Valuation Construction Permit Uncertainties in Real Estate Development Projects with Stochastic Decision Tree Analysis

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ABSTRACT

With the rapid development of real estate markets under globalization and exponential competitive market conditions, risk evaluation has been one of the most important tasks in the process of real estate investment valuation. This paper describes the relationship between construction permit uncertainties and real estate development projects by using the Decision Tree Analysis (DTA) approach together with Monte Carlo simulations. Expected Value (EV) criterion for an office development project proposed and incorporated into conventional Discounted Cash Flow (DCF) analysis which is determined by stochastic DTA. This will help utility function to come closer to the real world, so that decision making and risk analysis can be done based on the real and possible data providing better conditions for investors. The results are consistent with the results calculated by conventional DCF analysis. However research demonstrates that is of application Monte Carlo Simulation (MCS) and DTA obviate the deficiencies of conventional DCF analysis under construction permit delays and scheduling uncertainties. Results also emphasize the importance of applying EV and DTA for the construction permit delays generate a significant change in NPV and also investment decisions of real estate development projects.

Key Words: *Real Estate Development, Valuation, Decision Tree Analysis, Expected Value, Monte Carlo Simulation*

INTRODUCTION

From viewpoint of investors, real estate development projects while covering a very broad field are realized on the condition that they are the most profitable, most efficient and/or highest yielding projects for investors, as is the case with all investments. Most of the time, investors are forced to choose between investment options in various fields. Due to limitation of resources, each investor is limited by their respective investment capacity. Investors make decisions under numerous restrictions, such as liquidity, information, capital, duration, know-how, infrastructure, land, laws, and permits. These constraints require analysis and comparison of investment alternatives in different fields, accurate projections, and development of protection strategies against risks.

When real estate projects are investigated, it is seen that commercial real estate investors have been significantly more inclined to take risks as a result of globalized free market activities and increased competition in recent years. Real estate investments have distinct characteristics in comparison to other sectors, as they are investments with relatively high uncertainty and risks such as high capital requirement, immovability, long payback periods, long project life, and low liquidity compared to other investment options. This is why risk-based real estate valuation has become an important field for real estate industry. As the ability to take risks is becoming the prime criterion in realizing a real estate investment today; Risk identification, analysis, and management is the major determinant of investment profitability [1]

This study focuses on potential uncertainty and risks in cash flows resulting from delays in development and construction permits, an issue most frequently encountered in real estate development projects. In many valuation reports prepared for real estate investment decisions, possible time lapses and delays in cash flow are usually overlooked. Conventional investment valuation methods most frequently utilized in the industry, *Net Present Value* (NPV) and *Internal Rate of Return* (IRR) assume cash flows to take place in a fixed time frame; this is why they do not have the flexibility to measure possible schedule changes in cash flows. [2]

Delay risks resulting from development and construction permits, discussed in detail in this study are risk factors directly affecting project profitability, and might cause change in investment decisions. Delays due to construction permit in a project mostly result in loss. The aim of this study is to investigate the relation between cash flow setbacks in real estate investments and investment expectations, and attempt to provide investment experts with the most accurate/ realistic investment valuation reports.

This study uses Monte Carlo Simulations (MCS) and Decision Tree Analysis (DTA) to evaluate risks resulting from delays in cash flows, and attempts to improve shortcomings of conventional investment valuation methods using Precision *Tree*[3] software. A valuation model is applied as an example with multidimensional assumptions considering alternative investment options. By evaluating possible risks and uncertainties (regarding development permit for an office investment project) in projects assessed with known conventional investment valuation methods NPV and IRR, Expected Value (EV) is obtained. Findings are interpreted with Sensitivity Analysis.

SHORTCOMINGS OF CONVENTIONAL INVESTMENT VALUATION METHODS

Today, real estate investors widely use methods such as NPV and IRR which calculate profitability by present value of their cash flows and its time value. However, investors cannot make decisions depending solely on these results, and their decisions are usually based on their knowledge and intuition, and market research.

The shortcomings of conventional valuation methods are discussed in detail in books by Brealey vd. (1995), Levy and Sarnat, Uslu (2007), and Berk (2010). Criticism generally focuses on topics of determining Discount Rate[4], setting cash inflow, issues concerning IRR method, and cost estimate. Determination of discount rates and risk premiums is investigated in detail by Damadoran (2002) and Chandrashekaran-Young (2000). Geltner (2002) discusses evaluation of

1 Geltner,vd.,2002

2 Baroni, 2005, Hughes, 1995 and Young,2006

3 Excel based computer software by Palisade company, developed for Decision Tree Analyses.

4 Also used as “discount rate” in the literature.

conventional valuation methods in investments and uncertainties in cash flows specific to real estate industry. Dixit and Pindyck (1994) developed their treatise on the necessity of including uncertainties such as investment delays in investment valuation process, and criticized consideration of real estate investments as investments with no return. The limitations from the perspective of strategic management are investigated by Uçkun (2010), Young (2006), Alkaraan, and Northcott (2006).

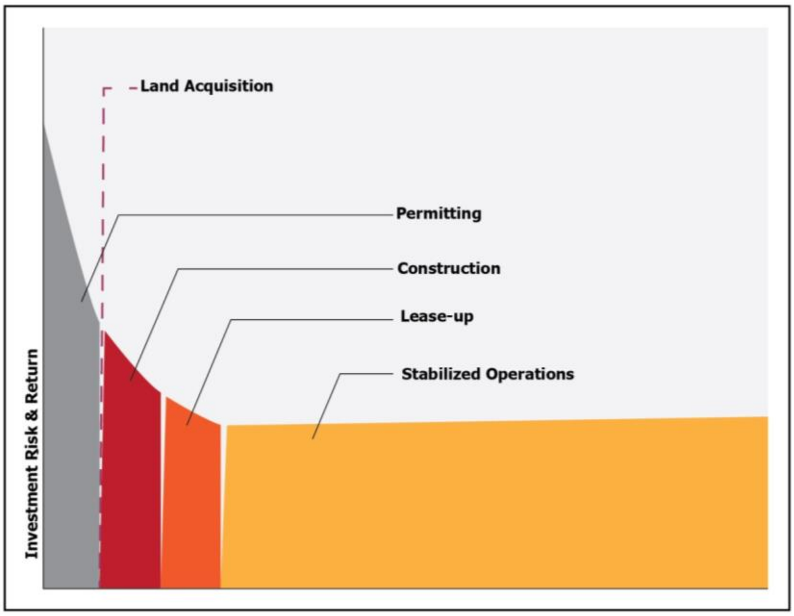
Main criticism towards conventional approaches to investment valuation is that they use projected data derived from current hypothetical data. There is no doubt that cash flow tables created with well-analyzed data are responses to these criticisms. However we cannot speak of a real estate development project without uncertainties, due to nature of real estate investments. Additionally, these methods while included in the literature as static methods, fail to represent the dynamism and flexibility in real estate investment process and management phases. In real estate projects, usually extending over a long period of time, investment decisions are assumed to be fixed by the onset of project valuation process. However during investment phase, investors can shape their decisions according to the market information and learning. Prudential flexibility of projects with high strategic extent is ignored. In brief, conventional valuation methods overlook the fact that the project is manageable.[5]

In conclusion, although conventional investment valuation approaches impart a certain measurement and comparison value, in theory these methods are deficient, misleading, and insufficient for making strategic decisions.[6] Nevertheless methods most frequently used in real estate investment valuation process are NPV and IRR rate methods.

