Chap 5:
Global Supply Chain (GSC)

- Globalisation of SC
  - → Opportunity (Zara, Nokia) , some unprepared
  - → Increase risk especially in case of uncertainty
- Impact of globalisation
- Off-shoring decisions
- Risk Management in GSC
- Various aspects of evaluating GSC designs
- Case studies

Impact of Globalisation in SC

- **A) Opportunities:**
  - Developing countries (20-30% growth global sales)
  - Example: Opportunity for Nokia: 2007

    China & India → 20%;

    BRIC countries (Brazil, Russia, India China) → 25%
  - Example: Consumer Electronic

    → Cost reduction: light weight products, high value, cheap and easy to ship

    → Large economy of scale

    → Production consolidation in a few locations for multiple products

Examples of Risk within GSCs

- **Huricane in 2005:**

  Damage 40,000 acres of plantation (25% drop in banana production)

- **Introduction of Sony Play station 3:**

  Components shortage & company stock marked price dropped.

- **Main risks (>30%):**

  Natural disaster (35%), volatility of fuel prices (37%), performance of SC partners (38%), logistic capacity (33%).

- **Massive fluctuation of euro vs $:**

  2000-2008 [0.84 -1.60] → affects significantly fragile SCs

Off-shoring Decisions

- Off-shoring→ Benefits via cost reduction
  - Labor & fixed cost;
  - Possible tax advantage

- But Total Cost (not just unit cost!) is crucial
  - Evaluate the complete sourcing process
  - Risk of increase length of the following 3 flows (information flow; product flow & cash flow)

Off-shoring Decisions (cont)

- Negative factors
  - Transport cost may increase
  - Cost reduction may decrease
    - Those off shore countries develop.
    - Wage inflation (2003-3008: 20% china but just 3% in US)
    - Exchange rate can be problematic
  - Risk of political/economical uncertainty
  - The decision may become less attractive

Attractive products for GSCs

- High labor content
- Large production value
- Not too much variety
- Low transportation wrt product value
  - Components highly dense
  - Tight packaging (eg; IKEA ship components flat & high density; Nissan redesign some of their globally sourcing components, EU encourage similar pallets sizes)

    →better packaging →decrease in transportation content
  - Efficient analytical loading techniques!
- Selection of production process

  - which activity to off-shore?

Risk Management in GSCs

- Global SCs are subject to more risks than local SCs
- Variety of risks:
  - Supply disruption
  - Supply delay and congestion at ports
  - Demand fluctuation
  - Exchange rate
  - Other risks and how to design mitigation strategies (student discussion)?

Effects of Risk in GSCs

- Example: In March 2000, Plant owned by Royal Philips Electronics (New Mexico) caught fire, several companies were affected but let examine two firms that were affected differently, Nokia and Ericson.
  - Nokia: responded to the disruption using other suppliers → effect was contained
  - Ericson: had no backup suppliers in its network → suffered a loss of $400M
- Need for flexible capacity is part of the SC design

Cost of Flexibility vs Risk Effect (some examples)

- **Having several suppliers**

  → reduce risk of disruption → increase cost (economy of scale not great) → overall control and confidentiality.

- **Building larger plants or more plants than required**

  →extra cost (idleness, etc) →can be used if needed

- **Allowing extra inventory for rainy days**

  →extra cost incl perishable/out of date goods → allow the SC to respond to high unexpected demand.

Some Mitigations Strategies in GSCs

- **Increase capacity**: Low cost, decentralised capacity for predictable demand but centralised capacity otherwise.
- **Redundancy of suppliers**: redundant suppliers for high volume but centralised redundancy for low volume
- **Increase responsiveness**: favor cost over responsiveness for commodity products but the opposite for short life cycle products.
- **Increase Inventory**: decentralised inventory for predictable & low value products, centralise otherwise.
- **Increase flexibility**: favor cost vs flexibility for predictable & high value product, do the opposite otherwise. Centralise flexibility in a few places only if cost is high.
- **Increase capability**: favor capability over cost for high-value & high risk products, do the opposite otherwise. Centralise high capability where there is flexible source if possible.

