REAL OPTION VALUE

CHAPTER 3 REAL OPTION PAYOFFS and POSITION STRATEGIES

Graphing the simple payoffs from real options combined with real assets or real liabilities is often a useful exercise before specific, mathematical modelling of the real option. This chapter first illustrates a "simple complete academic" hedge of an underlying real asset (or exposure) using commodity futures. Then five strategies of combinations of real assets and real and commodity options are viewed in terms of payoff positions. These are graphs of the "intrinsic" option and exposure value, that is V-K for a call option, or V_0-V_T for an exposure, say to oil prices today and then also at a range of oil prices at some time horizon T, usually ignoring the time value of money or the actual option price over time. The investment (call) or abandonment (put) options are similar to purchasing a real call or a real put, or writing a real call or a real put, or to establishing a real collar (limited upside potential and limited downside loss from holding the combined positions).

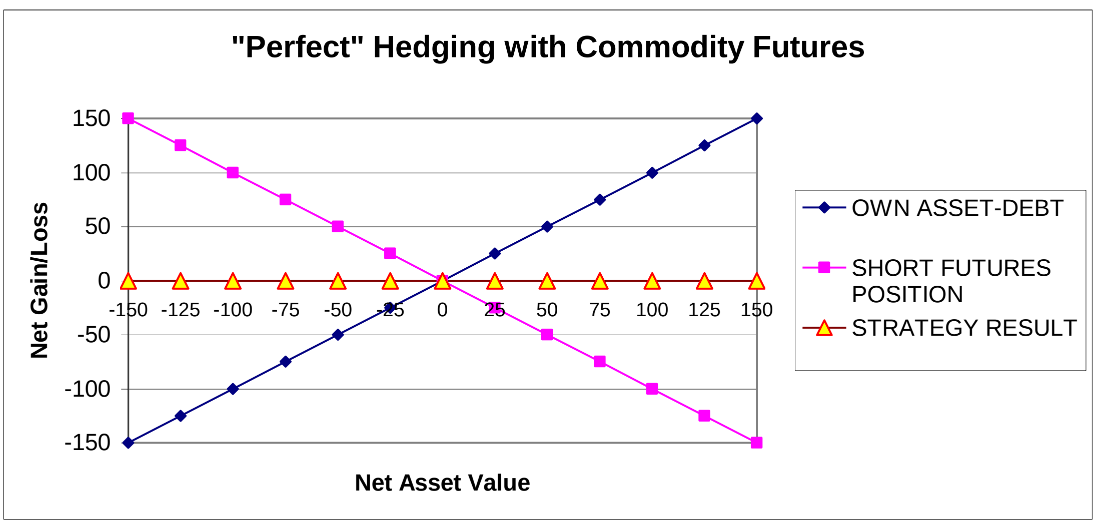
3.1 POSITIONS: LONG ASSETS and SHORT FUTURES

Suppose a petroleum company owns a production field with output prices tied to exchange traded crude oil prices. A natural hedge to minimize risk would be for the petroleum company to enter into short positions in the futures market approximately corresponding to the production schedule over the reserve life. While price risk might be minimized by a natural hedge, residual risk remains. The residual risk would be **basis** risk (difference between the field price paid for oil and the standard futures price), **timing** risk (the difference between the actual production date and the ladder of monthly futures positions, which might include production uncertainty risk), **termination** risk (the difference between the ladder of monthly futures positions and the eventual termination of production), **liquidity** risk (mis-pricing, margin requirements for futures positions and excess transaction costs of futures for longer maturities), and **operational** risk (mis-estimating the competence of systems and persons involved in the hedging process). A “simple academic complete” hedging ignores these risks, and assumes that the production company enters into short positions in the futures market equal to the production schedule, and minimizes price risk. Whether the “simple academic complete” hedging process allows for the real management options in operating the field in the future is an interesting research problem[1].

The primary example is an investor owning an asset currently worth \$150, burdened by debt of \$150, so the net asset value is nil. Then illustrations are given for a range of the asset from 0 to \$300, so the net asset value ranges from -\$150 to +\$150. Figure 3.1 shows a simple academic complete hedge of an asset price with a short position in commodity futures or forwards, established at a futures price of \$150.

Figure 3.1

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**REAL POSITION PAYOFFS**													
2	ASSET VALUE	0	25	50	75	100	125	150	175	200	225	250	275	300
3	OWN ASSET-DEBT	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150
4	SHORT FUTURES POSITION	150	125	100	75	50	25	0	-25	-50	-75	-100	-125	-150
5	STRATEGY RESULT	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Debt, K	150												
7	Hedging cost, y	0												
8	**Own asset subject to debt K, short an equivalent amount of commodity future, at hedging cost y.**													
9	**STRATEGY RESULT equals net gain/loss of hedging cost.**													
10	SHORT FUTURES POSITION	-B3+\$B\$7												
11	STRATEGY RESULT	B3+B4												



[1] Real management options include contracting production as prices fall, or costs rise, or simply abandoning in adverse circumstances.

Look at the extremes. If the asset price falls to nil, the asset less debt would be worth -$150, but there would be a gain of +$150 on the futures position, so the net gain/loss is nil, ignoring transaction costs and other "frictions".

