Inventory Management

Summer 2025

- Assignment 4 -

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Exercise Sessions

15 min

Discuss with your partners: exchange solutions and problems encountered → Present your solution to the class (Volunteer) → Summarize solution, Q&A

Exercise 1:

A wholesaler of telecommunication components could surprisingly obtain a new retailer to distribute its digital receivers. The wholesaler uses distribution requirements planning and has already calculated the projected gross requirements for the digital receivers. But this calculation was done without considering the new retailer's demand.

It takes **one period for orders to be shipped** from the wholesaler to the retailer and the retailer aims at **holding safety stocks of 30** units. The wholesaler has a **lead time of 3 periods and no safety stock.** The tables below show the current gross requirements plan of the new retailer and the obsolete one of the wholesalers. The table also contains orders placed by the retailer with another wholesaler which are scheduled to arrive in periods 3 and 6.

New retailer								
Time period	0	1	2	3	4	5	6	7
Projected gross requirements	--	150	120	130	180	160	90	100
Planned order receipts				200			180	
Projected net inventory at the end of period	230							

Wholesaler								
Time period	0	1	2	3	4	5	6	7
Projected gross requirements	--	200	110	120	160	180	80	140
Planned order receipts			200		100			
Projected net inventory at the end of period	280							

Exercise 1.a) Update the projected gross requirements of the **wholesaler**.

Retailer (L = 1, ss = 30)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Projected gross requirements		150	120	130	180	160	90	100
Starting inventory $= Inv_{t-1} - Gross\ Re_{t-1} + Net\ Re_{t-1} + Order\ Receip\ t_t$		230	80 (230-150+0+0)	230 (80-120+70+200)	100 (230-130+0+0)	30 (100-180+110+0)	210 (30-160+160+180)	120 (210-90+0+0)
Net requirements $[(ss + Gross\ Re - Inv)\ in\ t]^+$		0 $[30+150-230]^+$	70 $[30+120-80]^+$	0 $[30+130-230]^+$	110 $[30+180-100]^+$	160 $[30+160-30]^+$	0 $[30+90-210]^+$	10 $[30+100-120]^+$
Planned order receipts				200			180	
Order release	**0**	**70**	**0**	**110**	**160**	**0**	**10**	**0**

Wholesaler	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Projected gross requirements (old)		200	110	120	160	180	80	140
Projected gross requirements (new)		270 (200+70)	110	230 (120 + 110)	320 (160 + 160)	180	90 (80 + 10)	140

Exercise 1.b) Compute the projected **net inventories at the beginning of each period** and determine the corresponding **orders** that should be placed **for the wholesaler**.

Wholesaler (L = 3, ss = 0)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Projected gross requirements (new)		270	110	230	320	180	90	140
Starting inventory		**280**	**210** (280-270+0+200)	**100** (210-110+0+0)	**100** (100-230+130+100)	**0** (100-320+220+0)	**0** (0-180+180+0)	**0** (0-90+90+0)
Net requirements		0 $[270-280]^+$	0 $[110-210]^+$	130 $[230-100]^+$	220 $[320-100]^+$	180 $[180-0]^+$	90 $[90-0]^+$	140 $[140-0]^+$
Planned order receipts			200	0	100	0	0	0
Order release	130	220	180	90	140	0	0	0

Exercise 2:

Hifi-Expert, a distributor of flat screens, has two local shops (A and B) and a central warehouse. The central warehouse supplies the local shops where the flat screens are available for the end customer. The distributor has forecasted the following demand in the next periods:

Time period	1	2	3	4	5	6	7
Shop A	120	130	160	120	40	70	100
Shop B	50	150	130	110	50	170	140

Shop A has a lead time of two periods, shop B has a lead time of one period and the warehouse has a lead time of two periods. The initial inventories are 250 units at shop A, 300 units at shop B and 450 units at the warehouse. There are also outstanding orders, which the locations plan to receive: shop A 150 units in period 2 and shop B 120 units in period 4, the warehouse 100 units in period 3. In case of inventory rationing use **the priority approach (shop B has higher priority).**