Three categories in mitigating risks & uncertainties

1- New Product flexibility

- Ability to launch new products quickly
- Useful in competitive environment where technology evolves & customer is paramount
- Use of common architecture & product platforms →various distinct models (PC industry, Pharmaceutical industry,...)

2- Mix Flexibility

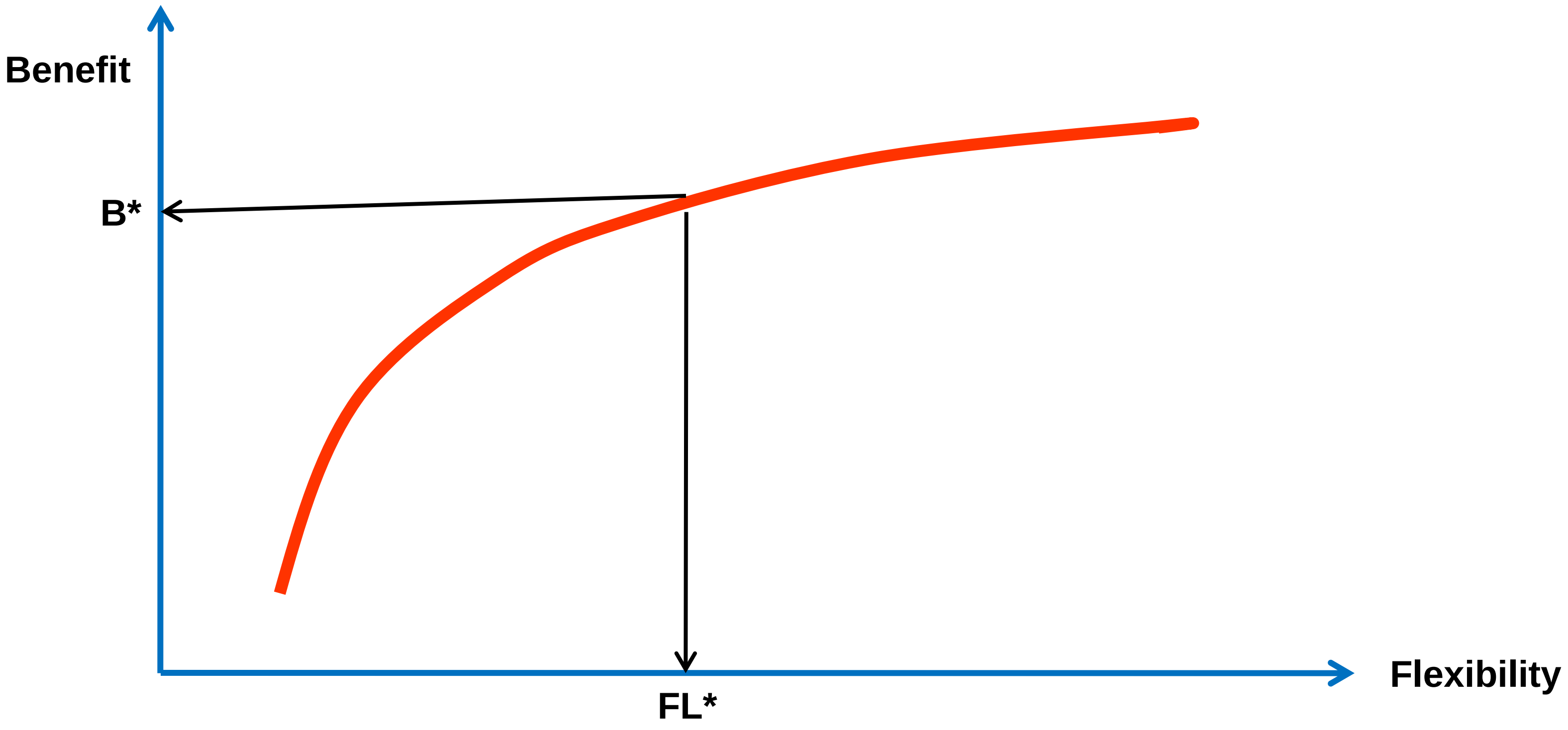
- Ability to produce a variety of products quickly
- Useful when demand is small & unpredictable, supply uncertain, technology evolving rapidly
- Consumer electronic (modular design & common components)

Mitigating Risks (Cont)

- **3- Volume flexibility (VF)**
  - --- Ability to operate well under various levels of output
    - Cyclical industries
    - Example: In 2008 automotive industry lacking VF suffered when the US market collapsed
      → build up of inventory
      →drop of steel price
      →opportunity for the steel industry to take action and consolidate to avoid future drop.