3.2 POSITIONS: LONG ASSETS and REAL CALL or PUT

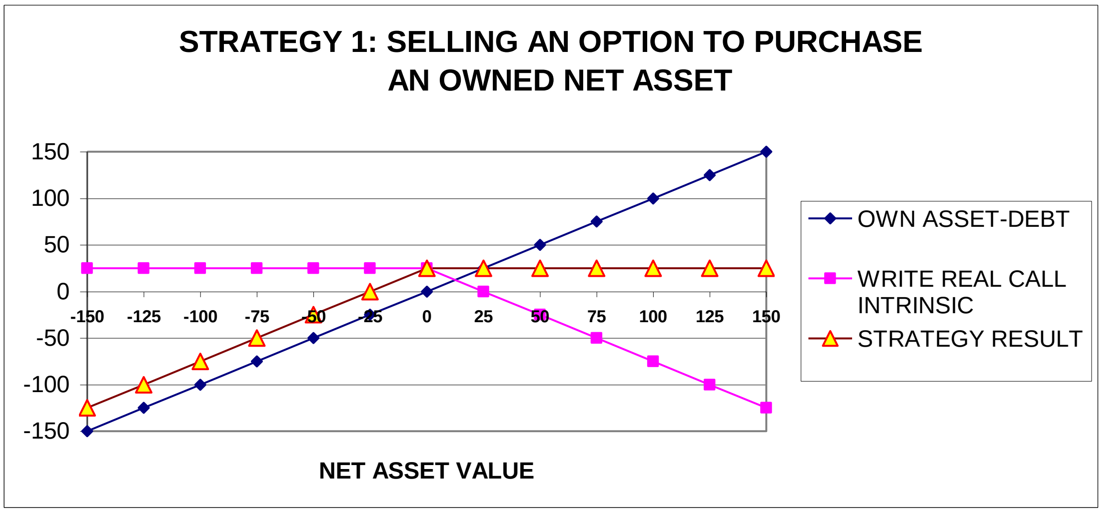
There are several plausible position strategies involving assets, real and commodity options such as: establishing a position in the real option and the underlying asset; forming a spread (a position in two or more real options of the same type); and combination positions in a mixture of real and commodity calls and puts. Consider five strategies involving positions in real net assets (assets burdened by debt) and real and commodity options. The first strategy results in writing, in effect, a real put; the second strategy results in holding a long real put; the third strategy results in holding a real call; the forth strategy results in writing a real call; and the fifth strategy is similar to establishing a "costless collar", with limited upside and limited downside established without having to pay an net option premium.

Payoffs are hypothetical, illustrating combinations of the intrinsic options and intrinsic net asset values. Thus the payoff diagrams ignore the basis, timing, termination, liquidity and operational risk of the strategies, and importantly ignore both the actual real option value, based on expected future volatilities of the underlying assets, other parameters and a "real options aware" management environment.

Strategy 1. Own an asset subject to debt, sell to a third party investor the right to buy the net asset at nil cost (if today asset–debt=0) for an immediate payment of an option premium. Offering this "incentive to buy at a fixed price" is equivalent to writing (or going short on) a real call option. The intrinsic value of the written call option is MAX (OWN ASSET –K + Premium, Premium), so the upside payoff from writing the call option is limited to the premium, but on the downside, the negative payoff is unlimited. Since the call writer owns the asset, the strategy result equals writing a real put on the net asset value, as shown in Figure 3.2.

Figure 3.2

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**REAL OPTION PAYOFFS**													
2	ASSET VALUE	0	25	50	75	100	125	150	175	200	225	250	275	300
3	OWN ASSET-DEBT	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150
4	WRITE REAL CALL INTRINSIC	25	25	25	25	25	25	25	0	-25	-50	-75	-100	-125
5	STRATEGY RESULT	-125	-100	-75	-50	-25	0	25	25	25	25	25	25	25
6	Debt, K	150												
7	Option cost, y	25												
8	**Own asset subject to debt K, give investor an option to buy net asset at nil cost, for immediate payment of option premium of y.**													
9	**STRATEGY RESULT equals write real put on net asset value.**													
10	WRITE REAL CALL INTRINSIC	IF(B3>0,-B3+$B$7,$B$7)												
11	STRATEGY RESULT	B3+B4												



Strategy 2. You are required or committed to use (or deliver) an asset subject to debt, and seek protection against increases in the price of that net asset. Buy a real call option to purchase that net asset at nil cost, if net asset is currently worth 0, for an immediate payment of an option premium. Strategy result is a long real put on the net asset value, as shown in Figure 3.3. An example would be entering into a contract to take physical delivery of oil in storage now worth $150, funded by $150 in debt; the strategy of buying a protective call could involve purchasing a call option on crude oil futures. In this case the intrinsic value of the purchased call option is MAX (ASSET –K - Premium,

- Premium), so the upside payoff from purchasing the call option is unlimited, and the downside payoff is limited to the premium.