PERMIT DELAY UNCERTAINTY REGARDING CASH FLOWS IN REAL ESTATE DEVELOPMENT

The success of real estate investment decisions is directly related to information and liquidity where correct analysis of risk and uncertainties done. This is why real estate investors should be well-informed about risk types in real estate investments and real estate life cycle. Common risks in the life of real estate investment project or matters of uncertainty are operation costs, vacancy rates, construction costs, lease and construction process, and permit processes. But as is the case in all investments, there are risks due to special structure of real estate industry. **(see: Fig 1).**

Fig. 1 . Risk in Real Estate Development Process[7]



5 Uçkun, 2010 and Neuffille, 1990

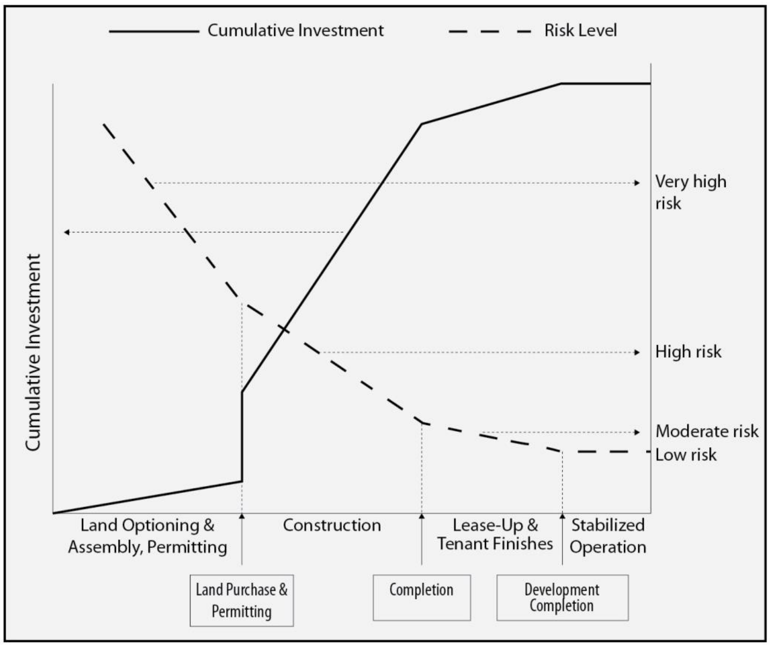
6 Alkaran and Nothcott, 2006

7 Geltner, 2006

In general, risk types encountered within project life cycle are summarized under headings such as planning permits, division of ownership, construction, lease, sales, location, operation, credit, rate of exchange, inflation, partnership, pricing, management, event and valuation risks.[8]

In theory or when past data is compared, it can be said that the most risky periods for real estate investments are periods until development is allowed on the plot, or in other word the term until construction permits are obtained. **(see: Fig. 2)**. This is the term when future uncertainties peak.[9]

Fig. 2. Investment and Risk Distribution in Real Estate Development Process.[10]



This phase consists of risks encountered in process of obtaining necessary permits from municipalities or other establishments, determination of construction conditions, compliance with planning regulations, construction permits, permits concerning trade associations, permits obtained from specific establishments like preservation boards, and all legal and administrative permits which vary depending on construction features. Uncertainty and risks regarding construction permits are especially high in developing or undeveloped countries. These risks result in delay of cash inflows since they hinder initiation of construction activities. Conventional valuation methods assume that cash flows are inflows which increase by certain increase rates in certain time frames. Usually in NPV methods, the disruptions in cash flows remain unevaluated either by adding certain risk premiums on reduction ratio or by the revision of NPV.[11] However in real world, when real estate development projects are observed, risks regarding development and construction permits do not always yield results directly proportional to risk premium rates. When investor behavior is observed, the decisions taken in permit phases are gradual, sequential, and flexible.

DECISION TREE ANALYSES

Decision Theory is defined to be the approach to optimally decide a large number of decisions, and it contributes to decision-making processes such as capacity planning, equipment selection, product and service design, and location selection. By determining the probable prospective situations or alternatives which affect outcomes of decisions, it deals with potential future profits from these alternatives, and the process of choosing the best among alternatives. In general, decision-making processes can be defined as decision-making under certainty, uncertainty and risk.[12]

8 Geltner, vd, (2002), French, (2010) and Damadoran, (2002)

9 Geltner, vd., 2002

10 Geltner, 2006

11 Damadoran, 2002

12 Taha, 1997, sy. 511-523.

DT analyses are schematic methods illustrating dependency between choices (decisions) made in multiphase or sequential decision-making processes, and alternative results.[13] In other words, it is the illustration of mathematical functions of probable outcomes and alternatives (scenarios) by diagrams. In some sources these are also referred to as Decision Flow Diagrams.[14]

In literature, DT Analyses are discussed for the first time by J. Magee (1964) for their contributions to decision-making processes, and the possibility to use them in valuating capital investments is investigated. Later Raiffa (1968) investigated decision theory and potential uses of decision tree analyses under uncertainty. Today DT analysis is a technique which helps investors to choose the best alternative by providing them with critical paths. Decisions illustrated schematically, enables the investor to assess strategic priorities and opportunities in investment process at once. DT analysis can be utilized in managing decision changes regarding information to be acquired in the future. This is the reason it is considered as one of the most useful tools in evaluating flexibility in terms of investment.

Decision-making processes for investments sometimes require highly complex calculations that are difficult to comprehend. In such cases, DT analyses determine all possible investment alternatives for investors and provide convenience in assessing their financial equivalent systematically and objectively.[15] DT analyses can be helpful to investors to manage decisions made in "t" phase when a necessity rises in "t+1" or later phases to make changes to decision-making process under uncertainty or risk. DT analyses may also include data exhibiting stochastic characteristics illustrated by probability distributions.[16]

In investments, Expected Value method composes the theoretical foundation for DT analyses. Risk-based investment decision generally requires selecting highest yielding scenario. In this spirit, EV methods calculate yield using the arithmetic mean of the resulting yields of probable scenarios and their standard deviations. EV is the final resulting yield obtained by incorporating each scenario with their respective uncertainty level.