Benefits & limitations of Flexibility

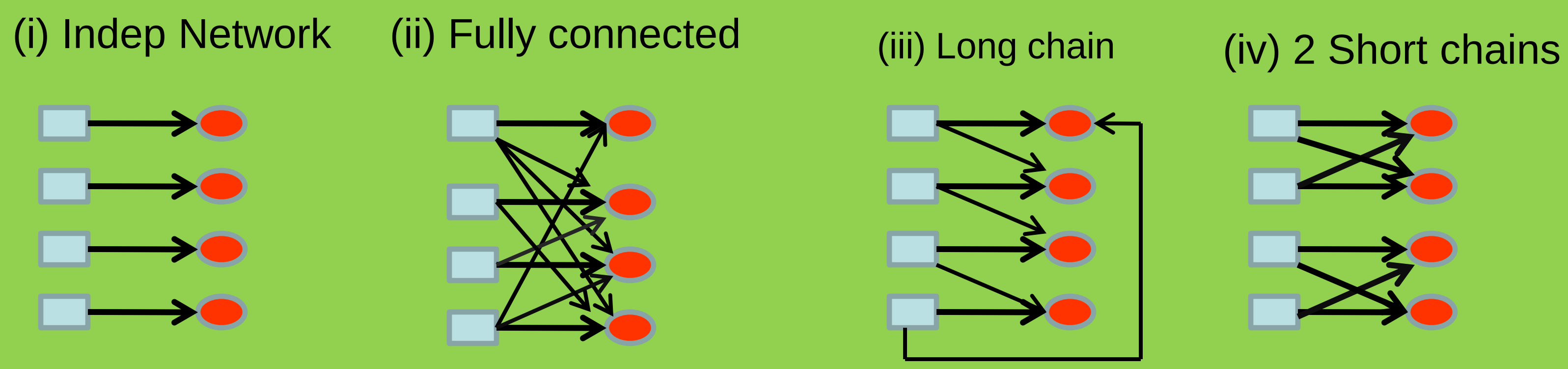
- Benefits of Flexibility is not always increasing (see figure below)



Flexibility with Chaining & Containment

- **Chaining**

(Example of 4 plants and 4 products)



- Compare (i) ...(iv) and others: cost vs risk [(iv) safer!]
- Chaining good for demand fluctuations but not supply disruption.

- **Containment:** Smaller chains better for supply disruption

→ contain the impact of disruption.

Example of pig farming (large farms for economy of scale but put in groups to avoid risk of spread of desease.

Evaluation of GSCs

- Sequence of cash flows over the period.
- Future cashs flows accounting for risks & uncertainties
- Discounted cash flow (DCF)
  - Basic idea: £1 today is worth less tomorrow (inflation, investment, interest rate, etc)
  - Discount factor (α); $\alpha = \frac{1}{(1+r)}$ where r is the rate of return over the next period, say 10% (also known as discount rate, hurdle rate or opportunity cost of capital).

Cash Flow

- Example:

1£ next year is equivalent to 1/(1+0.1)=0.91pence today.

- Consider a sequence of cash flows over the next T periods (say T=3 years): $C_0, C_1, ..., C_T$ where C_t represents the cash flow in year t (t=1,...,T).

- Net Present Value of the project based on the next T periods is:

$$NPV = C_0 + (\frac{1}{1+r})C_1 + (\frac{1}{1+r})^2 C_2 + ... + (\frac{1}{1+r})^T C_T$$

$$NPV = \sum_{t=0}^{T} (\frac{1}{1+r})^t C_t$$

Cash Flows (Cont)

- **How to select the best SC:**

  - Consider K possible supply chains (say 3 options),each having its NPV, say NPV(k), k=1,...K found for each SC.

