Real Options in Supply Chain Management

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Objectives of this presentation

- To stress the role of flexibility in design and management of supply chains
  - It provides the means to adjust to the consequences of inevitable risks
- To define Options, as means to create flexibility
  - Build upon their use in financial context
  - Focus is on application to the design and then effective management of the system over time
- Take-away: "options thinking" is crucial

Outline

Managers need flexibility to respond to unexpected

- **This concept implies a deep change in way we think about design of supply chain systems**
  - **From: designing to specified circumstances**
  - **To: planning for a range of possibilities**
- **Options analysis is way to value flexibility**
  - **Builds upon options analysis as used in finance**
- **Example from current work on disruptions**

Managers need flexibility

- Both suppliers and customers need flexibility to deal with unexpected changes
- Aircraft industry has been selling options for years, to benefit of airlines and manufacturers
- Product modularity and platforms enhance ability to adjust products to market demands
- Short life cycles provide flexibility to recognize manufacturing issues, to respond to design changes requested by marketplace

Flexibility for Disruptions

- Managers frequently encounter disruptive situations that demand, or would benefit from, out-of-ordinary responses

- Recent Examples:
  - Key supplier cannot deliver (fire in a chip plant)
  - Normal links broken (West Coast shipping strike)
  - Product demand surges (hit fashion or holiday item)

- Ability to respond quickly can be critical
  - Nokia responded fast to chip plant fire, Ericsson couldn't => Nokia was able to expand market share significantly

Flexibility => Insurance, Opportunity

- One way to view flexibility is as “insurance”, the capability to avoid bad outcomes
- Another: readiness to capitalize on opportunities
- [these are like ‘puts’ and ‘calls’ – see later]
- Either way, flexibility requires prior preparation
  - Backup suppliers or alternative designs
  - Commitments by manufacturers for extra capacity
  - Capacity to re-deploy supply chain

Flexibility thinking => Mental Shift

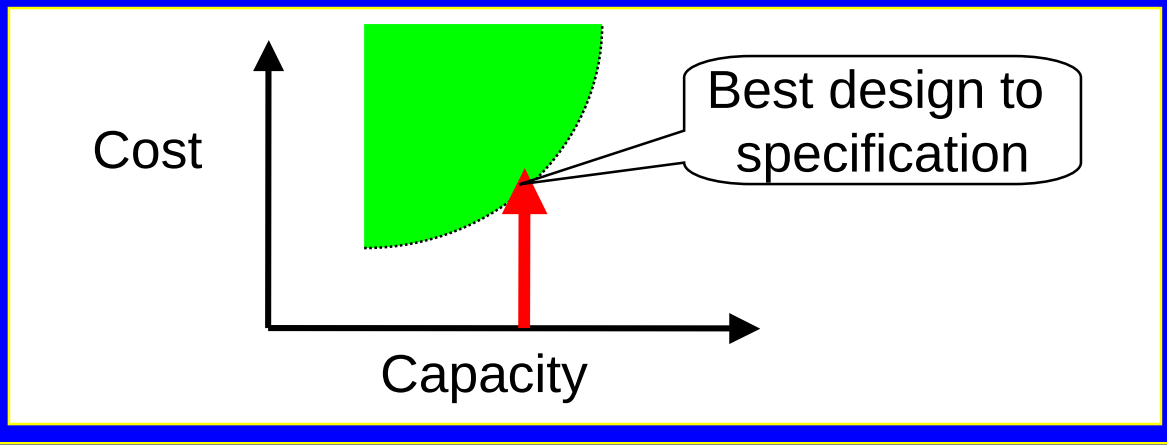
- Building flexibility into system requires a mental shift in framing of supply chain

- Problem viewed as
  - managing risk over time (time varying practices)
  - … and over range of circumstances
  - not traditional optimization of performance for given specifications

- Need to face a more complex problem, building on our capability to optimize for particular situations

