Economics Lecture 8

2016-17

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Course Outline

1 Consumer theory and its applications

1.1 Preferences and utility

1.2 Utility maximization and uncompensated demand

1.3 Expenditure minimization and compensated demand

1.4 Price changes and welfare

1.5 Labour supply, taxes and benefits

1.6 Saving and borrowing

2 Firms, costs and profit maximization

2.1 Firms and costs

2.2 Profit maximization and costs for a price taking firm

3. Industrial organization

3.1 Perfect competition and monopoly

3.2 Oligopoly and games

2.1 Firms and Costs

1. The objective of the firm
2. Opportunity cost
3. Production function
4. Cost functions
5. Economies of scale
6. Returns to scale

1. What is the objective of the firm?

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- Some firms have mission statements
- They also have annual reports in which they set out objectives.

easyJet

to provide their customer with safe, good value and point to point air services.

Google's mission is "… to organize the world's information and make it universally accessible and useful."

"We believe that our user focus is the foundation of our success to date. We also believe that this focus is critical for the creation of long-term value. We do not intend to compromise our user focus for short-term economic gain. "

August 2015: Alphabet became owner of Google:

https://abc.xyz/ Larry Page

We are excited about…

- Getting more ambitious things done.
- Taking the long-term view.
- Empowering great entrepreneurs and companies to flourish.
- Investing at the scale of the opportunities and resources we see.
- Improving the transparency and oversight of what we're doing.
- Making Google even better through greater focus.
- And hopefully… as a result of all this, improving the lives of as many people as we can.

Profit maximization: the standard assumption

The objective of the firm is to maximize profits.

Profits = revenue – opportunity cost.

This is the objective of the firm's shareholders who control the firm.

The simple model of the firm starts with either a production function or a cost function.

It ignores the fact that a firm is an organisation run by people who have individual objectives and agendas.

It ignores conflicts of interest between investors and senior managers.

Reasons for assuming profit maximization

Competition in the product market

(if a firm can at best make zero profit it has to maximize profits to stay in business.)

Incentives generated by the financial sector and the market for managers. (reputation, reward packages, takeover threat).

As a reasonable first approximation, particularly

in areas where conflicts of interest seem unimportant.

Risk taking

You have made a trade that has made a **big loss**.

It has not **yet** been observed.

You will be sacked when the loss is observed.

You could make a second trade with a small probability of making a very high return and a large probability of a big loss.

If you make the high return you **keep** your job.

If you make the big loss you **loose** your job.

What do you do? 

Is risk management necessary?

Risk management is necessary.

Is managing the risks of long term decisions difficult? 

Risk management is necessary.

Managing the risks of long term decisions is difficult.

Some incentive schemes, e.g. bonuses and stock options may reduce or increase risk?

Risk management is necessary.

Managing the risks of long term decisions is difficult.

Some incentive schemes, e.g. bonuses and stock options may encourage risk taking.

The situation is greatly complicated by **asymmetric** information and **incomplete** contracts.

This is the focus of much research in corporate finance.

"Compensation schemes **overvalued the present** and heavily **discounted the future**, encouraging imprudent risk taking and **short-termism**," he said.

"Standards may need to be developed to put non-bonus or fixed pay at risk. That could potentially be achieved through payment in instruments other than cash."

Mark Carney, Governor of the Bank of England, 17 November 2014

http://www.bbc.co.uk/news/business-30079451

Research in Corporate Finance has focused on relations between

- Providers of finance and senior managers
- Providers of different types of finance:
    - equity (shares), debt
- Different groups of equity holders:
    - family and others,
    - financial institutions, other firms
- Different types of debt, banks, bonds

Which economists assume profit maximization?

Teachers of standard intermediate microeconomics courses.

Usually industrial economists at the research level.

Usually not corporate finance economists at the research level.

In this course we want to understand **how the nature of competition in the product market affects prices and quantities**. Assuming profit maximization we get good insights from this.

Introducing the complications I have just discussed would make this analysis much more complicated.

Firms get profits at many dates.

The standard assumption is that firms maximize the **present discounted value** V of profits, having π_t profits at date t

$$V = \frac{\pi_1}{(1+r)} + \frac{\pi_2}{(1+r)^2} + \frac{\pi_3}{(1+r)^3} \ldots\ldots$$

Profits = revenue - costs

Measuring revenue can be problematic

Tesco estimates of profits March – August 2014

€1,100 million August 2014,

€850 million September 2014

"principally due to the accelerated recognition of commercial income and delayed accrual of costs"

Fall in Tesco share price 2014

http://www.tescoplc.com/index.asp?pageid=39#tabnav

Profits = revenue - costs

Costs are complicated if the firm has **durable equipment**, **intellectual property** or **long run contracts**

economic cost (**opportunity cost**) can be different from cash flows to providers of inputs and from accounting costs.

2. Opportunity Cost

2. Opportunity Cost

- Defined as the value of an input in its best alternative use.
- Sometimes called economic cost.
- For something a person or firm is buying now, the opportunity cost is the current price.

Opportunity cost to you of studying

The cost to you of studying is

- how much you pay to be in this classroom
- the opportunity cost of your time, that is the value of your time in the best alternative use.

If the best alternative use of your time is employment, then the salary you would earn if you were not at Charles University is your opportunity cost.

Opportunity cost to you of running your own business

The opportunity cost to an entrepreneur of running her business is

at least as big as the salary she could earn elsewhere.

If there is a more valuable alternative to employment the opportunity cost is higher.

Opportunity cost to a firm

What is the opportunity cost of using an input from inventory

e.g. oil? 

What is the opportunity cost of land, buildings and equipment?

in the short term?

in the long term?

Opportunity cost to a firm

What is the opportunity cost of using an input from inventory

e.g. oil?

If the only alternative is selling now, then it's the current price.

But there may be other more valuable alternatives. Like what?

What is the opportunity cost of land, buildings and equipment?

in the short term?

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Opportunity cost to a firm

What is the opportunity cost of using an input from inventory

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But there may be other more valuable alternatives.

