Insides from Real Options and Risk Analysis

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ABSTRACT

Risk analysis is used to evaluate many aspects of a project, specially the sensitiveness of some key variables. Risk analysis together with statistical analysis allow managers to know some insides like their variables dependency or independency and their variance. Scenario analysis provides best-case, most likely-case and worst-case scenarios. These scenarios help managers to recognize when the project is moving in a specific direction. Break-even anlysis helps managers recognize for example the minimum number of units to sale before a project starts making a profit. Simulations allow managers to see the interrelation of the ramdomness of key variables that could be expected. However, none of these analysis allow us to recognize the expected results at the end of the jorney as real options does. Real Options when combined with a decision tree show the expected results of the different roads the project turns. It is like a map that shows finantial results at each possible road in the map and helps in decision making while in the middle of the project, helping to turn the project in the right direction. This paper uses an example to tour what can be known from inside of the real options and risk analysis.

Keywords: Risk Analysis, Real Options, Construction Management

1. INTRODUCTION

Usually contractors know that when uncertainties are present, there is a possibility of making money, because uncertainties create value. The problem when valuing an ingeniering or construction project is the recognition of the variables that generate uncertainties and their interaccions. Many analysis had been designed to investigate specific aspects of engineering projects. However many managers would like to have a cristal ball to help them recognize the future, because designed tools are designated for specific aspects and do not allow them to prevent undesired results. Through a case study, this document pretend to tour and find the insides coming from different traditional tools available to analyze a project, including the real options theory, imported from the stock market. To see better the insides, a case study will be used.

1.1 CASE STUDY

A builder has $1.5 Million dollars to invest in a new residencial development to build in five years with an 8% return paid annually until the money is returned at the end of the project. He bought a land for $400,000. After an initial design, he estimates to build 50 new homes with a smal club house and a play ground for children, and call it "Windy Hill". The initial $1.5 Million will be used to pay for the land, the development of it and build the amenities. The finance for each house is included with the construction expenses through a specific loan for each unit the builder decides to build. The builder plan is to develop and sell the total units in a period of 5 years. Because the builder only has capacity to build 6 units per year, he invited another builder who will construct the excess on demand. Today (year 0) the unit selling price of $190,000/unit and this price is expected to increase over the next five years at a rate of 4% per year. The builder expect to maintan the expenses of each unit at $85,000. But because he is using the services of a second builder, the second builder price for each house today is $105,000 ($20,000 more than the first builder) with an increase in price of 3% annually. Every unit has $2,000 in a fixed expenses for sales and clossing papers. The buider pays taxes at a rate of 25%/year and expects to sale any lot that is not build at the end of the 5th year at $45,000 each. This quantity will be considered for this problem as a salvage value. The risk free of return is 4%.

1.1.1 SCENARIOS

The process of analysing possible future events by considering potential alternative outcomes is what is called scenario analysis.With the information given by the second builder and his own optimistic projections, this builder created table No. 1 that contains the present and the net present value for the Windy Hill project.

Scenario analysis considers the sensityvity of the NPV to changes in key variables and allow to compare the best case, the most likely and the worst case scenario, when changes in sales, prices, costs etc are expected to occur,, but when changing more than one variable at a time the scenarios become a simple picture with a few changes.

Table 1: Best Case Scenario

Year		0	1	2	3	4	5
Revenues							
Total Sales			**$1,976,000**	**$2,055,040**	**$2,137,242**	**$2,222,731**	**$2,311,641**
Builder 1			6	6	6	6	6
Builder 2			4	4	4	4	4
Total Units Sell			10	10	10	10	10
Sale / Unit (Incr 4%/year)	4.00%	$190,000	$197,600	$205,504	$213,724	$222,273	$231,164
Expenses							
Cost/Unit Builder 1		$85,000	$85,000	$85,000	$85,000	$85,000	$85,000
Ext Cost/Unit B2 (3%/year	3.00%	$20,000	$23,150	$29,736	$40,375	$56,111	$78,587
Const Cost			$942,600	$968,945	$1,011,502	$1,074,445	$1,164,346
Land+Dev+ClubHouse		$400,000	$1,100,000				
Other Fixed Cost	$ 2,000		$20,000	$20,000	$20,000	$20,000	$20,000
Interes paid (Investment)	8.00%		$120,000	$120,000	$120,000	$120,000	$120,000
EBT*		($400,000)	($206,600)	$946,095	$985,740	$1,008,286	$1,007,294
Taxes	25.00%			($236,524)	($246,435)	($252,072)	($251,824)
Salvage value							$0
Tax							$0
EAT*		($400,000)	($206,600)	$709,571	$739,305	$756,215	$755,471
WACC*	10.00%						
Discount Factor		1	0.909	0.826	0.751	0.683	0.621
PV*		($400,000)	($187,818)	$586,422	$555,451	$516,505	$469,088
PV of Cash Flow		**$1,539,647**					
Initial Investment		$1,500,000					
NPV* of Project		**$39,647**					
***NOTES:**							
EBT = Earnings before Taxes		**WACC = Weighted Average Cost of Capital**				**NPV= Net Present value**	
EAT = Earnings After Taxes		**PV = Present Value**					