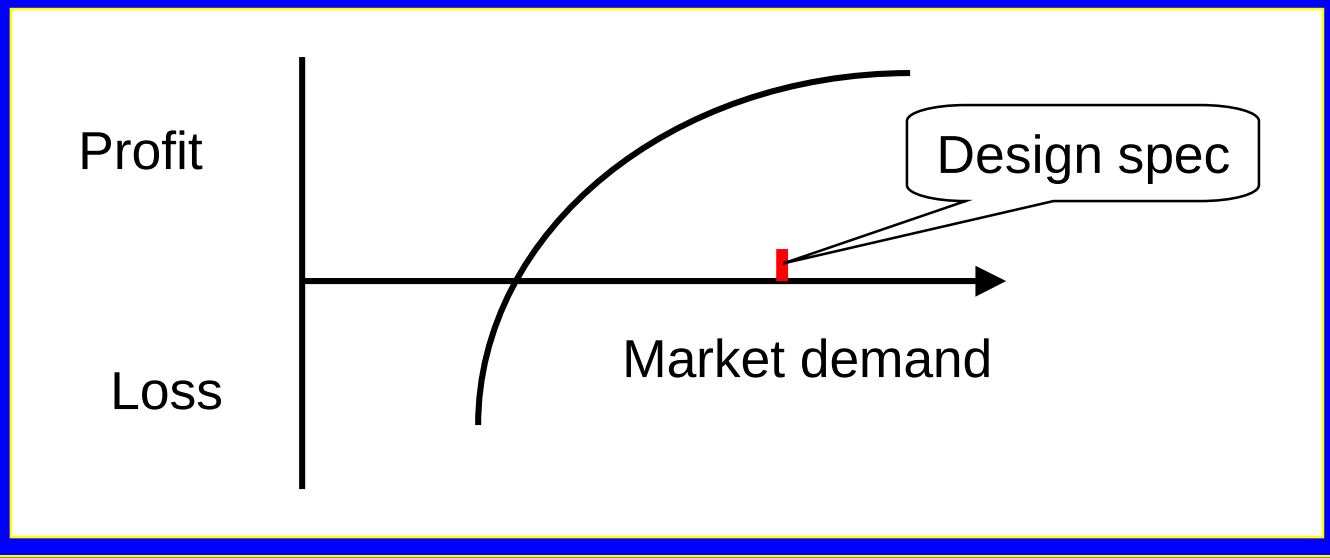
Traditional Practice

- Typically focuses on design to specifications
- This is a complex optimization process
- These specs decided outside the optimization process (for example, by market analyses)



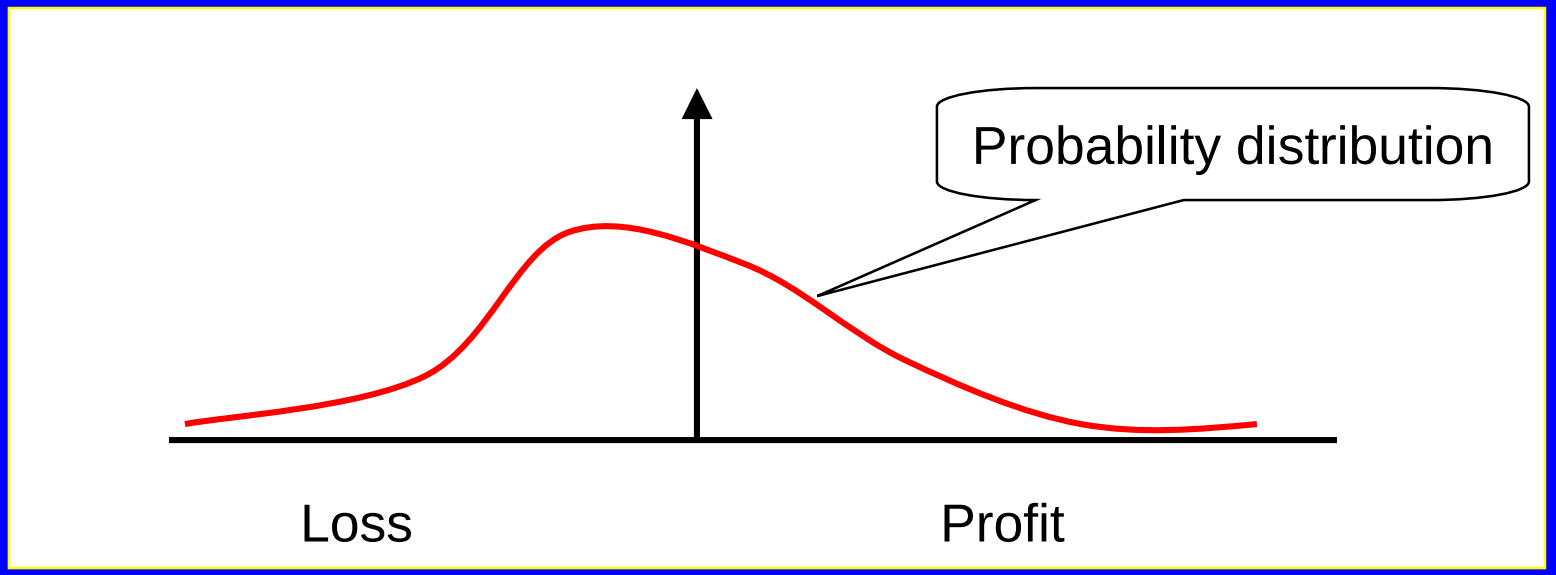
Actual System Performance is Risky

- Why is this?
- Because market and other conditions uncertain
- Example: Profitability depends on market size



