

Real Options Analysis

The challenge and the opportunity

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IAAust BIENNIAL CONVENTION 2003



Overview

What is a real option?

The benefits of ROA

Brief history of ROA

The acid test

Current ROA usage

Opportunities for actuaries

Education proposals

Conclusions & discussion



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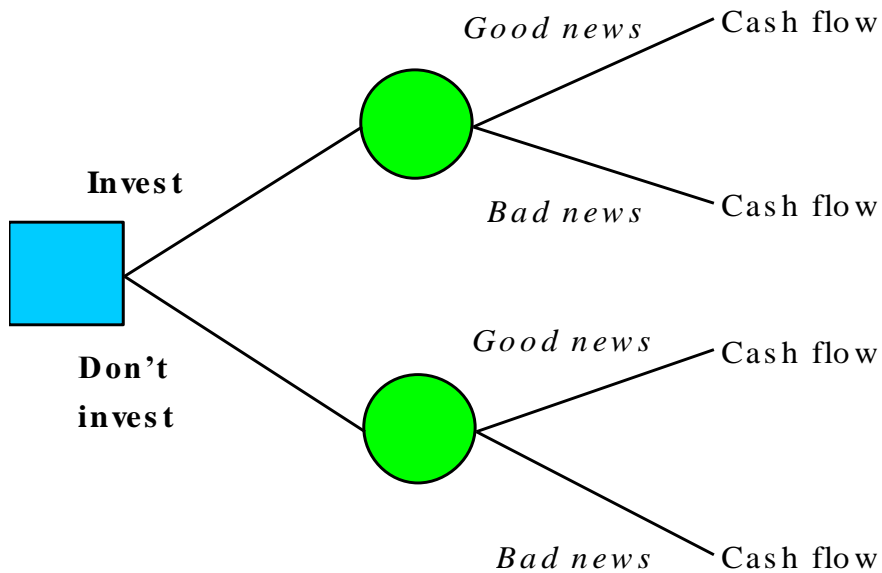
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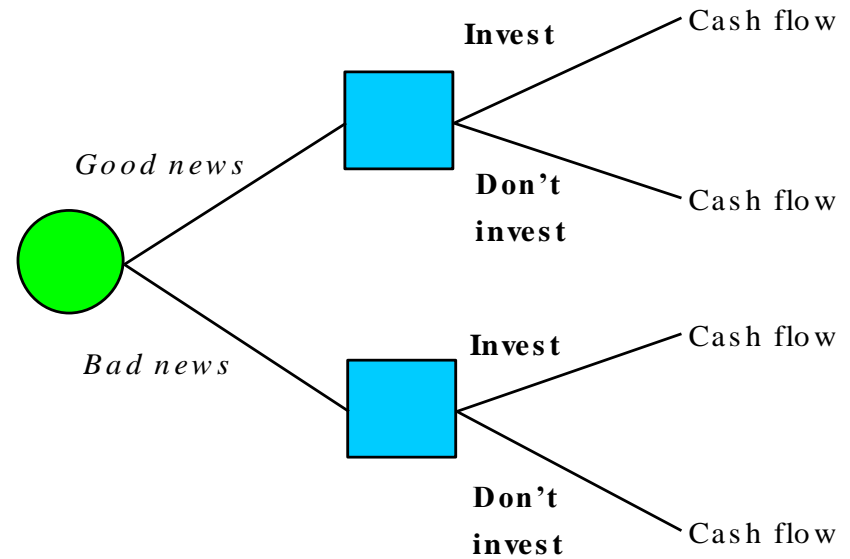


This is an asset-in-place



Invest now and hope for best

This is a real option



Wait for uncertainty to be resolved



What is a real option?

“A real option is the right, but not the obligation, to acquire, expand, contract, abandon or switch some or all of an economic asset on fixed terms on or before the time the opportunity ceases to be available.”



