Real Options: Overview

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Agenda

- Investment Theory
- Real Options Approach
- Uncertainties
- Implications for Economics
- Conclusions

Overview

"The new view of investment opportunities as options .... has shown that the traditional "net present value" rule can give very wrong answers."

Dixit & Pindyck

Investment under Uncertainty, page ix

Investment Theory: Olde Tyme View

- Investment Valuation:
  - Net Discounted Present Value
  - Jorgenson's User cost of capital
  - Tobin's q

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Investment under Uncertainty, Chapters 1 & 2

Investment Theory: Olde Tyme View

- Traditional DCF
  - Management's flexibility not captured
    - Adapt
    - Revise decisions
**Investment Theory: Olde Tyme View**

- **Traditional DCF**
  - Management’s flexibility **not** captured
  - adapt
  - revise decisions
- **DCF**
  - Static operating strategy
  - Cash flows are projected with certainty
  - Discount rate accounts for uncertainty

**Investment Theory**

- **Traditional DCF**
- **Real world**
  - Change
  - Uncertainty
  - Competitive interactions

**Investment Theory**

- **Traditional DCF**
- **Real world**
  - New information
  - Flexibility to alter strategy
  - Flexibility similar to financial options
  - Modelled with financial option tools

**Investment Theory: Olde Tyme View**

- **Traditional**
- **Discounted Present Value**
  - DPV > 0, invest
  - Also called NDPV or DPV or PV
  - \[ DPV = \sum_{t=0}^{T} \frac{CF_t}{(1 + r)^t} \]

**Olde Tyme: Discounted Value**

- **Discounted Present Value**
  - \[ DPV = \sum_{t=0}^{T} \frac{CF_t}{(1 + r)^t} \]
- "r" **Constant**
  - Constant discount rate over time
  - Opportunity cost of capital

**Investment Theory: DCF**

What is the appropriate risk-adjusted discount rate?

One based on a comparable security.
Investment Theory: DTA

- Investment Theory
  - Olde Tyme View
  - Decision-tree Analysis (DTA)

Ex Ante Decision
- Expected Value of DTA
- Risk-adjusted Rate?

\[
\begin{align*}
\text{Expected Value} = & \sum_{t=1}^{\infty} \frac{(CF_t)}{(1+r)^t} \\
\text{Risk-adjusted Rate} = & \sum_{t=1}^{\infty} \frac{(CF_t)}{(1+r_a)^t}
\end{align*}
\]

Investment Theory: DTA, example

- \( I_0 = $104 \)
- \( r_i = 8\% \)
- \( r_a = 20\% \)
- \( q_i = 0.5 \)
**Investment Theory: DTA**

\[ q_t = 0.5 \]

\[ \sum_{t=1}^{T=1} \frac{\$180}{(1 + 0.2)^t} \]

\[ \sum_{t=1}^{T=1} \frac{\$60}{(1 + 0.2)^t} \]

**Investment Theory: DTA, example**

DCF =  

\[ - \$104 + 0.5(\$240)/(1 + 0.2) = \]

\[ = \$100 - \$104 = \$4 \]

**Opportunity Cost of Capital**

- Divine Discount Rate!?  
- Options Pricing Model  
  - Security of equivalent risk  
  - Calculate implied rate

**Real Options Approach**

- Investment Theory  
- Real Options Approach  
  - Definition  
  - Characteristics  
  - Investment characteristics

**Real Options Approach**

- Option definition  
  - The "right" to purchase an asset in the future but not the obligation  
  - Uncertainty of future  
  - Asymmetry of returns
Real Options Approach

- Options characteristic
  - Time limited
  - "Killed" or exercised terminates

Non-linear

- Uncertainty
- Contingent Decision

Call Option v. Real Options

- Value of stock
- Exercise price
- Expiration
- Uncertainty of value
- Riskless interest
- PV of E(CF)
- Investment costs
- Opportunity goes
- Project value uncertainty
- Riskless interest

Trigeorgis (1996), p.125

Call Options v. Investment

- Stock price
- Exercise price
- Expiration
- Variance of return
- Risk-free RoR
- PV of assets
- Expenditure
- Deferral
- Riskiness
- Time value of money


Financial v. Real Options

- Specified in contract
- Off the shelf software
- Output: $’s
- Search for
- Tailored solutions
- Way of thinking

Types of Real Options

- **Natural**
  - Option to defer a capital investment
  - Option to abandon
- **Planned for and created**
  - Research & development
    - New services/products
  - Alter investment levels
  - As state of nature revealed

**Investment Theory: DTA**

What is the appropriate risk-adjusted discount rate?

Enter Real Options!