Not very happy with this projections, he started thinking what could happened if not all the houses are built. Then he decided to do another scenario where only 40 units are built and the 10 lots left sell at the end the project. In the new scenario other variables like construction cost, and selling prices were decreased by 15%. The result were no good as Table 2 shows. The NPV (Net Present Value) becomes negative and it becomes a bigger negative number when the number of units to build decreases more. What it shows is that there is a potential for loss or in other words, the Windy Hill project is risky.

The worst case scenario table is not shown in this document, but it was considered in the study. This scenario supposed to sell 35 houses during the life of the project, 15 lots will sell at the end of the project, and fixed cost and variable cost were decreased as well.

Table 2: Most Likely Case Scenario

Year		0	1	2	3	4	5
Revenues							
Total Sales			**$1,539,200**	**$1,600,768**	**$1,664,799**	**$1,731,391**	**$1,800,646**
Builder 1			6	6	6	6	6
Builder 2			2	2	2	2	2
Total Units Sell			8	8	8	8	8
Sale / Unit (Increase 4%/year)	4.00%	$185,000	$192,400	$200,096	$208,100	$216,424	$225,081
Expenses							
Cost/Unit Comp 1		$84,000	$84,000	$84,000	$84,000	$84,000	$84,000
Cost/Unit Comp 2 (incs 3%/year	3.00%	$19,000	$22,090	$28,551	$38,987	$54,423	$76,471
Const Cost			$716,180	$729,102	$749,975	$780,847	$824,941
Land+Dev+ClubHouse		$400,000	$1,100,000				
Other Fixed Cost	$ 2,000		$16,000	$16,000	$16,000	$16,000	$16,000
Interes paid (Investment)	8.00%		$120,000	$120,000	$120,000	$120,000	$120,000
EBT		($400,000)	($412,980)	$735,666	$778,824	$814,544	$839,705
Taxes	25.00%			($183,917)	($194,706)	($203,636)	($209,926)
Salvage							$450,000
Tax							($112,500)
EAT		($400,000)	($412,980)	$551,750	$584,118	$610,908	$967,279
WACC	10.00%						
Discount Factor		1	0.909	0.826	0.751	0.683	0.621
PV		($400,000)	($375,436)	$455,991	$438,856	$417,258	$600,604
PV of Cash Flow		**$1,137,274**					
Initial Investment		$1,500,000					
NPV of Project		**($362,726)**					

1.1.2 RISK ANALYSIS

Any deviation from a desired outcome is known as a risk. If the builder from this case has the guarantee that everything occurs accordingly with his projections that 10 units are built and sold every year until the project is completed, he is not at risk. Changes in the number of units to build and sell every year, the selling price, construction expenses, the interest rates for loans and taxes could change any time, changing the project profits or losses. The accuracy of the mentioned variables are difficult to determine and all of them influence the exactness of the cash flow for the project or in other words if these variables are subject to substantial uncertainty, the estimated cash flow becomes uncertainty too. For example, the type of product and the state of the economy (demand) plays a role in the number of units to sell and they can affect the final result. The risk associated with the project can be analyzed by determining the uncertainty of the cash flow. One of the methods for doing this kind of analysis is known as sensitivity analysis.

1.1.2.1 SENSITIVITY ANALYSIS

A sensitivy analysis shows how much the Net Present Value (NPV) changes in response to a change in the input of a single variable as it is shown on Table 3. its desadvantage is that the interaccion or correlations between inputs can not be seen and small changes in a input may be is not shown in the results. Sensitivity analysis can be useful to identify crucial variables that could contribute to the riskiness of the investment.