For high-risk and broad investments generally require complex investment decisions, risk factors affecting the investment can be defined by probability distributions for each alternative processes of decision making under risk are held abiding by EV method. Expected value is the highest target utility or the highest return for investors. DT analyses utilized in investment decisions are probabilistic representations of n number of scenarios. The return in terms of investments is the weighted mean of probability distributions of NPVs obtained from various scenarios as a continuation of conventional DCF analyses.[17] DT is the schematic illustration of EV method.

Decision Trees are diagrams which resemble tree branches from right to left with square boxes for Decision Nodes, round boxes for Chance Nodes and triangle boxes for completed decisions (*End Nodes*). In the simplest term, decision trees are tree branches that change course with decision and chance nodes.[18] At each node, NPV or IRR rate of the project can be seen. Expected value is probability value of occurrence of risky alternative. It can mathematically be expressed as follows **(1);**

$$\textit{Expected Value} = E(v) = \Sigma s \ \mathbf{Pr}(s).\, g(s) \qquad (1)$$

$E(v)$: Expected Value

$\mathbf{Pr}(s)$: The occurrence probability of scenario

$g(s)$: Return of scenario

s : Scenario

Expected value criteria can be investigated under different headings such as **Posterior Probabilities** and **Utility Functions.**

13 Monks, 1987

14 Levy and Sarnat,1999

15 Levy and Sarnat,1999

16 Also used as "probabilistic" in literature.

17 Bodie, vd., 2002 and Kargül, 1996

18 Palisade Precision Tree, 2012

DT analyses might require computer software for valuating possible scenarios in extensive investments, or if options are too many to calculate. DT analyses do not produce alternative risk values in decision-making processes under risk; they only allow schematic illustration of various scenarios with uncertainty and risks, together[19] with the use of uncertainty.

In order to obtain meaningful results from DT analyses, correct determination of probable outcomes and separate calculation of probability levels are required. This usually depends on insights, experience, projections, or results of market researches. Quality of data improves the efficiency of analysis results; however, even data based on insights or estimations increase the utilization possibility of decision tree analyses for decision strategies.[20]

The contributions of decision tree analyses to investing decisions can briefly be summarized as follows;

- Allow us to procure easy-to-understand diagrams which can be read in one go, in cases where complex and numerous distinct scenarios under uncertainty should be evaluated together.
- Allow the numeric expression of EV criterion in any given time slot for the optimal alternatives which affect investment decision.
- Allow us to determine optimal strategy for numerous different time slots.
- Unlike DCF methods, DT can include factors that affect investment decision into decision-making processes. By including investment decision flexibility to the model, it postulates that project is not only momentarily manageable but manageable in different time slots.[21]

MODELLING DECISION TREE

DT analyses can be highly useful for analyzing real estate investment in large-scale, extensive, and complex decision processes. Maximization of the expected return and its calculations are easily illustrated via DT. Today It is possible to produce a flexible model which can easily be altered by computer software. In this study, phases below will be followed to build DT model;

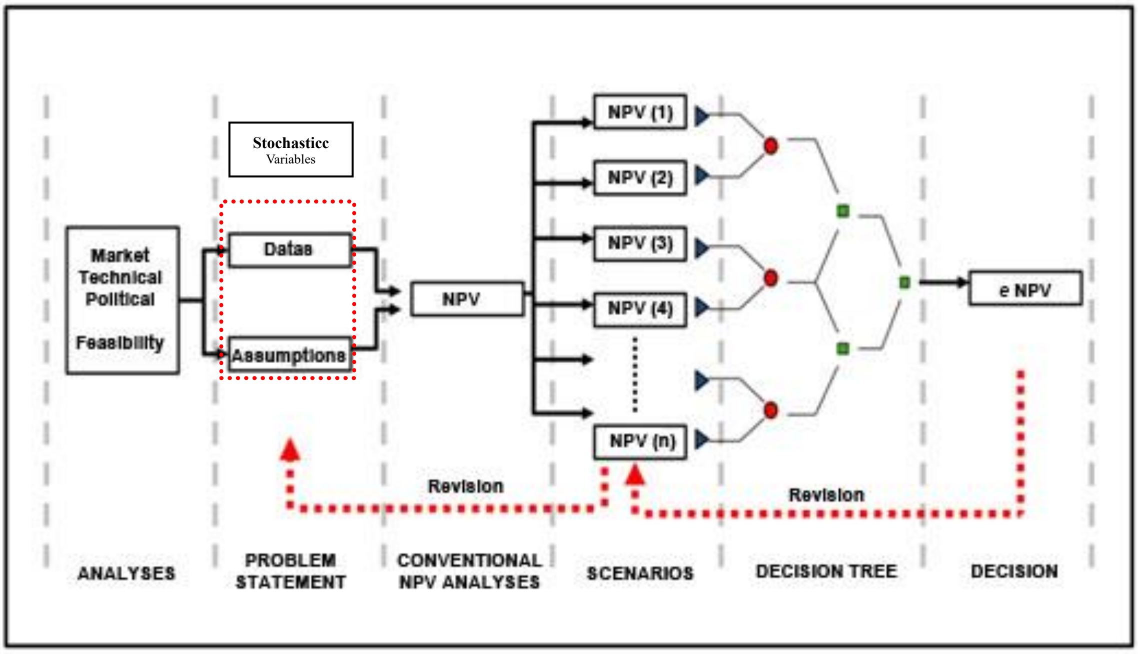
- **Building DCF Table:** In this phase conventional DCF table is built and results such as NPV and IRR will be obtained based on certain assumptions. Depending on the uncertainty in cash flows, alternative NPV outcomes are obtained. Using determined risk factors, best, moderate, or bad scenarios produce different NPVs. Market research determines the probability of occurrence of these results.
- **Identification of the problem:** In problem identification phase, risk factors in cash flows are determined by using simple data analyses and stochastic inputs. Sensitivity is calculated by measuring obtained risk factors' effects on NPV. To better understand the topic, an example highly sensitive to delays resulting from construction permits was selected for this study.
- **Building DT model:** By considering life time of real estate development project and including factors such as logical relations and investment behavior under distinct scenarios, decision tree model is built. Here the possibility of investor abandoning the investment must be considered.
- **Entering data to DT model:** NPV results obtained at the end of different scenarios, and probability percentages acquired from the market are entered in DT model risk adjusted data with the help of Monte Carlo simulation.
- **Interpreting Solution (Sensitivity Analyses etc.):** Obtained EV can be represented monetarily or as utility value. Factors affecting this value can be determined, the uncertainty in cash flows can be interpreted using sensitivity analyses, tornado and spider graphs, and strategic decisions can be produced.

19 Levy and Sarnat, 1999

20 Uçkun, 2010 and Flanagan, 2002

21 Neufville, 1990

Fig. 4. Stochastic Decision Tree Model (own illust.)