  - The most profitable SC is the one with the largest NPV:

$$NPV(k^*)=Maximum\{NPV(k); k=1,...,K\}$$

- **Example:**

Trips Logistics , a 3rd party logistic, wishes to lease some warehousing space. The expected demand is 100,000 units and each unit requires $1m^2$ so the company needs 100,000 m^2 . The company sells each unit at £1.22 . The company can sign a 3 year deal to lease all the space at £1 per m^2 whereas if they buy it on the spot market, it costs £1.20 m^2 . The discount rate is 10%. Does the company lease all of it or use the spot market?

Example (cont)

- **Option: Lease from the market** (spot market option)
  - Expected Annual Profit (Spot), E(S)

    = (100,000x1.22)-(100,000x1.20)=£2000=C_o
  - Net Present Value (S)

$$NPV(S) = C_0 + \frac{C_0}{(1+0.1)} + \frac{C_0}{(1+0.1)^2} = 2,000 + \frac{2,000}{1.1} + \frac{2,000}{1.1^2} = £5,471$$

- **Option: Lease for 3 years**
  - Expected Annual Profit (Lease), E(L)

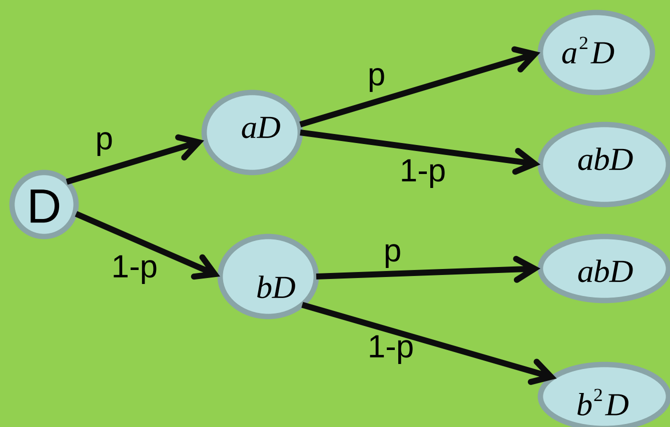
    = (100,000x1.22)-(100,000x1.00)=£22,000=C'_o
  - Net Present Value (S)

$$NPV(L) = C'_0 + \frac{C'_0}{(1+0.1)} + \frac{C'_0}{(1+0.1)^2} = 22,000 + \frac{22,000}{1.1} + \frac{22,000}{1.1^2} = £60,182$$

- **Decision:** NPV(L)>NPV(S) → **Better to Lease**
- **Question**: What happen if the demand drops or increases, if the spot market rate increases, does this strategy remains valid **(robust)?**

Dealing with Uncertainty

- Use of binomial trees
  - Multiplicative binomial tree D: demand; a>1;b<1, (say a=1.1; b=0.85), go up with probability p and down with 1-p:



  - Additive binomial tree: same as above except that D→D+u or D→D-v instead

- The coefficients a,b, u, v do not need to be fixed at each period.

Evaluation via Decision Trees

- **Knowledge of the alternatives** at end of each period with corresponding probability. For instance by the end of next year, the market goes up by 10% with a 20% probability.
- **Not necessary binary trees:** demand, price, exchange rate if all three changed but independently →8 leaves from each node (ie 2^3)
- **Construction of the tree**
  - Identify the duration of each period (month), # periods and the period discount rate r.
  - Indentify the factors that could be affected (demand, price, etc) and choose the right distribution for each factor to show uncertainty.
  - Represent the decision tree with defined states and transition probabilities
  - Start from the end, evaluate each node then work backward until period 0 is reached where the final decision will be taken.

Case study: Trips Logistics

- **Same data as before + the following**: demand can go up or down by 20% with p=0.5. The spot market price can also go up and down by 10% with p=0.5. The manager of Trips Logistics wishes to explore the following questions.

