ACADEMIC PAPERS

Option pricing for real estate development: Hong Kong Disneyland

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Keywords *Real estate, Pricing, Modelling, Hong Kong*

Abstract *It is well known that the traditional net present value (NPV) approach fails to take account of the multiple effects arising from the interactions of the operating and strategic flexibility during the course of a project. Option pricing theory (OPT) has been successfully applied in the valuation of both financial and real investments in the last two decades. However, it is still a relatively new approach in the valuation of real estate investments. This paper thus attempts to extend the application of OPT to the valuation of real estate development projects, providing insights into rectifying the limitations of traditional approaches. The paper starts with an overview of the development of OPT relating to real estate investments. It then examines the appraisal method adopted by the Government for Hong Kong Disneyland and explores the real options that may create added value to the project. A binomial option pricing model is proposed that estimates the potential values of the project with those options available. The study concludes that OPT is superior to NPV approach on the valuation of real estate investments in that it enhances upside potential as well as reducing downside risk.*

Introduction

Over the past two decades, a number of finance analysts and practitioners attempted to use option pricing theory (OPT) to explore the operating flexibility and strategic opportunities embedded in investment projects that cannot be captured by the use of net present value (NPV) method. They conclude that an investment project often has added value from its associated real options. These associated options arise in real marketplace which is characterised by uncertainty and changes. As new information arrives and uncertainty about the market condition is gradually revealed, investors may have valuable flexibility to alter its initial operating strategy in order to capture the favourable future opportunities or to mitigate losses if an adverse market is

The research described here has been assisted by many individuals and organizations. The work has been funded by the Research Grant Committee Direct Allocation (Account No: A-PB69). Thanks to Miss Margaret Wong and Mr Leon Lam for their assistance in conducting the case studies of the Disney theme parks. We would also like to thank the various branches of the Government which include the Financial Services Bureau, Hong Kong Tourist Association and the Economic Analysis Division for the provision of the financial data which are indispensable for the success of this research. The opinions and comments of this study are only those of the research team and do not represent the opinions of any of the above mentioned institutions or individuals.

Journal of Property Investment & Finance, Vol. 20 No. 6, 2002, pp. 473-495. © MCB UP Limited, 1463-578X
DOI 10.1108/14635780210446487

developed. Paddock *et al.* (1988) valued options embedded in undeveloped oil reserves and provided the first empirical evidence that option pricing is better than the traditional discounted cash flow (DCF) and NPV-based bids in valuing offshore oil leases. Similar results were also obtained in the studies of Mason and Merton (1985) and Trigeorgis and Mason (1987). In the studies conducted by Trigeorgis (1991, 1993a, b), he successfully developed a stochastic valuation model which can incorporate the multiple options that are embedded in a generic investment project in order to capture its full value.

The application of OPT in real estate development so far is relatively limited. Ward and French (1997) applied an option pricing model to examine the right to restrain upwards-only rent reviews on the attractiveness of property as an investment and found that the impact of the right is non-trivial. In land development, Shoup (1970) worked on the timing option of an urban land development whereas Capozza and Sick (1992) examined the value of the option to redevelop a property. In the study of Quigg (1993), she concluded that the value of vacant urban land should reflect not only its value based on its best immediate use, but also its option value should development be delayed. Although the findings are to be applauded, these researches focused only on valuing individual real options without realizing that investment projects are usually equipped with multiple options within the development process, and these options often interact.

Real estate development projects are usually complex and involve a long timescale. They range from building a single residential block in a couple of years to spending a decade in constructing an international amusement park like Disney theme parks. To find the operating flexibility inherent in the projects and how they can hedge against the potential risks that may arise, it is important to examine the development process. In general, real estate development process can be categorised into four major stages, i.e. evaluation, preparation, implementation and disposal upon the completion of the project (Gore and Nicholson, 1991). Progress can be blocked within these stages due to unforeseeable future market behaviours and technical problems. These problems may arise in preparing the land into developable status, in the negotiating process of the development scheme and the arrangement of finance. As real estate development is characterised by large investment capital and irreversibility, evaluation of its feasibility is thus of the utmost importance in deciding whether the developer should commit to such a project (Leung and Hui, 2000).

Baldwin (1982) found that optimal sequential investment for firms with market power facing irreversible decisions may require a positive premium over NPV to compensate for the loss in value of future opportunities. On the other hand, Roberts and Weitzman (1981) found that in sequential decision making, it might be worth undertaking investments with negative NPV when early investment can provide information about the project's future benefits and growth path, especially when their uncertainty is high. In fact, the degree of risk that real estate development projects take on is very much affected by

the unique characteristics of the type of development as an investment asset. Like building amusement parks, the total risk is relatively higher. Nye (Bryman, 1995) has explicated seven different ways in examining them. He described theme parks as:

(1) controlled environments, which are designed to be different from everyday life;

(2) fantasy lands in which visitors can enjoy ephemeral contact with exotic and sometimes erotic worlds;

(3) spectacles with all-encompassing visual and aural experience;

(4) liberation from the obligation to engage in mundane behaviour;

(5) an entertainment experience specifically designed for families;

(6) a direct consequence of improvements in transport; and

(7) a context within which the major forms of human play can be enacted.

As such, the design of the superstructure that a theme park takes is much more complex than a residential unit or a commercial office in meeting the requirements of safety, security and the operational functions specific to the park. In view of these, the risk involved in building a theme park as real estate development is considered even higher. The substantial investment it involves and its irreversibility have made the operating flexibility even more valuable. This paper attempts to expand the application of OPT in real investment to the valuation of a spectacular theme park case-studying the construction of Hong Kong Disneyland. It also examines the limitations of the valuation method adopted by the Government using NPV approach.