What is a real option? (cont)

- **Physical and strategic economic assets and opportunities of firm**
 - Not financial options or contractual liabilities
- **Management flexibility**
 - to time investment decisions
 - to optimise those assets and opportunities
- **Usually**
 - distant from market
 - not well defined
 - very large sums of money
 - long option life



Example: ACME Mines Inc

- **Phased investment:**
 - Phase 1: survey: \$50m - 3 years
 - Phase 2: test drilling: \$300m – 4 years
 - Phase 3: build mine: \$500m – 2 years
 - At each phase, various chances of success in terms of potential reserves and purity are estimated
- **Optionality**
 - Depending on results, decisions are made at time whether to proceed to next phase
 - Limits downside risk
- **Other parameters:**
 - Gold price: \$300 per ounce
 - Extraction cost: \$250 per ounce
 - Demand: 1m oz pa
 - \$US exchange rate: \$0.60
 - Risk-free discount rate: 5%



Example: ACME Mines Inc (cont)

- Traditional DCF works well until we introduce market uncertainty:
 - Gold price: 30% volatility
 - Extraction cost : 15% volatility, 10% drift
 - Demand: 20% volatility, 10% drift
 - \$US exchange rate: 10% volatility, mean reverting
- DTA goes a lot of the way but is flawed
 - Market inconsistent discount rate
- We require:
 - Real options approach (risk neutrality)
 - Sophisticated modeling tools and techniques



The flaw in the traditional investment decision rule

Invest now if $NPV > 0$

- Traditional capital budgeting attempts to optimise decision when:
 - Available capital resources limited
 - Available investment alternatives exist
- ...but ignores ability to **delay** investment



Every potential investment includes an option to wait

Invest now if $NPV_{NOW} > \max(NPV_{DEFER}, 0)$

Defer investment if $NPV_{DEFER} > \max(NPV_{NOW}, 0)$

- ROA identifies and values such options



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When traditional valuation models work fine

- **Future changes are reasonably predictable**
- **No significant real options exist**
- **Little uncertainty about significant real options that do exist**
- **Mature investments with little or no follow-on opportunities**