  (i) Should the firm opt for the spot market strategy for their warehousing space?

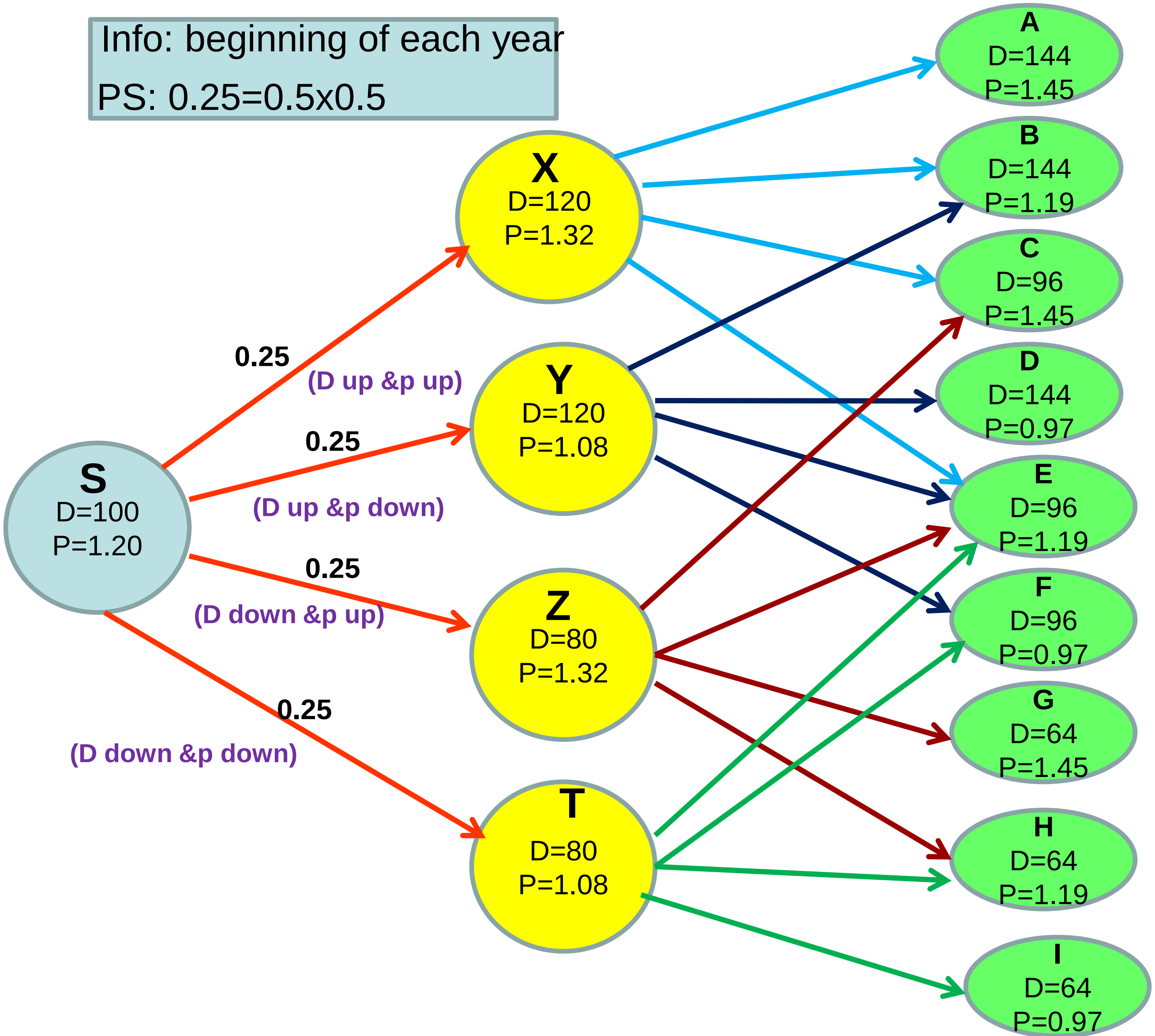
  (ii) Should they go for a lease strategy and cover any additional space through the spot market?