IMPLEMENTATION OF DECISION TREE ANALYSIS TO REAL ESTATE DEVELOPMENT PROJECTS

To better understand the topic, it is useful to evaluate an example real estate development project;

As can be remembered, construction and development permit delays which might occur in real estate development projects are risk factors dramatically affecting IRR and NPV of investment. Now let us take this delay resulting from time period as a risk factor, and evaluate it using stochastic decision tree analysis.

Stochastic DTA modeling for Office Development Project:

Real estate investor desires to invest in real estate at the end of technical, legal, and market research. The price of the plot found for building construction is 9 million dollars.[22] A sum of 270 thousand dollars was calculated for permits, which is approximately 3% for soft costs. Land cost and expenditures will be paid when construction activities begin in actuality. At the end of high and best use analysis, it was decided to build an office building on the plot, and the expectation of net return for annual operation was determined as 2 million dollars.

After completion of building construction, a 6 month worth lease income loss is anticipated. When similar projects are examined, capitalization rate* was found as 8%. Investor company determined capital cost as 10% by also considering alternative investments and cost of external source funds. Assuming this investment poses higher risks compared to the rest at the end of market research, a 3% project risk premium was calculated. For investor, risk-free return rate is 5%, gained from current long-term Euro-Dollar treasury bonds in the market. Long-term growth rate is estimated as 2%. Construction period is 2 years, and tender received for its cost is a total of 7 million dollars, to be paid evenly in 2 years. Project is expected to become a business yielding regular and steady income at the 4th year. The value of the building in the third year, with 10% discount rate and 2% growth rate, is determined as follows; (2)

22 Currency is selected as $ to overcome confusion regarding currency risks.

(2)

NPV (Net Previous Value) = $\frac{\textbf{Net return for annual operation}}{(\textbf{capital cost} - \textbf{growth rate})}$

= 2.000.000 / (0.1 - 0.02)
= 25.000.000$

In this example, there are two types of prospective cash flows as incomes and costs. The difference between cash inflow (yield generated by the building) and cash outflow (construction and plot costs) equals to NPV result (3).

(3)
NPV = PV (Inflow) - BD (Outflow)

Income and costs are valuated with/by two distinct discount rates in this study. What matters here is to find the current value for steady cash outflows with 5% risk-free return rate, and to calculate current value of incomes with 13%, the sum of capital cost and project risk premium. Although there are various approaches in the industry, cash inflows and outflows having different discount rates can produce more realistic results.[23]

PV (Inflow)=

$$= \frac{1.000.000}{1.13^3} + \frac{25.000.000}{1.13^3} = 18.019.304\$$$

PV (Outflow)=

$$= 9.270.000 + \frac{3.500.000}{1.05} + \frac{3.500.000}{1.05^2} = 15.777.937\$$$

Current value of costs is as follows;

NPV=

= 18.019.304$-15.777.937$=2.241.368$

As a result, current value of project yield is higher than current project cost. This provides us with the information that current net value of project is bigger than zero and it is feasible for investment **(see: Table 1)**. Project risk premium is found as 3% under market conditions. At the end of market research, the highest risk in the market is expected to be 4%, and 2% under the best market conditions. According to this result, project is estimated to have a NPV of 2,728,350$ highest, and 1,771,323$ lowest. Project's cash flow chart is as follows;

Table 1. Office Development Project Cash Flow Chart, NPV Analysis.

	GOOD	MODERATE	BAD	
Cap Rate	8%	8,00%	8%	CONSTRUCTION
Growth Rate	2%	2%	2%	PERMIT
Project Risk Premium	2%	3%	4%	EXPECTED COND.
Risk Free Rate	5%	5%	5%	

	YEAR 0	YEAR 1	YEAR 2	YEAR 3	
OFFICE DEVELOPMENT PROECT					
Operating Incomes	0	0	0	$1.000.000	$2.000.000
Reversion (sell)	0	0	0	$25.000.000	
Construction Costs	0	$3.500.000	$3.500.000		
Land Value + Soft Costs	$9.270.000				
	$9.270.000	$3.500.000	$3.500.000	$26.000.000	

	GOOD	MODERATE	BAD
PV of Operations	$18.506.286	$18.019.304	$17.549.259
PV of Expenditure	$6.507.937	$6.507.937	$6.507.937
PV of Investment	$15.777.937	$15.777.937	$15.777.937
Residual Vale	$11.998.350	$11.511.368	$11.041.323
PV + Costs	$9.270.000	$9.270.000	$9.270.000
NPV	$2.728.350	$2.241.368	$1.771.323

23 Brealey, vd., 1995

Cash flow chart above is based on the NPV approach principle; in other words, profitability of investment is calculated as time value of money is included. According to cash flow projection in coming years, IRR was calculated as 21,4%. IRR rate obtained shows that investor has the capacity to take 11.4% higher speculative risk than capital cost. However it is difficult to appraise this 11.4% rate because this difference is a result of two distinct cash flows being construction costs and lease incomes. This is why in such decision-making processes, it is more suitable to determine and set development period, and calculate the fixed rate in this period.[24]

According to Geltner (2007), because real estate investment is a sector directly related to other industries, investors can easily estimate construction costs, value of the building and lease returns, and calculate risk levels. But NPV method is based on the assumption that short-term construction costs are equivalent to long-term steady investments. In the previous cash flow chart, investment's profitability is measured theoretically by calculating NPV and IRR rates on theoretically reduced current values. It is disputable how realistic this method is in actuality and how consistent estimations are. When realistic conditions are considered for large scale and long-term real estate investments, cash flow of project can be sequential and irregular. There are also types of project risks other than risks resulting from market conditions or future cash inflows. Starting time or delivery of the construction can be delayed mostly due to legal processes. These types of delays are frequently encountered in construction industry. For instance, let us assume that the construction permit of office development project we valuate is delayed due to legal matters either one or two years, in two different scenarios. This delay has the following effect on cash flows and current values **(see: Table 2)**

Table 2. Office Development Project Cash Flow Table, NPV Analysis.

	GOOD	MODERATE	BAD			1 YEAR DELAY
Cap Rate	8%	8%	8%			
Growth Rate	2%	2%	2%			
Project Risk Premium	2%	3%	4%			
Risk Free Rate	5%	5%	5%			

	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	
OFFICE DEVELOPMENT PROECT						
Operating Incomes	0	0	0	0	$1.020.000	$2.040.000
Reversion (sell)	0	0	0	0	$25.500.000	
Construction Costs	0	0	$3.570.000	$3.570.000		
Land Value + Soft Costs	$9.270.000					
	$9.270.000	$0	$3.570.000	$3.570.000	$26.520.000	

	GOOD	MODERATE	BAD
PV of Operations	$16.853.939	$16.265.213	$15.701.969
PV of Expenditure	$6.321.995	$6.321.995	$6.321.995
Residual Vale	$10.531.944	$9.943.217	$9.379.973
PV + Costs	$9.270.000	$9.270.000	$9.270.000
NPV	$1.261.944	$673.217	$109.973

A one-year delay resulting from project's permit process is found as 673.217$, and investors will lean towards it since NPV is positive. Looking closely, a one-year delay has a positive value increase on NPV in this analysis. This result allows us to say that unexpected construction permit delays may sometimes produce positive outcomes.