Design involves a distribution of risk

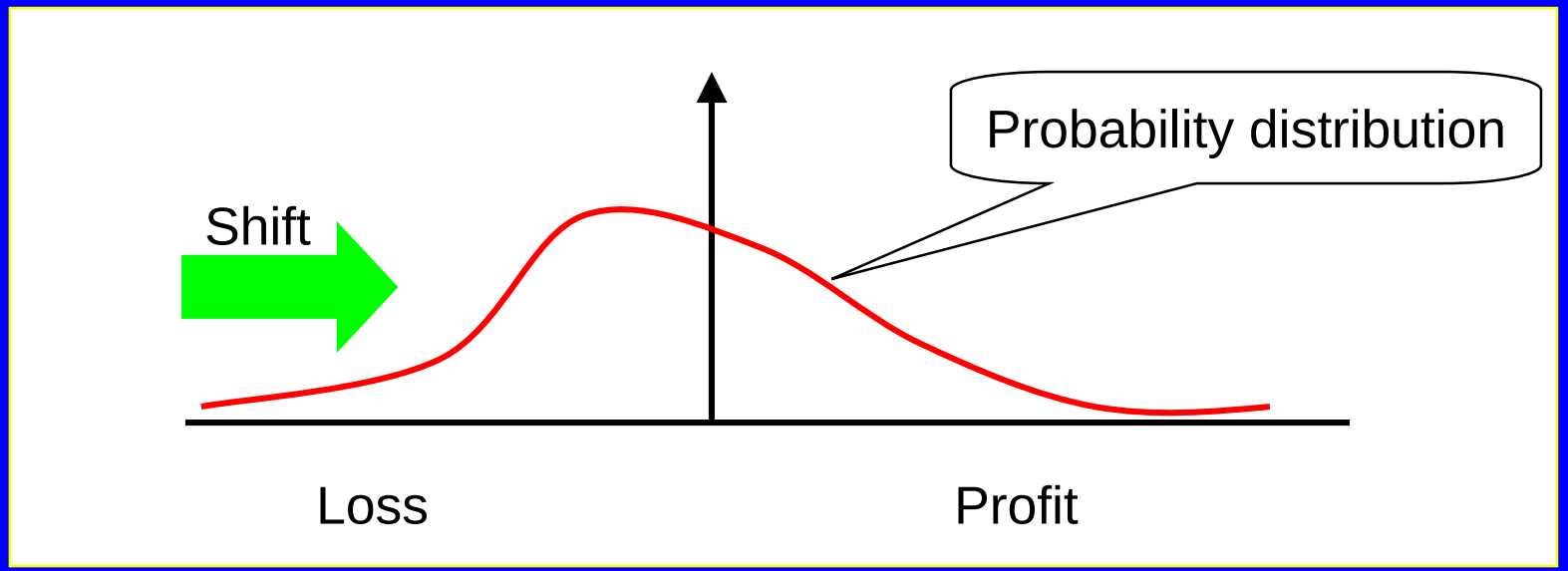
- Outcomes vary in probability
- Results of outcomes times probability => pdf (probability distribution function)



