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Website:
www.jehp.net

DOI:
10.4103/jehp.jehp_57_19

The feasibility study of investment in public hospital construction project using the real options model

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Abstract:

BACKGROUND: The investment decision can be affected by changing levels of uncertainty and risk. The main objective of this research was to identify, characterize, and quantify the parameters which are essential in evaluation hospital construction projects and provide useful modeling techniques to give the best investment decisions for investors in Iran's health-care projects investment.

MATERIALS AND METHODS: The methodology of this study was employing discounted cash flow (DCF) and real option valuation to investigate the feasibility investment in the public hospital construction project. The Islamshahr, Mashhad, and Fardis hospitals were included in the analysis. Economic indices of DCF methods were internal rate of return (IRR) and net present value.

RESULTS: The economic evaluation of the Black–Scholes model was almost as same as the binomial tree model, but there was a significant difference between the real options model and traditional methods. According to the traditional methods, the profitability with IRR for Islamshahr, Mashhad, and Fardis hospital projects was 35%, 43%, and 26%, respectively. Black–Scholes model showed profitability only for Islamshahr and Mashhad hospitals, and there was no adequate profitability for investors of Fardis Hospital project during the study.

CONCLUSIONS: The methods derived from the real options valuation could provide a more flexible and reliable indices for investors in dynamic and high revolution economic conditions. On the other hand, dynamic economic evaluation models can be applied to correctly evaluate the projects because of Iran's health revolution and its health plans.

Keywords:

Feasibility, investment, project, public hospital, real options model

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Received: 02-03-2019
Accepted: 22-06-2019

Introduction

Decision-making for the investment in projects is associated with the level of uncertainty and risk. Courtney *et al.*^[1] suggested that managers should use analytical tools for different levels of uncertainty. Due to the economic change of modern societies, uncertainty of economic projects should be included in the new investment evaluation methods. Economic changes in Iran extremely effect on projects in health-care sector. All possible decisions of investment projects are considered in the

real options model, unlike the conventional evaluation methods. This provides sufficient flexibility for the manager's decisions in uncertain environments. Several researches showed that conventional discounted cash flow (DCF) methods and net present value (NPV) were not reliable to evaluate the economic projects.^[2-6] The flexibility of investment decision was neglected in these methods, so evaluation results underestimated the real investment value. Real options method is proposed as a new approach for financial and economic decision due to the changing economic condition and the complexity related to activities.^[4,7-10] This approach, based on

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How to cite this article: Hematyar H, Sari AA, Jafari DD, Pourreza A. The feasibility study of investment in public hospital construction project using the real options model. *J Edu Health Promot* 2019;8:190.

decision-making in uncertain and complex situations, can play an essential role to determine the upcoming changes and existing uncertainties.^[11] The most important application of real options model is in high risk and flexible investment projects. Therefore, it is a necessity to have a method to evaluate investment opportunities by considering the uncertainty and risk of projects and simulation the random process of the future cash flow of the project.^[12-16] The risk and uncertainty should be addressed by managers due to their critical nature in the decision procedure. There is a lot of risk of investment, high flexibility, and complexity in health-care projects. Using traditional methods for the financial evaluation of these projects leads to ignoring important factors in investment resulted in underestimation the projects' evaluation.^[17-21] Recently, there are three types of tariffs in Iran's health-care system, including private, public, and collaborative tariffs. The existence of these three types of tariffs led to a large difference in the cost of health-care services in Iran. Many health centers, operated under government tariffs, are unprofitable, unlike private centers. There are many health-care projects in Iran which are not feasible because of providing services with government tariffs. The main reason for this was the traditional methods of project evaluation approved by the ministry. Many of these projects, used by government tariffs, may become feasible using real options evaluation methods. All the possible decisions are considered in real options evaluation method, unlike traditional ones. Real options evaluation method provides sufficient flexibility for managers to make decisions in uncertain environments. The main objective of this study was to apply real options approach for feasibility investigation of investment in public hospital construction projects. Therefore, the real options model has been utilized for the feasibility study in three hospital construction projects: Islamshahr, Mashhad, and Fardis hospitals.