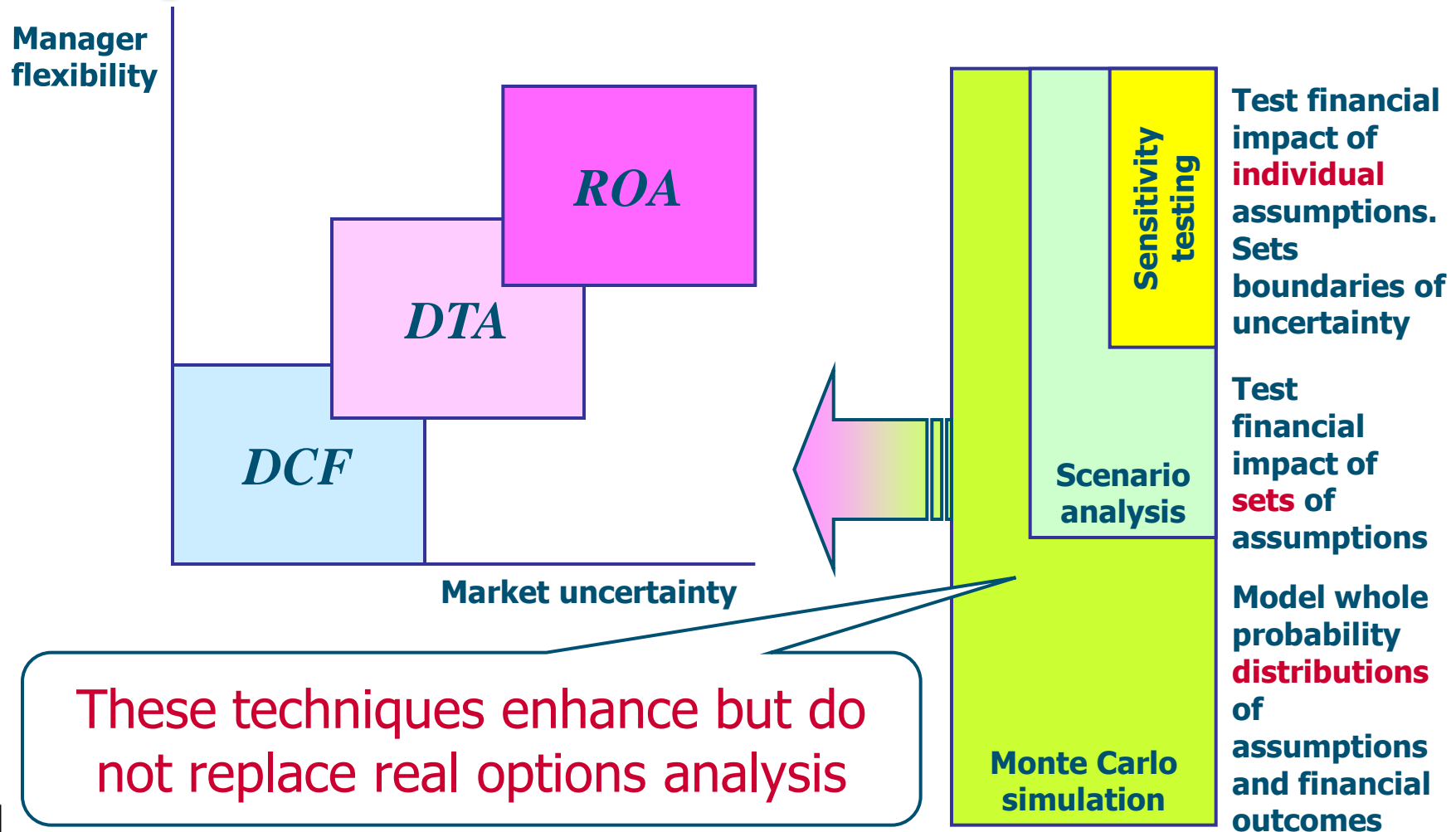


When traditional valuation models fail

- **High market uncertainty**
 - Market prices
 - Supply or demand
- **Contingent proposition**
 - postponement
 - information discovery
 - management flexibility to make mid-course changes
- **Near-the-money decisions**
 - where the decision is not obvious
- **Non-linear outcomes**
 - $\max[E(V)-K,0] \neq E[\max(V-K,0)]$
 - ‘actuarial’ approach vs options approach



ROA takes over when others may falter



Benefits of ROA

- Focuses on importance of **timing**, not just value
- Recognises management's **flexibility** to alter its operating strategy and the value of opportunities:
 - **reactively** as events unfold
 - **proactively** by manipulating option value drivers
- Market consistent valuation of non-linear real option payoffs



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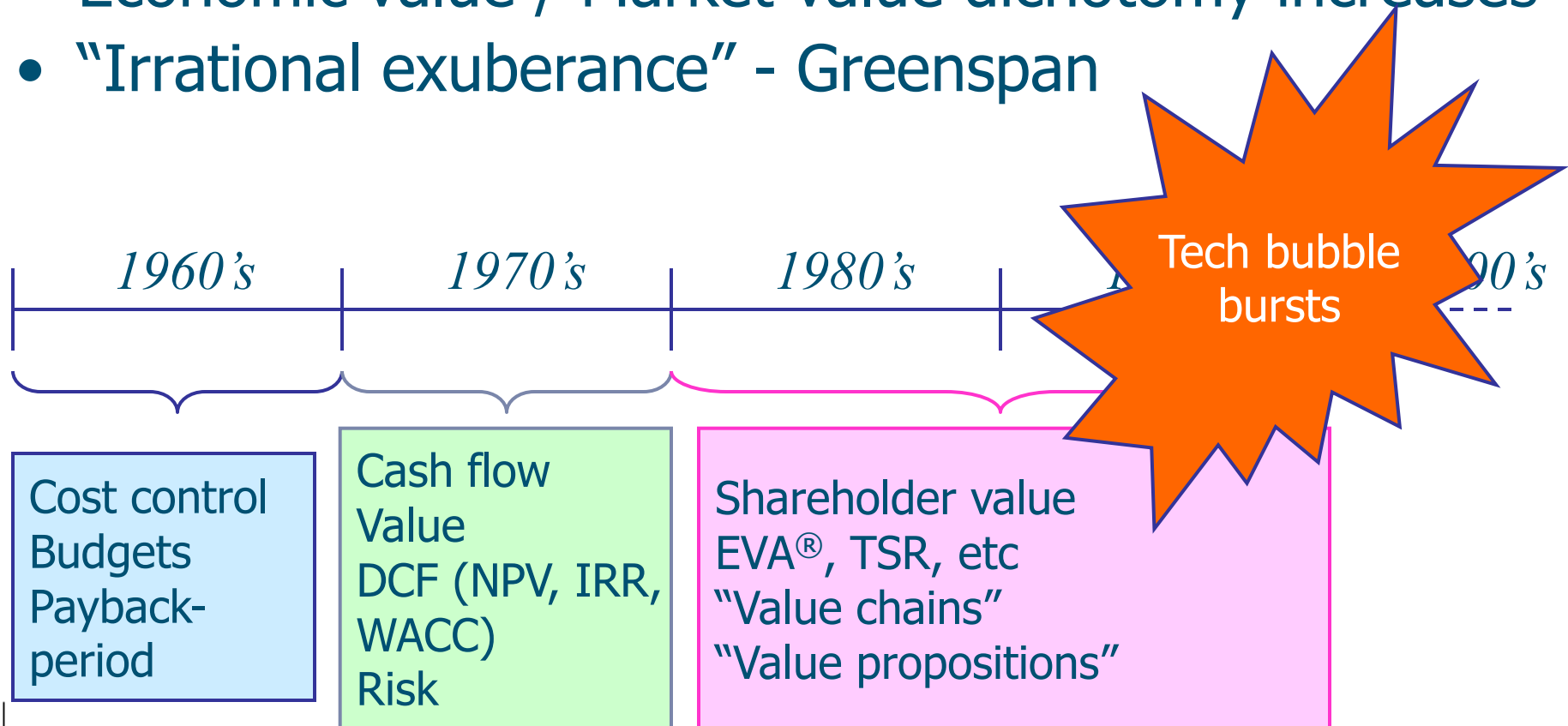
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Market:

seemingly rejects CF based valuation

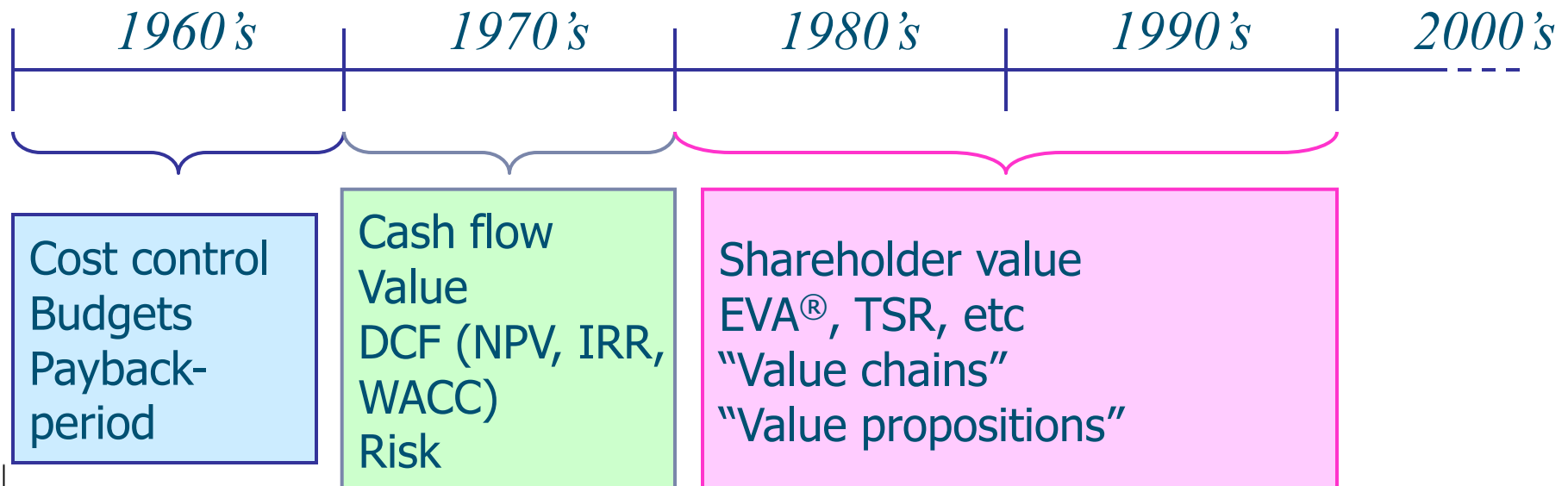
- Technology and venture stock boom
- Economic value / Market value dichotomy increases
- “Irrational exuberance” - Greenspan