Design Opportunity

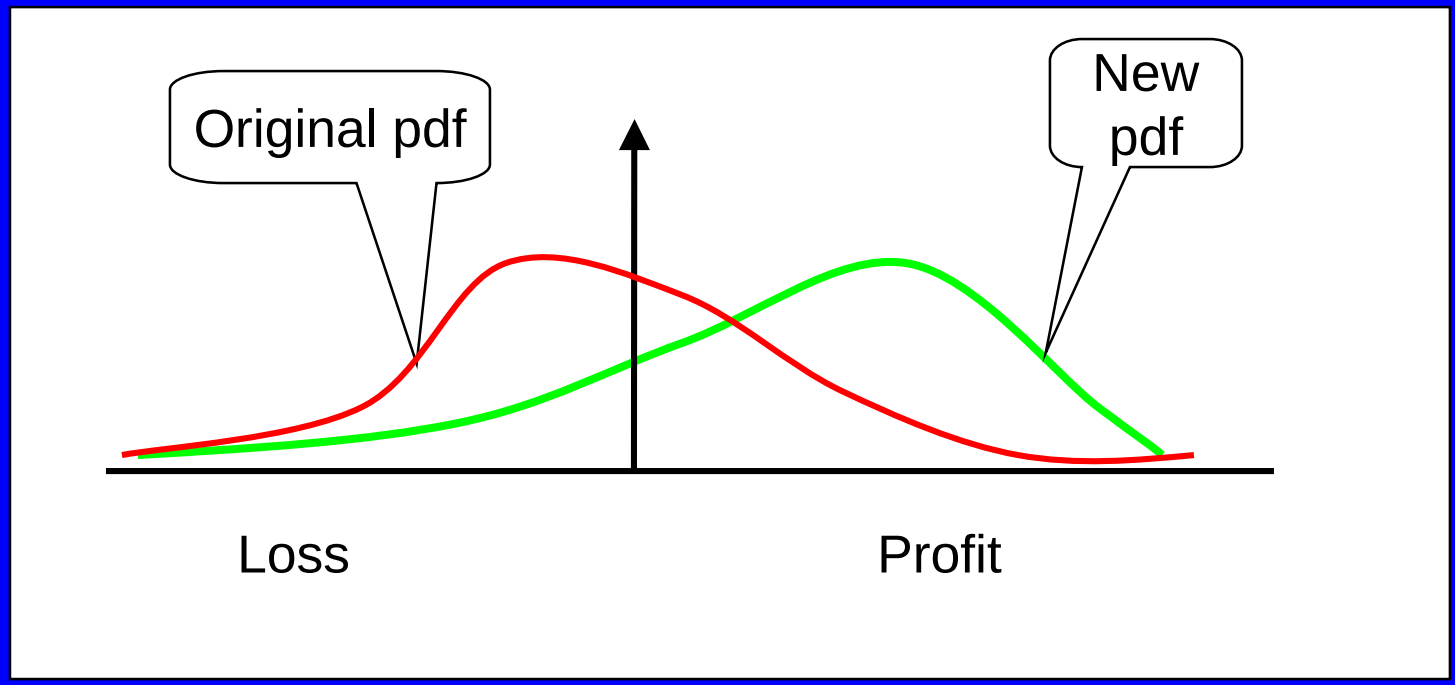
- To vary the distribution of probability distribution to increase, maximize value

- Key means of doing this: flexibility that permits adaptation of design to circumstances



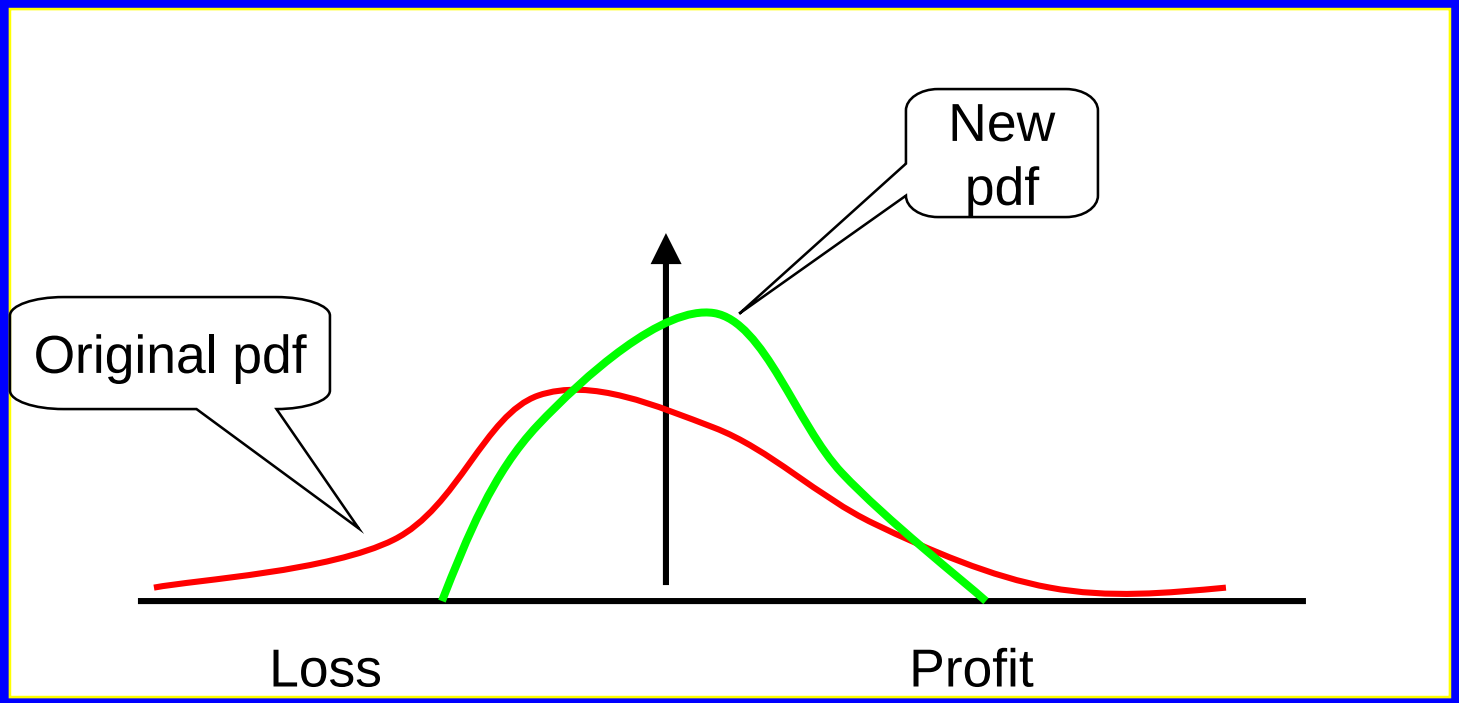
Consequences of Flexibility (1)