Materials and Methods

The research methodology was a combination of quantitative and qualitative methods. In this study, a feasibility study model is designed to investigate public hospital construction projects by using the real options method for the first time in Iran. This model identified the real choices in hospital construction projects and investigated their impact on the feasibility of projects. The investment costs, after calculating them, were divided according to the duration of the construction project.

It should be mentioned that Iran's Ministry of Health considers 3 years as the time duration of construction projects, so investment costs are divided into these 3 years. Then, operating incomes and costs are calculated

for the base year and adjusted according to the inflation rate for each year. Later, the project's free cash flow is calculated for each year, and the project's financial indicators (NPV and internal rate of return [IRR]) are estimated. In this method, the feasibility of the model is investigated according to the DCF method. After evaluation of the studied hospital construction project, the feasibility of the project is discussed in the real options methods. In these methods, effects of different options on the free cash flow of the project are determined as project financial indicators are re-estimated according to this new free cash flow.

Discounted cash flow methods

Today, NPV is considered as one of the most extensive methods used in investment valuation. The time value money is the key point of this method for making decisions of investment. The net equivalent amount duration, the projects are provided in this method. The difference between the equivalent negative cash outflows (expenses) and the equivalent positive cash inflows (revenue) is introduced as follows:

$$NPV = C_0 + \sum_{t=1}^N \frac{C_t}{(1+r)^t}$$

Where C_0 and N are the initial investment and useful life of the project, respectively. R stands for discount rate. T and C_t are time duration of specific cash flow and net cash flow at time t , respectively.

There are several advantages of NPV such as its clearness and providing the same results regardless of risk preferences for investors. It is worth mentioning that this index can be simply explained to the managers.

Internal rate of return

The IRR is known as a capital budgeting index to define the value of an investment. The yield on the investment can be annually represented by IRR as effective return rate earned from the invested capital. Therefore, a profitable investment of the project has IRR values higher than the rate of return that could be earned by other risk-free investments. IRR requires a suitable risk premium to sufficiently compare the analyzed project with any alternative costs of capital.

Real options model

The real options analysis is applied to evaluate the value flexibility in the design of the studied construction projects. Methods and indices, developed in this study, showed the applicability of the real options in the health-care construction projects. The Black-Scholes and the binomial trees methods are utilized as the real options models in this study, as shown in Table 1.

Data analysis

The main objective of this work was to analyze and evaluate the feasibility of investment in government and private hospital projects by using traditional and new valuation methods. First, DCF methods were investigated in this study. The results showed that NPV and IRR indices were effective in the evaluation process. Accordingly, these indices were utilized to evaluate the feasibility of investment in the present study. The require variables of NPV and IRR indices were net profit, rate of return, discount rate, current debt, depreciation period, depreciation expense, manpower, operational cost, and the risk-free rate.

Real options valuation methods have been also investigated in this study. According to the objectives of this research, Black–Scholes and binomial tree have been applied. The require variables and data for these models were current stock value, the exercise time, standard deviation of stock value, exercise value, the risk-free return rate, project time period, and investment return period. All these variables and mentioned models have been used to investigate the feasibility investment in Islamshahr, Fardis, and Mashhad hospitals. These projects are chosen with regard to the primary investigation and considering limitation access to projects data from the ministry of health. Therefore, construction projects were the 404-bed hospital of Islamshahr, rescue hospital of Mashhad and 163-bed hospital of Fardis, respectively. All selected projects had the license of article 27 from the fifth development plan of Iran which allowed them to be transferred to the private sector in the form of public-private partnerships.

Excel and options pricing software were used to analyze and evaluate the results. The indices of Black–Scholes model are calculated by transaction negotiation calculator available in the official website of Tehran Stock Exchange.

Results

The present section has two main parts. In the first part, Islamshahr, Fardis, and Mashhad hospital projects are investigated by DCF methods, and in the second part, real options evaluation methods are used to investigate the projects.

Applying the of discounting cash flows methods

The main objective of this section is to calculate NPV and IRR indices for three hospital construction projects. There are essential assumptions to evaluate these indices. All these assumptions are considered to be the same for studied projects except the operating coefficient for hospitals. The assumptions are as follows:

- The hospital construction and operation periods are 3 and 50 years
- The annual inflation of income and expenses is 15% (inflation is 15%)
- Discount rate, considered as the minimum interesting rate for investment, is equal to 15%.