Figure 3.3

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**REAL OPTION PAYOFFS**													
2	NET ASSET VALUE	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150
3	REQUIRE USE OF NET ASSET	150	125	100	75	50	25	0	-25	-50	-75	-100	-125	-150
4	BUY REAL CALL INTRINSIC	-10	-10	-10	-10	-10	-10	-10	15	40	65	90	115	140
5	STRATEGY RESULT	140	115	90	65	40	15	-10	-10	-10	-10	-10	-10	-10
6	Debt, K	150												
7	Option cost, y	10												
8	**Require use of asset subject to debt K, buy option to buy net asset at nil cost, for immediate payment of option premium of y.**													
9	**STRATEGY RESULT equals buy real put on net asset value.**													
10	BUY REAL CALL INTRINSIC	IF(B2>0,B2-$B$7,-$B$7)												
11	STRATEGY RESULT	B3+B4												

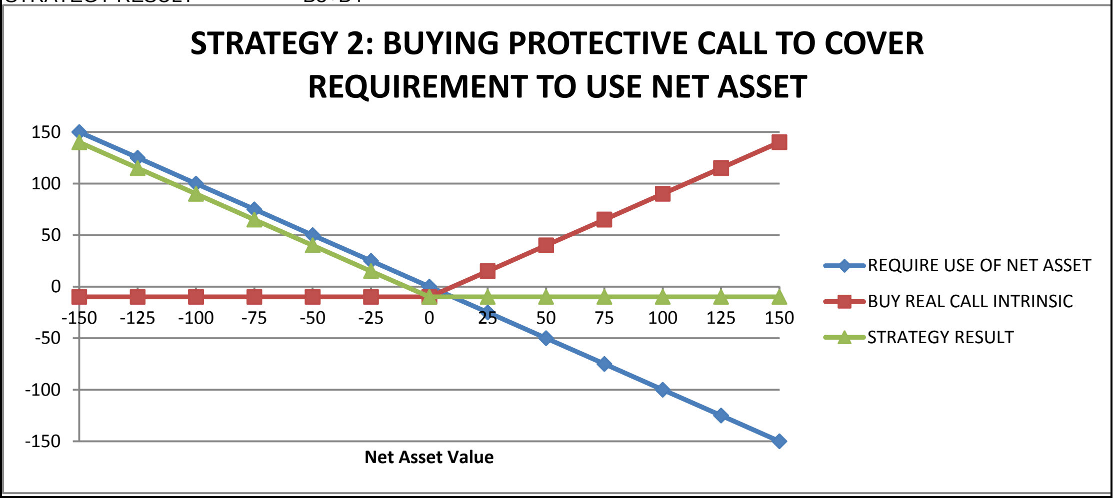
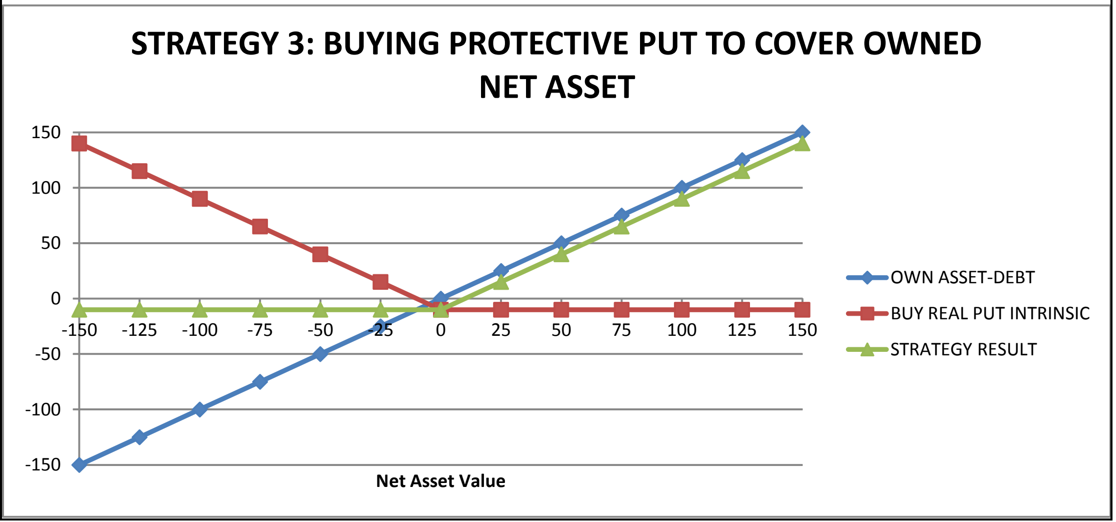


Figure 3.4

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**REAL OPTION PAYOFFS**													
2	OWN ASSET-DEBT	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150
3	BUY REAL PUT INTRINSIC	140	115	90	65	40	15	-10	-10	-10	-10	-10	-10	-10
4	STRATEGY RESULT	-10	-10	-10	-10	-10	-10	-10	15	40	65	90	115	140
5	Debt, K	150												
6	Option cost, y	10												
7	**Own asset subject to debt K, buy right to sell asset at debt amount K, for immediate payment of option premium of y.**													
8	**STRATEGY RESULT equals buy real call on net asset value at nil exercise cost.**													
9	BUY REAL PUT INTRINSIC	IF(B2<0,-B2-$B$6,-$B$6)												
10	STRATEGY RESULT	B2+B3												

