Lancaster University Management School

Introduction to Operations Management

Inventory Management

2024 – 25

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- Slack et al, chapter 13

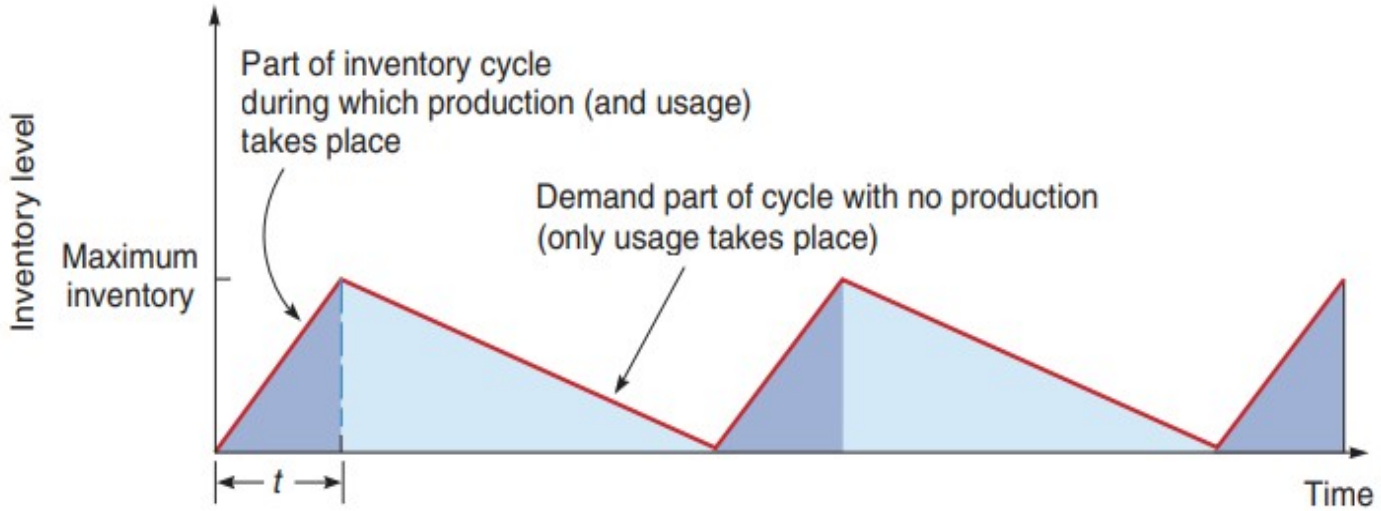
- What is inventory?
- Why do we get it?
- Why not have a lot more of it?
- How do we determine how much to have?

And when do we get it?