Business:

increasingly uncomfortable with DCF

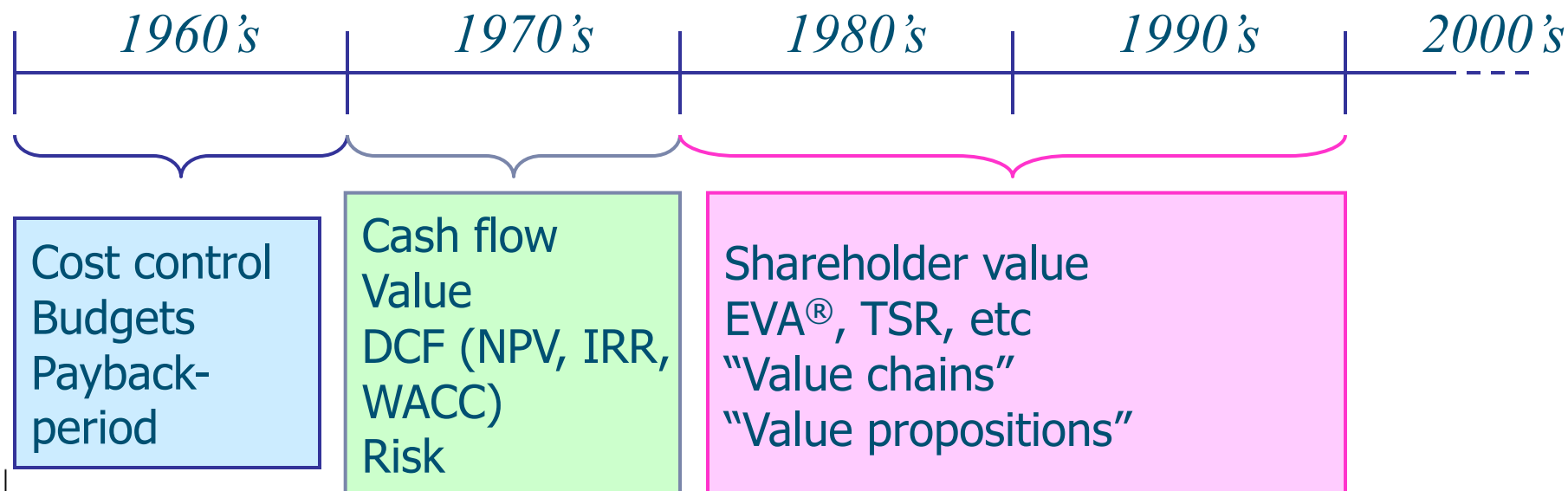
- Excessive discount rates (little relation to MPT)
- Conservative terminal values
- Many projects were rejected due to (or accepted despite of) a perception of undervaluation



Academics:

increased misgivings about DCF

- DCF, while not flawed, was
 - being misunderstood and/or misused
 - missing the manifestations of decision making flexibility
 - DCF was failing to give right signals



Beginning of closure between strategy and finance.

1973

Black-Scholes-Merton

- First closed formula solution for option pricing

1994

Dixit & Pindyck

Brought academic research together into one reference

1984

Myers

- Recognised that DCF tended to understate option value in growing businesses.
- Coined term 'real options'

Increasing flow of research:

- Flexibility and information have real and sometimes substantial value.
- Option theory can help identify and measure options embedded in real assets.