Option to sell in the future.

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If the only alternative is selling now the current price.

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in the short term? Possibly zero.

in the long term? 

Opportunity cost to a firm

What is the opportunity cost of using an input from inventory

e.g. oil?

If the only alternative is selling now the current price.

But there may be other more valuable alternatives.

Option to sell in the future.

What is the opportunity cost of land, buildings and equipment?

in the short term? Possibly zero.

in the long term? Possibly the amount it can be sold for.

Opportunity cost

- Can be impossible to measure accurately,
- Is always useful to think about when making decisions.
- Accountants need to produce precise numbers for financial statements.

The Cost of Capital

The Cost of Capital

- The simplest model.
- Suppose you must buy capital goods 1 year in advance at which time you pay a price p.
- After buying the capital good you can (if you wish) sell it after 1 year for price p. Then, you have p in cash.
- The opportunity cost is rp where r is the interest rate.
- Why?

- If you save p at interest rate r for 1 year you have cash (1+r)p next year.

- If you buy the capital good, and you do nothing, you would have cash p next year

- The difference in the amount of cash is the opportunity cost of capital rp.

- If p = 1 the cost of capital is r.
- This is why textbooks use notation r for the cost of capital

More realistically the cost of capital depends on

- rate of physical or technical deterioration
- continuation or not of technical support
- technical obsolescence
- changes in the price of the capital good
- installation and transaction costs
- taxes

What matters for opportunity cost is where you are now.

How you got there is irrelevant.

People know this

“Look to the future, you can’t change the past.”

“Let bygones be bygones.”

“Don’t throw good money after bad.”

But we find it hard to do.

What you think and feel about the past is part of the present.

3. Production functions

3. Production functions

In this part of the course we assume the firm produces one output from two inputs, capital K and labour L.

With more maths this can be generalized to many inputs and outputs.

Important limitation: no modelling of innovation, research & development

3. Production functions

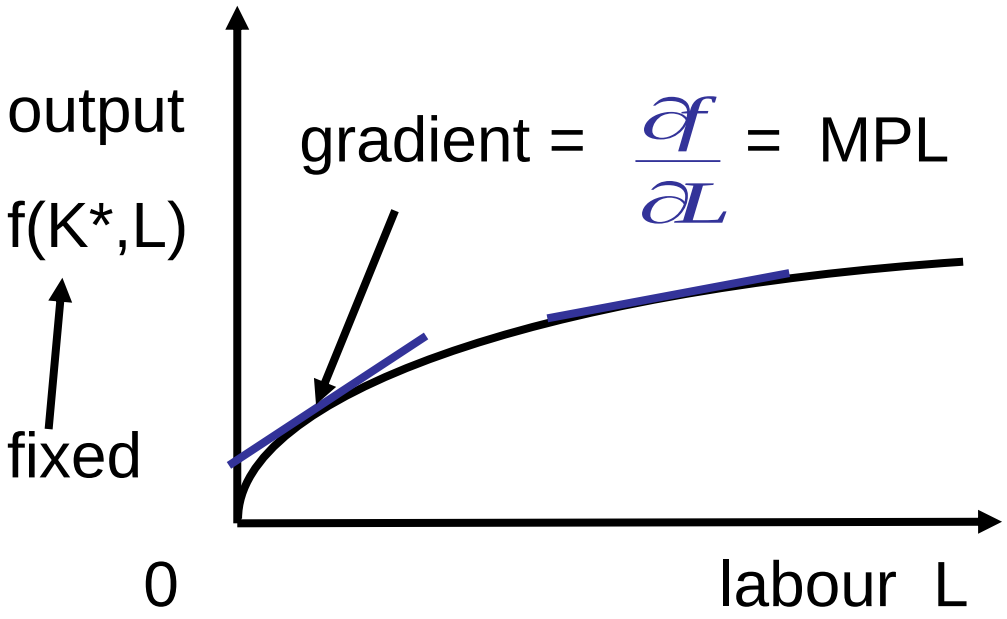
Marginal Products

Output q = f(K,L), f(K,L) is the **production function**.

$$\frac{\partial f}{\partial K} = \text{marginal product of capital} = \text{MPK}$$

$$\frac{\partial f}{\partial L} = \text{marginal product of labour} = \text{MPL}$$

Standard assumptions on marginal products



With fixed K, output increases as L increases MPL = $\frac{\partial f}{\partial L} > 0$.

MPL decreases as L increases, $\frac{\partial^2 f}{\partial L^2} < 0$

with fixed K, output is a concave function of L,

Similarly MPK > 0, MPK decreases as K increases.

“Law of Diminishing Marginal Returns”

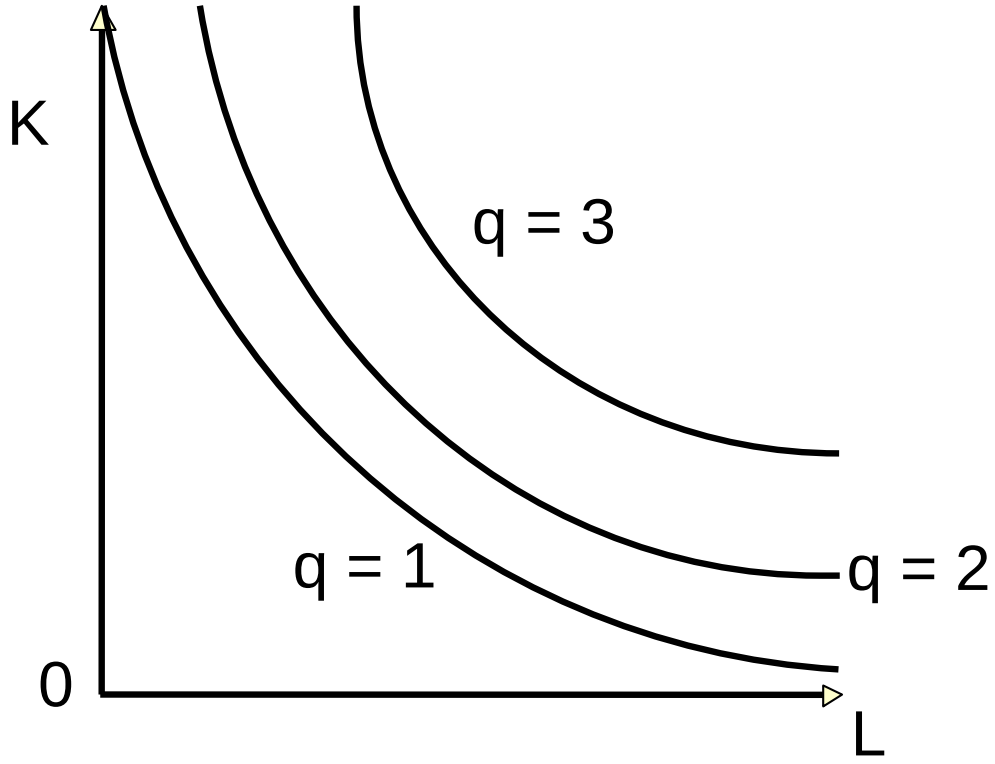
A general statement of the previous slide.