Table 3: NPV for changes in Key Variables for the Best Case Scenario

Sensitivity Analysis for a Key Input Variables Using the Base-Case Scenario									
Deviation	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Units Sale Price	($1,258,269)	($933,790)	($609,311)	($284,832)	**$39,647**	$364,126	$688,606	$1,013,085	$1,337,564
Unit Cost Builder 1	$604,457	$463,254	$322,052	$180,850	**$39,647**	($101,555)	($242,757)	($383,959)	($525,162)
Unit Cost Builder 2	$98,855	$84,053	$69,251	$54,449	**$39,647**	$24,846	$10,044	($4,758)	($19,560)
Interes Paid	$113,336	$94,914	$76,492	$58,070	**$39,647**	$21,225	$2,803	($15,619)	($34,041)
Taxes	$181,478	$146,021	$110,563	$75,105	**$39,647**	$4,190	($31,268)	($66,726)	($102,184)
Units to sale	($259,327)	($217,072)	($109,840)	($67,585)	**$39,647**	$134,293	$293,915	$388,561	$548,183
Result register here NPVs									

With the information from Table 3, a sesitivity plot can be build as shown on Figure No. 1. The table and the figure allow us to understand what happens when the first builder increases the units cost by 5% or more: the project will be at loss. We can also see the impact when at the same time the 2nd builder increases the construction cost by 15%. Additionally if the unit selling price decreases 5% or more, the project will be at loss.

The cash flow indicates that the actual price is just the necessary for not having losses. Similarly, when the interest paid increases by 15% or more, the project will be at loss and similar situation hapens when taxes increase 10% or more. This graph communicates the relative sensitivities of the different variables with respect to the NPV. The problem is that this graph does not explain or show the interaction between the variables and does no explains the variability of the NPV when more than one variable changes. It only shows one variable at a time.

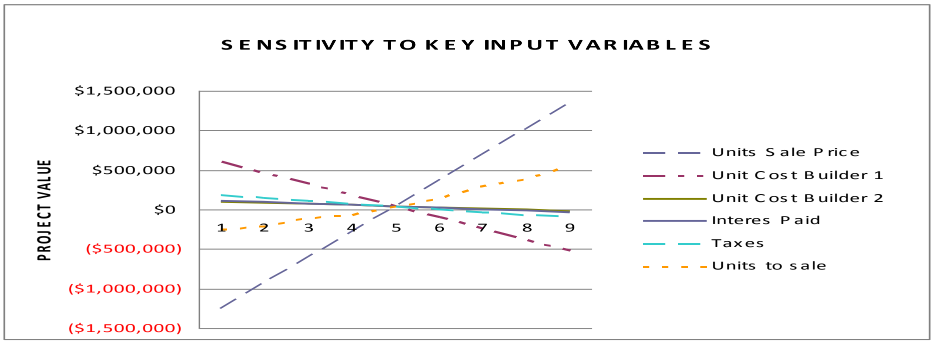

Figure 1: Sensitivity analysis for the key input variables

1.1.2.2 BREAK-EVEN ANALYSIS

Break-Even analysis is more a concept than a specific method. The purpose of break-even analysis is to evaluate the robustness of a decision to changes in inputs (Von Winterfeldt and Edwards, 1986). While building a project, it is important to know how many units the builder needs to sale before the project starts getting in a good standing. This type of analysis is similar to the one used to calculate the internal rate of return where the interest rate that makes the NPV zero is found. Table No. 4 contains the break-even analysis for Windy Hill Project.

Table 4: Break-Even Point

Year	0	1	2	3	4	5
Sales in PV	$ -	$ 1,796,364	$ 1,698,380	$ 1,605,741	$ 1,518,155	$ 1,435,347
Expenses in PV	$400,000	$1,984,182	$721,010	$679,990	$657,314	$653,534
Cumm Sales in PV	$ -	$ 1,796,364	$ 3,494,744	$ 5,100,485	$ 6,618,640	$ 8,053,987
Cumm Expens in PV	$ 400,000	$ 2,384,182	$ 3,105,191	$ 3,785,182	$ 4,442,496	$ 5,096,029
Cumm Units	0	10	20	30	40	50

Observe that for getting a NPV equals zero, the cumulative sales need to be equal to the cumulative expenses. For this specific project it occurs before 20 units (Table 4 and Figure 2). If we graph these information as shown below on Figure 2, it is easy to observe that profits, just starts after the cumulative sales overpass the cumulative expenses after less than 20 units are sold.