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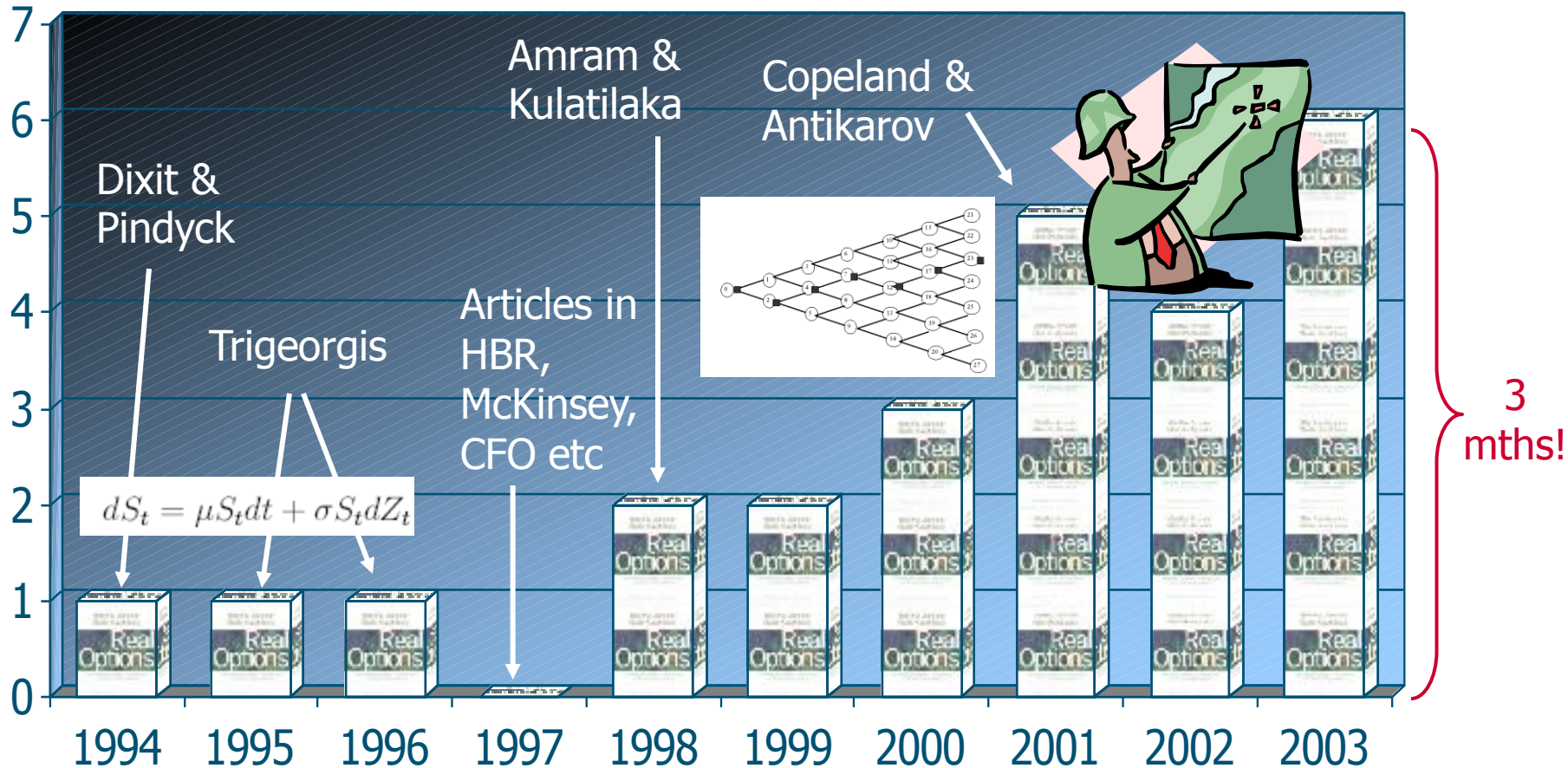
"The acid test of any weird
theory is this:
Can you make money from it?"

Paul Davies in *About Time*, p67



Yes! Authors, publishers...

Real Options - New Book Releases



Yes! Conference organisers, travel industry...

Workshop

Option Valuation
in Energy and
Environmental
Issues

11 February 2003
Fraunhofer ISI
Karlsruhe, Germany



Fraunhofer
Institute
Systems and
Innovation Research

7th Annual International Conference on **Real Options** *Theory Meets Practice*

Fachliche Leitung:
Stiftungslehrstuhl für Investitions- und
Risikomanagement an der
EUROPEAN BUSINESS SCHOOL
PRICEWATERHOUSECOOPERS

**How To Apply Real Options in
Valuing & Managing Strategic
Investments**

29 August 2000

The Sebel of Sydney, 23 Elizabeth Bay
Road, Elizabeth Bay NSW 2011



2. Deutsches
Realoptions-Symposium



Institute of Actuaries of Australia

Yes! Trainers, Web developers, advisers...