If one input increases while the others are held constant the marginal product of that input falls as output expands.

Example: labour in agriculture

with a fixed amount of land, seed, tractors etc. beyond a certain point the extra output from increasing labour starts falling.

Isoquants



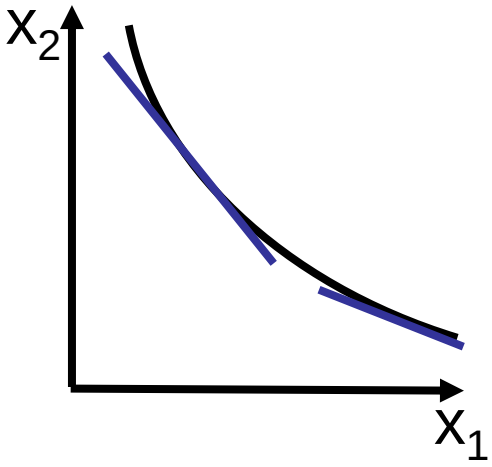
Isoquant q = 1 shows all the combinations of inputs for which f(K,L) = 1.

Changing the numbers on the isoquants changes output obtainable from inputs.

This matters. Different from indifference curves.

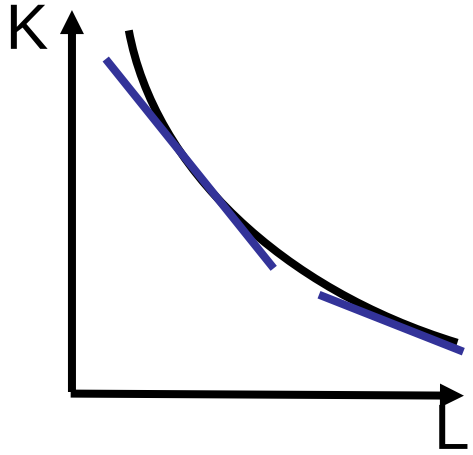
Consumer Theory: Marginal Rate of Substitution (MRS)

MRS = - gradient of indifference curve



$$\text{MRS} = \frac{\frac{\partial u}{\partial x_1}}{\frac{\partial u}{\partial x_2}} = \frac{\text{marginal utility of good 1}}{\text{marginal utility of good 2}}$$

Producer Theory: Marginal Rate of Technical Substitution (MRTS)



MRTS = - gradient of isoquant.

Using the same maths as consumer theory

$$\text{MRTS} = \frac{\frac{\partial f}{\partial L}}{\frac{\partial f}{\partial K}} = \frac{\text{marginal product of labour}}{\text{marginal product of capital}}$$

Standard assumption, **decreasing MRTS,**

moving along an isoquant by increasing L the MRTS decreases.

4. Cost functions

4. Cost Functions

The cost function c(v,w,q) is the minimum cost of producing output q using capital K and labour L with prices v and w.

This definition assumes that all inputs can be varied, later we will call this a long run (as opposed to short run) cost function.

Sometimes this is called a total cost function (as opposed to a marginal or average cost function).

Parallels with Consumer Theory

Given a production function f(K,L) the cost function c(v,w,q) is the minimum cost of producing output q using capital K and labour L with prices v and w.

Given a utility function $u(x_1,x_2)$ the expenditure function $E(p_1,p_2,u)$ is the minimum cost of obtaining utility u by consumption of x_1 and x_2 with prices p_1 and p_2.

You find the expenditure function by

finding the levels of x_1 and x_2 that minimize

$p_1x_1 + p_2x_2$ subject to the constraints $u(x_1,x_2) \geq u$ and non negativity constraints $x_1 \geq 0$, $x_2 \geq 0$.

Write these as

$x_1 = h_1(p_1,p_2,u)$ and $x_2 = h_2(p_1,p_2,u)$. This is compensated demand. Note compensated demand depends on (p_1,p_2,u).

The expenditure function is

$E(p_1,p_2,u) = p_1h_1(p_1,p_2,u) + p_2h_2(p_1,p_2,u)$

It depends on (p_1,p_2,u).

You find the cost function by

finding the levels of K and L that minimize

vK + wL subject to the constraint $f(K,L) \geq q$ and non negativity constraints $K \geq 0$, $L \geq 0$.

Write these as

K(v,w,q) and L(v,w,q). Note they depend on (v,w,q). They are sometimes called conditional factor demand.

The cost function is

c(v,w,q) = vK(v,w,q) + wL(v,w,q).

It depends on (v,w,q).

The Mathematics of Finding Cost Functions

- This is exactly the same as the mathematics of finding expenditure functions.
- It is possible to create examples:

  for a Cobb-Douglas Production Function $q = K^{3/5} L^{2/5}$

  for a fixed proportions Production Function $q = \min(3K, L)$.