Exercise 2.a) Calculate the requirements planning sheet for **the whole supply chain** if the distributor wants to **use an installation stock policy** with the following parameters: **S_A= 400, S_B= 300, S_W= 700 and R=1.**

*Lead time: **A(2), B(1), W(2)** *Initial Inventory: **A(250), B(300), W(450)** *Outstanding Order: **A(150) in P2, B(120) in P4, W(100) in P3 – (R, S) policy**

Period	Entity	Outstanding Orders (O/O)	Received Units (R/U)	Starting Inv (S/I)	Inventory Position(IP)	Order (q)	Demand	Ending Inv(E/I)	Satisfied Demand	Ship W-->A	Ship W-->B	Backlog A	Backlog B
1	A		0	250	400 (=250+150)	0 $[400-400]^+$	120	130 (=250-120)	120				
	B		0	300	420 (=300+120)	0 $[300-420]^+$	50	250 (=300-50)	50				
	W		0	450	550 (=450+100+0-0)	150 $[700-550]^+$	0 (=0+0)	450 (=450-0)	0	0	0	0	0
2	A	150	150 (O/O + W->A_{t-2})	280 (=130+150)	280	120 $[400-280]^+$	130	150 (=280-130)	130				
	B		0 (O/O + W->B_{t-1})	250 (=250+0)	370	0 $[300-370]^+$	150	100 (=250-150)	150				
	W		0 (O/O + W->q_{t-2})	450 (=450+0)	580 (=450+100+150-**120**)	120 $[700-580]^+$	120 (=120+0)	330 (=450-120)	120	120	0	0	0
3	A		0	150	270 (=150+120)	130 $[400-270]^+$	160	-10 (=150-160)	150				
	B		0	100	220	80 $[300-220]^+$	130	-30 (=100-130)	100				
	W	100	250 (=100+150)	580 (=330+250)	490 (=580+120-**210**)	210 $[700-490]^+$	210	370 (=580-210)	210	130	80	0	0

Exercise 2.a) Calculate the requirements planning sheet for **the whole supply chain** if the distributor wants to **use an installation stock policy** with the following parameters: $\mathbf{S_A = 400, S_B = 300, S_W = 700}$ **and R=1.**

*Lead time: **A(2), B(1), W(2)** *Initial Inventory: **A(250), B(300), W(450)** *Outstanding Order: **A(150) in P2, B(120) in P4, W(100) in P3 – (R, S) policy**

Period	Entity	Outstanding Orders (O/O)	Received Units (R/U)	Starting Inv (S/I)	Inventory Position(IP) Starting Inv + Order	q	Demand	Ending Inv(E/I)	Satisfied Demand	Ship W-->A	Ship W-->B	Backlog A	Backlog B
4	A		120	110 (=120-10)	240 (=110+130)	160 $[400-240]^{+}$	120	-10	120				
	B	120	200	170	170	130	110	60	140				
	W		120	490 (=120+370)	410 (=490+210-**290**)	290 $[700-410]^{+}$	290	200	290	160	130	0	0
5	A		130	120 (=130-10)	280 (=120+160)	120 $[400-280]^{+}$	40	80	50				
	B		130	190	190	110	50	140	50				
	W		210	410	470	230	230	180	230	120	110	0	0
6	A		160	240 (=160+80)	360 (=240+120)	40	70	170	70				
	B		110	250	250	50	170	80	170				
	W		290	470	610	90	90	380	90	40	50	0	0
7	A		120	290	330	70	100	190	100				
	B		50	130	130	170	140	-10	130				
	W		230	610	460	240	240	370	240	70	170	0	0

Exercise 2.b) Calculate the requirements planning sheet for **the whole supply chain** if the distributor wants to **use an echelon stock policy** with the following parameters: **S_A = 400, S_B = 300, S_W= 1100 and R=1.**

*Lead time: **A(2), B(1), W(2)** *Initial Inventory: **A(250), B(300), W(450)** *Outstanding Order: **A(150) in P2, B(120) in P4, W(100) in P3 – (R, S) policy**

