ($q_1^M < q_0^C$).

The argument about the replacement effect can be extended to a multiproduct firm. Prediction: a firm has a higher incentive to innovate in market segments where it faces competition than in those segments where it enjoys significant market power.

EXAMPLE (Microsoft's incentives to innovate)

Microsoft's launch of the Xbox in 2005:

> It is surely no coincidence that Microsoft's hidden ability to innovate has become apparent only in a market in which it is the underdog and faces fierce competition. Microsoft is far less innovative in its core businesses, in which it has a monopoly (in Windows) and a near monopoly (in Office). But in the new markets of gaming, mobile devices and television set-top boxes, Microsoft has been unable to exploit its Windows monopoly other than indirectly – it has financed the company's expensive forays into pasture new.

("The meaning of Xbox", The Economist, November 24, 2005)

[1] This is so long as the process innovation is not so large that the profit-maximizing monopoly price of the innovating firm is less than the marginal cost of the firms that do not innovate.

4.2 Dynamics of R&D competition

Does an incumbent or a potential rival have more incentive to carry out a *product innovation*?

4.2.1 Basic model

An incumbent

- Initially earning monopoly profit π^M

A potential competitor ('rival')

- Initially earning zero profit

An R&D lab

- Just discovered and patented an innovation
- R&D lab unable to market its innovation directly, so sells to firm willing to pay most

Assume if neither incumbent nor rival submits a bid, then new patent is unused and incumbent continues as monopolist

Pre-emptive patenting

Is the incumbent or rival willing to pay more for the patent?

- If the incumbent did not face the threat of entry then it would not be willing to pay anything for the patent
- The potential rival cannot enter without purchasing the patent
- The only reason the incumbent may want to purchase the patent is to deter entry (*pre-emptive patenting*)
- The incumbent may be better off accommodating entry (the rival may be willing to pay more for the patent)

Plan

Using the same basic setup we will look at the cases where the patent is for a

- *Gradual innovation*: the innovation does not replace the existing product
- *Drastic innovation*: the innovation makes the existing product obsolete

We will also allow for uncertainty about the existence of a potential rival.

4.2.2 A gradual innovation

First, consider a gradual innovation. If the incumbent bids and acquires patent:

- Rival cannot enter market; incumbent remains a monopoly.
- Rival gets zero profit, incumbent receives profit π^M,

If the rival bids and acquires patent:

- Rival will enter market (which becomes a duopoly)
- Each firm receives duopoly profit π^D

Willingness to pay for the patent

The rival is willing to pay

The incumbent is willing to pay

The incumbent is willing to pay more if

If products are identical, then this inequality holds for sure; it will still hold if the firms' products are close substitutes. An incumbent's incentive to invest in a gradual innovation is greater than its rival's.

The efficiency effect and persistence of monopoly

The *efficiency effect*:

- the incumbent's fear of losing its monopoly position provides it with a stronger incentive to innovate,
- so industry structure will move in the direction that industry profits are higher (monopoly)

The dominance of the incumbent will tend to persist over time.

4.2.3 A gradual innovation with uncertainty

Suppose now that incumbent is unsure of rival's intentions: when it bids, the incumbent does not know if rival is submitting bid.

- With probability ρ, the rival does not bid for the patent at all.

Now who is willing to pay more for the patent? If the incumbent bids and acquires the patent, then (as before):

- Rival gets zero, incumbent gets π^M

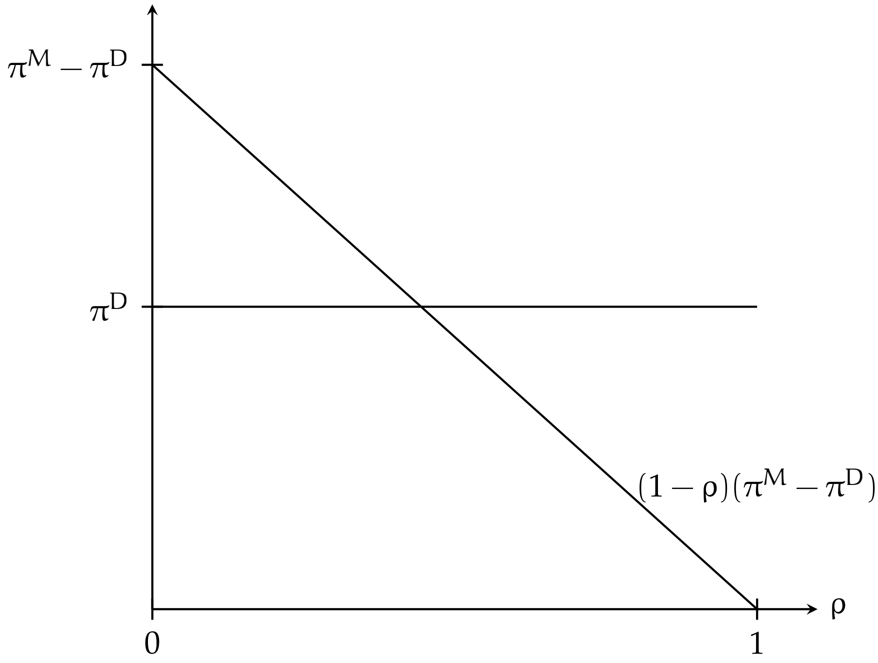
If the incumbent does not bid and acquire the patent:

- $1-\rho$: rival bids (and wins): each firm gets duopoly profit π^D
- ρ: rival does not bid: incumbent gets π^M, rival gets zero
- The incumbent's expected profit if it does not bid and acquire the patent is

Willingness to pay for the patent

The rival is willing to pay

The incumbent is willing to pay:



If ρ is small (there is little uncertainty about the presence of a rival) then the incumbent is still willing to pay more than rival. If ρ is sufficiently high[2] (there is sufficient uncertainty about the presence of a rival) then rival is willing to pay more than incumbent.

