Real-Options Valuation and Supply-Chain Management

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Outline

- Supply chain planning questions
- Problems with traditional analyses
- Real-option structure
- Assumptions
- Resolving inconsistencies
- Conclusions

Supply Chain Situation: Automotive Company

- Goal:
  - Decide on coordinated production, distribution capacity and vendor contracts for multiple models in multiple markets (e.g., NA, Eur, LA, Asia)
- Traditional approach
  - Forecast demand for each model/market
  - Forecast costs
  - Obtain piece rates and proposals
  - Construct cash flows and discount
- ✍ Optimize supply chain for a single-point forecast

Traditional Methods Results

- Focus on:
  - Cost orientation (not revenue management)
  - Single program (model, product)
  - NPV
  - Piece rates
- Result: support of traditional, fixed designs, little flexibility, little ability to change, immediate investment or no investment

Trends Limiting Traditional Analysis

- Market changes
  - Former competition:
    - Cost
    - Quality
  - New competition:
    - Customization
    - Responsiveness

Limitations of Traditional Methods for New Trends

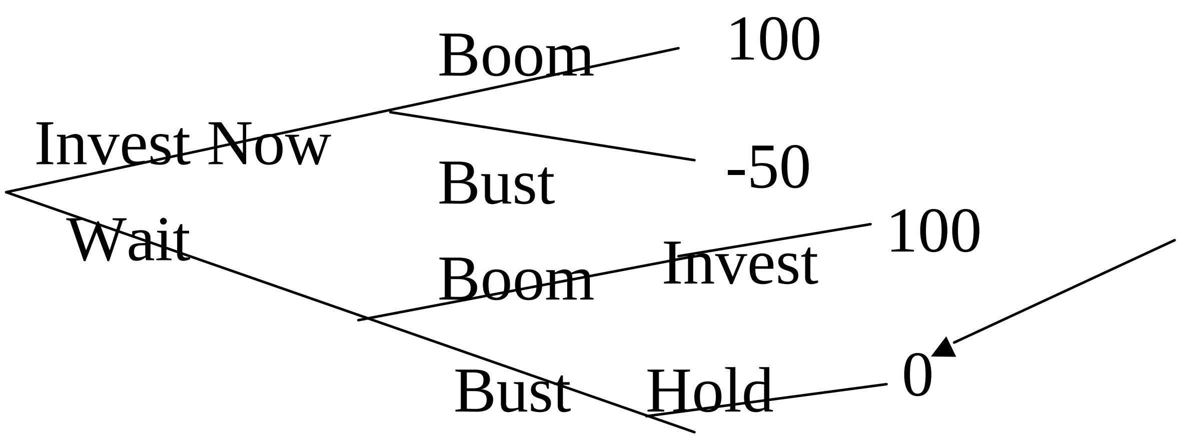
- Myopic - ignoring long-term effects
- Often missing time value of cash flow
- Excluding potential synergies
- Ignoring uncertainty effects
- Not capturing option value of delay, scalability, and agility (changing product mix)

Real Options

- Idea: Assets that are not fully used may still have option value (includes contracts, licenses)
- Value may be lost when the option is exercised (e.g., developing a new product, invoking option for second vendor)
- Traditional NPV analyses are flawed by missing the option value
- Missing parts:
  - Value to delay and learn
  - Option to scale and reuse
  - Option to change with demand variation (uncertainty)
  - Not changing discount rates for varying utilizations

Value to Delay Example

- Suppose a project may earn:
  - $100M if economy booms
  - $-50M if economy busts
- Each (boom or bust) is equally likely
- NPV = $25M (expected) - Start project
- Missing: Can we wait to observe economy?



Here, we don't need to invest in "Bust" - Now we expect $50M

It's worth $25M to wait.

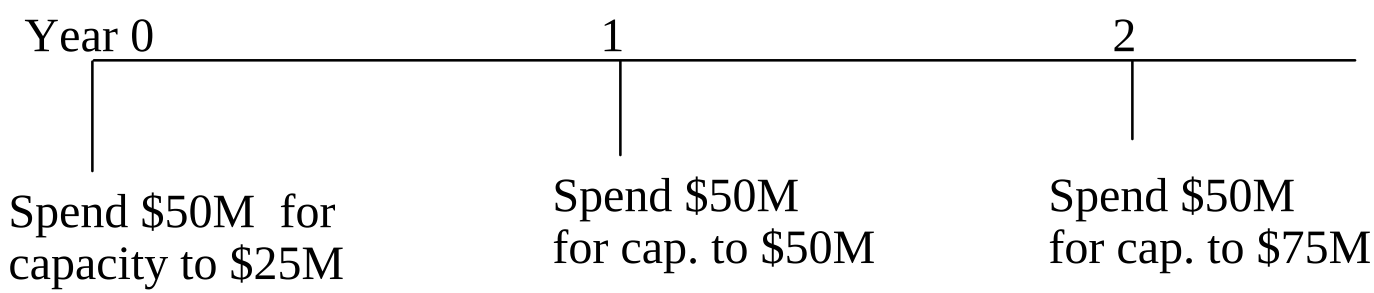
Scale Option Example

- Scalability
- Suppose a five year program
  - Cost of fixed capacity is $100M
  - Cost of scalable capacity is $150M for same capacity
  - Predicted cash flow stream:

Year	1	2	3	4	5
Net	25	50	75	50	25

Scalability Example - cont.