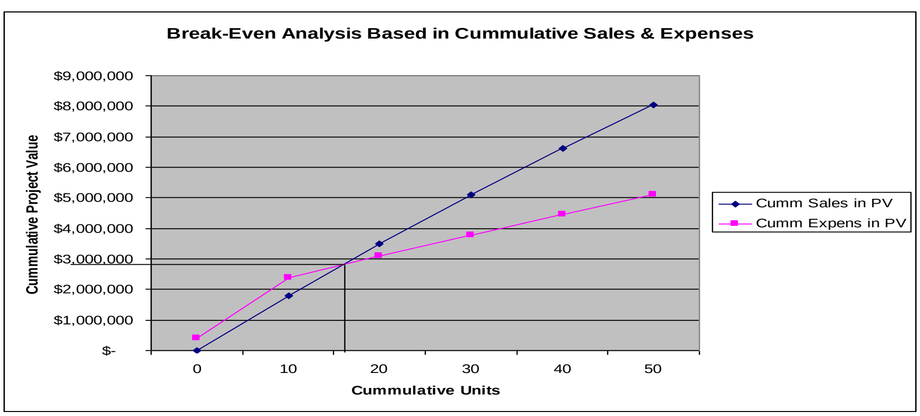

Figure 2: Break-Even Analysis Based in Cumulative Sales and Expenses

Knowing that the Break-Even point is an useful concept, the method is not a straightforward to apply due to the compexity of the number of sensible inputs. There is no clear ranking to distinguist the relative importance of the sensitivity imputs (Von Winterfeldt and Edwards, 1986).

1.1.2.3 SCENARIO ANALYSIS

Scenario Analysis is a technique that considers the sensitivity of the NPV to changes in key variables and the likelihood of those variables. Table 5 contains the results when 10 units are sold /year (Best Case Scenario), 8 units/ year (most likely) and 7 units/year (worst case scenario). The result includes the sale of the remaining lots after taxes. Looking at the table is easy to conclude how sensible the project is at the prices and the number of units to sale each year given the changes in the NPV from one case to another. The scenarios only provide us with a picture of what to expect en each case and no more than that, further analysis then is required.

Table 5: Scenario Analysis

Variable Considered	Best-Case Scenario	Most Likely-Case Scenario	Worst-Case Scenario
Unit Demand	10	8	7
Unit Sale Price	$ 190,000	$ 185,000	$ 180,000
Variable Cost	$20,000	$19,000	$18,000
Fixed Cost	$85,000	$84,000	$83,000
Salvage Value	$0	$337,500	$506,250
NPV (10%)	$39,647	($362,726)	($596,258)

Note: Salvage Value = Sale of remaining Lots minus taxes

1.1.3 PROBABILISTIC ANALYSIS

Probabilities can provide some insights into possible outcomes and the likelihood of different alternatives. "The assignment of probabilities to the various outcomes of an investment is generally called risk Analysis" (Park, 2011). Probabilities can be assigned based on historical data or based on current believes about possible events. In the first case, these type of probabilities are called objective probabilities (based on historical data) and in the second case are called subjective probabilities.

When making decisions under conditions of certainty, managers always choose the alternative with highest return or payoff. Under conditions of risk, decisions are made under our expectations of the outcomes. The expected value (also called the mean) of any event is the value of the payoff of the event times the probability of the event. Then, the rule for decision making is to choose the alternative that results in the payoff with the highest expected value (Fowler & Sandberg, 1966).

Another value needed when analyzing probabilistic situations is the measure of the risk due the variability of the outcomes. In statistical analysis the variability is measured by the variance or the standard deviation. The variance give us the dispersion of the distribution on either side of the mean value and the standard deviation is the probability-weighted deviation from the expected value, and it gives us an idea of how far above or below the expected value is likely to be. Table 6 contains the probabilities the builder believes will be happening for the Windy Hill Project.

Table 6: Probability Distribution for Unit Demand (X) and Unit Price (Y).

Product Demand (X)		Unit Sale Price (Y)	
Units(x)	P(X=x)	Unit Price (y)	P(Y=y)
10	0.30	$190,000	0.20
8	0.40	$185,000	0.20
7	0.30	$180,000	0.60
Sum =	**1.00**	**Sum**	**1.00**

Based on the subjective probabilities, the mean and the variance can be calculated for the product demand (X) and the unit sale price (Y). Calculation are shown on table 7.

Table 7: Means and Variance for Unit Demand (X) and Unit Price (Y).