- **Accentuate the positive -- take advantage of opportunities (also known as "call options")**



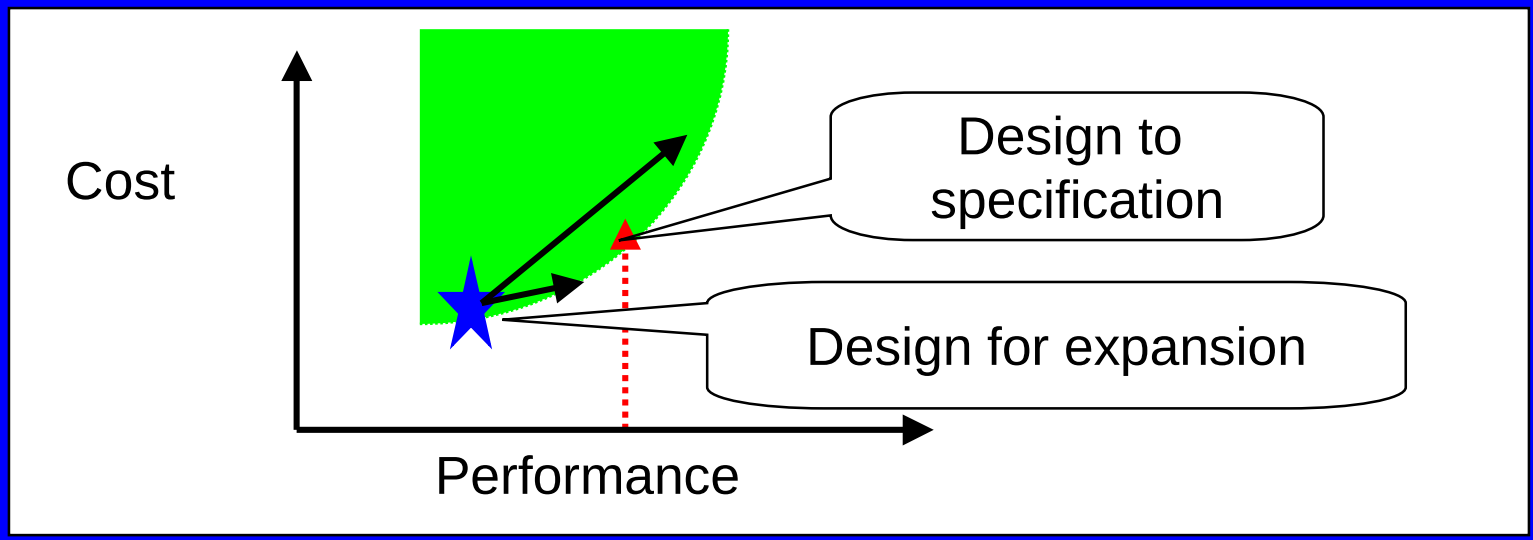
Consequences of Flexibility (2)

- **Minimize the negative -- avoid big losses (as with insurance) (also known as "put" options)**



Stress on Flexibility

- Represents a real change in concept of design and management of systems over time
- Why is this?
- Because: instead of designing to a specification, design for range of possible levels of performance



Flexibility Adds Value

- **Flexible systems allow managers to**
  - **Recover from bad events, such as disruptions**
  - **Take advantage of opportunities**
- **Flexibility can reduce total costs**
  - **Costs less to adapt to variability and change**
- **Example: Fire in chip plant**
  - **Ability to redesign product with alternative chips permitted Nokia to reduce cost of interruption and, in this case, to take advantage of weakness of competitor**

Flexibility Costs

- **Money**
  - Inventories, investment in design, computer systems
  - Extra Space for Expansion
- **Complexity**
  - Management systems more complex
- **Time**
  - Design and Planning Efforts take time

Central Issue

- What Flexibility should we incorporate in System?
- The question is in effect:

  "What elements of flexibility are more valuable than their cost?"

