Real Options Analysis of Information Differences and Investment Strategies

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- Valuation can involve much more than projecting future cash flows and discounting at a rate that reflects risk and the time value of money
- Optimal investment strategy can involve much more than maximising NPV

Choices per se are Not Real Options

The right to invest in stock or bonds does not make a business any more valuable than the amount of the cash to be invested.

A choice only has value if the right to make the choice is a ***right that others do not have***.

R&D that will give rise to a future ability to spend €65 mill on a campaign to launch a 'diet whiskey' product can have value today because the product can be patented. The resultant product may generate payoffs that are worth more than €65 mill cost of launching it.

A nonzero valuation for a growth option requires that you identify the Property Right that underlies that value

Growth Option: New vineyard project

Consider a vineyard project in County Cork.

- Cost to purchase the necessary land and equipment and plant the vines = €25 mill. The land is currently used to raise dairy cows.
- Production = 1 mill bottles per annum beginning 5 years hence.
- Cost of bottling = €4 per bottle.
- In 5 years, after the first crop is harvested, a decision must be made about whether to invest €10 million in equipment. For the first crop, your family/friends will provide the necessary labour.
- If the €10 million investment is made, wine can then be produced in perpetuity at a cost of harvesting and bottling of €4 per bottle. If the investment is not made, the land can be sold for subdivision for €28 million in five years' time.
- Assume the discount rate is 10% per annum.

20% chance: 1 million €30 bottles of Premium wine each year

Value of a winery business in 5 years time after the first harvest given that the vineyard produces a Premium quality wine

$$= \frac{1\text{mill} \times (€30 - €4)}{0.1} - €10\text{mill}$$

$$= €260\text{mill} - €10\text{mill} = €250\text{mill.}$$

Value in 5 years of the sum of the cash flow from first harvest plus the value of the business in 5 years time if optimally exercise expansion /abandonment options

$$= 1\text{mill} \times (€30 - €4) \quad + \quad \max[€250\text{mill}, €28\text{mill}]$$

$$= €276\text{mill.}$$

Optimal to expand winery

80% chance: 1 million €7 bottles of Average wine each year

Value of a winery business in 5 years time after the first harvest given that the vineyard produces Average quality wine

$$= \frac{1\text{mill} \times (€7 - €4)}{0.1} - €10\text{mill}$$

$$= €30\text{mill} - €10\text{mill} = €20\text{mill.}$$

Value in 5 years of cash flow from first harvest plus value of business in 5 years time if optimally exercise expansion /abandonment options

$$= 1\text{mill} \times (€7 - €4) + \max[€20\text{mill}, €28\text{mill}]$$

$$= €31\text{mill.}$$

Optimal to abandon wine growing and sell land for housing

Present Value today of Payoff in 5 years time from an optimally-managed business $= \dfrac{0.2 \times €276\text{mill} + 0.8 \times €31\text{mill}}{1.1^5} = €49.7\text{mill}.$

Net Present Value today of decision to invest €25 mill in land and vine planting $= €49.7 \text{ mill} - €25 \text{ mill} = €24.7 \text{ mill}.$

It is optimal to undertake the R&D of acquiring the land and planting the vines today, and then it is optimal to exercise an expansion option if the vineyard produces premium wine and an abandonment option if the vineyard produces average quality wine.

Valuation requires working with the net cash flows from the optimal management strategy; i.e., from optimally exercising options to expand and contract.

What is the Property Right that makes having the idea of acquiring land and planting vines in Cork worth €24.7 mill?

The valuation appears to suggest that simply investing €25 million to acquire land and plant vines produces a venture worth €49.7 mill!

- Perhaps you have skill in identifying the right type of soil for growing great wine. You know that this particular section of the county has a 20% chance of producing great wine. Others do not know this and hence land in this area is under-valued.

- Perhaps you have skill in identifying potentially great wine makers. You have tasted the wines made by all new graduates of the leading wine-making schools in Europe and have identified a rare individual with a 20% chance of being able to make premium wines. Others have not. You will be able to hire this talented lady without paying her a premium salary and you then have a 20% chance of her producing a premium wine at a cost of only €4 a bottle in the first year.

How to protect the Property Right that makes an ability to acquire land and plant vines worth €24.7 mill?

- Suppose you have skill in identifying potentially great soil types.