24 Geltner, 2007

Table 3. Office Development Project Cash Flow Table, NPV Analysis.

	GOOD	MODERATE	BAD				2 YEAR DELAY
Cap Rate	8%	8%	8%				
Growth Rate	2%	2%	2%				
Project Risk Premium	2%	3%	4%				
Risk Free Rate	5%	5%	5%				

	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	
OFFICE DEVELOPMENT PROECT							
Operating Incomes	0	0	0	0	0	$1.040.400	$2.080.800
Reversion (sell)	0	0	0	0	0	$26.010.000	
Construction Costs	0	0	0	$3.641.400	$3.641.400		
Land Value + Soft Costs	$9.270.000						
	$9.270.000	$0	$0	$3.641.400	$3.641.400	$27.050.400	

	GOOD	MODERATE	BAD
PV of Operations	$15.349.123	$14.681.873	$14.049.130
PV of Expenditure	$6.141.367	$6.141.367	$6.141.367
Residual Vale	$9.207.756	$8.540.506	$7.907.763
PV + Costs	$9.270.000	$9.270.000	$9.270.000
NPV	-$62.244	-$729.494	-$1.362.237

A two-year delay resulting from project permit process will yield negative results in NVP, being -729,494$, and will prompt investor to abandon the investment. As can be seen, a valuation was held considering the development risks in the previous model but delays in construction process may directly affect investment decision.

Identification of the Problem:

When this case is studied, investment project yielding a profit or a loss depends both on fixed costs, and profits from sales or operating income, according to conventional DCF approach. Change in fixed capital directly affects whether project will be accepted or not. Generally NPV is more affected in a project with high fixed costs. From the point of investors projects with high fixed investments are investments with high operating leverage. In short, value increase in fixed investments in real estate development projects result in higher increases on NPV and IRR. Similarly, a decrease in fixed investment rate affects the profitability. This is why projects with high operating leverage, in other words projects with high fixed cost rate carry more risks.[25]

There is no doubt that IRR and NPV are useful methods to choose the better option between alternative investment projects. However these are not adequate analysis methods to calculate risk levels of investments and to make strategic decisions with regard to risks. This is why investors make their decisions based on various criteria and methods in practice. Conventional NPV methods are inadequate especially in cases when consecutive, interactive investment decisions should be made. In such cases, together with MCS and DT analyses introduce a new dimension to NPV method, and by taking into account the probabilities where we can consider many different alternatives, make more healthy decision-making processes possible.

It must be emphasized that conventional investment valuation approaches such as NPV and IRR are based on assumptions. But these assumptions can sometimes be illustrated more comprehensibly with MCS and DT. Setting off from this point, let us elaborate the assumptions (scenarios) regarding the project. Our assumptions are as follows;

- There is also the risk to take construction permit with one year delay. The investor will naturally demand a higher price for a plot with permits, considering the time value of money. If we assume that at the end of year 1, development and construction permits are obtained, there will be a speculative value rise for the plot. This value equals to the sum of land cost, growth rate, and increase in speculative value. Investor can sell the plot with permits at the end of one year. After one year we assumed that the annual volatility is 0.25 according to market. Volatility is an estimate and sensitivity analysis shows that decision is not highly sensitive to market volatility. If permit is still not obtained at the end of the second year, investor again has an option to abandon in worst-case scenario or wait considering future uncertainties. It should be kept in mind that investor has option to wait which is higher than 0 NPV.
- Initial evaluation of investment project is cash flow table with 3% risk premium which can be characterized as moderate scenario. In decision tree analysis in order to evaluate good

25 Brealey, vd., 1995

and worst case scenarios which might emerge in the market, risk premium, risk growth rate, risk free rate and cap rate with probabilistic (Stochastic) values also taken into account.

- Investor is not compelled to invest in the project; investor has the option to sell the plot/ abandon when necessary. The amount paid for the plot is $9.270.000, not including permit costs. Investor has the option to abandon the investment with this price. In other words investor can sell the land as NPV being zero (unprofitable), or under expected conditions with NPV three different bad case scenario which are $1.771.323 (construction permit, %30), $109.973 (one year delay, %50 probability), $-1.362.237 (two year delay, %20 probability). The below, current process review is extended and analyzed with permit duration data. Istanbul Metropolitan Municipality (IMM), Central Business District (Büyükdere Region) analysed as the field study. Here are the procedures and minumum legal days (See Table 4).

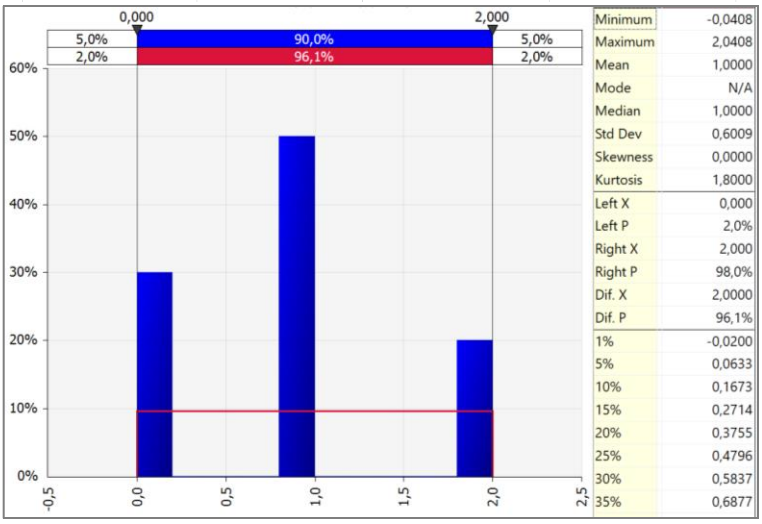
Table 4. Procedures And Minumum Legal Days

#	**Procedures Before Construction.** *MinTime (days), Number (Turkiye)*	DAYS
1	Obtain zoning plan (Imar Durumu)	4
2	Obtain cadastral plan (Aplikasyon Krokisi)	3
3	Obtain construction direction plan (Insaat Istikamet Rölövesi) and elevation of cross section (Kot Kesit Belgesi)	5
4	Hire an independent building inspector	4
5	Obtain approval of architectural drawings from the municipality	30
6	Obtain proof of payment and clearance of water and sewerage Infrastructure	7
7	Register with Social Security Institute before the commencement of construction works	1
8	Obtain building permit	30
9	Obtain excavation (Kazı) permit from the Department of Environment of the Municipality	1
10	Obtain proof of "no outstanding taxes" clearance certificate from the Tax Authority	1
11	Request and obtain a "no outstanding social security premium" clearance upon completion of construction works	1
12	Receive final inspection from the Fire Department	1
13	Submit final inspection report and receive final inspection from the municipality	5
14	Obtain occupancy permit	15
15	Change the title deed from a land title deed to a building title deed	10
16	Obtain operation permit from the Municipality	15
17	Receive inspection from the water and sewerage department	1
18	Obtain water and sewage connection	8
	Minumum Legal Day:	**142**