Efficiency and replacement effect

When the presence of the rival is certain ($\rho = 0$), only the efficiency effect is present.

- The efficiency effect means the incumbent has a higher incentive to carry out a gradual innovation.

When the monopoly believes there is no potential rival ($\rho = 1$), only the replacement effect is present.

- The replacement effect means the *rival* has a higher incentive to carry out a gradual innovation.
- The incumbent believes it has nothing to gain by bidding ($\pi^M - \pi^M = 0$): it would just be replacing its monopoly profit with monopoly profit.
- The rival has more to gain ($\pi^D - 0 = \pi^D$): the rival would replace zero profit with duopoly profit

When $0 < \rho < 1$, both the efficiency effect and replacement effect are present

- When ρ is sufficiently large (the incumbent is sufficiently uncertain about the presence of potential rival) the replacement effect dominates the efficiency effect, and so the incumbent has less incentive to acquire patent than a potential rival.

[2]Assuming, $\pi^M > 2\pi^D$, the precise condition is that $\rho > \frac{\pi^M - 2\pi^D}{\pi^M - \pi^D} = 1 - \frac{\pi^D}{\pi^M - \pi^D}$.

4.2.4 A drastic innovation

Now consider a drastic innovation. Now if the rival acquires the patent and enters the industry, the incumbent's profits are zero and the rival makes monopoly profits. Compared with the gradual innovation case, this increases the incentive of the rival to acquire the patent. If the incumbent bids and acquires the patent, then (as before):

- Rival gets zero, incumbent gets π^M

If the incumbent does not bid and acquire the patent

- $1-\rho$: rival bids (and wins): incumbent gets zero, rival gets π^M
- ρ: rival does not bid: incumbent gets π^M, rival gets zero
- The incumbent's expected profit if it does not bid is

Willingness to pay for the patent

The rival is willing to pay

The incumbent is willing to pay

As long as there is some uncertainty ($\rho > 0$) the rival is willing to pay more than the incumbent.

Incumbent firms tend to have a greater incentive than entrants to perform R&D toward a gradual innovation. However:

- if there is uncertainty regarding the threat of entry
- if the innovation is sufficiently drastic,

then a potential rival may have a greater incentive to perform R&D than the incumbent.

4.3 Patent Policy

4.3.1 Introduction

A *patent* gives the holder exclusive rights to the invention (for a limited period of time). Without a patent there would be little incentive to innovate:

- Any other firm could simply copy the firm's innovation
- The innovating firm's profit would be too low to justify the investment

Patents, by bestowing market power on the patent-holder, have two opposing effects on welfare:

- Increase incentive to innovate: a greater rate of technical progress
- Lead to inefficiency in the post-innovation market: underproduction by the patent-holder

Both effects must be taken into account when designing patent policy.

Policy instruments

There are two broad aspects of patent design:

- Patent length
- Patent strength
  - Novelty/nonobviousness requirements: what can be patented
  - Patent breadth: coverage of the patent

Increasing the length or strength of a patent involves a trade off:

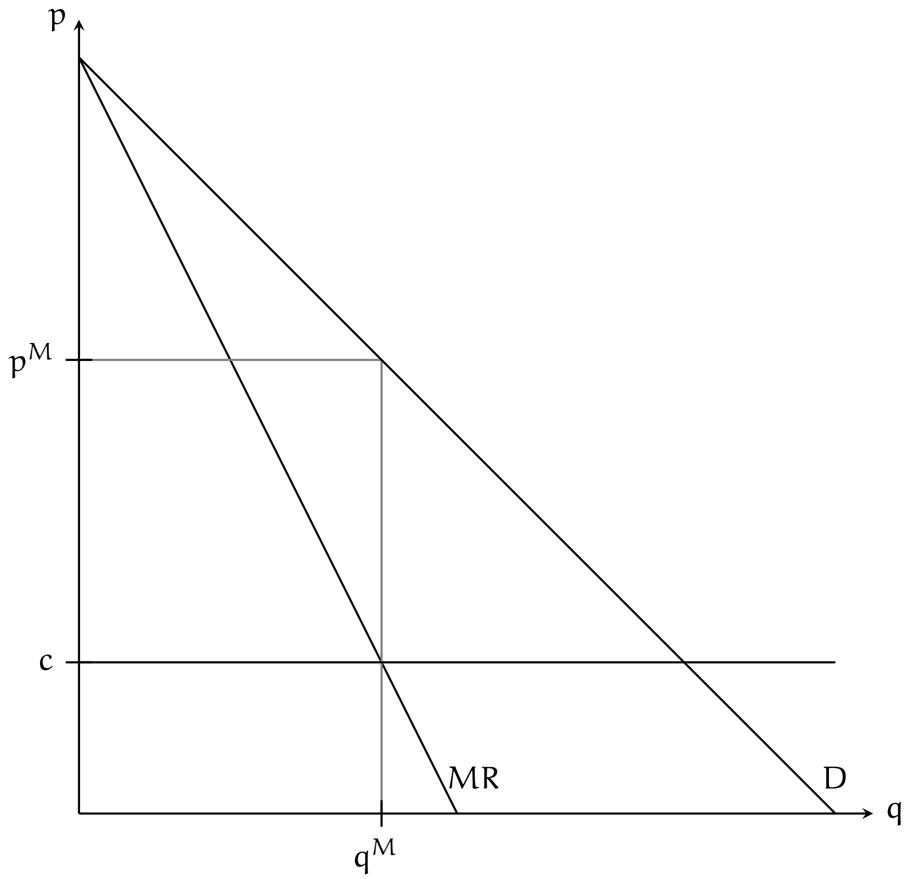
- Increased profits from innovation and so increased incentive to innovate.
- Increased welfare loss from the usual inefficiency associated with market power:
  - Increasing strength increases the market power of the patent holder
  - Increasing length increases the period of time in which the patent holder has market power

4.3.2 A slight weakening of a patent

A strong patent gives the patent holder monopoly profits for the duration of the patent. Could a weaker patent be better?