Product Demand (X)				
x_j	P_j	x_jP_j	$(x_j-E[X])^2$	$(x_j-E[X])^2(P_j)$
10	0.30	3	2.89	0.867
8	0.40	3.2	0.09	0.036
7	0.30	2.1	1.69	0.507
25	E[X] =	8.3	**Var[X] =**	**1.41**
			σ_x =	**1.19**

Unit Price (Y)				
y_j	P_j	y_jP_j	$(y_j-E[Y])^2$	$(y_j-E[Y])^2(P_j)$
$190,000	0.20	$38,000	$49,000,000	$9,800,000
$185,000	0.20	$37,000	$4,000,000	$800,000
$180,000	0.60	$108,000	$9,000,000	$5,400,000
	E[Y] =	$183,000	**Var[Y] =**	**$16,000,000**
			σ_y =	**$4,000**

The joint Probability of two or more independent events is the product of the probabilities of the independent events. The marginal probability of an event is the sum of the joint probabilities of that event and all other events with which the event can occur. (Fowler & Sandberg, 1966). For this case, the builder estimates the conditional and joint probabilities shown on table 8.

Table 8: Conditional and Joint Probabilities

Unit Price	Probability	Conditional Unit Sales X	Assumed Joint Probability	Joint Event (xy)	Probability (x,y)
$190,000	0.20	10	0.10	(10,$190,000)	0.02
	0.20	8	0.4	(8,$190,000)	0.08
	0.20	7	0.5	(7,$190,000)	0.10
$185,000	0.20	10	0.1	(10,$185,000)	0.02
	0.20	8	0.64	(8,$185,000)	0.13
	0.20	7	0.26	(7,$185,000)	0.05
$180,000	0.60	10	0.5	(10,$180,000)	0.30
	0.60	8	0.4	(8,$180,000)	0.24
	0.60	7	0.1	7,$180,000)	0.06
				Sum =	**1.00**

Marginal Probabilities or prior probabilities are assessed before any information is obtained. It represents what managers believe the frequency with which the various outcomes will occur. Table 9 below shows the marginal distribution for the product demand, variable x. It tell us that 45% of the time we can expect of having a demand of 8 homes per year and 34% and 21% of the time we can expect of having a demand of 10 and 7 homes respectively per year.

Table 9: Marginal Distribution for x

x_j	$P(x_j) = \Sigma_y P(x,y)$	
10	P(10,$190,000)+ P(10,$185,000)+ P(10,$180,000)=	0.34
8	P(8,$190,000)+ P(8,$185,000)+ P(8,$180,000)=	0.45
7	P(7,$190,000)+ P(7,$185,000)+ P(7,$180,000)=	0.21
	Sum =	**1.00**

It is possible that one variable influences one or more variables. The dependency is expressed in terms of conditional probabilities, for example, one product demand can be influenced by its price, but this is not always the case. The parameter that tell us the degree in which two variables (X,Y) are related, is the covariance Cov(X,Y). This shows how X and Y vary directly or inversely with one another. Table 10 shows the calculations of the correlation coefficient between the random variables X (number or units) and Y (price).

Table 10: Correlation Coefficient between the Random Variables X and Y

(x,y)	(x-E[X])	(y-E[Y])	p(x,y)	(x-E[X])*((y-E[Y])	p(x,y) *(x-E[X])*((y-E[Y])
P(10,$190,000)	1.7	$ 7,000.00	0.02	$ 11,900	$ 238
P(9,$190,000)	-0.3	$ 2,000.00	0.08	$ (600)	$ (48)
P(8,$190,000)	-1.3	$ (3,000.00)	0.10	$ 3,900	$ 390
P(10,$185,000)	1.7	$ 7,000.00	0.02	$ 11,900	$ 238
P(9,$185,000)	-0.3	$ 2,000.00	0.13	$ (600)	$ (77)
P(8,$185,000)	-1.3	$ (3,000.00)	0.05	$ 3,900	$ 203
P(10,$180,000)	1.7	$ 7,000.00	0.30	$ 11,900	$ 3,570
P(9,$180,000)	-0.3	$ 2,000.00	0.24	$ (600)	$ (144)
P(8,$180,000)	-1.3	$ (3,000.00)	0.06	$ 3,900	$ 234
		Sum =	**1.00**	**Sum =**	**$ 4,604**
				Cov(X,Y)=	**4604**
				ρ_{xy}=	**$Cov(X,Y)/\sigma_x\sigma_y$ = 4604/(1.19*4,000)**
				ρ_{xy}=	**0.97**

The coeficiente of correlation ρ_{xy} can vary within -1 and +1, where -1 indicated perfect negative correlation and +1 indicating perfect possitive correlation. When $\rho_{xy}=0$ no correlation exits between the two random variables. Given that in this problem the coeficient is closest to +1, it indicates that as the builder increases the unit price, it tends to generate a higher demand.