Operating coefficient for Islamshahr, Fardis hospitals, and Mashhad rescue hospital projects as presented in Table 2. IRR and NPV values versus years for Islamshahr, Fardis hospitals, and Mashhad rescue hospital projects are shown in Figures 1 and 2, respectively.

As shown in Table 3, the evaluations showed that NPV was positive in all the studied hospitals. This implied that the construction of these hospitals was economical. The IRR, as an index in the economic analysis and evaluation, was 35%, 43%, and 26% for Islamshahr, Mashhad, and Fardis hospitals, respectively. To this end, it can be concluded that a positive trend was observed in the rate of return and the net investment value on the profitability of hospital construction projects according to the discounted flow cash methods.

Applying real options methods

The estimation of considered prices for Islamshahr, Mashhad, and Firdis hospitals was 1808, 1044, and 1020 rials per stock, respectively. Black–Scholes model showed

Table 1: Examination of models, indices and formulas in research

Model	Index	Formula
Financial indices in cash flow valuation	IRR	If NPV (i*) = 0 i* = IRR
	NPV	$NPV = \sum_{t=0}^n \left(\frac{CF_t}{(1+K)^t} \right)$
Black Scholes model	P, Current stock value T, Time until option exercise σ, standard deviation of stock value x 'option striking price r 'risk free return rate	$d1 = \frac{[\ln(P/X) + r + \sigma^2 * t/2]}{\sigma * \sqrt{t}}$
Binomial tree	$u = e^{\sigma\sqrt{\Delta t}}$ $d = e^{-\sigma\sqrt{\Delta t}}$	$P = \frac{e^{rf\Delta t} - d}{u - d}$

NPV=Net present value

Table 2: Operating coefficient in three studied hospital projects

Operating coefficient	Fardis hospital (%)	Mashhad rescue hospital (%)	Islamshahr hospital (%)
1 st year	45	70	45
2 nd year	52.5	77.5	52.5
3 rd year	60	85	60

that stock prices of Islamshahr and Mashhad hospitals were increased, but it was decreased for Fardis hospital [Table 4]. Consequently, there was no interest for investors of Fardis hospital project. However, the investors of Islamshahr and Mashhad hospital projects were willing to contract because of the increase in their stocks price.

The results of the binomial price tree for economical evaluation of Islamshahr hospital are presented in Table 5. The main assumptions for economical evaluation of Islamshahr hospital were the price of the project (18,089,770 rials), useful life of project (6 years), and the risk-free interest rate equals to 35%. The economic evaluation indicated the minimum and the

maximum current value of future flows as 13,025,698 and 29,659,877 rials, respectively.

Table 6 depicts the results of binomial price tree for economical evaluation of Mashhad rescue hospital. The main assumptions for the economic evaluation of Mashhad rescue hospital were the price of project (1,044,536 rials), useful life of project (5 years), and risk-free interest rate equals to 42%. The economic evaluation showed the minimum and the maximum current value of future flows as 751,365 and 2,156,355 rials, respectively.

The results of the binomial price tree for economic evaluation of Fardis hospital are shown in Table 7. The

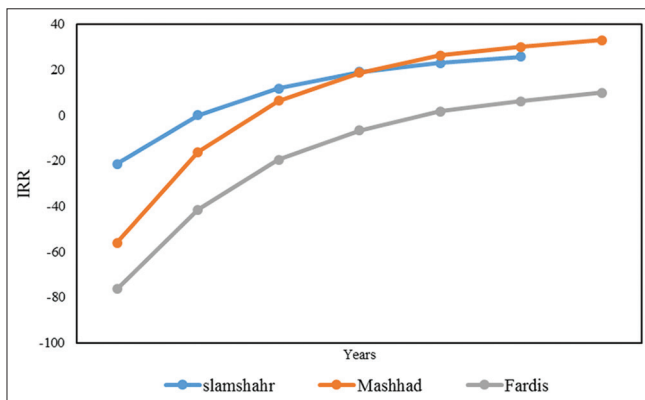


Figure 1: Internal rate of return versus years for three studied hospital projects