You will want to either buy the surrounding properties as well, or buy options to acquire those properties in 5 years time once you have learnt whether it really is great soil.

- Suppose you have skill in identifying potentially great wine makers.

If in 5 years time the wine maker does prove to be truly skilled, she will then increase her charge in future years by the equivalent of the €23 a bottle value that she adds.

€ 23 = €30 price of a premium wine – €7 price of an average wine.

You may need to give her a share stake in the winery and keep both her and the surrounding landowners confused about why the wine is wonderful. Is it because of her skill, or because of the great soil?

An Optimal Strategy can involve investing in order to signal to capital market the existence of your valuable opportunity

Consider a company that owns a property that management knows contains an ounce of gold.

The gold can be extracted at a cost of X where X is constant through time.

Gold is a store of value. Gold is currently worth G_0 and can be sold forward for delivery t years hence at a forward price of $G_0(1+r)^t$.

Value of company if extract today

$= G_0 - X.$

Value of company if strategy is to extract in t years' time (could sell the gold forward)

$$= \frac{G_0\left(1+r_f\right)^t - X}{\left(1+r_f\right)^t} = G_0 - \frac{X}{\left(1+r_f\right)^t} \quad > \quad G_0 - X.$$

It appears better to delay exercising the extraction option and to sell shares in the company than to pay to extract the gold and sell the gold itself.

But, if the company attempts to delay extraction when the world gold price is such that $G_0 > X$, then the market may be concerned that the company may be another *Bre-X*.

The extraction option must be exercised in order to prove that the underlying asset (the gold) actually exists.

Valuation, Corporate Strategy, and Governance are linked

a) True value of an optimally-managed mine =

$$\lim_{t\to\infty} G_0 - \frac{X}{\left(1+r_f\right)^t} = G_0,$$

yet the market value placed on this optimally-managed mine may = €0.

b) • If mine is owned by a wealthy family who do not need to interact with capital markets, then family wealth = G_0. • If mine is owned by a public company, it must operate and will be worth only $G_0 - X$.

• Maximizing shareholder current market value can be 'wasteful.'

Décaire, Gilje and Taillard, 2018, "Real Option Exercise: Empirical Evidence", Working Paper.

c) What is "good governance"? Suppose anti-takeover provisions are in place and the firm will not be taken over if it does not maximize current market value. Should the firm then operate in the interest of those selling out today, or in the interests of longer-term shareholders who plan on selling in, say, 10 years' time?

Valuation by Comparables and Comparable Governance

Suppose you wish to value a lignite deposit portrayed as a Coal To Liquid (CTL) opportunity. The 'Liquid' is oil. You consider the market value of other entities with deposits and make adjustments for differences in:

1. (a) Ore quantity – economies/diseconomies of scale in extraction costs will mean that value is not directly proportional to reserves.

   (b) Ore quality – coal moisture content.

2. Location – relative transportation costs to market.

3. A possible comparable = *LSE*-listed *Spitfire Oil* which also owns lignite deposits in Western Australia.

Market value of *Spitfire*'s value debt = value of assets
= cash + value lignite + value of comparative advantage at conversion

Market value of *Spitfire*'s debt + equity < *Spitfire*'s cash !!!!!

Consistent with the market believing that the cash will be frittered away in director and management fees.

Managerial optimism/pessimism about hedgeable events should not affect the investment decision

A shipping company, *Leakey Shipping*, is considering leasing an oil tanker. Those on the Board of Directors who are optimistic that demand for oil will be high, and hence oil prices and shipping rates will be high, are in favour. Board members who are relatively pessimistic argue that the firm should not pay to acquire additional capacity that in their view is unlikely to be needed.

- *Leaky Shipping* has an opportunity in June to pay €950,00 in June to lease an oil tanker for the forthcoming month of January.
- The tanker has the capacity to carry 2,000,000 barrels of oil. Operating will involve taking possession of the vessel in the Persian Gulf in January and making a single journey in January to the oil refineries in Houston.
- It will cost €3.5mill to load, transport, and unload in January if the vessel is used to transport oil. If the vessel is not used, there will be no operating cost.

- It is difficult to estimate the amount that Leaky will be able to charge to transport oil in January. Demand for oil and hence for shipping may turn out to be high or low.