Checks

- Check that increasing inputs increases output.
  - This is the equivalent of nonsatiation in consumer theory.
- Check for convexity.
  - This is exactly the same as in consumer theory.

For the Cobb-Douglas production function $f(K,L) = K^{3/5} L^{2/5}$

$K=(3w/2v)^{2/5} q$ $L= (2v/3w)^{3/5} q$

minimize the cost of producing output q when price of capital = v and price of labour = w.

The cost function is

$c(v,w,q) = v (3w/2v)^{(2/5)} q + w (2v/3w)^{(3/5)} q$

which is equal to

$[(3/2)^{2/5} + (2/3)^{3/5}] w^{2/5} v^{3/5} q.$

Properties of the Expenditure Function $E(p_1,p_2,u)$

1. Increasing in utility
2. Homogeneous of degree 1 in prices.
3. Non-decreasing in prices.
4. Concave in prices.
5. Shephard's lemma

From the consumer theory slides

$$\frac{\partial E(p_1,p_2,u)}{\partial p_1} = h_1(p_1,p_2,u)$$

compensated demand

Properties of the Cost Function c(w,v,q)

1. Increasing in output q
2. Homogeneous of degree 1 in

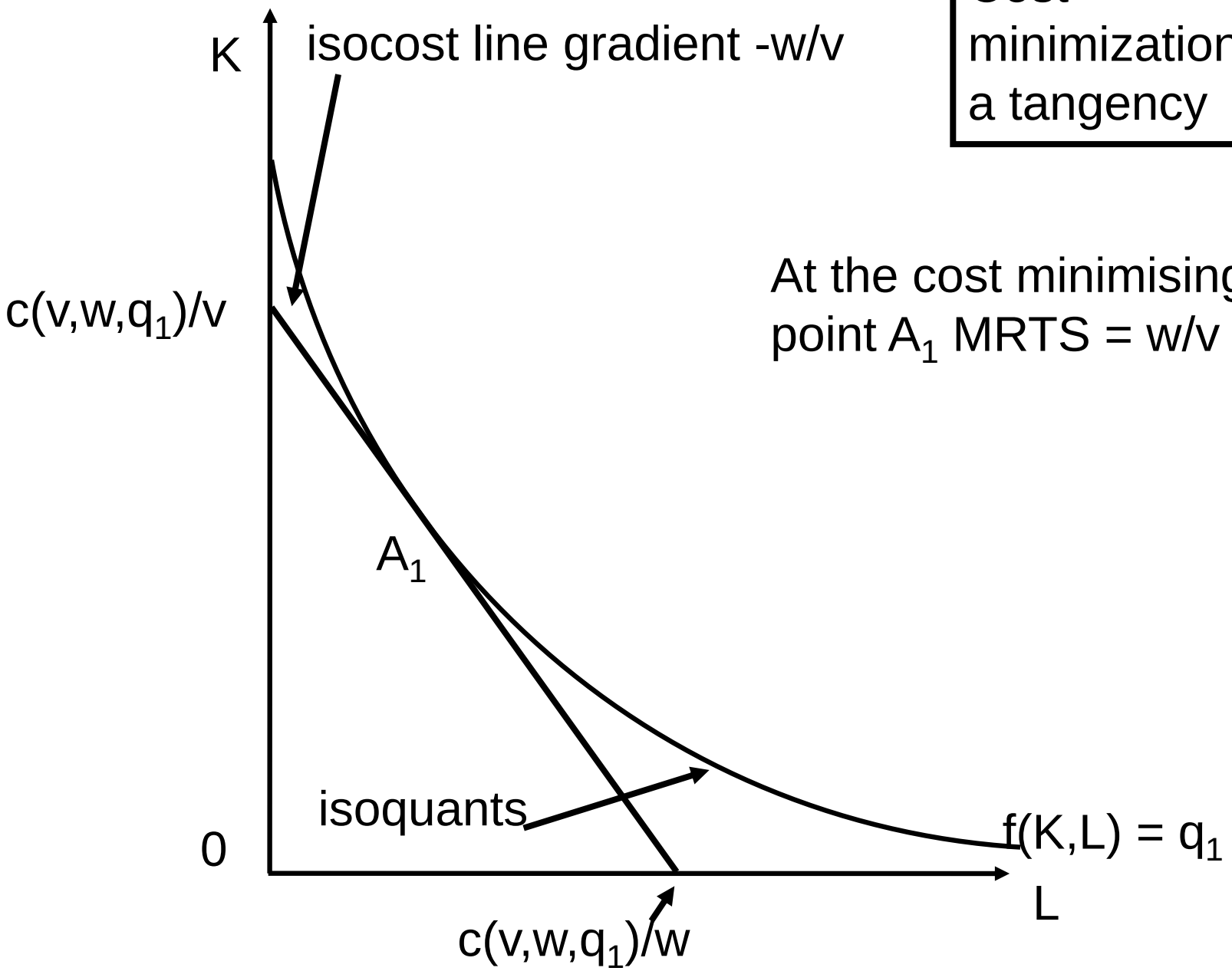
   input prices v,w
3. Non-decreasing in input prices.
4. Concave in input prices.
5. Shephard's lemma for cost functions