Consider a slight weakening of the patent so that the holder is subject to some competition. Specifically, suppose the patent holder is unable to charge more than p^L, where $p^L < p^M$.[3]

[3] Such a weakening can be implemented by forcing the patent holder to license the patent for $p^L - c$ per unit: The marginal cost of a firm using the patent is $(p^L - c) + c = p^L$. Under Bertrand competition the equilibrium price would be p^L.



A small weakening of patents increases welfare:

- It has almost no effect on profits, so does not reduce the incentive to innovate.
- It increases the quantity sold by the monopolist, so decreases the efficiency loss associated with monopoly.

4.3.3 Optimal patent policy

The policy maker is able to choose the length and strength of a patent. What combination of patent length and strength is best? We will answer this question under the following simplifying assumptions:

- There is only one firm considering whether or not to innovate.
- The fixed cost of innovation is F, and the innovation is certain
- Every period after innovation is identical (same demand and cost)
- After the patent expires the market becomes competitive

The policy maker has two instruments:

- Length: L
  - Determines the number of periods the patent holder has market power
- Strength: measured by per-period profit π
  - The strongest patent (monopoly): $\pi = \pi^M$
  - The weakest patent (competitive market): $\pi = 0$

The firm will carry out the innovation only if its profits cover the fixed cost of innovation:

$$L\pi \geqslant F$$

Increasing the length L or strength π increases the efficiency loss associated with market power. Thus the policy maker will optimal set

So the optimal choice is between:

- A shorter, stronger patent
- A longer, weaker patent

Which is optimal? We have already shown that a small weakening of a patent (from the strongest) increases welfare. It can be shown that *any* weakening of the patent (accompanied by the required lengthening of the patent) increases welfare; the optimal policy is a very weak, very long patent (tutorial).

4.4 Research and development agreeements

Public policy towards R&D agreements is more tolerant than towards other inter-firm agreements:

- Article 101 of the Treaty of the European Union prohibits inter-firm agreements that distort competition.
- However there is an exemption for agreements pertaining to R&D.

Why is this?

4.4.1 R&D spillovers

Bloom, Schankerman and Van Reenen (2013) obtained the following US estimates for the return to R&D:

- gross social rate of return about 55%,
- gross private rate of return about 21%

The social return greatly exceeds the private return; this gap is estimated to imply a socially optimal level of R&D twice as high as the observed level of R&D.

Spillovers and the free-rider problem

Let $0 \leqslant s \leqslant 1$ represent the degree of *spillovers* from R&D

- £1 of R&D expenditure by firm A benefits firm B the same as if firm B had spent £s itself
- If $s = 1$ then the outcome of R&D expenditure is a public good.

Where do these spillovers come from?

- R&D results may become public knowledge
- Workers may leave firm A and join firm B

The presence of spillovers implies a *free-rider problem*:

- When firm A chooses how much to invest in R&D it ignores the positive externality on firm B
- Since A ignores this positive externality it will tend to invest too little (from society's perspective)

The effect of an R&D agreement

The free-rider problem can be alleviated through an R&D agreement, i.e. an agreement where two (or more) firms jointly choose their expenditures on R&D. The firms will choose their total expenditures to maximize their joint profit.

EXAMPLE

Suppose £1 more expenditure benefits a firm by £0.60. Should A spend the £1? If A and B have an R&D agreement should they spend the £1?

	Benefit of extra £1 expenditure on R&D		
s	A	B	Joint
1	0.60		
1/2	0.60		

An R&D agreement alleviates the free-rider problem by internalizing the positive externality of R&D expenditure. Since in an R&D agreement the firms maximize joint profit, their choice of expenditure takes into account the effect of more R&D expenditure on *both* firms. The R&D agreement increases expenditure on R&D, which can increase welfare.

4.4.2 A patent race with a fixed prize

Are R&D agreements always a good idea? To illustrate why they might no be, consider a different scenario:

(i) R&D expenditure is a race with a fixed prize (as in a patent race)

(ii) When a firm increases its expenditure:
  - the probability that it wins increases
  - the probability that the innovation occurs at all increases
  - the probability the other firm wins decreases

(iii) The social value of innovation is much higher than the private value
  - Society would prefer more R&D expenditure than would maximize the firms' joint profits
  - This implies that if an R&D agreement reduces R&D expenditure then it reduces welfare

The effect of an R&D agreement

What effect will an R&D agreement have on R&D expenditure? When firm A increases its expenditure, it reduces the probability that B wins. Firm A does not take account of this negative externality on firm B. Since A ignores this negative externality it will (absent an R&D agreement) tend to invest too much (i.e. more than would maximize the joint profit of the firms). An R&D agreement causes the firms to reduce their expenditure. Given assumption 3 (social value of innovation is much higher than the private value) this reduces welfare

Interfirm R&D agreements may reduce the free-rider problem. However, they may also lead to an undesirable reduction in total R&D expenditures (tutorial).

Network Externalities 5

5.1 Introduction

Network externalities are a special kind of externality where the utility for a good depends on the number of other people consuming the good. *Direct network externalities*: A telephone is only worthwhile if you can communicate with other people.

EXAMPLE (Goods/services with direct network externalities)

Indirect network externalities: The more people who own a Playstation, the more attractive it will be to develop games for it; the more games are made for the Playstation, the more attractive it will be to consumers.[1]

EXAMPLE (Goods/services with indirect network externalities)

5.1.1 Coordination game

		Player 2 don't	**Player 2** buy
Player 1	don't	0, 0	0, −1
Player 1	buy	−1, 0	1, 1

(Payoffs listed as Player 1, Player 2.)