Data is gathered from the permit records of the Licensing Branch of IMM. For the period of January 1st 2010 until the January 1st of 2012, 50 large scale office building permit application files are collected. All applications are thoroughly examined in terms of their construction permit durations in the course of the complete permit process. This topic tracks the procedures and time to build an office building including obtaining necessary the licenses and permits, submitting all required notifications, requesting and receiving all necessary inspections and obtaining utility connection. The probability of acquiring construction permit at the end of year one is anticipated as 30%, one year delay %50 and two year delay is %20 (See Fig. 5).

Fig. 5. Statistical Contruction Permit Data.

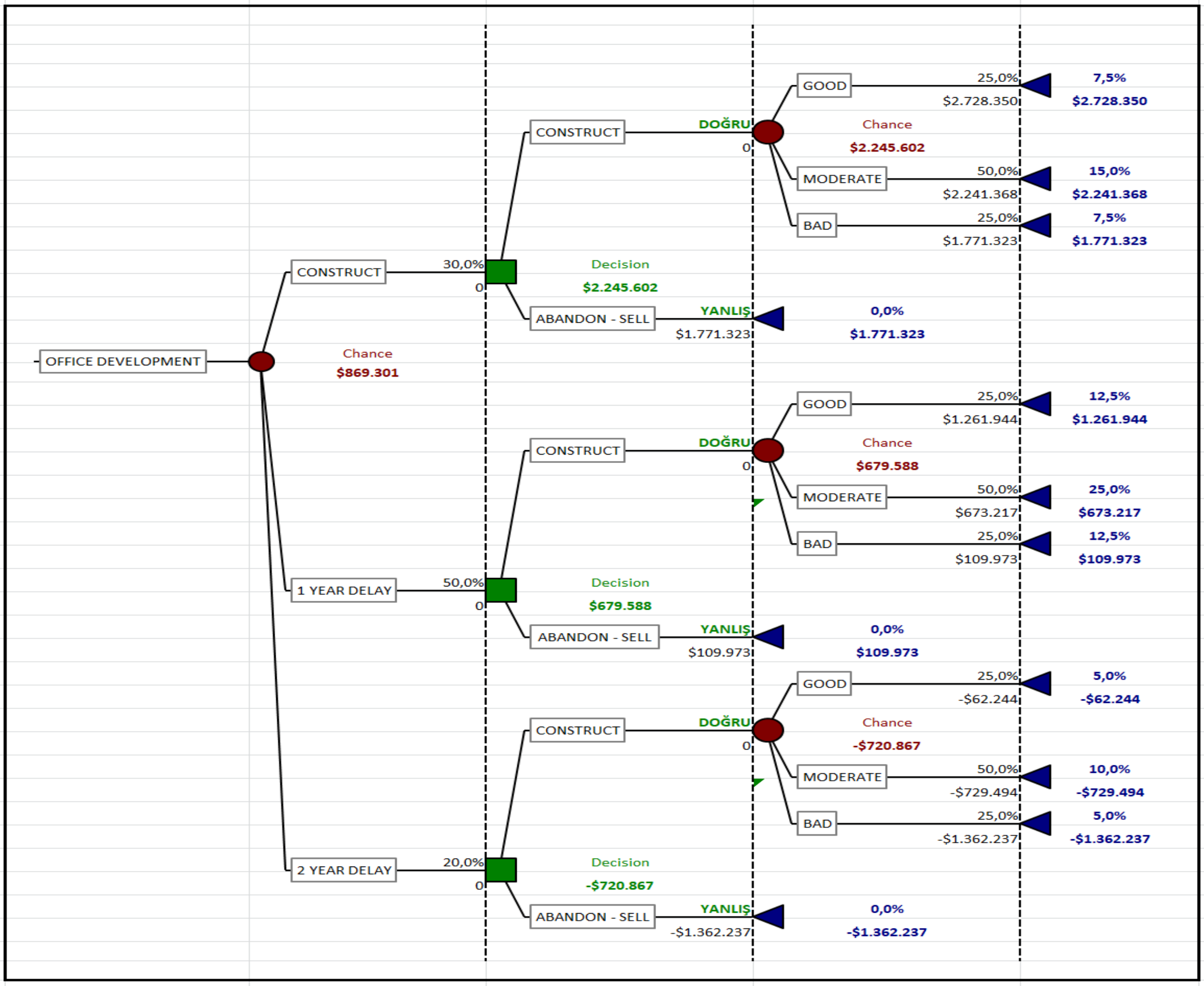
	In 1 Year	1 Year Delay	2 Year Delay
Construction Permit Data	30%	50%	20%



Building Decision Tree Model and Entering Data:

Decision tree model was built, considering life time of office development project, and including factors such as logical relationships and sell/ abandon options under various scenarios. NPV results obtained at the end of various scenarios and probabilities in percentile acquired from the market are applied on DT model as follows.

Fig.6. Decision Tree Model.



Interpretation of the Solution (Sensitivity Analyses etc.):

According to assumptions, 12 different NPV results were calculated for 3 different time frames, and at the end of DT analysis, a 869.301$ NPV was obtained, as illustrated in the table. This value is less than initially NPV acquired which is 2,241,368$. The reason behind this is that delay permit delay risks were also included in the valuation. At the end of analysis, the proposed method to gain highest income seems to be making investment. Here if everything runs its course and best market conditions are met, starting investment will be the best decision. The statistical data concerning investment is as follows (see: Table 5)

Table 5. Statistical Data Concerning Decision Tree Model.

Statistics	Optimal Path
Mean	$869.301
Minimum	-$1.362.237
Maximum	$2.728.350
Mode	$673.217
Std. Deviation	$1.118.731
Skewness	-0,0924
Kurtosis	2,2044

Again the spider web graphic **(see: Fig. 7)** and tornado graphic **(see: Fig. 8)** obtained for sensitivity analyses concerning investment; capitalization rate, risk premium, growth rate and discount rate change effects of decision are as follows,

Fig. 7. Spider web Graphic concerning Decision Tree Analysis.