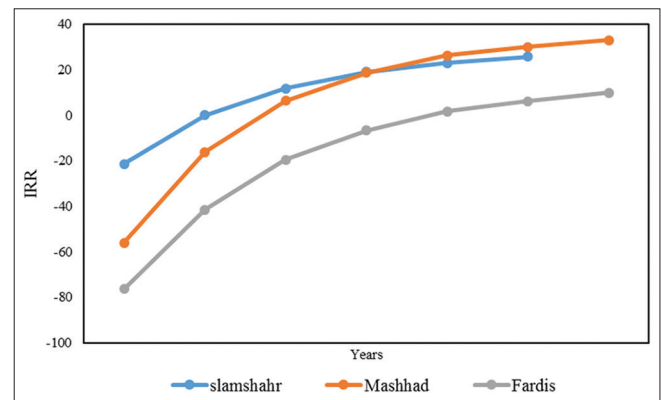


Figure 2: Net present values versus years for three studied hospital projects

Table 3: Summary results of economic evaluation (discounted cash flow models)

Items	Fardis hospital	Mashhad rescue hospital	Islamshahr hospital
Gross annual income	653,005*	1,278,267	1,836,911
Annual operation costs	515,692	979,757	1,379,132
Gross annual profit	137,313	298,510	457,778
Per capita cost per bed	6477.8	14.721	4443.52
Per capita income per bed	4043.87	17.128	4515.32
IRR (%)	26	42	35
NPV	102,734	4,123,944	18,089,770
Percent break-even point (%)	72	70	69

*P<0.01. IRR=Internal rate of return, NPV=Net present value

Table 4: Application of Black Scholes model in Islamshahr, Fardis hospitals, and Mashhad Rescue hospital

Model	Index	Islamshahr hospital	Mashhad rescue hospital	Fardis hospital
Purchase options	Price	1729.56	956.37	934.09
	Δ	0.89	0.75	0.61
	γ	0.00062	0.00051	0.00052
	v	7.28	5.36	5.28
	θ	-1.8	-1.02	-2.41
	ρ	17.69	14.85	16.93
Selling options	Price	221.36	96.81	104.16
	Δ	-0.095	-0.086	-0.092
	γ	0.00062	0.00051	0.00052
	v	7.28	5.36	-2.41
	θ	-1.8	-1.02	0.084
	ρ	-1.25	-0.97	-1.96
Real options		1950.92	1053.18	402.93

Table 5: Binomial price tree of Islamshahr hospital

Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
-	-	-	-	-	29659877
-	-	-	-	26302139	Continue activity
-	-	-	24568523	Wait to next step	24300654
-	-	23682541	To next step	22568230	Continue activity
-	21167296	To next step	21392147	To next step	20912360
18089770	To next step	18652654	To next step	18302144	Continue activity
-	15014509	To next step	16023871	To next step	16112637
-	Transfer	13745126	Transfer	14569710	Transfer
-	-	Transfer	11346954	Transfer	13690712
-	-	-	Transfer	12998543	Transfer
-	-	-	-	Transfer	13025698
-	-	-	-	-	Transfer

Table 6: Binomial price tree for Mashhad rescue hospital

Year 0	Year 1	Year 2	Year 3	Year 4
-	-	-	-	2156355
-	-	-	1765214	Wait to next step
-	-	1497543	To next step	1687543
-	1283241	To next step	1452811	To next step
1044536	To next step	1258637	To next step	1436589
-	805831	To next step	1076342	To next step
-	Transfer	697362	Transfer	952462
-	-	Transfer	536529	Transfer
-	-	-	Transfer	751365
-	-	-	-	Transfer

main assumptions for economic evaluation of Mashhad rescue hospital were the price of project (1,020,043 rials), useful life of project (6 years), and risk-free interest rate equals to 42%. The economic evaluation showed minimum and maximum current value of future flows as 696,801 and 1,762,419 rials, respectively.

Discussion

The aim of this study was to investigate the feasibility investment in the project of public hospital construction. For this purpose, the real options approach has been applied in Islamshahr, Mashhad, and Firdis hospitals. The methodology of research was based on comparative comparisons of feasibility investment in the construction projects using DCF and real options valuation models. The results indicated that all three studied projects were economical for investors. DCF methods showed positive evaluations for IRR and NPV in these projects. It should be mentioned that there were other advantages of these projects so that the priority of economic exploitation for investors was as following order: Mashhad, Islamshahr, and Fardis, respectively.