Colorado School of Mines

Using Real Options Short Course

May 28-30, 2003

"Using Real Options to Value & Manage Natural Resource Projects"

- **Training**
 - consultancies
 - software suppliers
- **Exclusive Internet sites**
 - number
- **Consultancies**
 - 4



Yes! ...and businesses!

- **Long-time adherents**

- Pharmaceutical & biotech companies
- Petroleum, gas & mineral companies
- Energy firms
- Chemical industry

- **Recent converts**

- Automobile
- Computer industry
- Airline industry
- Energy production
- Telecommunications
- Information technology
- E-commerce
- Environment



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ROA is being used in a wide variety ways

- **R&D decisions**
- **Phased investments**
- **Growth and expansionary planning**
- **Timing decisions**
- **Optimisation of competing interests**
- **Valuing assets**
- **Acquisitions**
- **Trading tool**



1997 survey of UK industrial companies

- **Real options play a significant role in investments and their appraisal.**
- **Firms use rules of thumb that concern options eg staging of investments**
- **Small number of firms studying ROA**
- **Behavioural and organisational considerations inhibit exercising options**



Why did barriers exist?

$$C = SN([\text{Ln}(S/X) + (r + \sigma^2/2)t]/\sigma\sqrt{t}) - Xe^{-rt}N([\text{Ln}(S/X) + (r - \sigma^2/2)t]/\sigma\sqrt{t})$$

$$V = Ge^{-r\tau} d(k, h; \rho) - Ke^{-r\tau} d(k - \sigma\sqrt{\tau^*}, k - \sigma\sqrt{\tau}; \rho) - K^*e^{-r\tau} D(k - \sigma\sqrt{\tau^*})$$

$$F(V(t)) = \max\{V(t) - I, e^{-\rho dt}E[F(V(t+dt))]\}$$

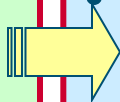


Early adoption of ROA was hindered but eventually overcome

Limited applications and misbeliefs...

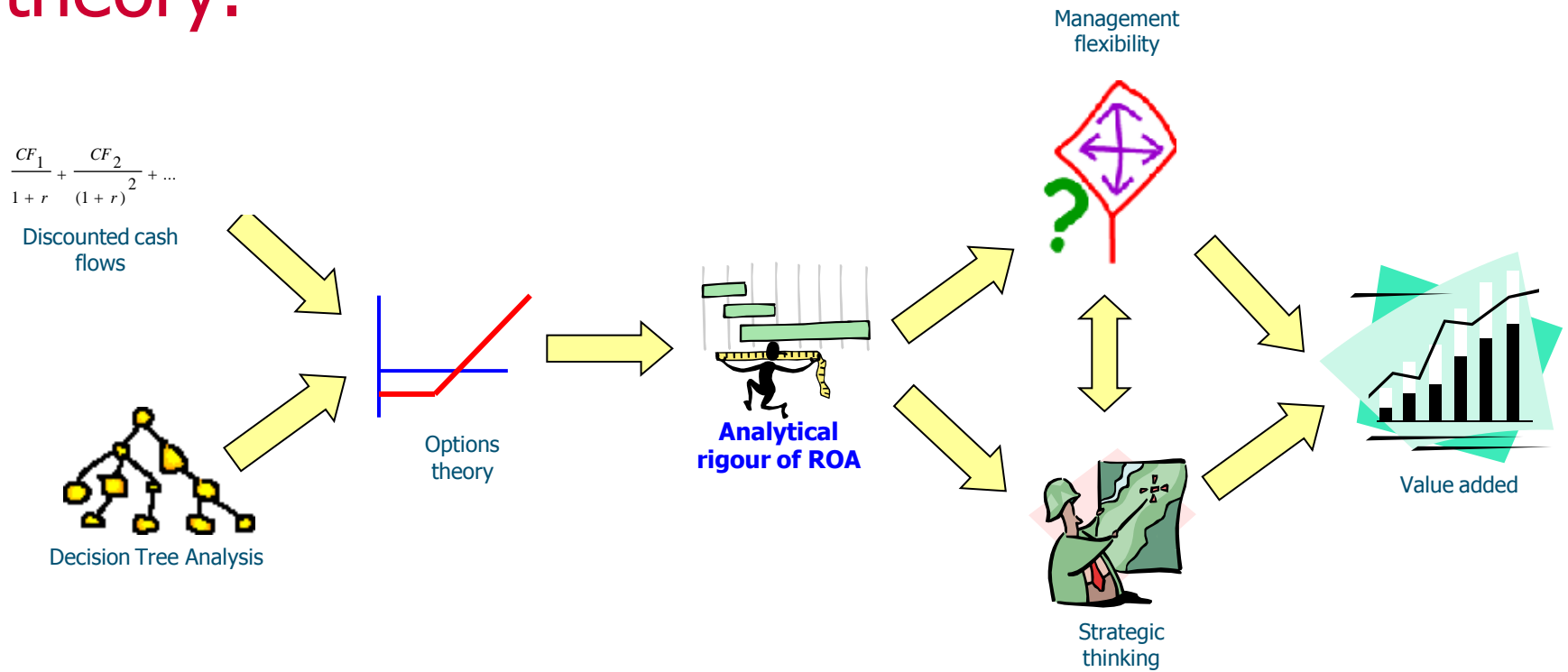
...became many applications.