- Economic Batch Quantity
- Inventory classification
- Re-order levels

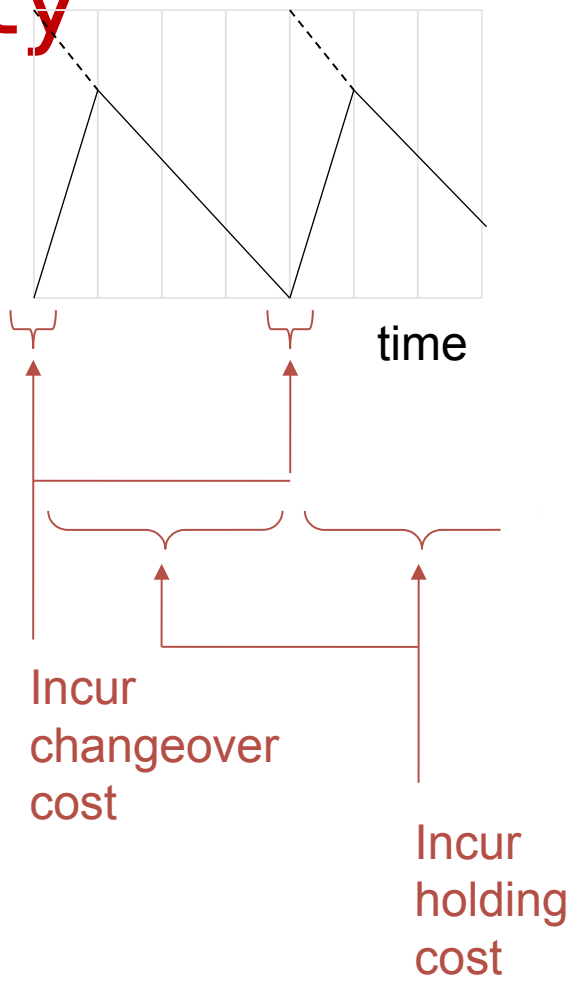
Economic batch quantity

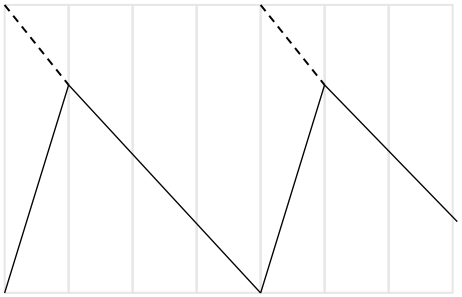
- Replenishment is not instantaneous
- Inventory is received over a period of time
- E.g., Units are produced and sold simultaneously (Contract manufacturer of bread for a local Superstore).
- White bread, Wholemeal, Seeded, Super seeded.
- Take into account the daily production rate and daily demand rate.



Economic batch quantity

- Cost at start of each replenishment = ‘setup’ cost
  - Analogous to ‘order’ cost
  - Sometimes also called a ‘changeover’ cost
  - Typically being the costs of switching product types
- Aim is now to calculate optimal ‘batch quantity’
  - Rather than ‘order quantity’
- But a similar trade-off
  - Large batches mean large inventory holding costs
  - Small batches mean many costly setups





Economic batch quantity

- **Now $Q_{min} = \sqrt{(2\ C_o D\ /\ C_h(1 - d/p))}$**
  (the *economic batch quantity* EBQ)

- Compare EOQ $Q_{min} = \sqrt{(2\ C_o D/\ C_h\ )}$
- Ie multiply the holding cost by factor (1 – d/p)
- To reflect the fact inventory never reaches total produced

EBQ, $Q_{min} = \sqrt{(2\ C_o D/\ C_h(1 - d/p))}$

C_h holding cost *per unit per year*
C_o changeover cost *per changeover*
Q size of batch
d is rate of depletion (demand)
p is rate of replenishment (production)

Solved example

Example (Slack *et al* p. 462)

- What is the optimal batch length for a bottling plant? There is a constant demand of 80 000 / month, a month has 160 hours, bottles fill at 3000 / hour, the line takes 1 hour to clean and reset, the changeover cost is £100 / hour, and holding costs are £0.1 / bottle / month.

A) 205

B) 9 798

C) 13 856

D) 78 333

$EBQ,\ Q_{min} = \sqrt{(2\ C_o D / C_h(1 - d/p))}$

$D = 80000 / 160 = d = 500$ / hour

C_o = £100 / 1 hour

$EBQ = \sqrt{[(2 \times 100 \times 80{,}000)/0.1(1 - 500/3000)]} = 13{,}856$

Solved example

Example (Slack *et al* p. 462)

If the changeover reduced from 1 to .5 hours what would the EBQ now be?

A) 205

B) 9798

C) 13 856

D) 78 333

EBQ, $Q_{min} = \sqrt{(2\ C_o D / C_h(1 - d/p))}$

Hint: Changeover time reduction means a change in C_o

EBQ = 9798

Solved example (p. 449)

How long does it take to *use* up a batch, and how long to *produce* a batch in this case?