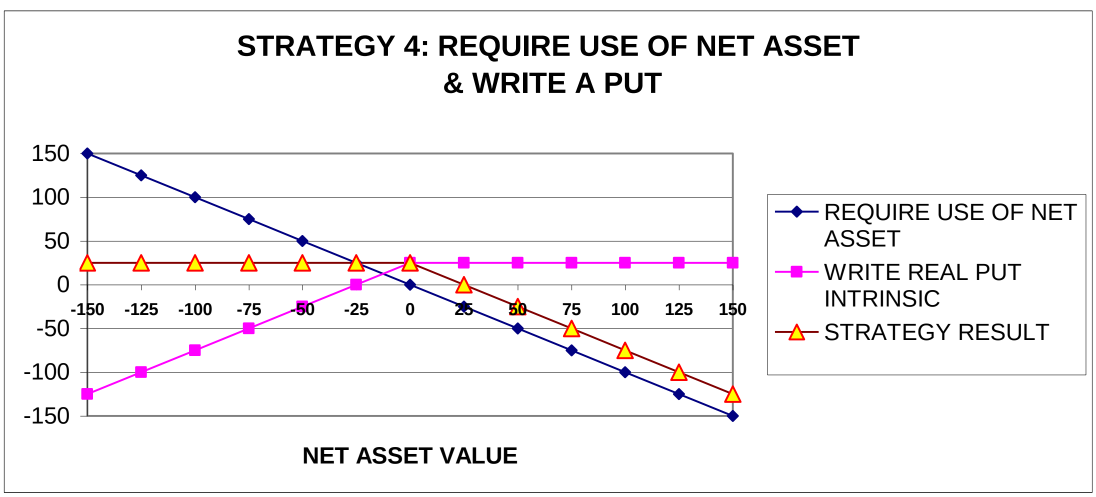


Strategy 3. Own an asset subject to debt, buy the right to sell the asset to a third party at the debt amount (if today asset–debt=0) for an immediate payment of an option premium. Strategy result equals buying a real call on the net asset value at nil exercise cost, as shown in Figure 3.4.

Strategy 4. You are required or committed to use an asset subject to debt, and seek partial protection against increases in the price of that net asset. Write a real put option to sell that net asset at nil cost, if net asset is currently worth 0, for an immediate payment of an option premium. Strategy result equals writing a real call on the net asset value, as shown in Figure 3.5.

Figure 3.5

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**REAL OPTION PAYOFFS**													
2	NET ASSET VALUE	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150
3	REQUIRE USE OF NET ASSET	150	125	100	75	50	25	0	-25	-50	-75	-100	-125	-150
4	WRITE REAL PUT INTRINSIC	-125	-100	-75	-50	-25	0	25	25	25	25	25	25	25
5	STRATEGY RESULT	25	25	25	25	25	25	25	0	-25	-50	-75	-100	-125
6	Debt, K	150												
7	Option cost, y	25												
8	**Require use of asset subject to debt K, write option to sell net asset at nil cost, for immediate payment of option premium of y.**													
9	**STRATEGY RESULT equals write real call on net asset value.**													
10	WRITE REAL PUT INTRINSIC	IF(B2<0,B2+$B$7,$B$7)												
11	STRATEGY RESULT	B3+B4												

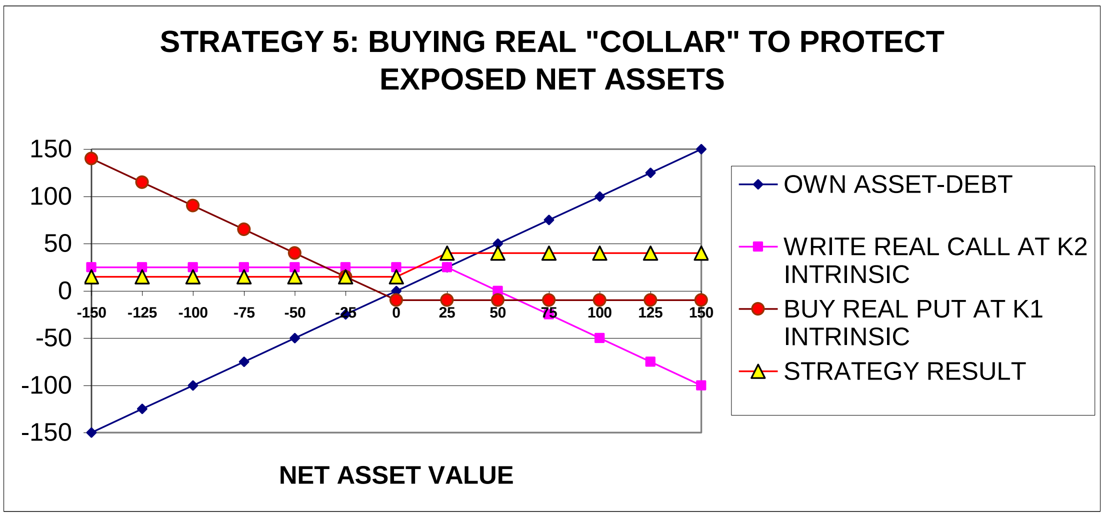


Strategy 5. Own an asset subject to debt, buy the right to sell to a third party the net asset at K1, and agree to sell the net asset at K2 (>K1) for an immediate payment (and receipt) of option premiums. If premiums are equal, then this is a “costless reverse collar”.

Strategy result equals a costless real collar, in effect pre-selling the asset for a net profit equal to the net option premium (at negative and low net asset value) or the difference between K2 and K1 plus the net option premium, as shown in Figure 3.6.