[1] Indirect network effects often arise in such *two-sided markets*.

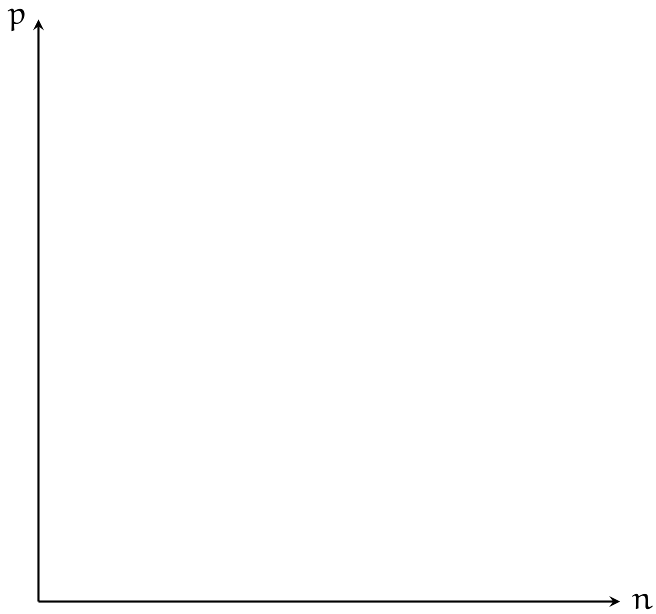
5.1.2 A market with network externalities

Demand

Consider the market for some good. Consumers are uniformly distributed along a line of length one. Their location $0 \leqslant v \leqslant 1$ on the line represents their willingness to pay.

What would demand look like without externalities? Without network externalities, consumer v buys if $v \geqslant p$.

The indifferent consumer is willing to pay p. All those with higher valuations will also buy. Thus the number of people who buy is $n = 1 - p$. This is the demand function.



Now suppose the the good exhibits network externalities. Consumer v values the good at nv, where n is the number that consume the good, and so will buy if $nv \geqslant p$. What does the demand function look like now?

If $n = 0$ then each consumer values the good at $0 \cdot v = 0$ and so will not purchase at any price. So part of the demand curve is the vertical line at $n = 0$

Suppose $n > 0$. There is an indifferent consumer $\bar{v}$ willing to pay p:

Those with $v > \bar{v}$ will also wish to buy. Thus number of people who buy is

Putting equations (5.1) and (5.2) together gives

This is the inverse demand function. The height of the demand curve represents the willingness to pay of the indifferent consumer

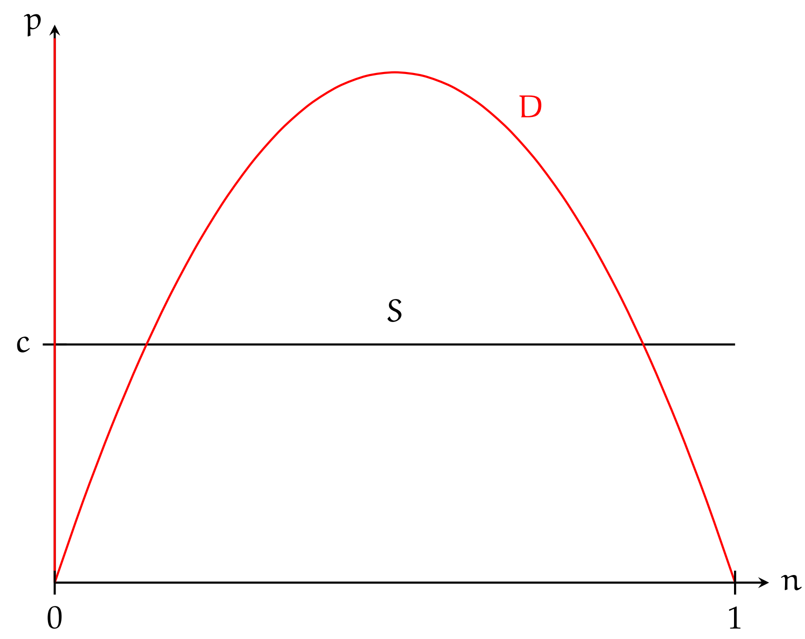
Supply

Suppose that the good is supplied by perfectly competitive firms with constant marginal cost c. Then the industry supply curve is horizontal at c.

Equilibrium

For sufficiently small positive marginal cost, there are three intersections between supply and demand:

- low-level equilibrium where no-one buys (noone buys so noone is willing to buy)
- middle-level equilibrium with small positive number of consumers
- high-level equilibrium with a large number of consumers

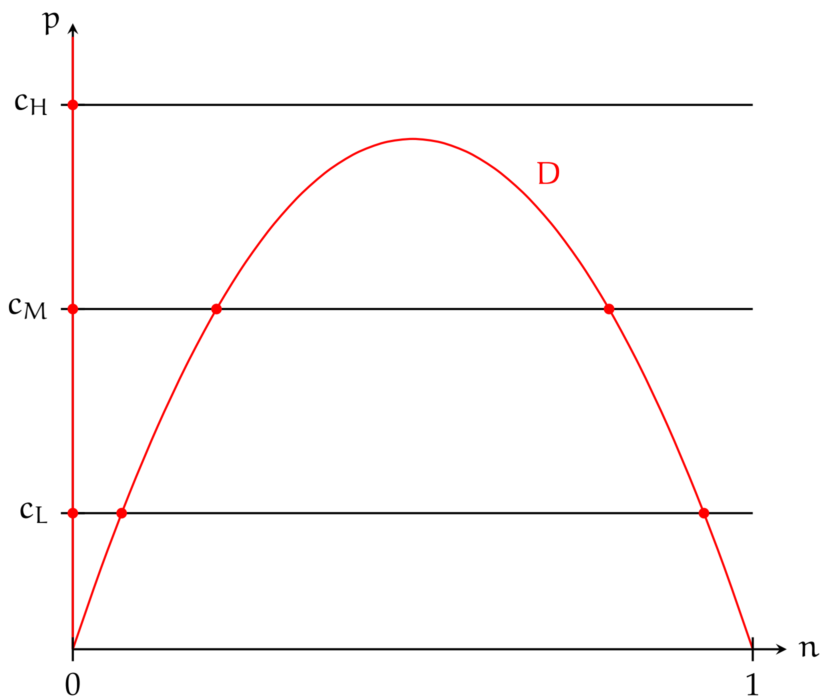


Market dynamics

Which equilibrium is more 'likely'? Suppose that:

- when people are willing to pay more than the cost, the size of the market expands
- when they are willing to pay less, it contracts.