- SDEs necessary
- Limited computer and software power
- OT cannot be applied to non-traded assets
- Simple options
- Single source of market uncertainty



- Binomial trees & simulation
- Low cost, fast, powerful PCs and software
- OT can be applied to assets distant from market
- Options on options
- Multiple sources of uncertainty

ROA offers the possibility of melding strategic thinking, management flexibility and analytic rigour, all using the well accepted and tested framework of traditional DCF and options theory.



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Go forth actuaries

- **Strategic & M&A**
- **Project evaluation, ie phased investments**
 - Testing new markets, channels, products etc
- **Other?**
- **Non-traditional areas**
 - **Resources**
 - Coal vs gas power generation
 - Water desalination plants vs dams
 - **Infrastructure**
 - Transport and road systems
 - Defence acquisitions
 - **Environment**
 - Urban planning
 - Forestry use



Life was not meant to be easy

- **Do not underestimate the selling job**
- **Do not overplay the numbers**
- **ROA does not guarantee a good outcome**
- **Do not lightly dismiss informal methods**
- **Recognise when options are 'shared'**



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Our profession is at increasing disadvantage compared to others

- **Finance courses generally are being expanded to include real options**
- **Corporate finance texts include more real options content in each edition**
- **Current IAAust Finance syllabus does not cover real options in any depth (if at all)**
- **Despite general trend, current suggestion is to eliminate real options entirely from IAAust syllabus**



Implications for education

- **Investment/Finance specialist level courses undergoing extensive syllabus revision**
- **Real options would fit very naturally**
 - most of necessary technical background already covered (stochastic calculus, option pricing theory, binomial methods, Monte Carlo simulation etc)
 - Scope to remove some of more technical material
- **Recommendation:**
 - Include/expand real options as a topic within the new Investment/Finance syllabus
 - Module 3 under ‘options’ and/or Module 2 under ‘capital budgeting’



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“Today, the real option approach can be regarded as a standard capital budgeting technique. After having been studied by academics for more than two decades, the idea of valuing real investment opportunities analogously to options in financial markets is now treated in many text books and appears ready for practical implementation.”



“The revolution in
[valuation] theory has yet
to become a full revolution
in practice.”

Dr F. Peter Boer in
Financial Management of R&D 2002



Our discussion options

- ***Exercise now***
 - “I can answer that!”
- ***Growth option***
 - “I’m glad you asked me that because it allows me to raise an another point.”
- ***Learning option***
 - “Can you elaborate?”
- ***Deferral option***
 - “That’s a good question. We look forward to answering it oneday.”
- ***Switching option***
 - “Would someone else like to answer that?”
- ***Option to abandon***
 - “No comment.”



Questions for discussion

- As a profession, do we want to be part of the ‘revolution in practice’?
- Is ROA another technique the profession should add to its ‘toolkit’ to help gain entry into (for us) new fields?
- Are there real opportunities for application of ROA techniques to actuarial work?
- What difference can actuaries make?
- What does our education system need to do?