1.1. 3 SIMULATIONS

Simulations may be a powerful tool for determining the relevant certainty-equivalent (Trigeorgis, 1998). Samuelson (1965) demonstrated that simulations can provide information about project volatility using NPV methods. This project volatility is necessary for the real options solution method.

This specific problem has uncertainties about selling price, quantity of output and cost per unit. We can use Monte Carlo simulation analysis (Copeland 2001) to produce an estimate of a project's NPV that takes into account the uncertainties of major project variables (Nembhard, Shi and Aktan 2001). Selling price, construction cost from both builders, and number of units to build each year are defined as random variables following particular distributions. A simulation of the project duration is then replicated to produce a distribution of expected NPV values. The project described in Table 1 was simulated and the standard deviation was used to calculate the ups and downs for the event tree. The main desadvantage of the simulations is the time required to build the model for the simulation. The results were similar to the ones obtained with the statistical analysis.

1.1. 4 EVENT TREE

Decision Tree Analysis (DTA) is a traditional method used to develop expected values under uncertainty. The PV of the decisions is estimated by discounting the expected cash flow at the weighted average cost of capital (r_{WACC}), that in our present case is 10%.

$$PV = \frac{p * CF_{up} + (1-p) * CF_{dwn}}{(1+r_{WACC})^{\wedge T}} \qquad (1)$$

While appearing to be a good approach, the DTA method assumes the discount rate is for an equal chance of *p* or *(1-p)* probability values for any pattern of cash flows that are perfectly correlated. The cash flows to value options are different. Using the ups *(u)* and downs *(d)* in the binomial tree, Cox, Ross, and Rubinstein (1979) defined the annual standard deviation of the risky asset as follows:

$$u = e^{\sigma\sqrt{\frac{T}{n}}} \qquad (2) \qquad\qquad \text{and} \qquad d = \frac{1}{u} \qquad (3)$$

T is number of years *(T=5)* and *n* the number of periods *(n=5)*. For our example *u = 1.5761* and *d = 0.6344*. Using the PV of the project and an estimated volatility of returns from the simulation, we can construct the event tree shown in Figure 4. This event tree provides the values of the underlying project without flexibility.

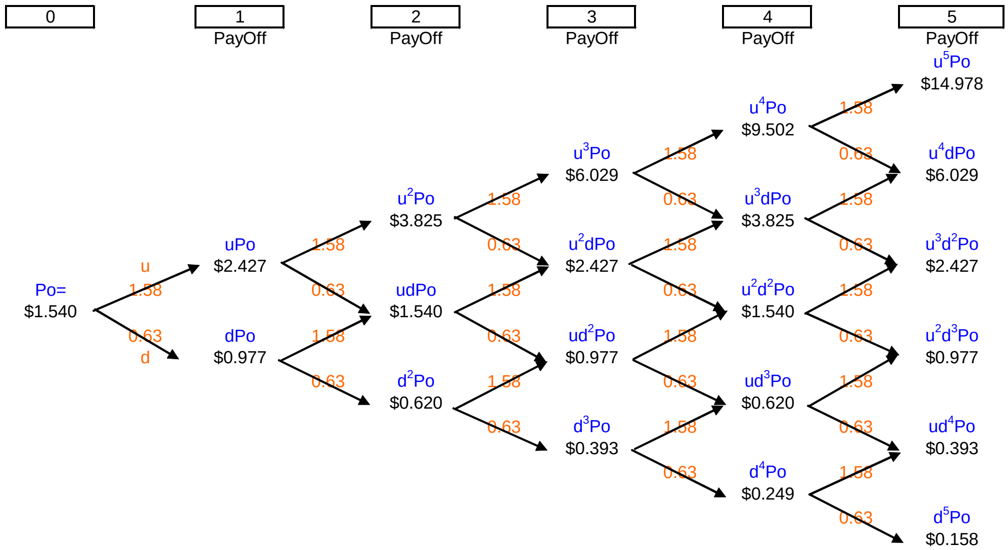

Figure 4. Project Value (Numbers in Millions)

Knowing there is a project today with the payoff shown in Figure 4, it would be helpful to find the probability of having a project with those payoffs today. We can calculate the probabilities with the payoffs of the first period. Figure 5 shows the expected values of the project at year one. The expected value of P_o knowing P_u and P_d is given by equation 4 (Cox, 1979)