Period	Entity	Outstanding Orders (O/O)	Received Units (R/U)	Starting Inv (S/I)	Inventory Position(IP) Starting Inv + Order	q	Demand	Ending Inv(E/I)	Satisfied Demand	Ship W-->A	Ship W-->B	Backlog A	Backlog B
	A		0	250	400	0	120	130	120				
	B		0	300	420	0	50	250	50				
1	W		0	450	1370 (=450+100+400+420+0)	0 $[\,1100-1370\,]^+$	0	450	0	0	0	0	0
	A	150	150	280	280	120	130	150	130				
	B		0	250	370	0	150	100	150				
2	W		0	450	1200 (=450+100+280+370+0)	0 $[\,1100-1200\,]^+$	120	330	120	120	0	0	0
	A		0	150	270	130	160	-10	150				
	B		0	100	220	80	130	-30	100				
3	W	100	100	430	920 (=430+270+220+0)	180 $[\,1100-920\,]^+$	210	220	210	130	80	0	0

Exercise 2.b) Calculate the requirements planning sheet for **the whole supply chain** if the distributor wants **to use an echelon stock policy** with the following parameters: **S_A = 400, S_B = 300, S_W= 1100 and R=1.**

*Lead time: **A(2), B(1), W(2)** *Initial Inventory: **A(250), B(300), W(450)** *Outstanding Order: **A(150) in P2, B(120) in P4, W(100) in P3 – (R, S) policy**

Period	Entity	Outstanding Orders (O/O)	Received Units (R/U)	Starting Inv (S/I)	Inventory Position(IP) Starting Inv + Order	Q	Demand	Ending Inv(E/I)	Satisfied Demand	Ship W-->A	Ship W-->B	Backlog A	Backlog B
	A		120	110	240	160	120	-10	120				
	B	120	200	170	170	130	110	60	140				
4	W		0	220	810 (=220+240+170+180)	290 $[1100-810]^+$	290	-70	220	90	130	70	0
	A		130	120	280	120	40	80	50				
	B		130	190	190	110	50	140	50				
5	W		180	110 (=180-70)	870 (=110+280+190+290)	230 $[1100-870]^+$	230	-120	180	70	110	120	0
	A		90	170	360	40	70	100	70				
	B		110	250	250	50	170	80	170				
6	W		290	170 (=290-120)	1010 (=170+360+250+230)	90 $[1100-1010]^+$	90	80	210	160	50	0	0
	A		70	170	330	70	100	70	100				
	B		50	130	130	170	140	-10	130				
7	W		230	310 (=230+80)	860 (=310+330+130+90)	240 $[1100-860]^+$	240	70	240	70	170	0	0

Exercise 2.c) Determine in-stock probability and (adjusted) fill rate for the results in b).

Period	1		2		3		4		5		6		7	
Entity	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Ending Inv	130	250	150	100	-10	-30	-10	60	80	140	100	80	70	-10

Entities	Number of Stock out	Total number of periods	Alpha-SL
Shop A	2	7	0.714 (=1-2/7)
Shop B	2	7	0.714(=1-2/7)

Entities	Backlogs w/o initial period	Total demand	Gamma-SL (adj.) fill rate
Shop A	20	740	0.973(=1-20/740)
Shop B	40	800	0.950(=1-40/800)

Exercise 2.d) How do the results in b) and c) change if shop **A had the higher priority**?

S_A = 400, S_B = 300, S_W= 1100 and R=1.

*Lead time: **A(2), B(1), W(2)** *Initial Inventory: **A(250), B(300), W(450)** *Outstanding Order: **A(150) in P2, B(120) in P4, W(100) in P3 – (R, S) policy**

Period	Entity	Outstanding Orders (O/O)	Received Units (R/U)	Starting Inv (S/I)	Inventory Position(IP)	q	Demand	Ending Inv(E/I)	Satisfied Demand	Ship W-->A	Ship W-->B	Backlog A	Backlog B
1	A		0	250	400	0	120	130	120				
	B		0	300	420	0	50	250	50				
	W		0	450	1370	0	0	450	0	0	0	0	0
2	A	150	150	280	280	120	130	150	130				
	B		0	250	370	0	150	100	150				
	W		0	450	1200	0	120	330	120	120	0	0	0
3	A		0	150	270	130	160	-10	150				
	B		0	100	220	80	130	-30	100				
	W	100	100	430	920	180	210	220	210	130	80	0	0

Period 1~3 same as before (Exercise 2.b): no inventory shortage (W), hence, no rationing needed!