- How do we value flexibility?
- This is the central topic of options analysis

"Options" = Formal Notion of Flexibility

- An Option is a formal way of defining flexibility
- Options valuation well developed for finance markets
- Field of "real" options applies theory to real projects
  - Future decisions have features similar to financial options
  - Financial options valuation can be extended to projects
- However, adaptation not simple:
  - We do not have statistics on future events
  - Developments unlikely to be random

What is an Option?

- A right, but not an obligation…
  - Asymmetric returns; exercise only if advantageous
  - Acquired at some cost
- to take some action…
  - to switch fuels, drop project, buy or sell something, etc, etc,
- now, or in the future...
  - May be indefinite, as for dual fuel burner
  - Often for a limited time after which option expires
- for a pre-determined price.
  - Cost of action separate from cost of option (down time for switching burners different from cost of dual fuel burner)

Example Financial Option

- Example: An Option to buy 100 shares of ATT at 20 through Oct. 3, 2003

- Option is a right. It allows, doesn't force owner to ...
- … buy shares at a specified price
- … for a specific time (up to October 3, 2003)
- "Strike" price is set in advance (at $20 in this case)

- Note: on May 23, 2003, quoted prices were:
  - 1 share of ATT = $ 19.25
  - option on 1 share = $ 1.95

    (Source: finance.yahoo.com)

Asymmetry of Option

- **Owner of Option Likely to exercise right to buy stock if its price > strike price or $S > $20**
  - **owner then makes profit = $(S - 20)**
  - **these profits may be unlimited**
- **Owner not required to exercise option**
  - **Loss limited to cost of buying option (example: $1.95/share)**
  - **losses are limited**
- **Once you own this option, Value is <u>not symmetric</u>**
  - **In this case: <u>All gain, No pain</u>**
- **Note: Other options might be all pain, no gain...**

Example: "Real" Option

- "Real" Options concerns things, as distinct from "financial" options embodied in contracts

- Example: The spare tire on your car is an option that gives you the right
- ... to change the tire
- … the right in this case has unlimited time
- ... "cost" of exercising option = effort to change tire

- Note Similarity to Financial Option
  - You will change tire only if you need to
  - You do not have to do a thing about it

Supply Chain "Real" Options

- "Real" Options for Supply Chain Management can come in many shapes

- Examples:
  - Maintenance of alternative supplier, perhaps at higher cost, to enable use as needed
  - Inventories motivated by disruptive events
  - Investment in platforms for products to reduce vulnerability to specific components
  - Contracts with manufacturers to insure priority supply
  - Cutting cycle-time of product, to make faster response to market and production issues

Recent Results (Pochard)

- Research on supply chain disruptions
- What circumstances justify a Second Supplier?
- We developed a model to estimate cost, benefits
  - set up of relationship, part costs, frequency of disruption
  - gain or loss of market share
- Model investigates option of delaying decision
  - This can be worth a lot
- A time-varying dynamic strategic is best!