  (iii) Exploring with the lease the possibility of having a flexible lease instead and cover remaining as in (ii)?

- Assume the price and demand are <u>independent</u>, the selling price remains at £1.22 per unit over the 3 year period, and the discount rate remains at 10% at the end of the next two years. **Assist the manager** in constructing the decision tree and evaluate each of the 3 options so to choose the right strategy for its SC.

Trips Logistics (Tree Construction)

- Construction of the decision tree with defined nodes



Option 1: The spot market

- **Phase 1 (evaluate nodes A-I): compute cost & profit**

Cost(A)=144,000x1.45=£208,800;

Profit(A)=Revenue-Cost=(144,000x1.22)-cost(A)=175,680-208,800=-£33,120

- Apply the calculations for all other nodes, see Table below.

Nodes	Revenue	Cost (1,000)	Profit (£)
A	144x1.22	144x1.45	-33,120
B	//	144x1.19	4,320
C	96x1.22	96x1.45	-22,080
D	114x1.22	144x0.97	36,000
E	96x1.22	96x1.19	2,880
F	//	96x0.97	24,000
G	64x1.22	64x1.45	-14,720
H	//	64x1.19	1,920
I	//	64x0.97	16,000

Summary results for T=2

Option 1: The spot market (cont)

- **Phase 2 (evaluate nodes X,Y,Z,T): compute cost, NPV & Profit**

- Expected profit (X) =Exp(X)=0.25(Profit(A,B,C, E))=0.25(-33,120+4,320-22,080+2,880)= → Exp(X) = -£12,000 (loss)
- PV(Exp(X))=Exp(X)/1.1=-12,000/1.1=-£10,909 (equivalent of true loss at T=1)
- Profit(X)=Revenue-cost+PV=120,000x1.22-120,000x1.32+(-10,909)= -£22,909
- Do the same for nodes, X,Y,Z and T, see results in table below.

Node	Exp(.)	PV	Revenue	Cost	Profit
X	-12,000	-10,909	14,640	15,840	-22,909
Y	16,800	?	?	?	32,073
Z	-8,000	?	?	?	-15,273
T	11,200	?	?	?	21,382

Summary of T=1

- **Phase 3 (evaluate final node S): compute cost, NPV & Profit.**

Exp(S)=0.25(Profit(X,Y, Z, T)=0.25(-22,903+32,073-15,273+21,382)=£3,818

PV(Exp(S))=3,818/1.1=£3,471

Profit(S)=100,000x1.22-(100,000x1.200+3,471=£5,471

→ Expected NPV for having the space from the spot market is: **NPV(Spot)= £5,471**

Exercise: **Do extra scenarios (different variations etc and conclude, use excel if you can)**

Option 2: Fixed Lease

- **Phase 1 (evaluate nodes A-I): compute cost & profit**

Cost(A)=100,000x1.00+44,000x1.45=£163,800;

Profit(A)=Revenue-Cost=(144,000x1.22)-cost(A)=175,680-163,800=£11,880

- Apply the calculations for all other nodes, see table below.

Nodes	Leased space @1£	Warehouse space (>100,000)	Profit (£)
A	1000,000	44,000	11,880
B	//	44,000	23,320
C	//	0	17,120
D	//	44,000	33,000
E	//	0	17,120
F	//	0	//
G	//	0	-21,920
H	//	0	//
I	//	0	//

Summary of T=2

Option 2: Fixed Lease (cont)

- **Phase 2 (evaluate nodes X,Y,Z,T): compute cost, NPV & Profit**

- Expected profit (X) =Exp(X)=0.25(Profit(A,B,C, E))=0.25(11,880+23,320+17,120+17,120)= → Exp(X) = £17,360 (profit)
- PV(Exp(X))=Exp(X)/1.1=17,360/1.1=£15,782 (equivalent of true profit at T=1)
- Profit(X)=Revenue-cost+PV=120,000x1.22-(100,000x1+20,000x1.32+15,782= £35,782
- Do the same for nodes, X,Y,Z and T, see results in table below.