That is, when the demand curve is above the supply curve, quantity goes up, and when it is below, quantity goes down. The low-level equilibrium and high-level equilibrium are both stable, whereas the middle equilibrium is unstable.



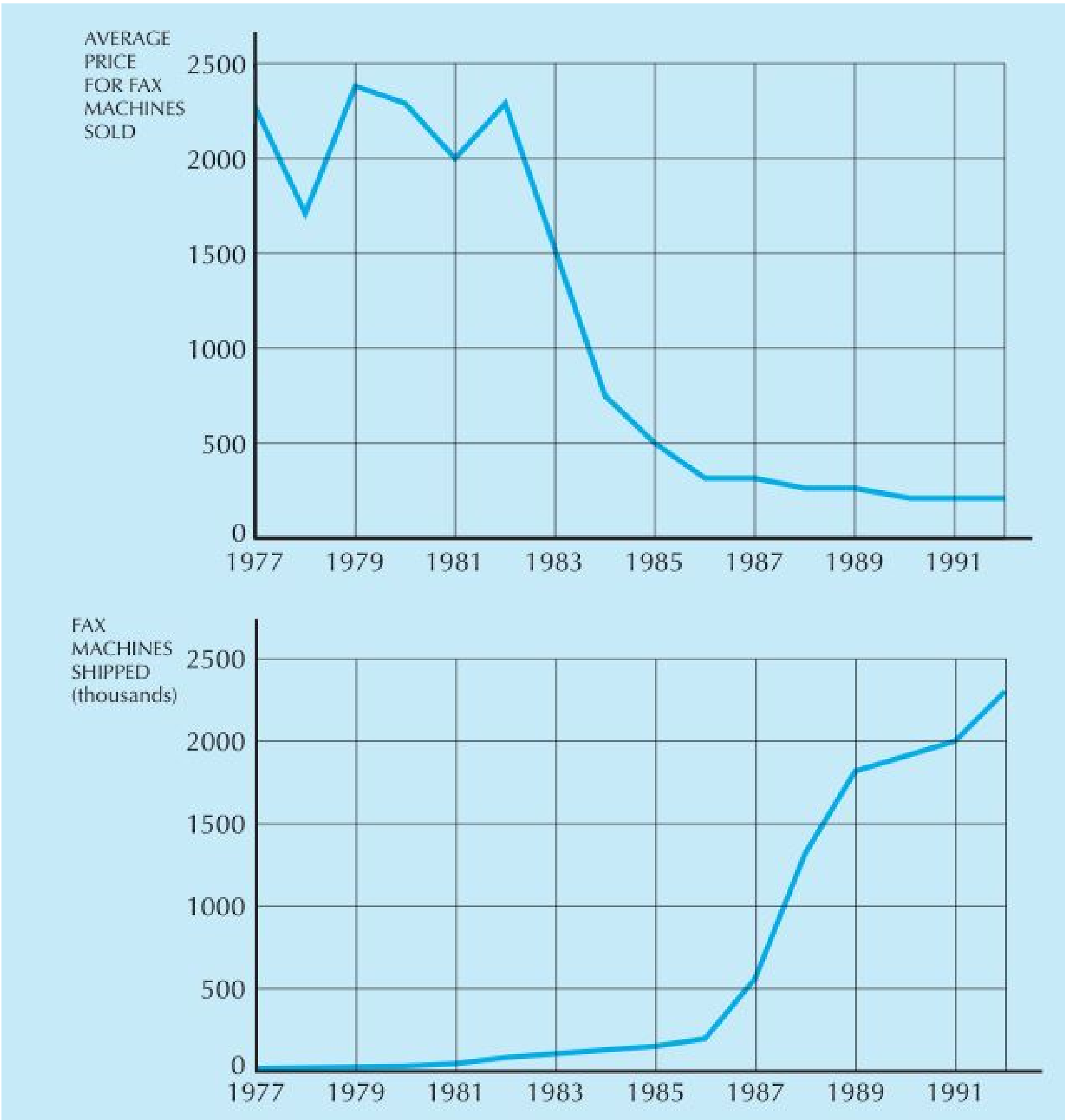
Suppose we perturb the number of people connected to the network around the equilibrium point zero.

- This could be a result of business strategies: initial discounts or other promotions

As the cost falls, it becomes more likely that one of these perturbations tips the system past the unstable equilibrium. Once this happens, the system will move towards the high-level equilibrium

EXAMPLE (Fax machines)

The demand for fax machines was low until about 1986 because few people used them From about 1982 to 1984, the price fell rapidly Eventually in 1986–7, a critical mass (tipping point) is achieved, and for a brief period of time, the system is in disequilibrium (snow-ball). Eventually, a new, higher-adoption equilibrium is reached.



Implications:

- It may pay to give away or heavily discount the good (at least in the beginning)
- In the case of two-sided markets, where a firm receives revenue from both sides, it might be worthwhile heavily discounting one of the goods (or even giving it away)
- For example, games consoles are often sold at a loss (at least in the first few years)
  - When the PS3 came out in 2006, the console cost about $805 to produce, losing Sony between $225 and $305 per unit sold
  - Profit is made from sales of games, accessories and online services

Network effects are everywhere. There are usually multiple equilibria: small changes can tip the market from one equilibrium to another.