$$\frac{\partial c(v,w,q)}{\partial v} = K(v,w,q)$$

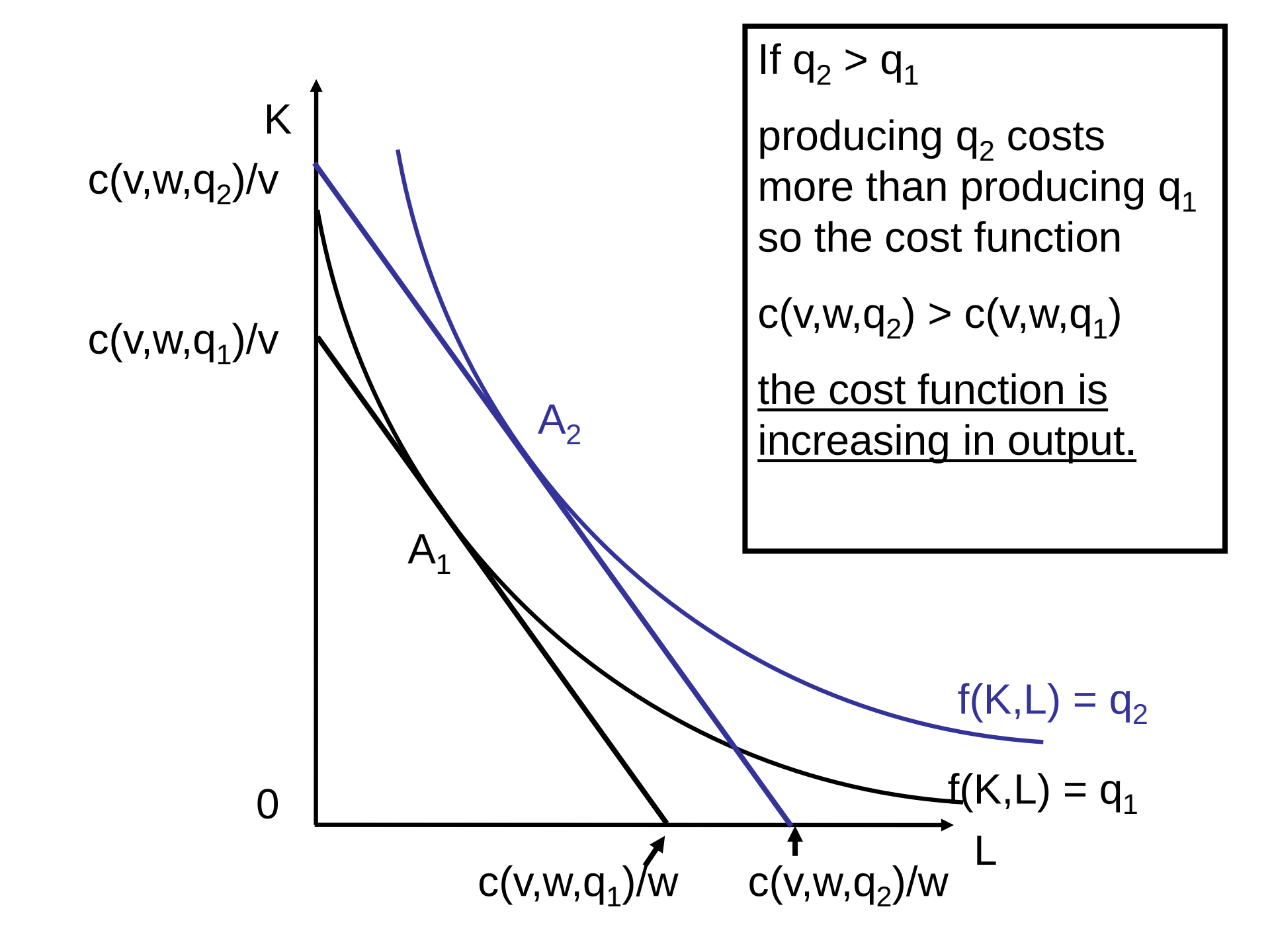
$$\frac{\partial c(v,w,q)}{\partial w} = L(v,w,q)$$

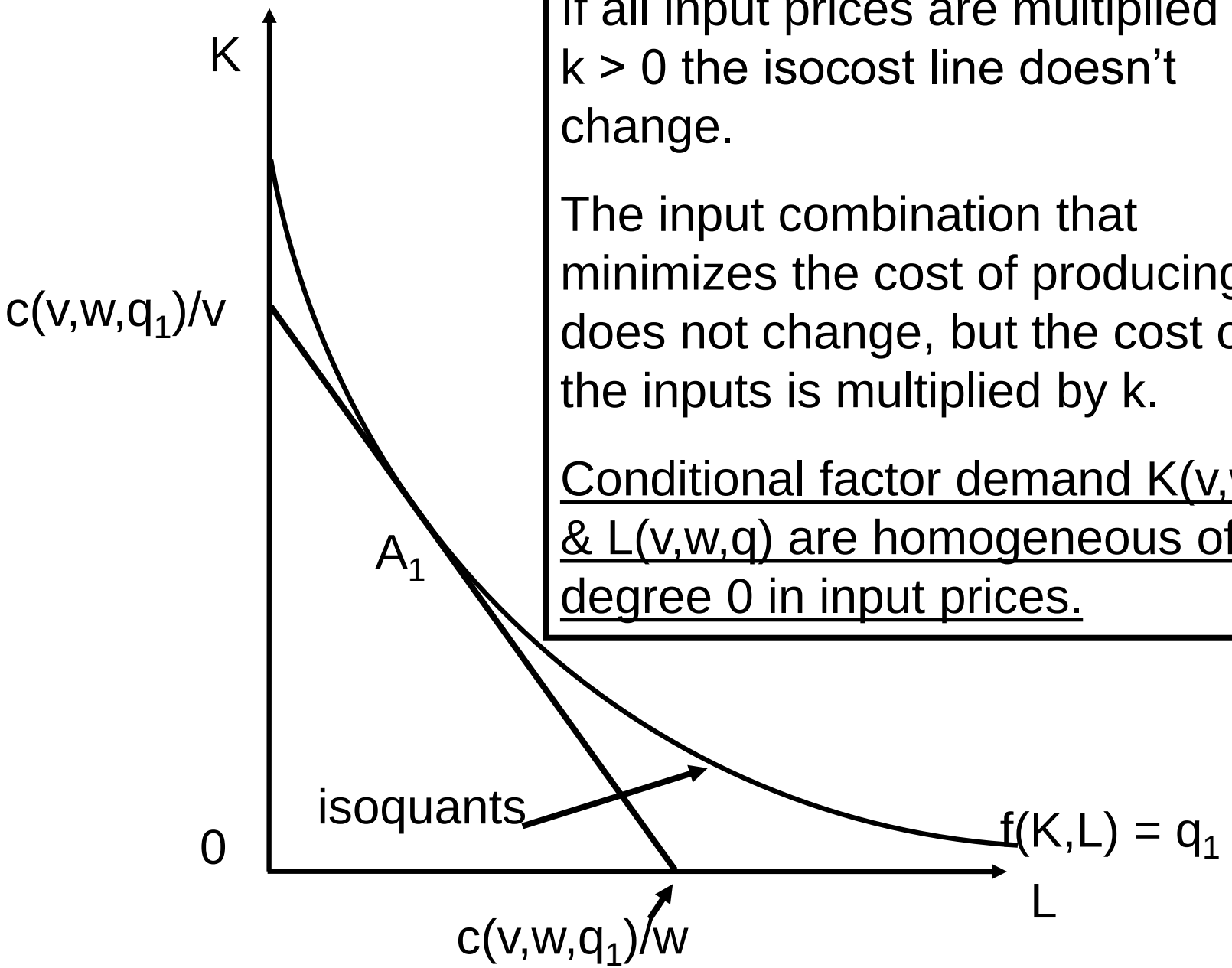
The maths of the cost function is exactly the same as the maths of the expenditure function so the cost function has the same properties as the expenditure function.