A) 20 hours, 3 hours

B) 15 hours, 1 hour

C) 5 hours, 15 hours

D) None of the above

EBQ = 9 798
Rate of demand d = 500 /hour
So time to use up = 9 798 / 500 ≈ 20 hours
Rate of production p = 3000 /hour
So time to produce = 9 798 / 3000 ≈ 3.3 hours

Cycle time CT = EBQ/d (time to use up a batch)
Batch time BT = EBQ/p (time to produce a batch)

Some criticisms

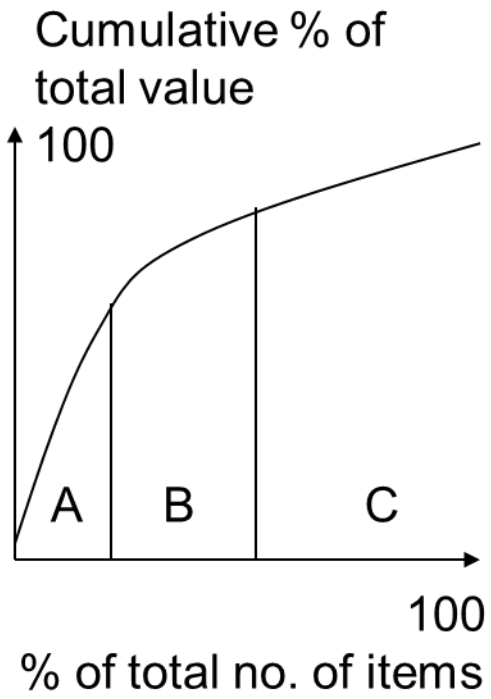
- Assumptions about stability
  - Demand typically irregular
- Assumptions about linearity
  - Costs can fluctuate
- Assumptions about what's fixed
  - Costs can be influenced e.g. by rapid setup, more efficient machines
- Assumption that this is worth doing for anything
  - Need for prioritisation

Inventory control – ABC Analysis

- A mechanism through which inventory is prioritised and categorised.
- ABC analysis is an inventory application of Pareto principle that states:

a "critical few and trivial many"

⇒ It is not realistic to monitor inexpensive items (*the many trivial*) with the same intensity as very expensive items (*the few critical*).



ABC Analysis

- A method for dividing on-hand inventory into three classifications based on value
- Pareto law: 80% of the value from 20% of inventory
  - Class A: low volume (20%) high value (80%). Very tight control & tracking.
  - Class B: medium volume (30%) and medium value (10%). Tight control & moderate tracking.
  - Class C: high volume (50%) and very low value (10%). little control & tracking.

Note: No need for this classification to be exact, but it is important to recognise the levels of control that match the risk

Benefits: Better forecasting, physical control, supplier reliability, and an ultimate reduction in inventory

ABC Analysis - example

You're a bike retailer and the profit you make on the top 18 road bikes are shown in the table. Which items account for 80% of the profit? Is it 20% of the stock?

Bike	Profit £
A	3120
B	2020
C	1080
D	840
E	800
F	680
G	510
H	440
I	440
J	240
K	220
L	210
M	180
N	170
O	170
P	160
Q	110
R	30
Total	11420

A) A to B (2/18 of total items)

B) A to E (5/18 of total items)

C) A to G (7/18 of total items)

D) A to I (9/18 of total items)

ABC Analysis - example

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Bike	Profit £	Acc £	%
A	3120	3120	27.32%
B	2020	5140	45.01%
C	1080	6220	54.47%
D	840	7060	61.82%
E	800	7860	68.83%
F	680	8540	74.78%
G	510	9050	79.25%
H	440	9490	83.10%
I	440	9930	86.95%
J	240	10170	89.05%
K	220	10390	90.98%
L	210	10600	92.82%
M	180	10780	94.40%
N	170	10950	95.88%
O	170	11120	97.37%
P	160	11280	98.77%
Q	110	11390	99.74%
R	30	11420	100.00%
Total	11420		

ABC Exercise: How to do ABC analysis?

Exercise									
Item stock number	Annual volume	Unit cost	Annual value	Percentage of annual value	Cumulative value %	Class	%value	%volume	Policy
#10286	1000	90							
#11526	500	154							
#12760	1550	17							
#10867	350	42.86							
#10500	1000	12.5							
#12572	600	14.17							
#14075	2000	0.6							
#01036	100	8.5							
#01307	1200	0.42							
#10572	250	0.6							

Prioritisation for concern

- Usage value is not the only means of prioritisation
- Also need to attend to items which become:
  - In rare demand
  - Over-stocked
  - Constantly at risk of shortage…
- So two measures commonly monitored:
  - Stock cover SC = Mean inventory/Mean demand
  - (fraction of a period's stock requirements on hand)
  - Stock turns = ST = 1/SC
  - (times per period the stock is renewed)

Example

Which are the problem bikes?