Exercise 2.d) How do the results in b) and c) change if shop **A had the higher priority**?

S_A = 400, S_B = 300, S_W= 1100 and R=1.

*Lead time: **A(2), B(1), W(2)** *Initial Inventory: **A(250), B(300), W(450)** *Outstanding Order: **A(150) in P2, B(120) in P4, W(100) in P3 – (R, S) policy**

Period	Entity	Outstanding Orders (O/O)	Received Units (R/U)	Starting Inv (S/I)	Inventory Position(IP)	Q	Demand	Ending Inv(E/I)	Satisfied Demand	Ship W-->A	Ship W-->B	Backlog A	Backlog B
4	A		120	110	240	160	120	-10	120				
	B	120	200	170	170	130	110	60	140				
	W		0	220	810	290	290	-70	220	160	60	0	70
5	A		130	120	280	120	40	80	50				
	B		60	120	190	110	50	70	50				
	W		180	110 (=180-70)	870 (=110+280+190+290)	230	230	-120	180	110	70	10	110
6	A		160	240	360	40	70	170	70				
	B		70	140	250	50	170	-30	140				
	W		290	170 (=290-10-110)	1010 (=170+360+250+230)	90	90	80	210	50	160	0	0
7	A		110	280	330	70	100	180	100				
	B		160	130	130	170	140	-10	160				
	W		230	310	860 (=310+330+130+90)	240	240	70	240	70	170	0	0

Exercise 2.d) How do the results in b) and c) change if shop **A had the higher priority**?

Period	1		2		3		4		5		6		7	
Entity	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Ending Inv	130	250	150	100	-10	-30	-10	60	80	70	170	-30	180	-10

A > B

Entities	Number of Stock out	Total number of periods	Alpha-SL
Shop A	2	7	0.714 (=1-2/7)
Shop B	3	7	0.571(=1-3/7)

Entities	Backlogs w/o initial period	Total demand	Gamma-SL (adj.) fill rate
Shop A	20	740	0.973(=1-20/740)
Shop B	70	800	0.913(=1-70/800)

B > A

Entities	Number of Stock out	Total number of periods	Alpha-SL
Shop A	2	7	0.714 (=1-2/7)
Shop B	2	7	0.714(=1-2/7)

Entities	Backlogs w/o initial period	Total demand	Gamma-SL (adj.) fill rate
Shop A	20	740	0.973(=1-20/740)
Shop B	40	800	0.950(=1-40/800)

Exercise 3:

Consider a two-stage serial inventory system where the retailer is facing **a yearly demand of 2500 units**. The retailer has the following cost structure: **ordering cost of 25€ and holding cost of 2.5€ per unit and year.** The central warehouse pays **20€ for each order and has a holding cost of 1.2€ per unit and year.**

Determine optimal lot sizes of the retailer and the warehouse for the following three approaches: independent, sequential and simultaneous planning. What are the resulting costs?

Exercise 3.a) Determine optimal lot sizes of the retailer and the warehouse for the following three approaches: **independent, sequential and simultaneous planning**. What are the resulting **costs**?

	Retailer		Warehouse	
D	2500	units/year		
A	25	Euro/order	20	Euro/order
h	2.5	Euro/unit and year	1.2	Euro/unit and year

1) Independent Planning

$$C(Q) = \frac{d}{Q}A + \frac{h}{2}Q$$

$$\frac{dC(Q)}{dQ} = -\frac{dA}{Q^2} + \frac{h}{2} = 0 \Rightarrow Q^* = \sqrt{\frac{2dA}{h}}$$

$$C(Q^*) = \sqrt{2dAh}$$

	Retailer	Warehouse	Total Cost
Q	$=\sqrt{\frac{2\cdot2500\cdot25}{2.5}}$ =223.61	$=\sqrt{\frac{2\cdot2500\cdot20}{1.2}}$ =288.68	559.02+346.41 = 905.43
C(Q)	$=\sqrt{2\cdot2500\cdot25\cdot2.5}$ =559.02	$=\sqrt{2\cdot2500\cdot20\cdot1.2}$ =346.41	