New and dynamic methods should be used along with global economic developments because the traditional economic evaluation methods are not suitable

anymore.^[19] Therefore, the economic evaluation of hospital construction projects was conducted based on real option methods in this study. In order to evaluate the real options methods, two common methods of the binomial tree and the Black–Scholes model were used to evaluate studied hospitals projects. The economic evaluation results of these two models were almost the same, but there was a significant difference between the results of real options models and traditional methods. For instance, traditional methods showed the profits of the Islamshahr, Mashhad, and Fardis hospital projects by IRR equals to 35%, 43%, and 26%, respectively. Furthermore, the profitability of Islamshahr, Mashhad, and Fardis hospitals has been achieved by the Black–Scholes model. Considering the similarity of the economic evaluation results in the studied models, it can be concluded that the real options methods could provide more suitable and flexible indicators for investors aligned with the time dynamics and different economic fluctuations. The results, obtained from this study, were in line with previous researches, including Dastgir *et al.*,^[22] Heybati *et al.*,^[23] Tarivardi and Daghani,^[24] Eslampanah *et al.*,^[25] Khalili Araghi *et al.*,^[26] Haskouee and Davoodi,^[27] Rasouli *et al.*,^[28] and Nabilu *et al.*^[29]

It should be noted that the application of methods, which can correctly evaluate the projects, is very important according to various fluctuations in Iran’s health-care plans. The studied methods are suggested for operational projects of Iran’s health-care system because of providing a dynamic model of economic evaluation. On the other hand, the real options evaluation approach can be applied to organize the health system of Iran. The main focus should be on providing funds to improve the efficiency of project evaluations. If there is not appropriate funds allocation, the traditional and new methods of financial evaluations are not effective, and their predictions are not reliable. Finally, to continue the current proposed approach, it is suggested that a comprehensive and integrated plan should be prepared for investment in different health-care projects of Iran. An appropriate software can also be designed

Table 7: Binomial price tree of Fardis hospital

Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
-	-	-	-	-	1,762,419
-	-	-	-	1,574,631	Continue activity
-	-	-	1,392,563	Wait to next step	1,396,212
-	-	1,258,984	To next step	1,291,745	Continue activity
-	1,132,248	To next step	1181033	To next step	1,159,807
1,020,043	To next step	1,036,987	To next step	1,084,213	Continue activity
-	915,253	To next step	946,520	To next step	974,434
-	Transfer	803,694	Transfer	869,841	Transfer
-	-	Transfer	712,624	Transfer	711,139
-	-	-	Transfer	623,974	Transfer
-	-	-	-	Transfer	696,801
-	-	-	-	-	Transfer

to measure the profitability of health-care projects for investors and decision makers in relevant areas.

The major limitation in this research was the lack of access to organized information. However, in the research process, there was not a particular problem about access to information, and this led to a reduction of errors in the study. The strength of this study is to combine economic models in Iran’s health services. Furthermore, the aim of the study was to apply a real options approach to the justification of investment in the construction of public hospitals, which can have a significant effect on the knowledge of related areas. Today, the theory of real options is accepted as an innovative tool in investment planning and asset valuation. Despite its high application in the field of health services, no research has ever been carried out in this area.

Conclusions

Different results of economic evaluation models in this research implied that the methods derived from the real options valuation could provide more flexible and reliable indicators for investors in dynamic and high revolution economic conditions. On the other hand, dynamic economic evaluation models can be applied to correctly evaluate the projects because of Iran’s health revolution and its health plans. Finally, it is recommended that dynamic economic evaluation models can be used for a feasibility study of health projects in Iran.

Acknowledgment

This paper was part of the Ph. D. thesis of Hassan Hematyar. The authors would like to thank the Tehran University of Medical Sciences its support. This study was approved by Ethic Committee of Tehran University of Medical Sciences (No. 922143001).

Financial support and sponsorship

This article extracted from Ph.D. thesis of Hasan Hematyar. This research was funded by the Tehran

University of Medical Sciences. Then, the authors would like to thank the Tehran University of Medical Sciences financial support.

Conflicts of interest

There are no conflicts of interest.

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