Bike	Mean inventory	Mean demand
A	4	1
B	4	1
C	7	6
D	9	4
E	6	1
F	1	0

Example

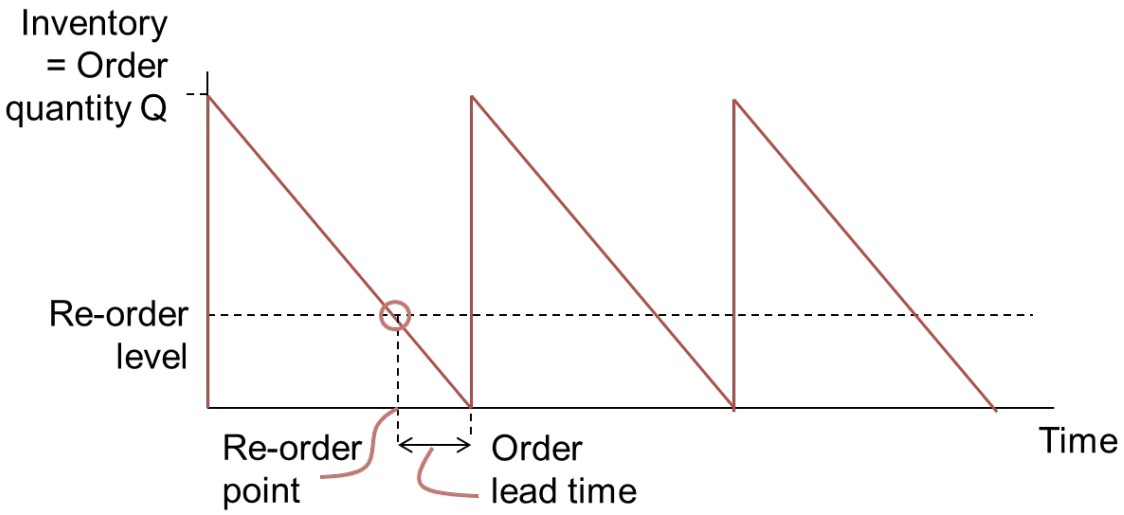
Which are the problem bikes?

- Depends on context
- Anticipated demand, reliability of supplies, cost
- E &F (possibly low SC with C)

Bike	Mean inventory	Mean demand	SC	ST
A	4	1	4	25%
B	4	1	4	25%
C	7	6	1.2	86%
D	9	4	2.3	44%
E	6	1	6	17%
F	1	0	#	#

Reorder level and time

- There's a timing decision to go with the volume decision
- Given a finite time to deliver an order (the lead time)
- Typically firms set a re-order level



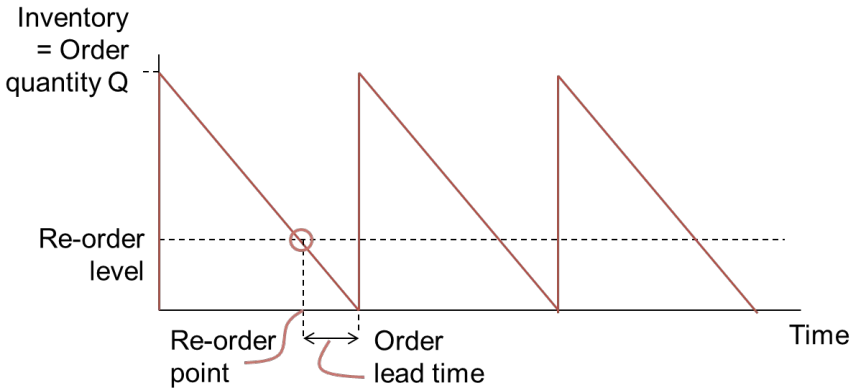
Reorder level and time

- There's a timing decision to go with the volume decision
- Given a finite time to deliver an order (the lead time)
- Typically firms set a re-order level
- If demand is D per unit time
- And order lead time is L
- Reorder level R = DL