5.2 Path dependence

5.2.1 Introduction

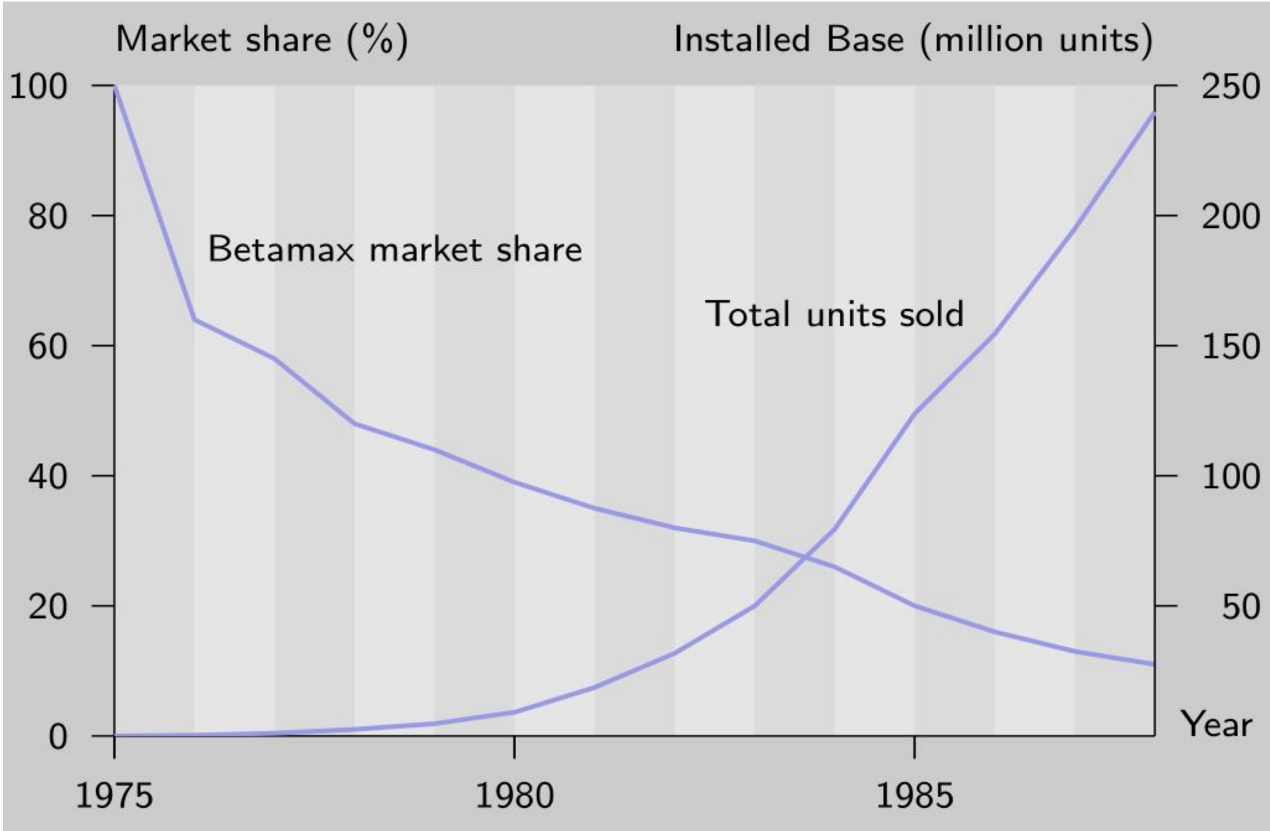


Figure 5.1: VHS vs Betamax

- Why did VHS triumph over Betamax?
- Why did Blu-ray beat HD DVD?
- Why is Windows the dominant operating system?
- Why do some countries drive on the left, some on the right?

In many cases there is no clear reason why one equilibrium was reached over another. When network externalities are present, small seemingly random events can control the outcome.

5.2.2 MODEL

Two versions of a technology: A and B

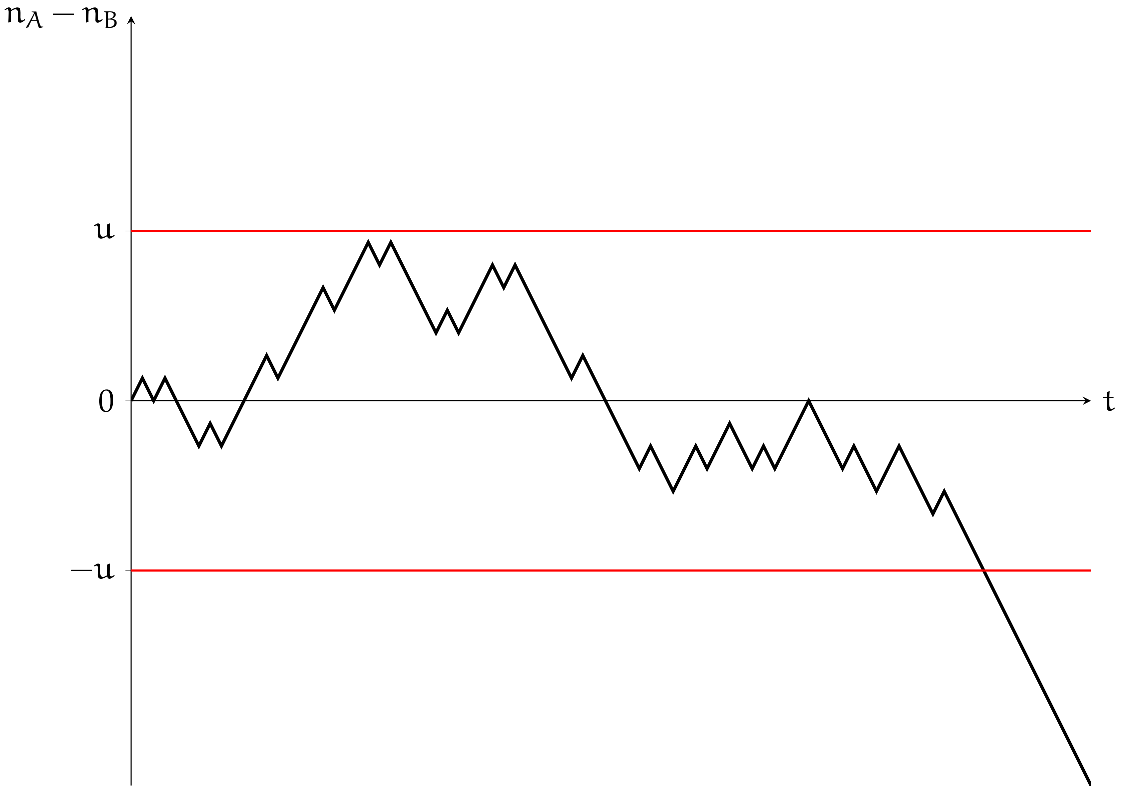
- Two types of consumers: A fans and B fans
  - If equal numbers consume each technology, A fans prefer A
  - An A fan gets extra $u > 0$ utility from A compared to non-fan
- Network externalities: utility of each technology is increasing in number n_i consuming it