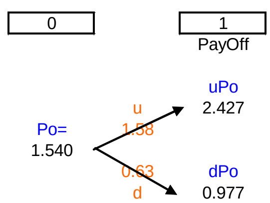

Figure 5. Risk Neutral Probabilities (Numbers in Millions)

$$Po = p.\frac{Pu}{(1+rf)^t} + (1-p).\frac{Pd}{(1+rf)^t} \quad (4)$$

Solving for p in the above equation and using t=1 we have p = 0.431, and *(1-p)* =0.569. With these probabilities and a risk free rate (r_f) of 4%, we can reproduce the same tree in backwards, starting the calculations from year 5th and finding the expected value of $1.54 Million dollars at year zero. Risk free frate of return $(r_f)$is used instead of the (r_{WACC}) because there is no risk at the moment of making the decision, since the decision is delayed to a point where more informastion is known.

1.2 REAL OPTIONS ANALYSIS

On the every day life options and alternatives are synonymous. When thinking on vacation, there are many choices or alternatives to choose from. When deciding where to go, it is a decition between alternatives. When holding an option, you defer the selection between the alternatives to a later date. When you hold a decision, until a specific date, all your alternatives are options or possibilities for a future decisions. There is a distinction between alternatives and holding options to decide in a future time. You can hold the alternatives until time pass and you get more information and when you set the time for a decision, alternatives became options.

An option is an opportunity to delay a decision to a latter time when more information arrives. Real Options theory demonstrates that when a decision is delayed, the value of the option can be more valuable (of course more information is known when time passes). If the option is worthy, the owner of the option will undertake the option and the actions associated with that option. Construction projects are full of options and economic results depend upon the actions taken when decisions are made.

The owner of the option has the right but not the obligation to exercise it, or not, at the expiration date. The owner exercises the option only if it is the smart thing to do. If the option is not exercised, it becomes valueless. The value of the option will then be either the difference between the cost and the expenditures or zero.

Options can be simple or compound. Compound options that have the same life and occur at the same time are called simultaneous compound options. Compound options can be sequential options, when the life of the second occurs only when the previous option is exercised. Most engineering and construction projects have several phases and can be viewed as sequential options, where an option is available only if an earlier option is exercised. It is the case of our builder with the Windy Hill project; ecah year he can decide the number of units to build or to sell (expand the project), or sell the land (abandon the project for a salvaje value).

To analyze Real Options, we have to solve each node of the binary decision tree backwards; we have to analyze the existing options at the beginning of each year in order to decide weather to expand the project with a new phase or to abandon the project and sell the land. At each node, the maximum value is the maximum from the present value of the project at the beginning of the year (before adding the FCF of the phase to build that year), the value given to the expansion and the value given to abandonment. Figure 6 shows the option valuation and actions to take.

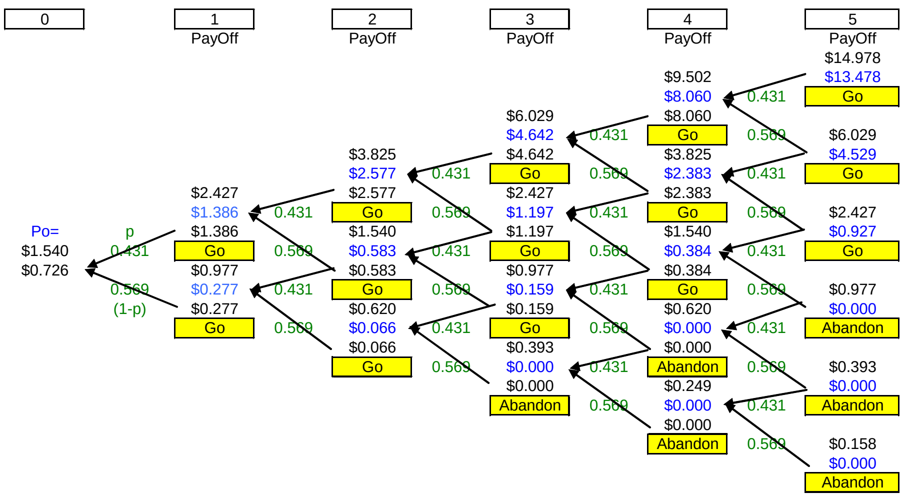

Figure 6. Option Valuation and Actions (Numbers expressed in Millions)

For example at the upper node of year five (Fig.7), \$ 14.978 is the value of the finished project at year 5th.To maximize the value of the project, it is necessary to know what is most convenient: expand the project building the ten left houses and paid the loan of \$1.5Million, or stop the project selling the 10 lots left for \$45,000 each minus 25% of taxes and paid the loan of 1.5 Million. To find out the answer, first, we need to find the value of the project after selling the land and paying the loan: \$13.060 = \$14.978 –\$0.755 (free cash flow for year 5th) plus \$0.337 of lots sales minus \$1.5 million loan, and compare this value with finishing the project and paying the loan: \$13.478 = \$14.978-1.5. Because \$13.478 is greater than \$13.060. it is better to finish the project. The answer is similsr for the three upper nodes of year 5th and to sell the land for the three lower nodes. When abandoning the project, the value of the options becomes “0” .The solution is labeled as “Go” or “Abandon” in a shadowed cell.