Cost minimization at a tangency



At the cost minimising point A_1 MRTS = w/v

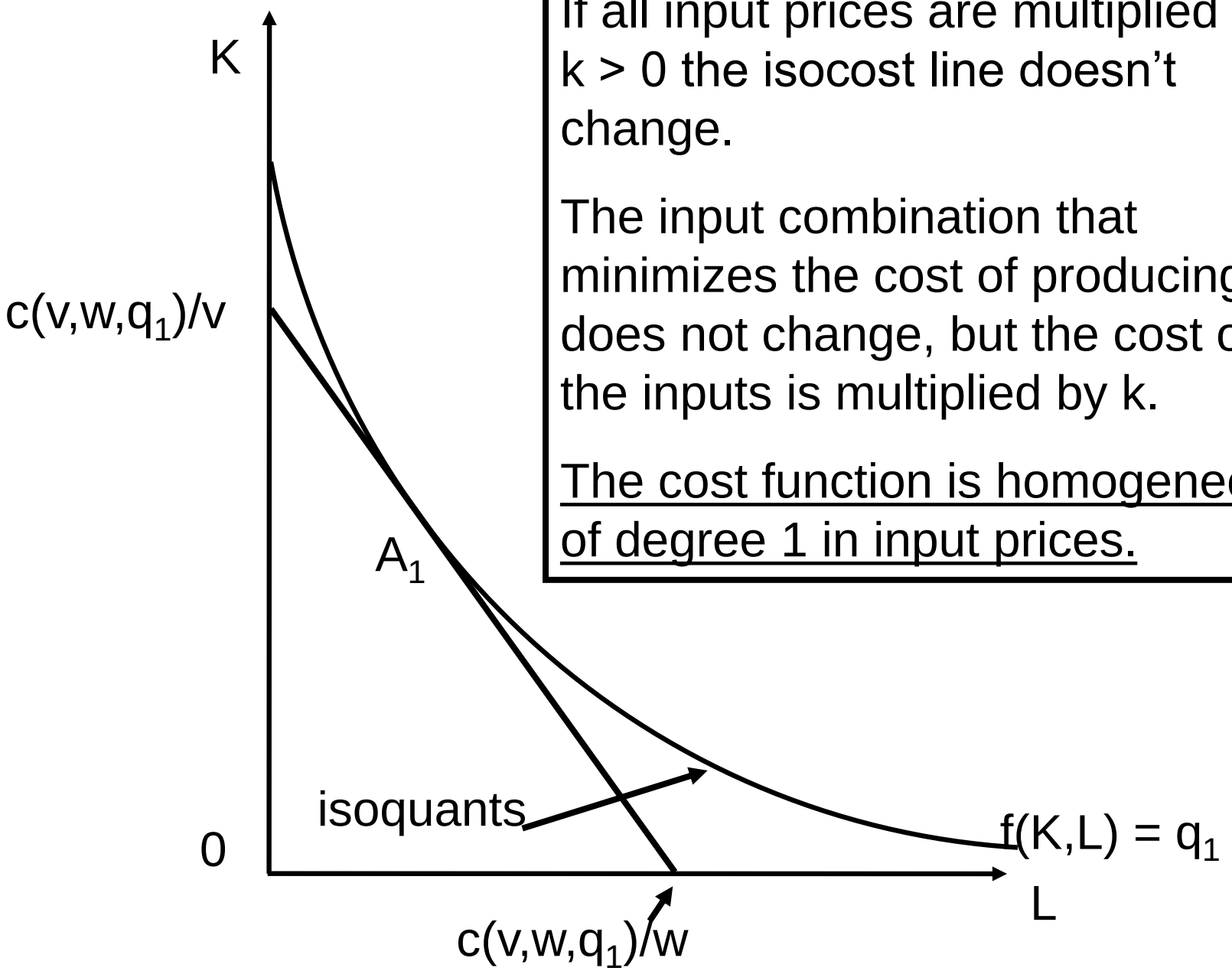

If $q_2 > q_1$
producing q_2 costs more than producing q_1 so the cost function
$c(v,w,q_2) > c(v,w,q_1)$
the cost function is increasing in output.
K
$c(v,w,q_2)/v$
$c(v,w,q_1)/v$
A_2
A_1
$f(K,L) = q_2$
$f(K,L) = q_1$
0
L
$c(v,w,q_1)/w$
$c(v,w,q_2)/w$



If all input prices are multiplied by $k > 0$ the isocost line doesn't change.

The input combination that minimizes the cost of producing q does not change, but the cost of the inputs is multiplied by k.