Figure 3.6

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**REAL OPTION PAYOFFS**													
2	OWN ASSET-DEBT	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150
3	WRITE REAL CALL AT K2 INTRINSIC	25	25	25	25	25	25	25	25	0	-25	-50	-75	-100
4	BUY REAL PUT AT K1 INTRINSIC	140	115	90	65	40	15	-10	-10	-10	-10	-10	-10	-10
5	STRATEGY RESULT	15	15	15	15	15	15	15	40	40	40	40	40	40
6	K2	25												
7	K1	0												
8	Debt, K	150												
9	Option cost, y2	25												
10	Option cost, y1	10												
11	**Own asset subject to debt K, buy a "costless protective put" (=protective collar).**													
12	**STRATEGY RESULT equals real collar.**													
13	WRITE REAL CALL AT K2 INTRINSIC	IF(B2>$B$6,$B$6-B2+$B$9,$B$9)												
14	BUY REAL PUT AT K1 INTRINSIC	IF(B2<$B$7,-B2-$B$7-$B$10,-$B$10)												
15	STRATEGY RESULT	B2+B3+B4												



Of course, there are many other combinations of real and commodity assets and options which could be designed to result in various payoffs, such as straddles (buying real calls and puts with the same exercise price, with positive payoffs only with substantial up or down movements from the exercise price)

3.3 EMBEDDED REAL CALL AND PUT OPTIONS

Frequently, assets explicitly or implicitly “contain” real options, which entitle the asset holder to upside call investment opportunities, or alternatively burden the asset holder with downside (or guarantee) put options. We will consider the payoffs of embedded held call options, and effectively embedded put obligations. The first option, an embedded call, is a perpetual American call option held by a property investor, with the opportunity at any time over the future to make a renovation expenditure which will enhance amenities and result in higher rents for the higher accommodation quality. The second option is considered a perpetual American put effectively written by the way of ownership of the property, with the requirement at any time over the future to restore the property to the equivalent of its initial condition. It may be socially and politically unacceptable for a reputable investor to possess decaying, unsafe and unhealthy accommodation facilities; or alternatively, the tenant or asset holder may have the warranty or obligation to maintain the facility in proper order.

Figure 3.7

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**REAL OPTION PAYOFFS**													
2	NET ASSET VALUE	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150
3	HOLD REAL CALL INTRINSIC	-15	-15	-15	-15	-15	-15	-15	10	35	60	85	110	135
4	STRATEGY RESULT	-165	-140	-115	-90	-65	-40	-15	35	85	135	185	235	285
5	Debt, K	150												
6	Option cost, y	15												
7	**Own property subject to debt K, hold an option to renovate net asset at nil cost, immediate payment of option premium of y.**													
8	**STRATEGY RESULT equals extreme upside potential, downside reduced by option premium.**													
9	HOLD REAL CALL INTRINSIC	IF(B2<0,B2-$B$6,-$B$6)												
10	STRATEGY RESULT	B2+B3												

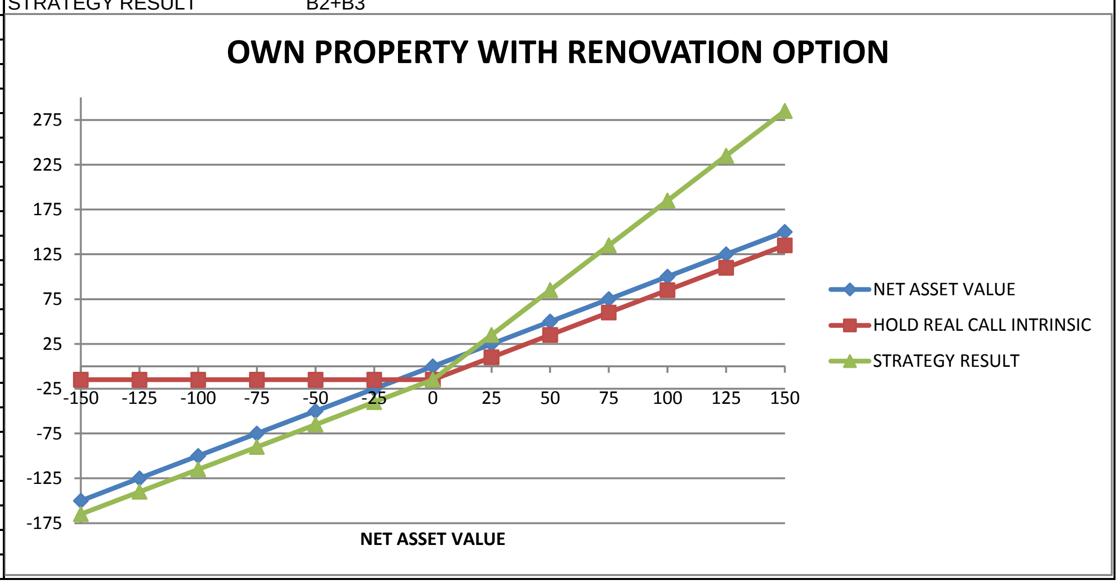


Figure 3.7 shows the simple payoff of a leveraged owned property with an embedded call option to renovate. On the upside if the value of the property increases, the value of the option to renovate will also increase, resulting in a dramatic upside potential. On the downside, if the value of the property decreases, the renovation option will be worthless, and the property owner suffers the decline of the property value as well. The option cost, y, similar to a traded option premium is assumed to be a lower initial yield or discount rate on the property when originally built or bought.