Node	Exp(.)	Warehouse Space (spot)	Profit
X	17,360	20,000	35,782
Y	22,640	20,000	45,382
Z	2,400	0	-4,582
T	2,400	0	-4,582

Summary of T=1

- **Phase 3 (evaluate final node S): compute cost, NPV & Profit.**

Exp(S)=0.25(Profit(X,Y, Z, T)=0.25(35,782+45,382-4,582-4,582)=£18,000

PV(Exp(S))=18,000/1.1=£16,364

Profit(S)=100,000x1.22-(100,000x1)+16,364=£38,364

→ Expected NPV for having the space from the Lease is: **NPV(Lease)= £38,364**

Note: This amount though it is still showing it is worth leasing instead of spot market (38,364>5,547) it is much less than the original profit of £60K. Produce a data table with the fixed lease as variable: 80,80,100,….120,000 and evaluate- repeat with a reduced but focussed range around the best option.

Option 3: Flexible Lease

- **Infos: 60,000<=D<=100,00 fixed at 1£m2+up front £10,000** **(this is paid once up front)**
- **Phase 1 (evaluate nodes A-I): compute cost & profit**

Nodes with D>100,000 not affected (see option 2, nodes A,B,D)

Profit(C)=Revenue-Cost=(96,000x1.22)-96,000x1.00=£21,120

- Apply the calculations for all other nodes, see table below**.**

Nodes	Leased space @1£	Space spot (>100,000)	Profit (£)
A	1000,000	44,000	11,880*
B	//	//	23,320*
C	96,000	0	21,120
D	100,000	44,000	33,000*
E	96,000	0	21,120
F	//	0	//
G	64,000	0	14,080
H	//	0	//
I	//	0	//

Summary of T=2

(*: unchanged from option 2)

Option 3: Flexible Lease (cont)

- **Phase 2 (evaluate nodes X,Y,Z,T): compute cost, NPV & Profit**

- Exp(X)=0.25(Profit(A,B,C, E))=0.25(11,880+23,320+21,120+21,120)= £19,360 (profit)
- PV(Exp(X))=Exp(X)/1.1=19,360/1.1=£17,600 (equivalent of true profit at T=1)
- Profit(X)=Revenue-Cost+PV=120,000x1.22-(100,000x1+20,000x1.32)+17,600= £37,600
- Do the same for nodes, X,Y,Z and T, see results in Table below.

Node	Exp(.)	Warehouse Space @1£	Warehouse Space (spot)	Profit
X	19,360	100,000	20,000	37,600
Y	24,640	//	//	47,200
Z	17,600	80,000	0	33,600
T	//	//	//	//

Summary of T=1

- **Phase 3 (evaluate final node S): compute cost, NPV & Profit.**

Exp(S)=0.25(Profit(X,Y, Z, T)=0.25(37600+47200+33600+33600)=£38,000

PV(Exp(S))=38,000/1.1=£34,545

Profit(S)=100,000x1.22-(100,000x1)+34,545=£56,545

→ Expected NPV for the lease is: Profit-Up front cost: **NPV(Lease)= £46,545** **(i.e., 56,545-10,000)**

Conclusion: **The flexible option is obviously more attractive** (46,546>38,364)

→ extra profit=£8,181 [discuss impact of upfront cost & other factors→ **A robust solution via Scenario Analysis with data table**]- change £1 to1+? and upfront to 10,000-? and analyse.

Global SCs (conclusion)

- **Discussion**

  - Impact of various places when leasing after year 2 say can affect customer service & cost due to extra manpower → affect the total cost

  - Incorporate marketing cost in the decision tree so the demand can increase in a controlled (say 20% if extra cost=10K, 10% is 5K, 0 else)

- **General decisions for GSCs under uncertainty**

  (i) Combine strategic planning & financial planning

  (design a few strategic options and evaluate each one using decision trees)

  (ii) Use multiple metrics: various criteria (cost, customer service, response time, possibility of extension and market share etc)-

  (iii) Use financial analysis as an input while deciding, not as a way of just performing the accounting aspect of the decision.