- Leaky's petroleum engineers have estimated that*

i) if demand is high, oil will be trading for around €115 per barrel in January and traders will be willing to pay €3 per barrel to ship oil.

ii) if there is a comparative glut/downturn in the economy, oil will trade for only €75 per barrel and traders will only be willing to pay €1 per barrel to ship oil.

* Poulakidas, Angela, and Fred Joutz, 2009, "Exploring the link between oil prices and tanker rates," *Maritime Policy & Management*, 36(3), 215-233(19).

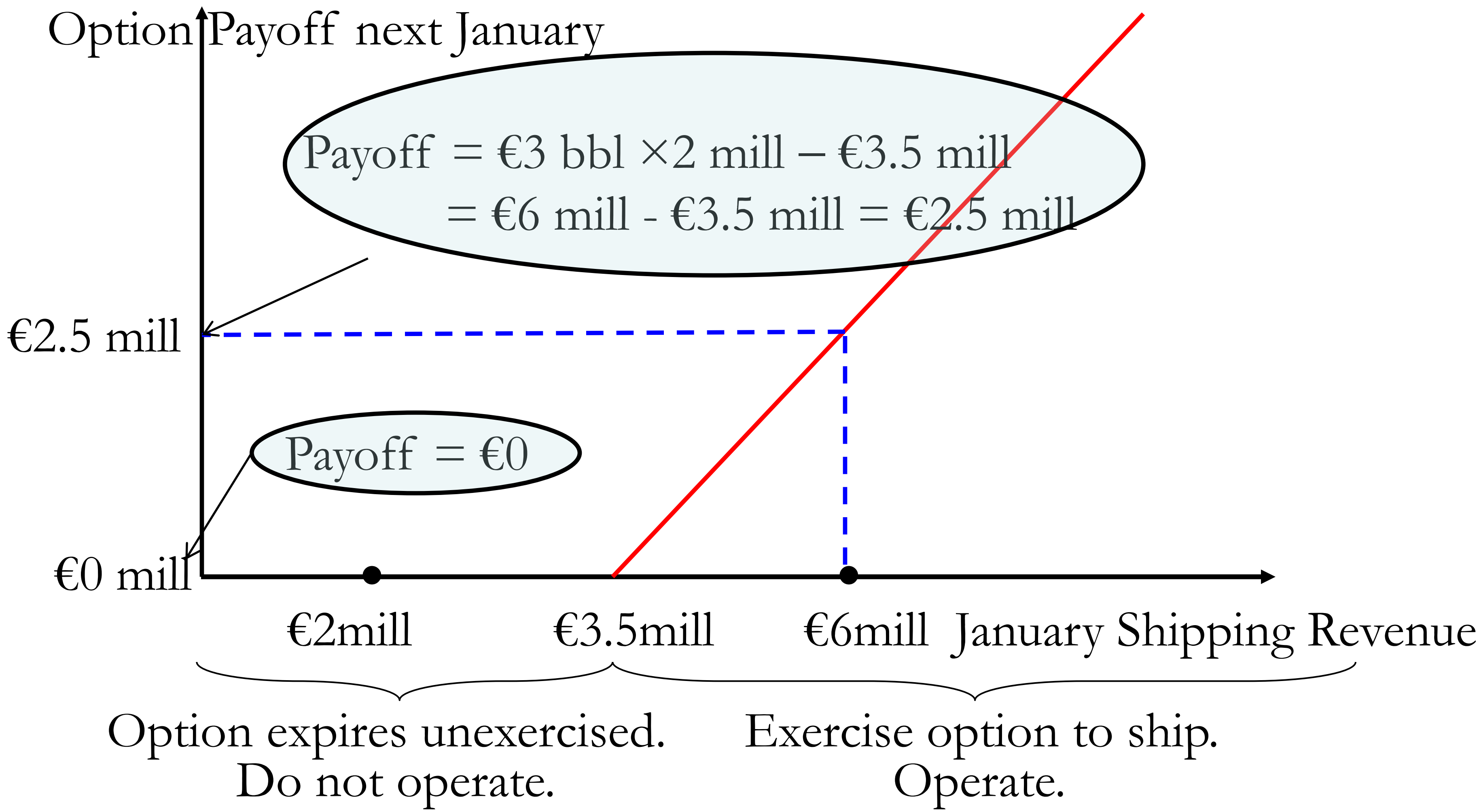
- After researching the oil industry you determine that the engineer's conditional projections are reasonable.
- In the futures market the futures price agreed upon today in June to be paid next January for the delivery of a barrel of oil in January is €90 per barrel.
- The interest rate between June and January is 4.1666666%.