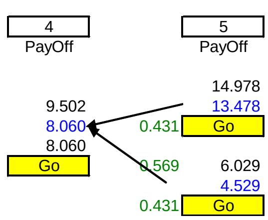

Figure 7. Valuation for the upper node of year four.

To continue the calculations at year four, it is necessary to find what is the maximun value between the abandonment or the expansion (construction of another 10 houses): Value of the abandonment $7.921 = Value of the project at the end of the year four $9.502 (Fig.6) minus $0.756 (FCF for year four as in Table 1, EAT year 4), , plus $0.675 (sales of 20 lots) minus the loan payment.
Of course, because the maximum value in this case comes from the option that takes into account the flexibility to decide every year the new phase; the decision at this node is to continue ahead as shown in figures 6 and 7 with the "GO" label. When the maximum value comes from selling the land, we choose abandonment

The $8.060 value, used at the calculations of the upper node of the four year came from the first and second node of year five ($13.478 and $4.529). There are two methods to get the value of the option when we move backwards in the tree: The risk neutral analysis and the replicating portfolio. The first method or the Risk Neutral Analysis uses the equation 4 and the values from figure 7. At the node in study, we have:

$$\$8.060 = 0.431 * \frac{13.478}{(1+.04)^1} + 0.569 * \frac{4.529}{(1+.04)^1} \quad (5)$$

After finishing all the calculation in backwards the NPV of the project is $0.726 Million insteak of the $39,647 dollars found with the traditional calculations. The difference between the two quantities in dollars is the added value due to the incorporation of the flexibility to decide every year to expand or abandon the project. Observe for example, that if the market turns down as it is seen at the lower nodes of year 2,3, 4 and 5, it is better to abandon the project. It is not the only answer we can get with real options analysis. The builder can stop temporarily the project or delay the construction of the new phase and all of these alternatives find answer in the real options analysis. When real options is combines with game theory, it becomes more powerfull when analysing the entrance of other builders who intend to sell similar products. The problem is that every problem has to be costomized (time consuming) and the theory of the real options is not familiar for many managers.

1.4 CONCLUSIONS

Traditional calculations of cash flow are enough to kill projects. Under traditional methods, there is no reason to develop projects when they have a NPV negative, because nobody chooses to lose money or work hard for a few dollars. Many builders use high discount rates that reduce the present value (PV) of the expected cash flows to cover the risk present during the project duration. Better tools are now available to solve this type of problem. Real options, simulations and risk analysis together brings more insides that before when everything was decided in advance and big discount rates were used to discount the cash flows to cover for bad decisions or adverse situations.

Builders like to start a project after they analyzed all the decisions that need to make and their consequences, but because they are not familiar with real options and sometimes risk analysistoo, they applied big discount rates to cover themselves for bad decisions. Many other tried to reproduce what they have in their own projections and think that if they finish the project both on time and within budget, they are good managers. They are convinced of this aproach because traditional tools always use the market rate to discount any expense regularly with a big margin for security.

Engineering and construction projects most probably contain real options that managers can use to influence the final economic results. It is possible when projects have uncertainties like units to sell and selling price (those depend on demand), construcction expenses and even taxes, because they are subject to change over time.
One option could be the option to contract, scale down or reduce the size of the project, or even stop permanently or delay it for a certainf time the construction until economic situation or demand change.

The option to scale down or contract, reduce substantially the risk of losses, since builders can know with anticipation the results when persisting in finishising the project as it was planning originally. The option to abandon a project protect investors to increase their losses. It usually appears when a secundary market exist: When an opportunity no longer exists for a builder, a new opportunity appeared for another builder.

There is no single method that is clearly superior to all others. Each method has its own key assumptions and limitations. Each method has its own pros and cons regarding the time and effort to apply the method and interpret the results. However, when taken in aggregate, there is not one obvious best method. Because each method is typically based upon a different assumption, it is possible that two different methods may lead to different solutions. But using two or more methods increase confidence on the identification of key variables.

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