Exercise 3.a) Determine optimal lot sizes of the retailer and the warehouse for the following three approaches: **independent, sequential and simultaneous planning.** What are the resulting **costs?**

	Retailer		Warehouse	
D	2500	units/year		
A	25	Euro/order	20	Euro/order
h	2.5	Euro/unit and year	1.2	Euro/unit and year

2) Sequential Planning

$$C_R(Q_R) = \frac{d}{Q_R} A_R + \frac{h_R}{2} Q_R \qquad Q_R^* = \sqrt{\frac{2dA_R}{h_R}}$$

$$C_W(n) = \frac{d}{nQ_R} A_W + \frac{h_W}{2} Q_R (n-1)$$

$$C_W(n+1) \le C_W(n) \Leftrightarrow n(n+1) \le \frac{A_W h_R}{A_R h_W}$$

$$n^* = \min\left\{ n \mid n(n+1) \ge \frac{A_W h_R}{A_R h_W} \right\}$$

	Retailer	Warehouse	Total Cost
Q	$=\sqrt{\frac{2 \cdot 2500 \cdot 25}{2.5}}$ =223.61	$=Q_R \cdot n_*$ =223.61	559.02+223.61 = 782.63
C(Q)	$=\frac{2500}{223.61} 25 + \frac{2.5}{2} 223.61$ =559.02	$=\frac{2500}{223.61} 20 + \frac{1.2}{2} 0$ =223.61	
n	$\min\left\{n \middle| n(n+1) \ge \frac{20 \cdot 2.5}{25 \cdot 1.2}\right\}$ $\min\{n \mid n(n+1) \ge 1.67\} \ \therefore n^* = 1$		

Exercise 3.a) Determine optimal lot sizes of the retailer and the warehouse for the following three approaches: **independent, sequential and simultaneous planning.** What are the resulting **costs?**

	Retailer		Warehouse	
D	2500	units/year		
A	25	Euro/order	20	Euro/order
h	2.5	Euro/unit and year	1.2	Euro/unit and year

Resulting Costs	
Independent	**905.43**
Sequential	**782.63**
Simultaneous	**750**

3) Simultaneous Planning

$$C(n,Q_R)=\frac{d}{nQ_R}A_W+\frac{d}{Q_R}A_R+\frac{h_W}{2}Q_R(n-1)+\frac{h_R}{2}Q_R$$

$$Q_R^*(n)=\sqrt{\frac{2d\left(\frac{A_W}{n}+A_R\right)}{nh_W+h_R-h_W}} \qquad C^*(n)=\sqrt{2d\left(\frac{A_W}{n}+A_R\right)(nh_W+h_R-h_W)}$$

$$C(n+1)\le C(n)\Leftrightarrow n(n+1)\le\frac{A_W}{A_R}\frac{h_R-h_W}{h_W}$$

$$n^*=\min\left\{n \mid n(n+1)\ge\frac{A_W}{A_R}\frac{h_R-h_W}{h_W}\right\}$$

	Retailer	Warehouse	Total Cost
Q	$=\sqrt{\frac{2\cdot2500\cdot(\frac{20}{1}+25)}{1.2\cdot1+2.5-1.2}}$ $=300$	$=Q_R\cdot n_*$ $=300\cdot 1$ $=300$	$= 750.00$
C(Q)	$=\sqrt{2\cdot2500(20+25)(1.2+2.5-1.2)}$ $=750$		
n	$\min\left\{n \mid n(n+1)\ge\frac{20\cdot(2.5-1.2)}{25\cdot1.2}\right\}$ $\min\{n \mid n(n+1)\ge 0.87\}\ \therefore n^*=1$		

Exercise 4:

A2 sells mobile phones in two different colors – silver and black. The following demands were observed during the past eight weeks.

Week	1	2	3	4	5	6	7	8
Silver	250	350	400	150	50	200	250	100
Black	200	200	50	210	330	180	80	250

a) Determine the coefficient of correlation, mean and standard deviation of demand.