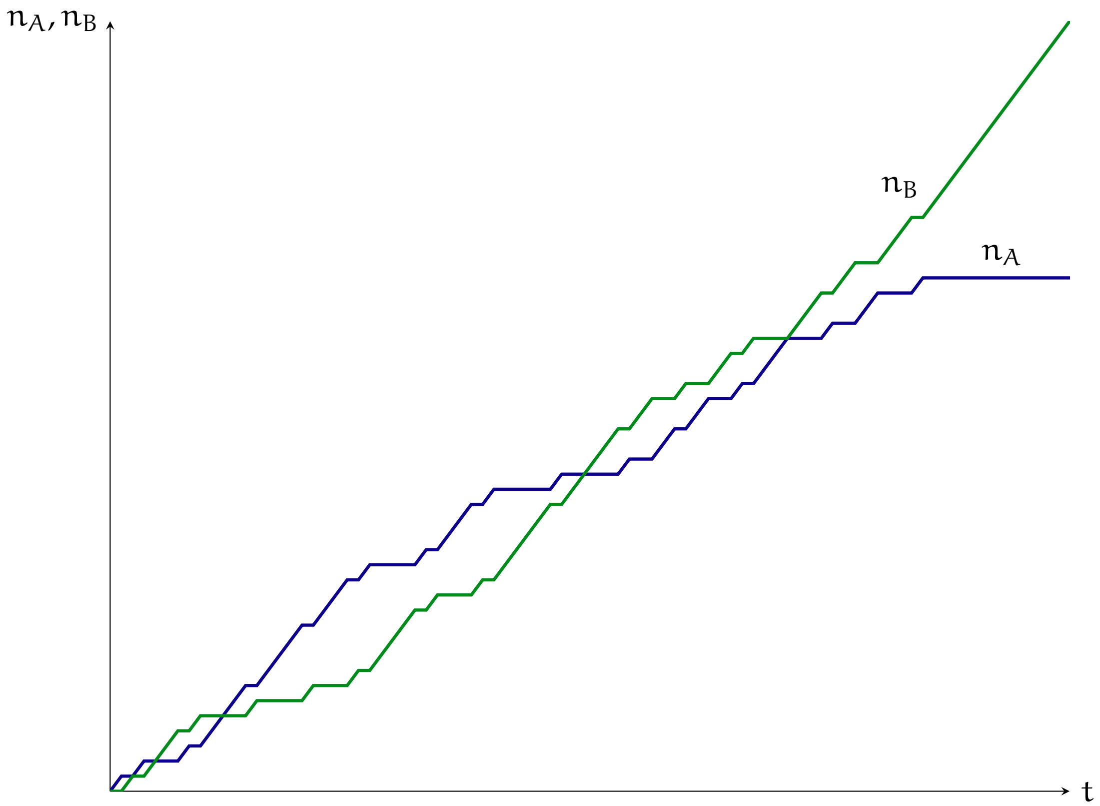
	Utility	
Type	A	B
A fan	$n_A + u$	n_B
B fan	n_A	$n_B + u$

- If $n_A = n_B$, then A fans buy A and B fans buy B
- But a B fan will prefer A if n_A is large enough compared to n_B:

- While an A fan will prefer B if n_B is large enough compared to n_A:

Suppose that each period an A fan or B fan randomly enters the market (with probability 1/2). Then we might get something like:





Lock-in

Eventually the industry becomes locked into one technology: once $|n_A - n_B| > u$, all consumers will purchase the technology with the bigger network:

- If $n_A - n_B > u$ then all subsequent consumers buy A
- If $n_B - n_A > u$ then all subsequent consumers buy B

The technology that eventually wins depends on whether early adopters are A or B fans: there is path dependence. Firms may be able to influence the outcome by offering initial discounts.

The industry may become locked into the 'wrong' technology:

- If most people are A fans, then it is efficient for technology A to be adopted (because then A fans will be obtaining the extra utility u)
- However, technology B may adopted if enough of the early adopters are B fans

EXAMPLE (Undesirable lock-in)

Suppose there are 80 A fans and 20 B fans. If the industry happens to become locked into B then utility is

The utility from A would be higher:

Network effects may allow small seemingly random events to control the outcome (path dependence).