E.g. if D = 1000 / y

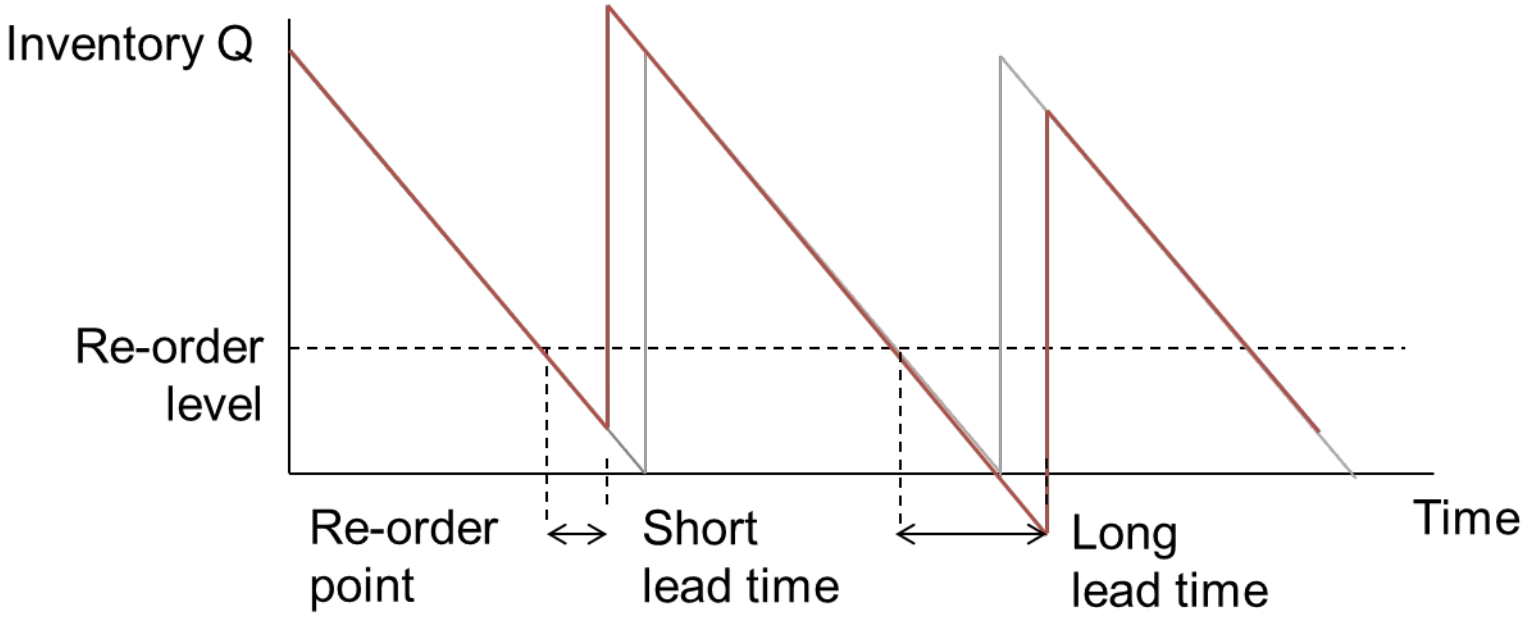
And L = 1 w = 1/52 y

Then R = 1000 x 1/52 ≈ 19



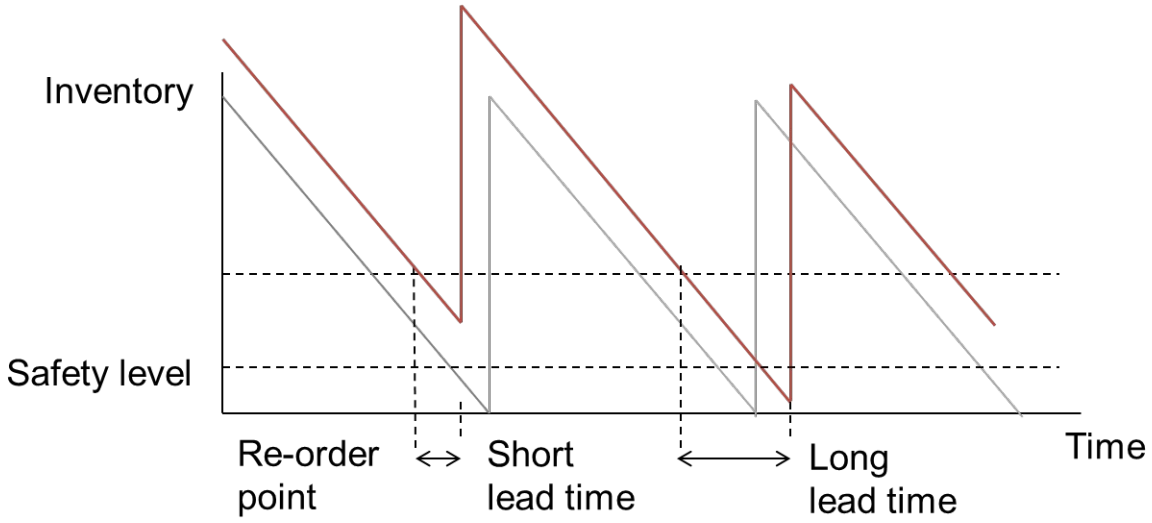
Reorder level and time

- But there is usually variation in lead times