Investment Theory: RO

Comparable Security

\[ uS = 1.8 \times (20) = 36 \]

\[ S = 20 \]

\[ dS = 0.6 \times (20) = 12 \]

\[ 1 - q_1 = 0.5 \]

\[ q_1 = 0.5 \]

\[ S = 20 \]

\[ uS = 1.8 \times (20) = 36 \]

\[ 1 - q_1 = 0.5 \]

\[ dS = 0.6 \times (20) = 12 \]
Investment Theory: RO

DCF = \sum \left[ \left( q_{it} \right) \frac{CF_{it}}{(1 + r)^t} \right] = \left[ \frac{0.5(180) + 0.5(60)}{(1 + 0.20)} \right] - 104

Investment Theory: RO

$180 \text{ max } [V, 0] = 180 - 104(1.08) = 67.68$

$60 \text{ max } [V, 0] = 60 - 104(1.08) = 0$

Twin Portfolio

\[ m(uS) - (1 + r_f)B = 67.68 \]
\[ m(dS) - (1 + r_f)B = 0.00 \]

\[ uS = 36, dS = 12, \text{ and } r = 8\% \]
\[ B = 31.33 \text{ and } m = 2.82 \text{ shares} \]
Twin Portfolio

\[ m(uS) - (1 + r)B = 67.68 \]
\[ m(uS) - (1 + r)B = 0.00 \]

\[ uS = 36, dS = 12, \text{ and } r = 8\% \]

\[ B = 31.33 \text{ and } m = 2.82 \text{ shares} \]
\[ mS - B = 25.07 \]

Investment Theory: DTA, example

Value of Option to Delay =

Expanded - static DCF

Twin Portfolio

\[ m(uS) - (1 + r)B = 67.68 \]
\[ m(uS) - (1 + r)B = 0.00 \]

\[ B = 31.33 \text{ and } m = 2.82 \text{ shares} \]

\[ \text{Option Value} = mS - B - \text{DCF} \]
\[ = 25.07 - (-4) \]
\[ = 29.07 > 28.20 \]

Investment Theory: RO

\[ \text{max} [V, 0] = 180 - 104(1.08) \]
\[ = 67.68 \]
\[ \text{max} [P, 0] = [60 - 104(1.08), 0] \]
\[ = 0 \]
\[ q_1 = .5 \]
\[ \text{DCF} = \sum \left( \frac{(q_1)CF_i}{(1 + r)} \right) \]
\[ = \left( 0.5 \cdot 67.68 + 0.5 \cdot 0 \right) / 1.20 \]
\[ = 28.20 \]

Benefits of Option

- Total Risk Addressed
- Avoids Mis-valuation
- Market Disciple
- Compatible Evaluation

Real Options Approach: Flexibility

- Defer
- Expand
- Abandon
- Start up (Shut down)
Real Options Approach: Defer

- **Investment Characteristics**
  - Irreversibility
  - Uncertainty
  - Timing

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Real Options Approach

- **Irreversibility**
  Investments become sunk cost (irreversible) when:
  - Firm or Industry specific
  - Regulations/laws
  - Partially irreversible, "lemons"

Real Options Approach

- **Opportunity cost of option**
  - Include in valuation
  - i.e. if the DCF plus the Option Value > 0, invest

Real Options Approach

- Irreversibility
- Waiting
  - Preempt investments preclude
  - Cost of delay
    - Competitive entry
    - Foregone revenues

Real Options Approach

Agenda

- Investment Theory
- Real Options Approach
- Uncertainties

Uncertainties

- Regulation/Legislative
- Competition
- Technologies
- Costs
- Market
Uncertainties

- Regulation/Legislative
  - Courts: Suspension of FCC Orders
  - Regulation: Decisions on RBOC LD
  - Legislative: Re-regulation of Cable
  - etc.

- Competition
  - Traditional: ATT/MFS/TPG
  - Incumbent’s reaction(s)
  - Cable’s Strategies
    - Entry into exchange market
    - Broadband modems

- Technologies
  - Wireless impact
    - WinStar
    - Wireless local loop
  - ISP(Packet Network versus circuit

- Costs
  - Spectrum costs
  - Unbundled Network Elements
  - Right of way
  - Leases

- Market
  - Product acceptance
  - Price and cross-elasticities
  - Size
  - Growth

Agenda

- Investment Theory
- Real Options Approach
- Uncertainties
- Implications for Estimation
Implications for Estimation

Investment Function
- Most obvious impact
- Interest Rates
  - High hurdle rates (3-4 times expectation)
  - Limited stimulation effect
- Shutdown point invalid
  - Price below AVC, not exit
  - Price substantially above LRAC, Invest

Implications for Estimation

Specification
- Desirable Properties
- Economic Theory

Implications for Estimation

Specification
- Based on theory
- Available information

Implications for Estimation

Economic Theory
- Basis for estimation
- Not data mining

Implications for Estimation

Lagged Variables
- Stock Adjustment Models
  - Koyck
  - Nerlove’s Partial Adjustment
  - Adaptive Expectations
Agenda

- Investment Theory
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- Implications for Estimation
- Conclusions

Conclusions

- DPV & DTA Inadequate
- Economic Models Redefined
- Implications for Estimation

Summary/Conclusions

- DPV & DTA Inadequate
  - No dynamics
  - Risk adjusted rate?
  - No Uncertainties
  - No Options Valuation

Summary/Conclusions

- DPV & DTA Inadequate
- Economic Models Redefined
  - Inadequate Specifications
  - Alternative view of dynamics
  - Implications for models
  - Rethink models

Conclusions

- DPV & DTA Inadequate
- Economic Models Redefined
- Implications for Estimation
  - Inadequate Specifications
  - Investment estimations
  - Lagged models
  - Others?