Should *Leakey* lease the tanker?

i) What is the real option that Leakey will acquire if it pays €950,000 in June?

ii) How should the board members estimates of the likelihood of high versus low oil prices affect the decision?

Payoff to option to ship oil



Expected Payoff in January = probability high oil prices × €2.5mill
+ probability low oil prices × €0mill

Let p denote the probability of high oil prices next January.

Expected Payoff in January = p × €2.5mill + (1 – p) × €0mill.

$$\text{Value in June} = \frac{p \times €2.5\text{mill}}{1 + \text{ discount rate}}$$

Leaky should not be willing to lease because it is more optimistic than other potential users of the tanker are about the probability of high oil prices and in turn high shipping rates in January.

Leaky should lease the tanker if *Leaky* is in fact a more efficient operator of the tanker than are other potential operators.

Value the payoff by determining the value of a comparable

Consider replicating similar oil-price dependent payoffs through a strategy of trading in securities.

The per barrel payoff in January from going long in June in a January oil futures contract.

€115 – €90 = €25

€0 investment

€75 – €90 = – €15

Consider the January payoff from a strategy of

- Buying today N oil futures contracts that mature next January
- Investing €B today in bonds that will mature next January and pay 4.1666666% interest over the period.

$$N \times €25 \; + B \times 1.041666666 = €2,500,000.$$
$$N \times (-€15) + B \times 1.041666666 = €0.$$
$$N = \quad 62,500.$$
$$B = €900,000.$$

By lending €900,000 and buying oil futures contracts for the delivery of 62,500 barrels in January, *Leaky* can replicate the January payoff from the lease. The cost today of acquiring the replicating portfolio = €900,000.

$$€900,000 + 62,500 \times €0 = €900,000.$$

Net Present Value of a decision to lease the tanker
= €900,000 – €950,000 = – €50,000 = €50,000 loss.

Leaky should not lease the tanker. Only a company that was more efficient than *Leaky* (i.e., that could operate at sufficiently less than €3,500,000) would find that signing the lease had a positive NPV.

Suppose that optimists on the Board are strongly committed to signing the lease, in effect, to betting on high oil prices.

What alternate strategy dominates signing the lease?

Rather than pay €950,000 for the lease, *Leaky* should instead lend €900,000 and buy oil futures contracts covering 62,500 barrels of oil. *Leaky* would then have €50,000 left over which it could use to pay a dividend. *Leakey* would have the identical exposure to oil prices that signing the lease would have given plus it could pay a €50,000 dividend.

Suppose *Leaky*'s operating costs were only €2,500,000.

Profit when oil prices are high = €3×2 mill – €2.5 mill = €3.5mill.

⇒ NPV of lease = €310,000.

Yet some on *Leaky's* Board argue that it is just too risky to pay €950,000 in June when oil prices may turn out to be low in January.

This risk can be hedged. Suppose *Leaky* pays the €950,000 and leases the tanker and also sells futures contracts on 87,500 barrels of oil for delivery in January and borrows €1,260,000 at 4.166666%.

High Oil Prices	€0 = €3.5mill profit from operations – €3.5 loss on futures and bond trades.
Low Oil Prices	€0 = €0 from not operating + €0 payoff from trades in futures and bonds.

Net cash flow in June if the lease is signed in June = €1,260,000 – €950,000 = €310,000. Leaky is fully hedged. Leakey have zero net cash flows in January next year.

What if Leaky is family-owned rather than a listed firm owned by well-diversified shareholders?

We have focused on the hedgeable risk of high versus low oil prices/ high versus low shipping rates. *Leaky* will also face company specific risks. For example, the weather during the voyage might be calmer or rougher than expected and hence operating costs might be higher or lower than expected. Shareholders who own positions in many different businesses will have diversified away this uncertainty and will argue that the calculated NPV of €310,000 is sufficient to justify signing the lease.

In contrast a family-owned company is unlikely to be well-diversified and will be exposed to the uncertainties of the weather and the resultant uncertainty as to the cost of operations. A family may not be willing to sign the lease.

Summary: Real Options Analysis has been used to demonstrate that Optimal Investment Strategies reflect Information Differences & Governance