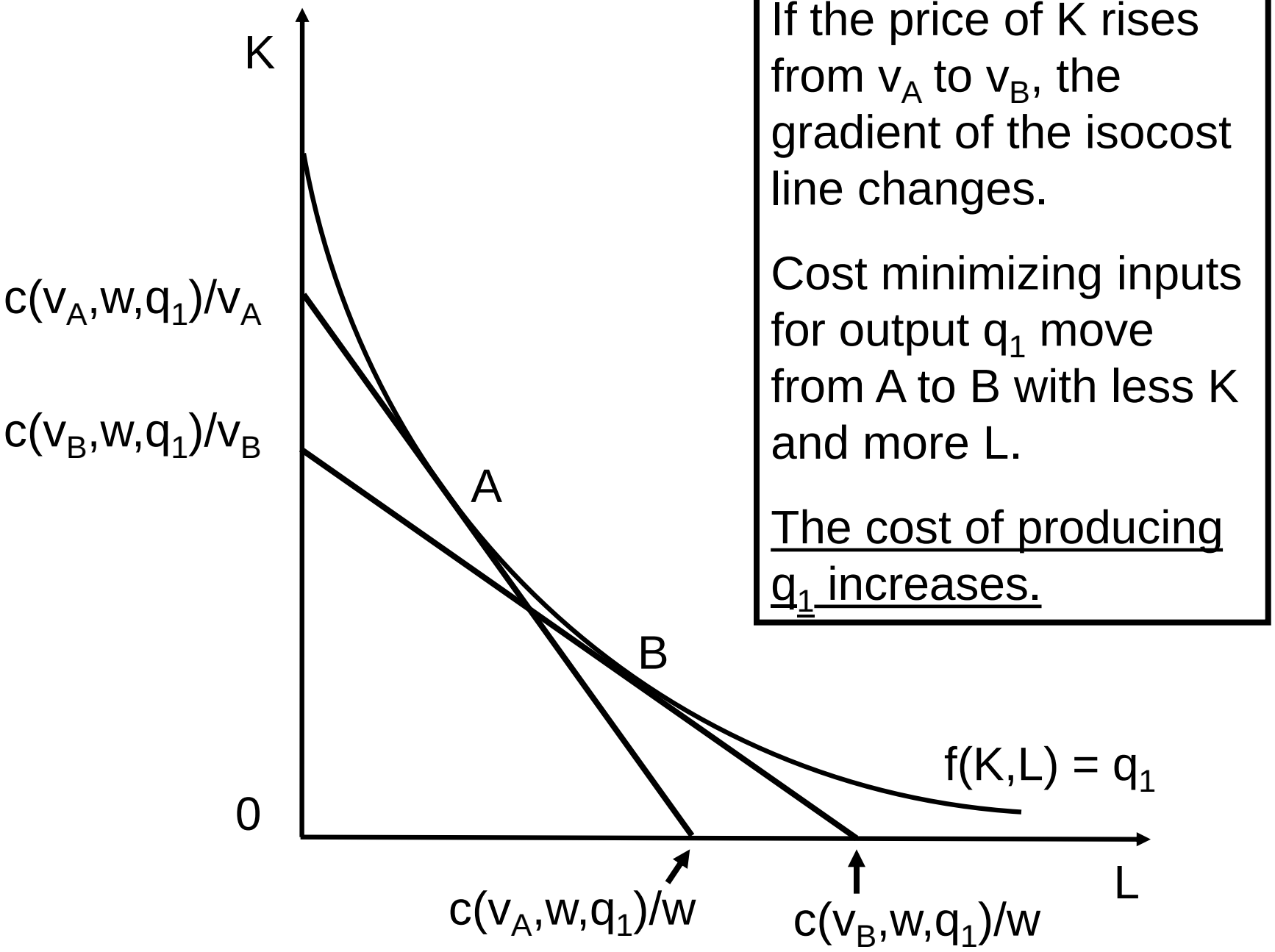
<u>Conditional factor demand K(v,w,q) & L(v,w,q) are homogeneous of degree 0 in input prices.</u>



If all input prices are multiplied by $k > 0$ the isocost line doesn't change.

The input combination that minimizes the cost of producing q does not change, but the cost of the inputs is multiplied by k.

<u>The cost function is homogeneous of degree 1 in input prices.</u>



If the price of K rises from v_A to v_B, the gradient of the isocost line changes.

Cost minimizing inputs for output q_1 move from A to B with less K and more L.

The cost of producing q_1 increases.

Returns to scale
& economies of scale

5. Returns to scale

Returns to scale are a property of the production function.

They have implications for the cost function which are important for understanding the competitive structure of an industry.

m > 1

If f(mK,mL) = mf(K,L) there are

returns to scale.

If f(mK,mL) < mf(K,L) there are

returns to scale.

If f(mK,mL) > mf(K,L) there are

returns to scale.

If this seems strange think about m = 2.

m > 1

If f(mK,mL) = mf(K,L) there are

constant returns to scale.

If f(mK,mL) < mf(K,L) there are

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If f(mK,mL) < mf(K,L) there are

decreasing returns to scale.

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returns to scale.

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m > 1

If $f(mK,mL) = mf(K,L)$ there are

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If $f(mK,mL) < mf(K,L)$ there are

decreasing returns to scale.

If $f(mK,mL) > mf(K,L)$ there are

increasing returns to scale.

If this seems strange think about m = 2.

Returns to scale with Cobb Douglas production function $f(K,L) = K^aL^b$

$a > 0$, $b > 0$, $m > 0$, implies $f(mK,mL) = (mK)^a(mL)^b = m^aK^am^bL^b$

$= m^{a+b}K^aL^b = m^{a+b} f(K,L)$

Assume $m > 1$. If **$a + b = 1$**, $m^{a+b} = m$, so $f(mK,mL) = m\, f(K,L)$

Returns to scale? 

If **$a + b > 1$**, $m^{a+b} > m$, so $f(mK,mL) > m\, f(K,L)$

Returns to scale? 

If **$a + b < 1$**, $m^{a+b} < m$, so $f(mK,mL) < m\, f(K,L)$

Returns to scale? 