Figure 3.8

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**REAL OPTION PAYOFFS**													
2	OWN LEVERAGED PROPERTY	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150
3	RENOVATION REQUIREMENT	-135	-110	-85	-60	-35	-10	15	15	15	15	15	15	15
4	STRATEGY RESULT	-285	-235	-185	-135	-85	-35	15	40	65	90	115	140	165
5	Debt, K	150												
6	Option cost, y	15												
7	**Own property subject to debt K, have requirement to renovate up to K value for receipt of put option premium of y.**													
8	**STRATEGY RESULT equals extreme downside potential, and slight improvement in upside.**													
9	RENOVATION REQUIREMENT	IF(B2<0,B2+$B$6,+$B$6)												
10	STRATEGY RESULT	B2+B3												

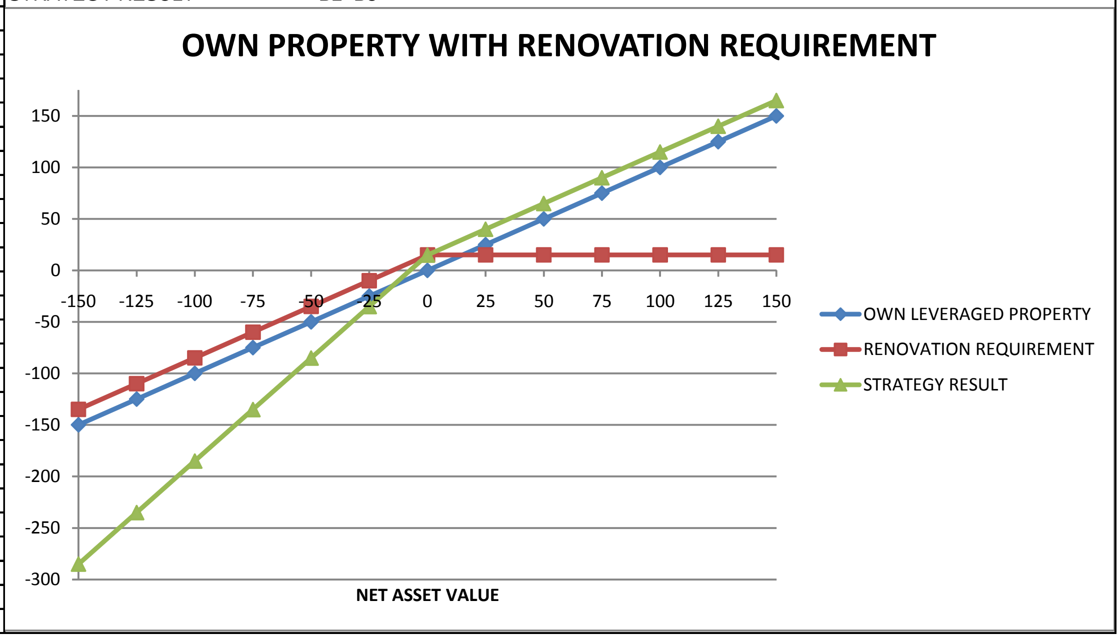


Figure 3.8 shows the simple payoff of a leveraged owned property with an embedded put option with the requirement to restore the property quality. On the upside if the value of the property increases, the value of the obligation to restore will be worthless. On the downside, if the value of the property decreases, the restoration option value will increase, and the property owner suffers the decline of the property value as well. The

option cost, y, similar to a traded option premium is assumed to be a higher initial yield or discount rate on the property when originally built or bought.

These are extreme simple examples, useful in illustrating dramatically the potential embedded opportunities and perhaps nightmares in owning property.

3.4 CASE: REAL STADIUM "GATE RECEIPT" CONTRACT

The Maine Road Stadium, formerly used by Manchester City, had a capacity of around 34,000 seats, which was slightly more than the usual attendance, except for critical games. With the stadium approaching near 100% usage for some home matches, the directors of the club and the Manchester City Council entered into a (convenient) arrangement regarding a new stadium, the City of Manchester Stadium, built for athletic competitions at the Commonwealth Games 2002.

The City of Manchester Stadium is part of Sportcity, a multi-million pound project for the redevelopment of East Manchester. Manchester City Council, the Lawn Tennis Association and Sport England funded the facilities. The Stadium was originally expected to cost £90 million[2]. This is on a 146 acre former industrial site in Eastlands, 1.5 km east of central Manchester (Piccadilly train station) adjacent to Ashton New Road and Alan Turing Way (M11). The Stadium has limited on-site car parking, but will be served by a planned Metrolink line. The planned capacity is 48,000, with a bowl design so that "every spectator will be within 100 meters of the centre spot". Designed by Arup Architects, and built by Laing, the arena is almost circular with high and low elevations providing a "saddle shape" skyline landmark.