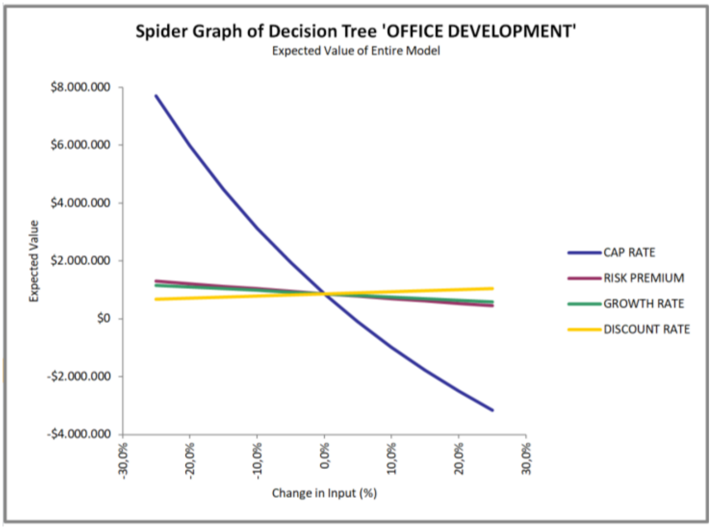
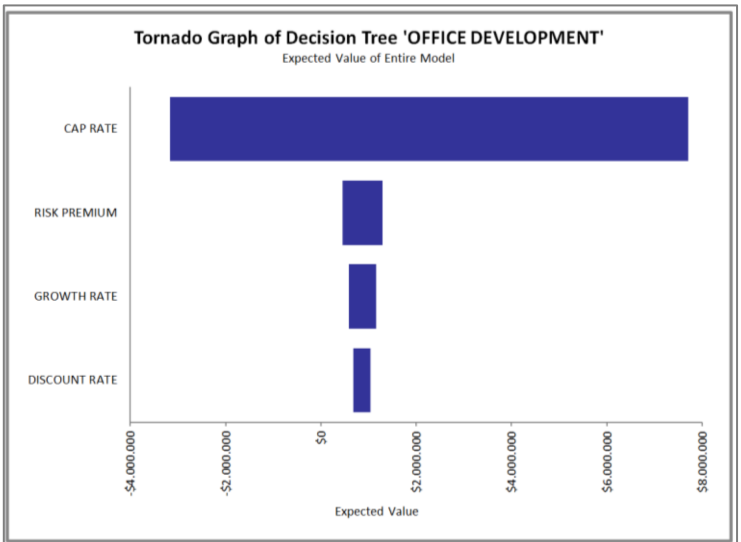


Fig. 8. Tornado Graphic concerning Decision Tree Analysis.



Tornado Graph Data

Decision Tree 'OFFICE DEVELOPMENT' (Expected Value of Entire Model)

			Minimum			Maximum		
			Output		Input	Output		Input
Rank	Input Name	Cell	Value	Change (%)	Value	Value	Change (%)	Value
1	CAP RATE	H67	-$3.168.831	-464,53%	0,1	$7.702.760	786,09%	0,06
2	RISK PREMIUM	H69	$454.924	-47,67%	0,0375	$1.297.596	49,27%	0,0225
3	GROWTH RATE	H68	$591.538	-31,95%	0,025	$1.153.250	32,66%	0,015
4	DISCOUNT RATE	H70	$686.095	-21,08%	0,0375	$1.044.644	20,17%	0,0625

As seen in graphs, the data affecting the expected value of investment most is capitalization rate. This is why it is advantageous to examine capitalization rates of similar projects around with a very thorough market research, before making an investment decision.

Criticism towards DT analyses is DT overly dependent on subjective preference and assumptions. Future uncertainties being presented through certain assumptions cannot make up this deficiency in conventional DCF analyses. In order to overcome this, we need thoroughly produced market researches. But in real estate markets, market research is both difficult and costly.

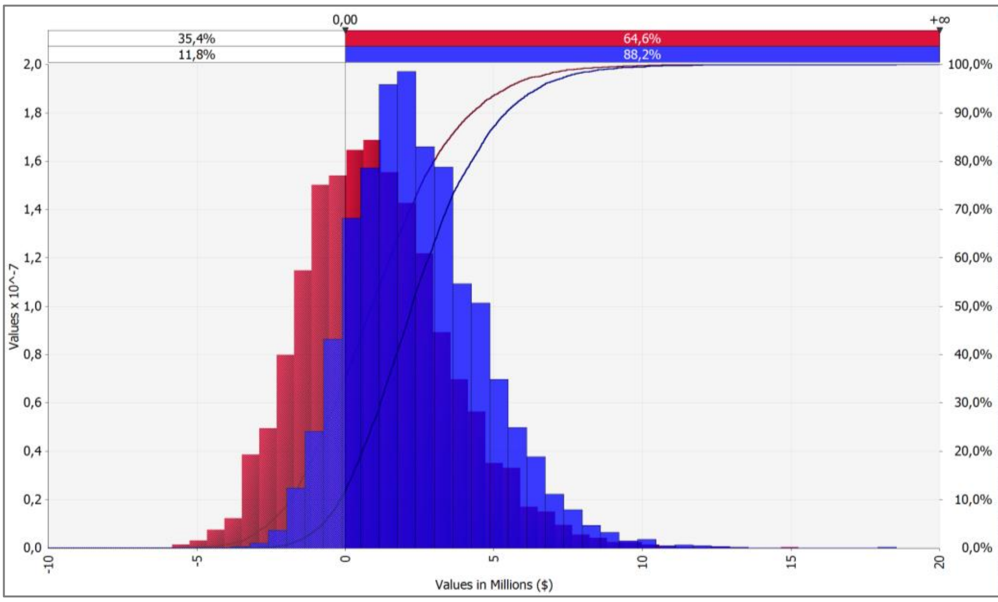
This deficiency was overcome by implementing stochastic processes like Monte Carlo Simulation, and more realistic results was obtained by producing random data with the help of computer software(See Fig. 9).

Fig. 9. Stochastic Input Probabilities

Name	Cell	Graph	Min	Mean	Max	5%	95%	Errors
Category: Cap Rate								
Cap Rate	H67	5% 11%	5,17%	8,00%	10,88%	6,68%	9,32%	0
Category: Growth Rate								
Growth Rate	H68	1,2% 2,8%	1%	2%	3%	2%	2%	0
Category: Project Risk Premium								
Project Risk Premium	H69	1,5% 4,5%	2%	3%	4%	2%	4%	0
Category: Risk Free Rate								
Risk Free Rate	H70	3,0% 7,0%	3%	5%	7%	4%	6%	0

In this study, stochastic probabilities were included in valuation method to better understand DT analyses. Investors can greatly benefit from more efficient and dynamic valuation models where Monte Carlo simulation and DT analyses are incorporated.