Returns to scale with Cobb Douglas production function $f(K,L) = K^aL^b$

$a > 0$, $b > 0$, $m > 0$, implies $f(mK,mL) = (mK)^a(mL)^b = m^aK^am^bL^b$

$= m^{a+b}K^aL^b = m^{a+b} f(K,L)$

Assume $m > 1$. If **$a + b = 1$**, $m^{a+b} = m$, so $f(mK,mL) = m\, f(K,L)$

Returns to scale? constant

If **$a + b > 1$**, $m^{a+b} > m$, so $f(mK,mL) > m\, f(K,L)$

Returns to scale? 

If **$a + b < 1$**, $m^{a+b} < m$, so $f(mK,mL) < m\, f(K,L)$

Returns to scale? 

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Returns to scale? constant

If **$a + b > 1$**, $m^{a+b} > m$, so $f(mK,mL) > m\, f(K,L)$

Returns to scale? increasing

If **$a + b < 1$**, $m^{a+b} < m$, so $f(mK,mL) < m\, f(K,L)$

Returns to scale? 

Returns to scale with Cobb Douglas production function $f(K,L) = K^aL^b$

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Returns to scale? constant

If **$a + b > 1$**, $m^{a+b} > m$, so $f(mK,mL) > m\, f(K,L)$

Returns to scale? increasing

If **$a + b < 1$**, $m^{a+b} < m$, so $f(mK,mL) < m\, f(K,L)$

Returns to scale? decreasing

6. Economies of Scale

- **Returns to scale** are a feature of a **production function**.
- **Economies and diseconomies of scale** are a feature of a **cost function**.
- Average cost AC = total cost/output
- There are <u>economies of scale if AC</u>  <u>with output</u>.
- There are <u>diseconomies of scale if AC</u>  <u>with output.</u>
- Increasing returns to scale in the production function imply  of scale, more on this later.
- There other sources of economies of scale.

Economies of Scale

- Returns to scale are a feature of a production function.
- Economies and diseconomies of scale are a feature of a cost function.
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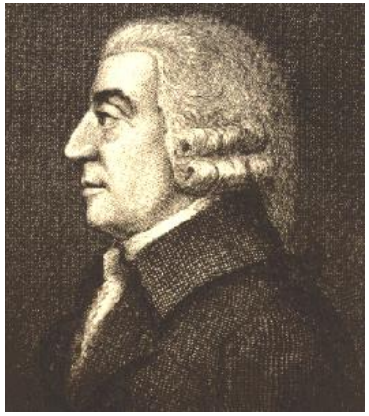
- Increasing returns to scale in the production function imply economies of scale, more on this later.
- **There other sources of economies of scale.**

Division of Labour



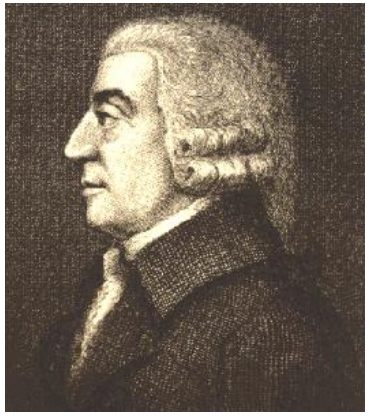
Adam Smith, Wealth of Nations, 1776

Description of a pin factory

“One man draws out the wire, another straightens it, a third cuts it, a fourth points it, a fifth grinds it at the top for receiving the head; to make the head requires two or three distinct operations; to put it on is a peculiar business, to whiten the pins is another; it is even a trade by itself to put then into the paper..... ten persons can make upwards of 48 000 pins in a day …”

can one person make 4 800 in a day?

Division of Labour



Adam Smith, Wealth of Nations, 1776

Description of a pin factory

"One man draws out the wire, another straightens it, a third cuts it, a fourth points it, a fifth grinds it at the top for receiving the head; to make the head requires two or three distinct operations; to put it on is a peculiar business, to whiten the pins is another; it is even a trade by itself to put then into the paper..... ten persons can make upwards of 48 000 pins in a day, one person certainly **cannot** make 4 800 in a day."

Division of labour on a production line 1977

A more automated production line 2009.

Note the change in technology and the substitution of capital for labour.

Volume Effects

For ships, pipe lines, planes, chemical works, blast furnaces, etc..

capacity depends on volume.

cost depends on surface area,

increasing size reduces cost per unit of output.

EMMA MÆRSK
Length: 379 meters
Capacity: 11,000 containers each weighing 14 tons

Source: Wikipedia

Argument that there can’t be decreasing returns to scale

Suppose that a factory produces 1 million cars.

If the firm wants to produce 2 million cars it could

set up an identical factory that produces another 1 million cars in exactly the same way.

So doubling inputs either doubles output or more than doubles output.

Thus **there must be** constant or increasing returns to scale.

Where might this argument be wrong?

- There might be some fixed input that cannot be doubled,

  example: a manager with experience and expertise in running the factory.
- There may be managerial diseconomies of scale.
- Management difficulties grow faster than the number of people.
- A very small organisation may be able to coordinate during a coffee break.
- Bigger organisations need formal structures.
- The transition from a small to a large organisation can be difficult and expensive.

Other Influences on Costs

- The production function model assumes a single unchanging product and that the amount of output from a given input is fixed by technology.
- This may not be so owing to
    - economies of scope
    - learning by doing
- Costs before production starts,

  e.g. research and development, website

Economies of Scope

One firm producing a range of related products has cost advantages over firms producing single products.

Are there economies of scope in running supermarkets and home deliveries of groceries?

Ocado does not have supermarkets and originally delivered Waitrose products. Runs from dedicated warehouses.

Tesco, originally goods for delivery were handpicked in stores, now “dark stores”.

Supermarkets In the UK © Getty Images

Learning by Doing

As firms build experience in producing a product → the average cost of producing the product falls.

Examples, silicon chips

aeroplanes

Concord Production © Getty Images

What have we achieved

- Modelling of the firm by a production function
  - Useful for understanding how input prices affect costs
  - Major limitations:
    no insight into firms as organizations
    no insight into R&D and innovation