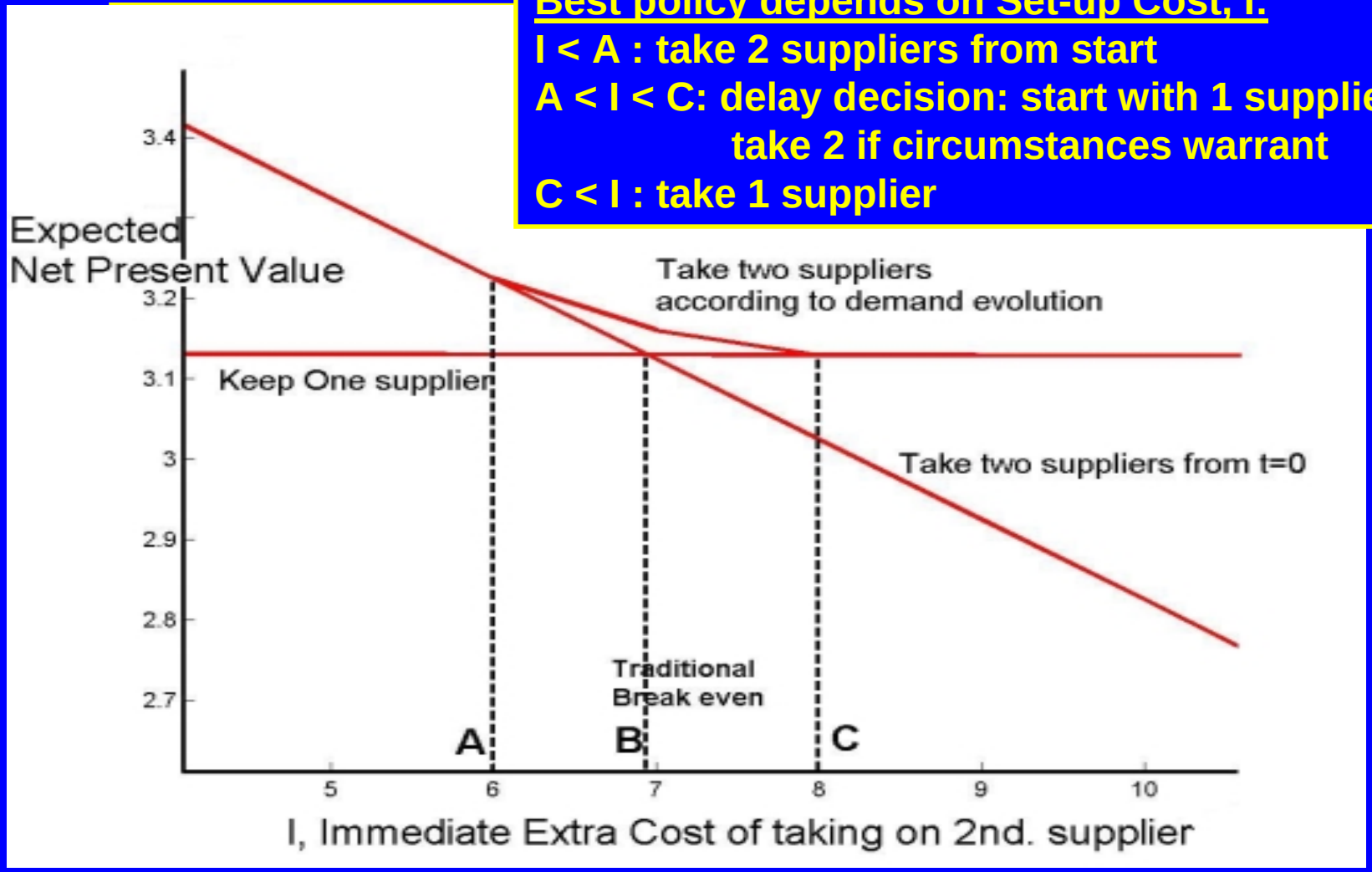
Best Policy for Second Supplier

Best policy depends on Set-up Cost, I:

I < A : take 2 suppliers from start

A < I < C: delay decision: start with 1 supplier, take 2 if circumstances warrant

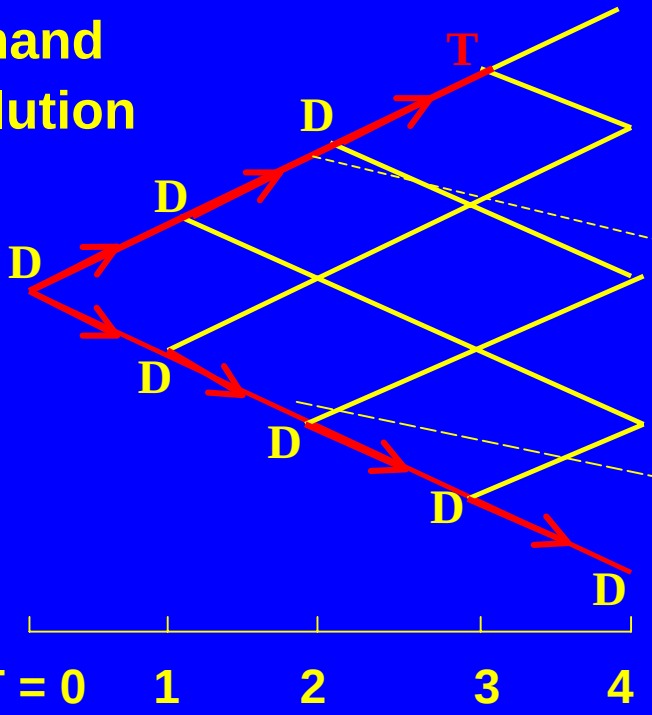
C < I : take 1 supplier



Valuing the Delay Option

Delaying decision to invest in dual-sourcing lets firm observe demand changes over time and make right decision at right time