It is assumed that the "rental agreement" between Manchester City Council and Manchester City F.C. is equivalent to a nominal fixed amount (maintenance expenses and

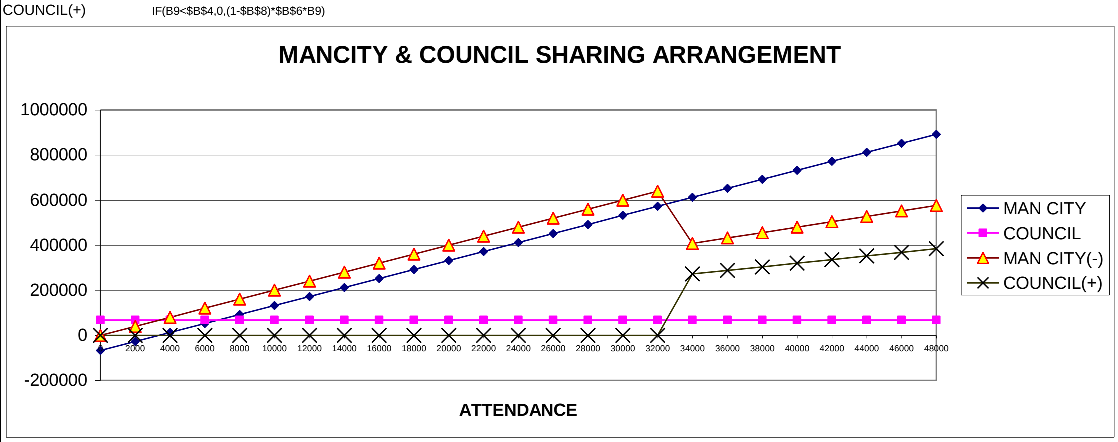
[2] According to David Conn, Independent, 11/11/1999, page 31, "£77 million is provided by the lottery and £13 million from the Council". The club is given a 250-year lease on the stadium in exchange for the Maine Road stadium, and is responsible for the new stadium's upkeep but no rent. After an attendance of 32500, "the council will take a share of the profit on each ticket".

the value of Maine Road), with a sharing agreement for attendances over 32,500[3]. As an illustration, suppose that a "fair straight fixed rental" per game is 34,000 times £2 or a total of £68,000 (times a season average of 23 games equals £1,564,000 or a yield of 1.7% on a (hypothetical) construction cost of £90,000,000). Such a "fair rent" would amount to a yield of 12% on the Council's contribution to the construction costs (assuming that the lottery grant is a donation towards the Commonwealth Games 2002). An alternative is a sharing agreement so that the Council receives a 40% of the gate receipts over 34,000 and that the average gate receipt is £20 per attendance.[4]

Figure 3.9

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	PAYOFF DIAGRAM FOR GATE RECEIPT SHARING ARRANGEMENT													
2	COUNCIL RECEIVES 40% OF GATE RECEIPTS OVER 34000, 2 POUNDS/ATTENDANCE RENT													
3	EXPECTED GATE RECEIPTS 20 POUNDS PER ATTENDANCE													
4	BARRIER	34000												
5	CAPACITY	48000												
6	GATE REC	20												
7	RENT	2												
8	SHARING	0.6												
9	ATTENDANCE	0	**2000**	**4000**	**6000**	**8000**	**10000**	**12000**	**14000**	**16000**	**18000**	**20000**	**22000**	**24000**
10	CITY(-), COUNCIL(+)		40000	80000	120000	160000	200000	240000	280000	320000	360000	400000	440000	480000
11	MAN CITY	-68000	-28000	12000	52000	92000	132000	172000	212000	252000	292000	332000	372000	412000
12	COUNCIL	68000	68000	68000	68000	68000	68000	68000	68000	68000	68000	68000	68000	68000
13	MAN CITY(-)	0	40000	80000	120000	160000	200000	240000	280000	320000	360000	400000	440000	480000
14	COUNCIL(+)	0	0	0	0	0	0	0	0	0	0	0	0	0
15	CITY(-), COUNCIL(+)													
16	MAN CITY	$B$6*B9-$B$4*$B$7												
17	COUNCIL	$B$4*$B$7												
18	MAN CITY(-)	IF(B9<$B$4,$B$6*B9,$B$8*$B$6*B9)												
19	COUNCIL(+)	IF(B9<$B$4,0,(1-$B$8)*$B$6*B9)												

	A	O	P	Q	R	S	T	U	V	W	X	Y	Z
9	ATTENDANCE	**26000**	**28000**	**30000**	**32000**	**34000**	**36000**	**38000**	**40000**	**42000**	**44000**	**46000**	**48000**
10	CITY(-), COUNCIL(+)	520000	560000	600000	640000	680000	720000	760000	800000	840000	880000	920000	960000
11	MAN CITY	452000	492000	532000	572000	612000	652000	692000	732000	772000	812000	852000	892000
12	COUNCIL	68000	68000	68000	68000	68000	68000	68000	68000	68000	68000	68000	68000
13	MAN CITY(-)	520000	560000	600000	640000	408000	432000	456000	480000	504000	528000	552000	576000
14	COUNCIL(+)	0	0	0	0	272000	288000	304000	320000	336000	352000	368000	384000



The "payoff diagram" for such an arrangement is shown in Figure 3.9. In a non-sharing arrangement, the ManCity "ascending line" represents a fixed rental agreement, with City

[3] The inputs are slightly altered in this illustration for convenience of graphing. The minimum rent "barrier" is 34,000, so the minimum rent is £2 times that amount.

[4] The expected average attendance assumption is based on the 1999-2000 average attendance times a 3% growth factor. The average gate receipt (or more precisely ticket profit) is based an estimated average ticket price of £15, increased by one third to reflect ticket inflation by 2002-2003 and better seating for all fans. Ticket sales price is assumed to equal ticket profit since "additional revenue from ticket sales was pure profit" Monopolies and Merger Commission (1999), *British Sky Broadcasting Group Plc and Manchester United Plc*, p. 43.

losing £68,000 in the unlikely event that a game is played without any spectators to a maximum gross profit of £892,000 for a sold out game. The Council "horizontal line" shows a fixed rental receipt of £68,000 regardless of attendance.