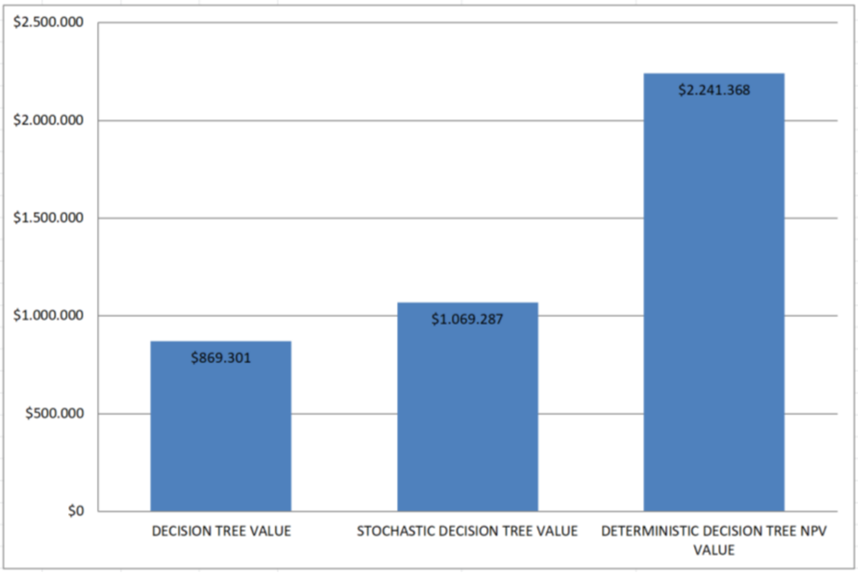
Fig. 10. Simulation Results (DT and Conventional DCF)



Statistics Grid	DT Put Option / stochastic	NPV
Minimum	-$5.824.949,5...	-$3.843.383,4...
Maximum	$15.260.100,2...	$18.545.991,6...
Mean	$1.069.287,00	$2.467.746,50
90% CI	± $56.877,04	± $52.098,82
Mode	$565.632,05	$2.220.578,36
Median	$888.334,40	$2.237.377,30
Std Dev	$2.444.636,53	$2.239.263,20
Skewness	0,5355	0,6946
Kurtosis	3,6989	4,1953
Values	5000	5000
Errors	0	0
Filtered	0	0
Left X	$0,00	$0,00
Left P	35,4%	11,8%
Right X	+∞	+∞
Right P	100,0%	100,0%
Dif. X	+∞	+∞
Dif. P	64,6%	88,2%
1%	-$3.763.685,4...	-$1.785.939,4...
5%	-$2.583.124,5...	-$756.823,77
10%	-$1.846.132,7...	-$174.849,87
15%	-$1.391.584,7...	$237.728,02
20%	-$1.003.657,2...	$560.742,84
25%	-$679.216,24	$872.895,18
30%	-$336.032,08	$1.186.352,43
35%	-$26.032,59	$1.445.521,82
40%	$298.937,45	$1.713.756,05
45%	$589.289,97	$1.989.847,39
50%	$888.334,40	$2.237.377,30
55%	$1.188.744,36	$2.495.730,27
60%	$1.504.335,37	$2.800.755,50
65%	$1.825.614,20	$3.103.635,43
70%	$2.174.719,41	$3.409.148,39
75%	$2.529.934,06	$3.779.032,13
80%	$2.972.033,28	$4.252.574,16
85%	$3.534.205,43	$4.741.188,95
90%	$4.258.789,71	$5.407.277,36
95%	$5.394.523,98	$6.472.376,68
99%	$7.694.857,86	$8.696.719,17

The expected value results from stochastic DT model provide information to investors who are considering investing in large scale office developments according to construction permit delays. With results such as in Figure 10, developer can monitor risks according to construction permit delays. The analysis indicates that the permit delay risk value has a negative effect on expected NPV. As permit delay comes at a cost, the optimal decision depends on the future uncertainties. In this model future uncertainties and volatility of market incorporated to the model and value at risk is %35,4 which is quite higher than stochastic DCF model result %11,8. A graphical representation for the office development value at risk is shown in Figure 10.

Fig. 11. Expected Values of Three Different Method



If the developer chooses the traditional DCF analysis and bases on NPVs obtained from without permit delay uncertainties will be $2.241.368. After the DT analysis, each permit delay uncertainty modelled. This allows the management to choose the way depends on the market. As calculated, presented stochastic DT framework helped to identify permit delay uncertainties which has quite lower expected value $1.069.287 is shown in Figure 11.

RESULT

As stated in the previous section, conventional investment valuation approaches are most commonly utilized methods in real estate development because they take time value of the money into account, facilitate decision-making, do not require complex calculations, and relatively examine the project and market risks. As real estate market is a relatively active market and investors can easily calculate capital costs the validity of these methods are improved. However real estate markets are not as active as money markets as stated before. Besides these are markets with high uncertainty and risks. The most typical characteristic of real estate investments is that they contain consecutive, interactive decision-making processes. Therefore real estate projects containing plot purchase, permit obtaining, construction, and operating are most suitable projects for application of stochastic DT analyses.

In conclusion, the most apparent contribution of DT analyses is that they allow us to valuate different alternatives/ probabilities numerically, easily modify values with help of computer software, and thus provide us with the chance to make flexible decisions. Values obtained by DT analyses as result of possible decision changes in real estate investments, are models which can easily be intervened. It assists us in determining the road map leading to highest expected return or highest expected value.

DT analyses are very useful analytical tools to valuate real estate investments. Some shortcomings and weaknesses of conventional investment valuation methods can be overcome with these analyses. However as Meyers (2002) and Neufville (1990) established in their works, DT analyses also have some very basic shortcomings and weaknesses. The findings of this study;

- It is not always easy to represent the complex and swift changes in decision-making processes on DT tree. When we valuate projects in a realistic case, we may encounter infinite distinct alternatives. Additionally, as decisions are always open to change, it is needed to update the data in DT analyses. In such cases, Decision Trees may be incomprehensible and complex. Because this type of DT analyses are mostly redundant and are a loss of time, they do not provide the investor with an added value. Investors cannot even make the simplest strategic decisions in this complexity. This is why DT should be an analysis as plain as possible where critical risk factors are carefully designated.

- Another criticism is that it is not possible to calculate a distinct discount rate for each node in DT analyses. Since for each completed tree branch, a corrected NPV is obtained, the discount rates of nodes cannot be modified due to lack of data and complexity.

DT analyses can never replace conventional DCF methods. Decision Trees are basically representation tools that correct deficiencies of DCF. A faulty or deficient DCF table will yield incorrect DT analysis results.

In conclusion, at the end of findings of sample project, DT analyses are highly beneficial in valuating real estate development projects, especially for valuation of risks in cash flows. As summarized above, deficiencies of DT analyses can be overcome with statistical methods based on simulation and more complex real option calculations. However the findings suggest that using DT analyses with the aim to make strategical decisions proves to be a better option than regarding them sensitive valuation, monitoring and analysis methods.

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