Demand Evolution



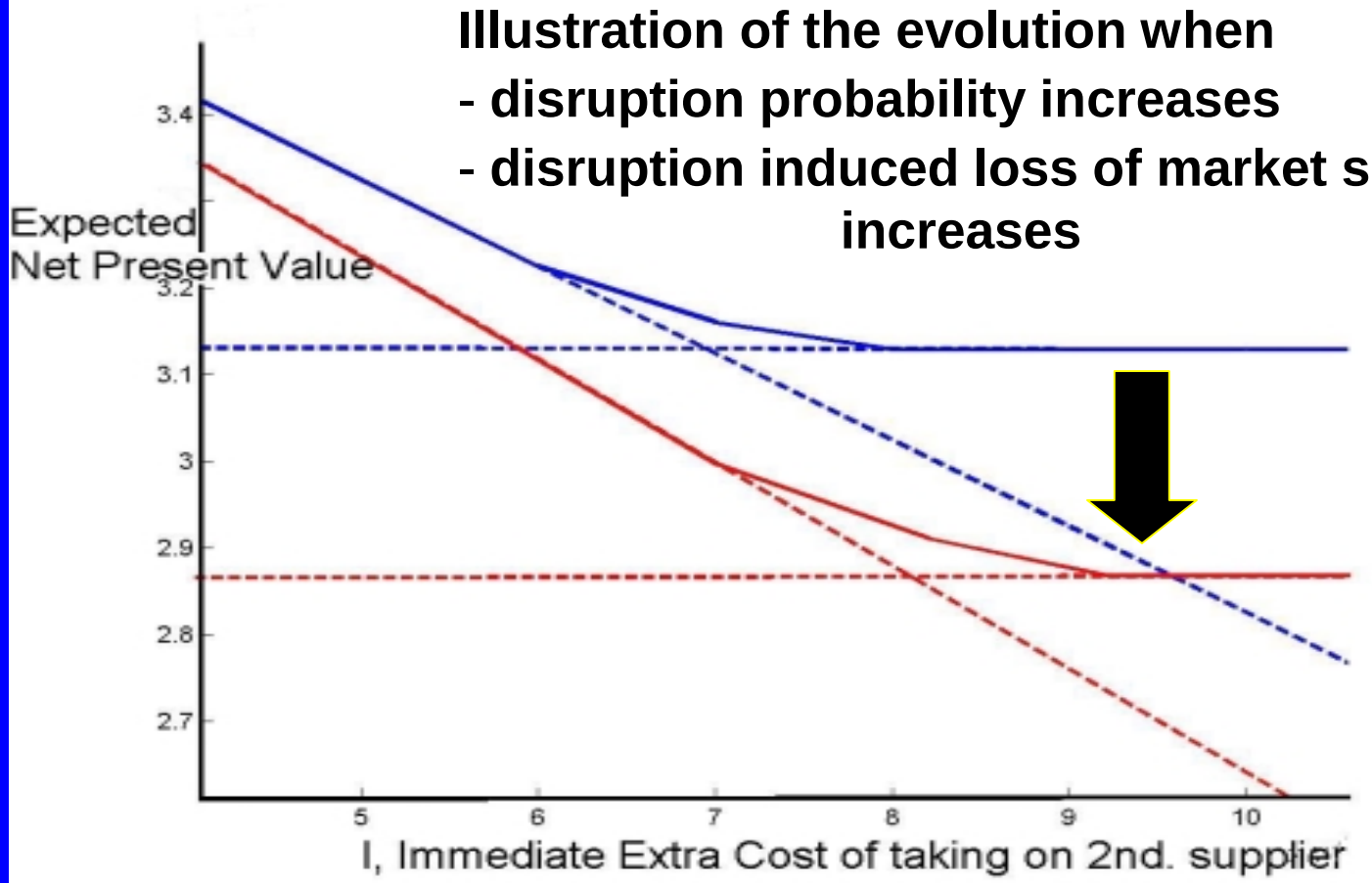
T = 0 Delay investment decision. Value of 2nd supplier not yet clear.

Path 1: Demand keeps increasing.
- Take 2 suppliers at t = 3

Path 2: Demand keeps decreasing.
- Stick to one supplier

Results Sensitive to Circumstances

Illustration of the evolution when
- disruption probability increases
- disruption induced loss of market share increases



Summary

- Flexibility has value, because of risk
- Supply chain design should incorporate flexibility
- Issue is: How do we value flexibility?
- Options embody formal concept of flexibility
- “Options Thinking” key
- Topic of current research