The sharing arrangement is equivalent to ManCity writing a call option to the Council at an exercise price of 34,000 attendance, and buying a call option (cap) from the Council at an exercise price of 48,000 attendance. The Council ends up with a type of call option "bull spread" or a collar with an exercise price of 34,000 and a cap (maximum payout) of 48,000 (between the lower and upper bounds the Council receives one minus the sharing percentage times the gate receipt average). In a strategic context, perhaps one would consider the option held by the Council as compensation for any shortfall in the "full rental" with no upside sharing arrangement.[5] The sharing payout is reflected in the Man-City (-) line above the previous ascending line, and the Council (+) line below the horizontal line until 34,000 (assuming a 60/40% gate receipt sharing arrangement), so that in a sharing arrangement the Council could receive as much as £384,000, while City maximum revenue is reduced to £576,000, but it would not suffer a loss on the downside.

Thus the framework of real option pricing illustrates that the rate payers of Manchester and the shareholders of ManCity will want to have carefully considered the expected volatility of future attendances at the new City of Manchester Stadium, in order to decide the appropriate rental terms.[6]

SUMMARY

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[5] The actual arrangement is more complex than this simplification.

[6] Perhaps to hedge such uncertainties, the Council has also entered into two share option arrangements with ManCity. The first option is to subscribe for a 2.5% stake for £1.875 million, if the market value of ManCity is greater than £75 million, and the team is not in the Premiership, exercised within 6 months from entry into the lease on Eastlands. The second option is to subscribe for 5% of ManCity's shares for £5 million, whether or not the club is in the Premiership, any time up to July 2009 [with a limit if both options are exercised of 5%]. Source: Chris Barry, "UK: Council May Get Stake in Blues", Manchester Evening News, 23/9/1999. These are up and in American barrier call warrants, way out of the money, showing perhaps sophistication in the Council and ManCity regarding exotic option valuation (see Rich, 1994, and Paxson, 1997). At a then share price of around 100p, the equivalent exercise prices were around 209p and 271p, with barriers which might have been around 214p and 286p, respectively.

Even though real options are usually "embedded" in real asset opportunities or positions, and therefore cannot always be easily detached or separately traded, outlining the simple payoffs from real options combined with real assets or real liabilities is often a useful exercise before specific modelling. This chapter illustrates increasingly complex combinations of real assets and real options, starting with a "simple complete academic" hedge of an underlying real asset (or exposure) using commodity futures. Then five combinations of real assets and real and commodity option are considered which result in basic payoff positions, similar to purchasing a real call or a real put, or writing a real call or a real put, or to establishing a real collar. Embedded held call and written put options are illustrated. The Excel spreadsheets are shown for each of the strategies. Finally, a practical example is provided of an actual gate-sharing arrangement in Manchester between the City Council and Manchester City football club.

EXERCISES

EXERCISE 3.1. Illustrate (over a range of asset values from 0 to £300) the payoff of owning an asset currently worth £150 subject to debt of £150, where the owner has sold the right to purchase the net asset at £0 for an immediate payment of an option premium of £50.

EXERCISE 3.2. Illustrate (over a range of asset values from 0 to $300) the payoff of owning an asset currently worth $150 subject to debt of $150, where the owner has bought the right to sell the net asset at $0 for an immediate payment of an option premium of $75.

EXERCISE 3.3 HUMANRACE is the promoter of the ITU Salford Triathlon, the major summer event in Greater Manchester (see www.trisalford.info and www.humanrace.co.uk). Fixed expenses are around £50,000, variable expenses are 50% of the entry fee of £100. Last year around 1000 triathletes competed. What is the payoff schedule against the number of triathletes? Suppose John Lunt, who is Mr. HUMANRACE, has an offer from the Salford City Council for a £40,000 fee in exchange for ¾ of all gross revenues over £100,000. Outline his payoff schedule, and evaluate this offer. Suggest alternative arrangements.

PROBLEMS

PROBLEM 3.4. Illustrate (over a range of asset values from 0 to $500) the payoff of being committed to use an asset (currently owned by a third party) worth $300 subject to debt of $300, where the user is willing to pay $75 for protection against increases in the price of that net asset.

PROBLEM 3.5. Illustrate (over a range of asset values from 0 to €1000) the payoff of owning an asset currently worth €500 subject to debt of €500, where the owner seeks a "costless" way of limiting the downside risk.

PROBLEM 3.6. Maria Knox is uncertain about the value of her MBA education, believing that post-MBA, she could be worth a lot, or a little. Some MBAs become very valuable, if they understand real options, and thus are able to appreciate management innovation, strategy and flexibility. However, her teachers are academics, some with little experience of the real world. Maria has been approached by FUD Bonus Insurance Company with an offer that for an insurance premium of £20,000, she will receive a bonus compensation of £30,000 if she obtains a top salary of less than £50,000 upon graduation, and a bonus of £30,000 if she obtains over £150,000. Outline her payoff schedule, and evaluate this offer. Suggest a more appropriate insurance arrangement, if Maria wants a minimum income in order to support her poor father, a senior academic at a UK university.