For both colors, the unit **revenue is 88 € while the unit procurement price is 55 €.** Leftover inventory at the end of the season can be sold to the service department as spare parts for **30 €.** You are now placing the final order for the last week of this season.

b) Assume that the respective demands are identically normally distributed with mean and standard deviation computed in a) What is the optimal order quantity for each color? What is the resulting expected profit?

Exercise 4:

A2 sells mobile phones in two different colors – silver and black. The following demands were observed during the past eight weeks.

Week	1	2	3	4	5	6	7	8
Silver	250	350	400	150	50	200	250	100
Black	200	200	50	210	330	180	80	250

A2 considers the option of a postponement strategy which means that all phones have the same body, but the color plates can be added quickly and locally according to incoming demand. This change would allow to flexibly react to demand and decrease lead time to 1 day, implying that the specific parts can be manufactured to order. Using this method, A2 will take the risk on the total quantity rather than on the quantity of each color. The procurement unit cost for the common components is **50 € and the color plates are purchased for 5 €**. At the end of the season, common components can be **salvaged at 29 €.**

c) Using postponement strategy, how many common components should A2 procure? What is the expected profit under the postponement strategy? Briefly explain the result and relate your answer to the portfolio effect.

Exercise 4.a) Determine **the coefficient of correlation, mean and standard deviation** of demand.

Week	1	2	3	4	5	6	7	8	Total Sum
Silver	250	350	400	150	50	200	250	100	1750
Black	200	200	50	210	330	180	80	250	1500
Silver*Black	50000	70000	20000	31500	16500	36000	20000	25000	269000
$(Silver)^2$	62500	122500	160000	22500	2500	40000	62500	10000	482500
$(Black)^2$	40000	40000	2500	44100	108900	32400	6400	62500	336800

$$\mu_{Silver} = \frac{250+350+400+\cdots+100}{8} = 218.75$$

$$\sigma_{Silver} = \sqrt{\frac{(250-218.75)^2+(350-218.75)^2+\cdots+(100-218.75)^2}{8-1}} = 119.34$$

$$\mu_{Black} = \frac{200+200+50+\cdots+250}{8} = 187.5$$

$$\sigma_{Black} = \sqrt{\frac{(200-187.5\ )^2+(200-187.5\ )^2+\cdots+(250-187.5\ )^2}{8-1}} = 89.08$$

$$\rho = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{\left[n\Sigma x^2 - (\Sigma x)^2\right]\left[n\Sigma y^2 - (\Sigma y)^2\right]}} = \frac{8(269000)-1750\cdot 1500}{\sqrt{[8\cdot 482500-(1750)^2][8\cdot 336800-(1500)^2]}} = -\ 0.79453$$

- ρ = +1: perfect positive correlation
- ρ = -1: perfect negative correlation

Negative or no correlation gives good results for portfolio effect!

Exercise 4.b) Assume that the respective demands **are identically normally distributed** with mean and standard deviation computed in a). What is **the optimal order quantity** for each color? What is the resulting **expected profit**?

	Silver	Black
CR $=C_u/(C_u+C_o)$	0.57 =(88-55)/(88-30)	0.57 =(88-55)/(88-30)
z	0.1737	0.1737
Q* $=\mu + z * \sigma$	**239.48** =218.75+0.17*119.34	**202.98** =187.5+0.17*89.08

P = 88 €
C = 55 €
S = 30€

F(k)	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0	0.50000	0.50399	0.50798	0.51197	0.51595	0.51994	0.52392	0.52790	0.53188	0.53586
0.1	0.53983	0.54380	0.54776	0.55172	0.55567	0.55962	0.56356	0.56749	0.57142	0.57535

Exercise 4.b) Assume that the respective demands **are identically normally distributed** with mean and standard deviation computed in a). What is **the optimal order quantity** for each color? What is the resulting **expected profit**?