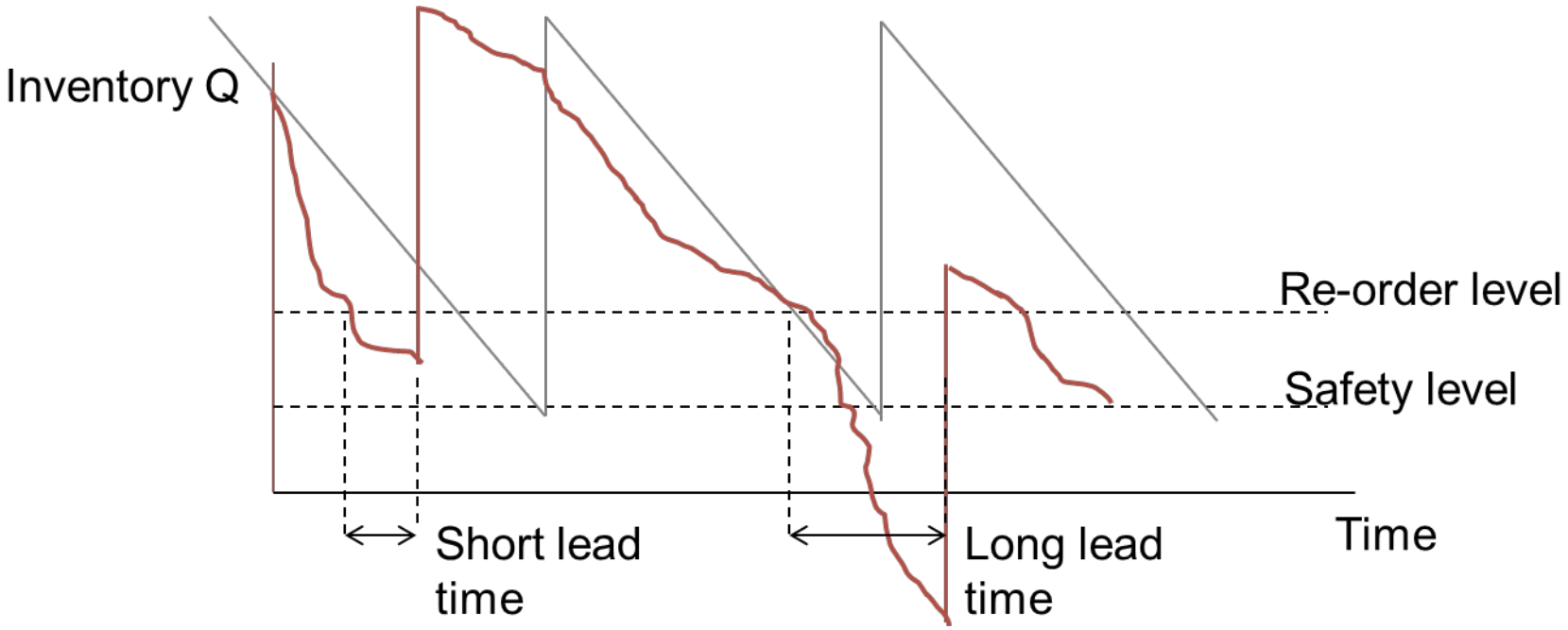
Reorder level and time

- So plan for safety inventory level



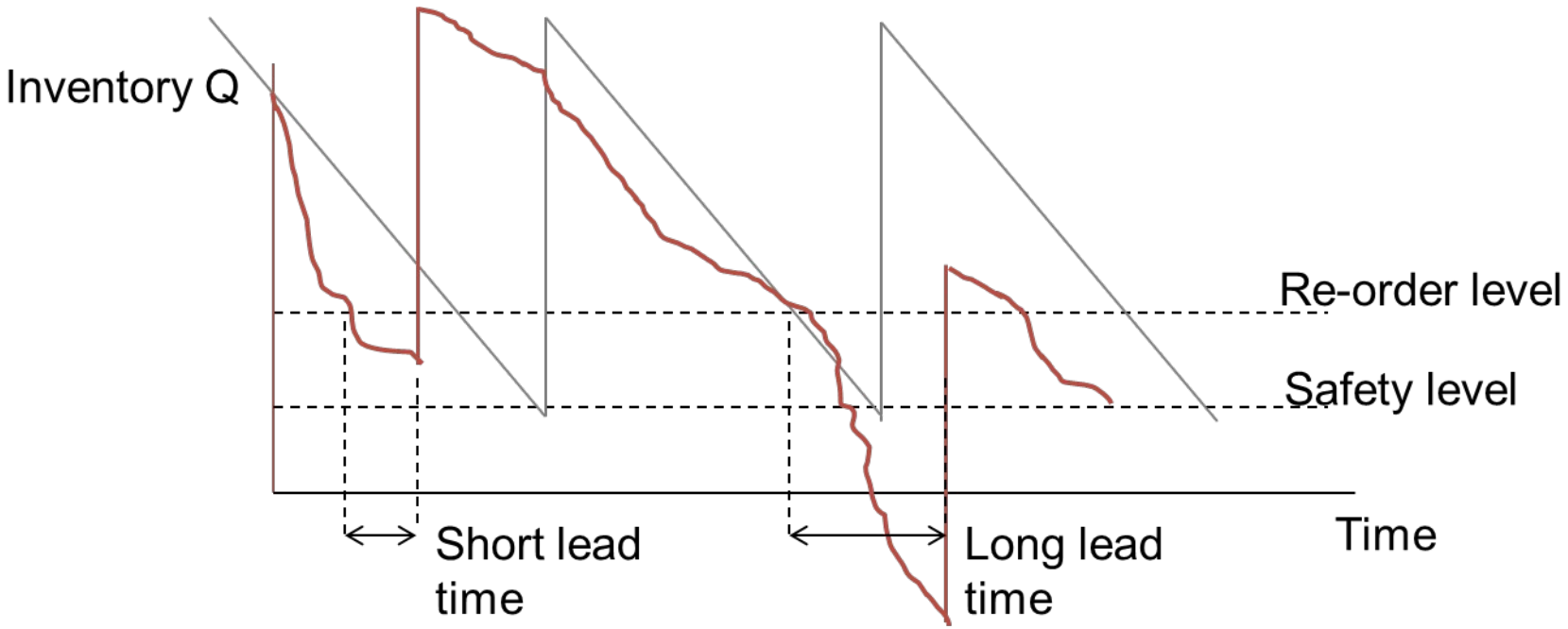
Reorder level and time

- But there is variation in rate of demand as well



Reorder level and time

- Not only manufacturing LT but also logistics and local LT
- Forward looking forecast



Questions

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Thank you for attending, email questions to a.Iftikhar@Lancaster.ac.uk