5.3 Excess inertia and excess momentum

5.3.1 Introduction

Will a new technology be adopted too quickly or too slowly? Network externalities may imply excess inertia or excess momentum:

- *Excess inertia*: a new technology is *not* adopted even though in total consumers would be better off if it were
  - There is also excess inertia when a new technology that should be adopted is adopted too slowly
- *Excess momentum*: a new technology *is* adopted even though in total consumers would be better off it were not

5.3.2 Excess inertia

Idea: nobody buys it because nobody buys it (multiple equilibria)

Simultaenous-move technology adoption game

Two players simultaneously choose old (O) or new (N) version. Cost of switching from old to new is c_i. Network externalities:

- If both have same technology: o_i is benefit of old technology, n_i is benefit of new
- If have different technologies: no benefit

Player 2

		O	N
Player 1	O	o_1, o_2	0, $-c_2$
	N	$-c_1$, 0	$n_1 - c_1$, $n_2 - c_2$

Nash equilibria:

Suppose $n_i = 2c_i$ and c_i is very large

		Player 2	
		O	N
Player 1	O	o_1, o_2	0, $-c_2$
	N	$-c_1$, 0	c_1, c_2

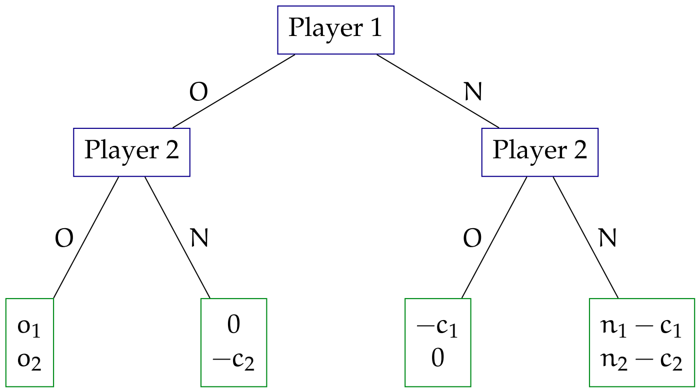
In this simple model, the existence of network externalities may imply excess inertia. In a more complicated model, we might introduce another period. In such a model, the uncertainty over whether other consumers will adopt, means consumers may adopt a wait and see approach. This means technology with network externalities may not be adopted at all: everyone is waiting to see if other people will buy, so noone ends up buying. Even if the technology is eventually adopted, it may be adopted too slowly (in the second period rather than the first).

5.3.3 Excess momentum

Idea: everybody adopts if there are enough early adopters

Sequential-move technology adoption game

Now suppose player 1 makes decision before 2 (who observes 1's decision before choosing).



Suppose player 1 prefers new to old, but only just:

- $n_1 - c_1 > o_1$ and $n_1 - c_1 \approx o_1$

Player 2 prefers old to new:

- $n_2 - c_2 < o_2$

Player 2 prefers to do adopt new technology if 1 does, but only just:

- $n_2 - c_2 > 0$ and $n_2 - c_2 \approx 0$

The equilibrium outcome is and total equilibrium payoffs are

If both don't switch, then total payoffs are

- Lead adopter has small benefit, imposes large loss on second adopter (compared to when both stay with old technology)
- Second adopter is better off with new technology, *given that* first adopter adopts new technology

Network effects may lead to excess inertia or momentum in technology adoption

5.4 Compatibility

5.4.1 Introduction

- A proprietary standard can be very profitable (e.g. Windows, CDMA)
- But often two or more standards compete for a market
- If the network effects are strong enough, people may abandon one standard when the other gets a substantial installed base
- Should a firm choose to be compatible or incompatible with rivals' products?

Incompatibility vs compatibility:

- Incompatibility: there is a chance I will end up empty-handed, but upside is also promising. There may also be significant costs from a 'standardization war'
- Compatibility: no standardization war, but tougher competition in the product market (I will never be a monopolist)
- Trade-off also depends on my relative strength

Examples:

- Betamax vs VHS
- macOS vs Windows
- Blu-ray vs HD DVD

5.4.2 Standard-setting game

- Two firms (or two coalitions of firms), A and B
- Two incompatible versions of a network good, α and β
- Firms each choose a version to produce
- Compatibility can only be achieved through standardization (producing the same version of the good)

		Firm B	
		Version α	Version β
Firm A	Version α		
	Version β		

Scenario one (intense standards competition)

Suppose compatibility battle is won by the firm that spends the most resources (on initial discounts, advertising etc). Then second-stage payoffs are as follows:

- If a firm wins they get π^M, if they lose, they get zero
- Firms are willing to spend (bid) up to π^M to win
- Thus both firms end up with zero (possibly less), regardless of whether they win or lose the battle

		Firm B	
		Version α	Version β
Firm A	Version α	π^D, π^D	0, 0
	Version β	0, 0	π^D, π^D

- Nash equilibria:

If standards competition is intense, then firms prefer compatibility.

Scenario two (weak standards competition)

Suppose winning standard is random (e.g. as in the model of path dependency). In particular, suppose there is an equal chance (1/2) that each standard is chosen. Then second-stage payoffs are as follows:

- If firms choose compatibility, then they end up with π^D each
- If firms do not agree, one of the standards is chosen with probability 1/2 and gets π^M, other firm gets zero. The expected payoff of each firm is

$$\frac{1}{2}\pi^M + \frac{1}{2}0 = \frac{1}{2}\pi^M$$

		Firm B: Version α	Firm B: Version β
Firm A	Version α	π^D, π^D	$\frac{1}{2}\pi^M$, $\frac{1}{2}\pi^M$
	Version β	$\frac{1}{2}\pi^M$, $\frac{1}{2}\pi^M$	π^D, π^D

- Nash equilibria:

- If product market competition sufficiently intense, firms prefer incompatibility

If standards competition is weak (and product market competition is sufficiently intense), then firms prefer incompatibility.