	Silver	Black
G(z=0.1737)	0.318	0.318
ELS = σG(z)	=0.318*119.34 =37.95	=0.318*89.08 =28.33
ES = μ - ELS	= 218.75 – 37.95 =180.8 (181)	=187.5 - 28.33 =159.17 (159)
ELO = Q - ES	= 239.48 – 180.8 = 58.68 (59)	=202.98 – 159.17 = 43.81 (44)
EP =-C*Q+P*ES+S*ELO	=-55*239.48+88*180.8+30*58.68 ≈4,498	=-55*202.98+88*159.17+30*43.81 ≈4,157
EP_total		= 4,499+4,157 =8,656

k	ϕ(k)	Φ(k)	G(k)
0.0000	0.39894	0.50000	0.39894
0.0100	0.39892	0.50399	0.39396
0.0200	0.39886	0.50798	0.38902
0.0300	0.39876	0.51197	0.38412
0.0400	0.39862	0.51595	0.37926
0.0500	0.39844	0.51994	0.37444
0.0600	0.39822	0.52392	0.36966
0.0700	0.39797	0.52790	0.36492
0.0800	0.39767	0.53188	0.36022
0.0900	0.39733	0.53586	0.35556
0.1000	0.39695	0.53983	0.35094
0.1100	0.39654	0.54380	0.34635
0.1200	0.39608	0.54776	0.34181
0.1300	0.39559	0.55172	0.33731
0.1400	0.39505	0.55567	0.33285
0.1500	0.39448	0.55962	0.32842
0.1600	0.39387	0.56356	0.32404
0.1700	0.39322	0.56749	0.31969
0.1800	0.39253	0.57142	0.31539
0.1900	0.39181	0.57535	0.31112

Exercise 4.c) Using **postponement strategy**, how many common components should A2 procure? What is **the expected profit** under the postponement strategy? Briefly explain the result and relate your answer to the portfolio effect.

Week	1	2	3	4	5	6	7	8
Aggregate	450	550	450	360	380	380	330	350

$$\mu(n) = \sum_{i=1}^{n} \mu_i \quad \mu_{Total} = \frac{450 + 550 + 450 + \cdots + 350}{8} = 406.25\ (218.75 + 187.5),$$

$$\sigma(2) = \sqrt{\sigma_1^2 + 2\rho_{12}\sigma_1\sigma_2 + \sigma_2^2} \quad \sigma_{Total} = \sqrt{\frac{(450-406.25)^2+(550-406.25)^2+\cdots+(350-406.25)^2}{8-1}} = 72.69\ \left(\sqrt{119.34^2 + 2 \cdot (-0.79453) \cdot 119.34 \cdot 89.08 + 89.08^2}\right)$$

Postponement

p	88
c1-common	50
c2-specific	5
g	29

C_u (=p-c1-c2)	33 (=88-50-5)
C_o (=c1-g)	21 (=50-29)
CR (=$C_u/(C_u+C_o)$)	0.611 (= 33/(33+21))
z	0.282
Q* (=μ+z$*\sigma$)	426.75 (=406.25+0.282*72.69)

k	φ(k)	Φ(k)	G(k)
0.2700	0.38466	0.60642	0.27840
0.2800	0.38361	0.61026	0.27448
0.2900	0.38251	0.61409	0.27060
0.3000	0.38139	0.61791	0.26676
0.3100	0.38023	0.62172	0.26296

Exercise 4.c) Using **postponement strategy**, how many common components should A2 procure? What is **the expected profit** under the postponement strategy? Briefly explain the result and relate your answer to the portfolio effect.

Postponement

p	88
c1-common	50
c2-specific	5
g	29

C_u	33
C_o	21
CR	0.611
z	0.282
Q*	426.75

$\mu_{Total} = 406.25$

$\sigma_{Total} = 72.69$

	Aggregated Results
G(z=0.282)	0.273617
ELS = σG(z)	19.889 (=72.69*0.273617)
ES = μ - ELS	386.361 (=406.25-19.889)
ELO = Q - ES	40.39 (=426.75-386.36)
EP =(P-C)*ES+(g-C1)*ELO	$\approx$11901 (=386.361*(88-55)+40.39*(29-50))
Portfolio Effect? = EP_{new} - EP_{old}	11901 – 8656 = 3245

k	ϕ(k)	Φ(k)	G(k)
0.2700	0.38466	0.60642	0.27840
0.2800	0.38361	0.61026	0.27448
0.2900	0.38251	0.61409	0.27060
0.3000	0.38139	0.61791	0.26676
0.3100	0.38023	0.62172	0.26296

Thank you!