- Assume 15% opportunity cost of capital:
  - NPV(Traditional) = $50M
  - NPV(Scalable)= 0
- Problem: Scalable can be configured over time:



Scalability Result

Cash flow for Scalable:

Year	0	1	2	3	4	5
Net	-50	-25	0	75	50	25

Now, NPV(Scalable)=$75M > NPV(Fixed)

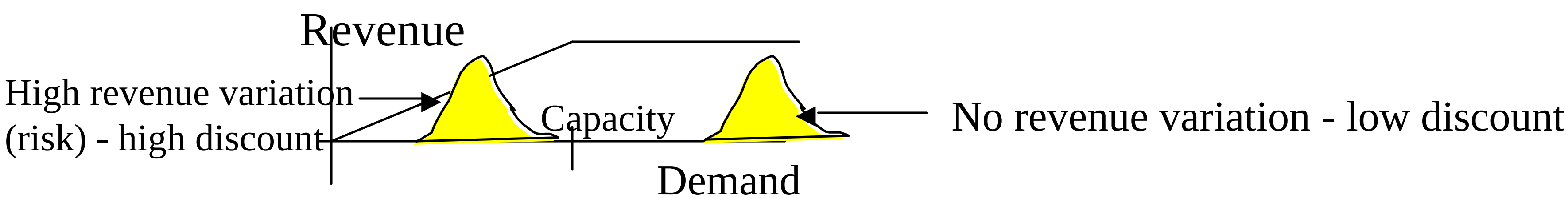
Traditional approach misses scalability advantage.

Discount Rate Determination

- Traditional approach
  - Discount rate is the same for all decisions in program evaluation
- Problems
  - Program evaluation includes decisions on capacity, distribution channel, vendor contracts
  - These decisions affect correlation to market – hence, change the discount rate
- Need: discount rate to change with decisions as they are determined; How?

Discount Rate Determination

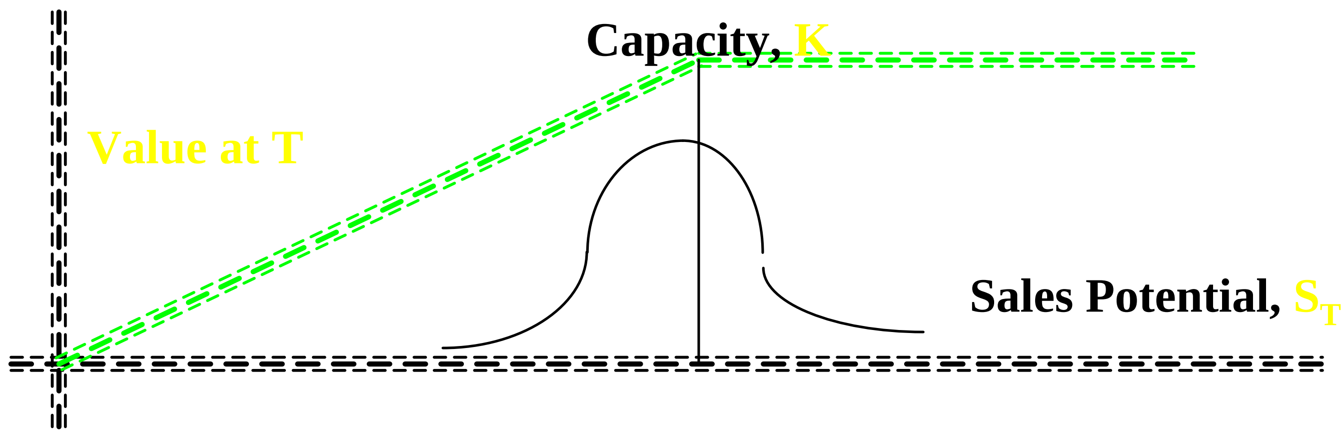
- USE CAP-M? FIND CORRELATION TO THE MARKET?
  - Can measure for known markets (beta values)
  - If capacitated, depends on decisions
    - Constrained resources - capacity
    - Correlations among demands



- ALTERNATIVES?
  - Option Theory
    - Allows for non-symmetric risk
    - Explicitly considers constraints -
    - As if selling excess to competitors at a given price

Using Option Valuation for Capacity

- Goal: Production value with capacity K
  - Compute uncapacitated value based on CAPM:
    - $S_t = e^{-r(T-t)} ? c_T S_T dF(S_T)$
    - where c_T=margin,F is distribution (with risk aversion),
    - r is rate from CAPM (with risk aversion)
  - Assume S_t now grows at riskfree rate, r_f ; evaluate as if risk neutral:
    - Production value = $S_t - C_t = e^{-r_f(T-t)} ? c_T \min(S_T,K) dF_f(S_T)$
    - where F_f is distribution (with risk neutrality)



Assumptions

- Process of prices or sales forecasts
- No transaction fees
- Complete market
  - How to construct a hedge?
  - If NPV>0, inconsistency
  - Process: Trade option and asset to create riskfree security

Creating Best Hedge

- Underlying asset: Max potential sales in market
- Option: Plant or contract with given capacity
- Other marketable securities:
  - Competitors' shares
  - Overall all securities min residual volatility
  - Due to incompleteness, some volatility remains (otherwise, NPV=0)
- Result:
  - Remaining volatility provides a range of choices which cannot be arbitraged
  - Can use utility max or other factors to choose within range

Summary

- Options apply to supply chain problems
- Can evaluate supply chain planning with proper option evaluation techniques
- Relaxed market assumptions lead to models that determine a range of policies
- Firm or investor utility can choose within range