Disney theme parks as real estate investment

The construction of Hong Kong Disneyland was announced on 2 November 1999, after more than a-year-long negotiations between Walt Disney Company and the Government of Hong Kong Special Administration Region (HKSAR). The Government is responsible to undertake a HK$11.9 billion package of infrastructure works (in present value term of 1999) which include land reclamation and road building. The theme park and the resort will cost another HK$8.8 billion to build. The agreement also anticipates a Phase II project upon the completion of Phase I.

However, there are divided views about the construction of the park. Some commentators claimed that the project is too risky with reference to the early experience of Disneyland Paris, and the deal is considered unfair because the total investment of Walt Disney Company in the project is only one-tenth of that of the Government (*Far Eastern Economic Review*, 1999). The Government has to bear the major investment costs on land formation and infrastructure in respect of the Penny's Bay site where the park is being built. Some described the project as a gamble; the betting is mainly on the Asian economy that numerous travellers would be attracted to Hong Kong by the park if the

economy in the region is prosperous, and on China's in particular. But the loss would be huge if the economy is sluggish. As such, the more the investment costs, the higher the risk involved.

Those who welcome Hong Kong Disneyland argued that the significance of the project does not lie in the earnings to be generated from the theme park, but from the induced economic benefits generated from the related industries which include tourism, restaurants, transport facilities, culture and entertainment industries, film and video production, and so on. These would lead to the development of the vicinity into commercial, residential and recreational areas (Chen, 1999; HKSAR, 1999a).

Based on the estimation of the Government, the projected economic benefits that will be generated from Hong Kong Disneyland are huge, despite billions to be invested (HKSAR, 1999b). The evaluation strategy in assessing the economic benefits is based on the use of DCF and NPV methods. It involves, first, projecting the level and composition of attendance at the theme park; second, estimating the additional spending of attendees; and third, assessing the value added or income that can be derived from such additional spending.

The Government projected that the park will attract a huge number of foreign and local attendees and they are expected to provide a significant stimulus to the overall spending in Hong Kong. Attendees broadly comprise "base tourists" who would have come to Hong Kong anyway but will spend additional time in Hong Kong to visit the theme park, induced tourists from mainly the Mainland China and Taiwan who come specially to visit the theme park, and local visitors.

Spending of attendees is accounted in terms of primary and secondary value added contributions. Primary value covers the additional spending of attendees both within and outside the theme park on various categories of goods and services produced by the sectors concerned. They include spending on retail, hotel, restaurant, transport and other tourist-related industries in the territory. Secondary value added contribution refers to the incomes generated from subsequent rounds of indirect spending on the further range of economic activities in support of those sectors. These benefits are adjusted by the income-to-business receipt ratios projected by the Hong Kong Tourist Association in the respective industries. According to the Financial Services Bureau, the construction work relies heavily on imported raw material, machinery, equipment and expatriate professionals and skilled labour, the economic benefits generated locally will be limited and, therefore, income-to-business receipt ratios are used to gauge the economic benefits generated.

A number of key parameters and assumptions based on the above are made by the Government for conducting the economic assessment. Schematic depictions of the relationship between the sets of parameters and total additional spending by local residents and tourists are contained in Appendices 1 and 2 (HKSAR, 1999c). By varying the values of these sets of parameters, six scenarios with respect to their different risk levels have been formulated for evaluation purpose. The projected life of Hong Kong Disneyland is expected to

be 40 years in line with the American theme parks because constant changes have to be introduced to the park over the intervening period.

Scenario A represents a prudent view of what is likely to happen if the economy is performing reasonably. Scenario F adopts a more cautious and conservative assumption among the other scenarios if the attendance target is hard to meet. Based on the estimation of the Government, the combined primary and secondary value added to the economy are estimated to range from HK$168 billion in scenario A to HK$101 billion in scenario F (see Table I). Matching the quantified economic benefits against the economic costs of approximately HK$20 billion estimated by the Government, the net economic benefit brought over by the project will be substantial, amounting to HK$148 billion in scenario A, as compared to HK$80 billion in scenario F.

In view of the huge economic benefits estimated by the Government, why was there a heated debate on whether the park should be built in Hong Kong? In fact, the evaluation strategy taken by the Government suffered from several limitations, and the controversy over Hong Kong Disneyland lies mainly in the lack of a convincing approach that the project is worth investing in with respect to the types and levels of risks involved. They are discussed as follows.

First, the Government plays the role of the investor in the project. The primary concern of an investor is at which stage the project is able to recoup the money he invested after taking into account the operating expenses incurred. The use of income-to-business receipt ratios without considering the operating costs to measure the profitability of the project is a rather crude assessment and cannot reveal a true picture of whether the project is viable. It is unwise to execute a project if it could survive only with heavy subsidy provided by the Government.

Second, the economic benefits derived from the additional spending are accounted in terms of primary and secondary value added contributions. Primary value added contribution represents the incomes generated initially from additional spending of the attendees on the various categories of goods and services. This covers the additional spending of attendees both within and outside the theme park. Secondary value added contribution refers to the incomes generated from subsequent rounds of indirect spending on further range of economic activities. However, neither of the values, primary nor secondary, can reflect the expected performance of the park itself. The returns that can be generated directly from the park are of utmost importance for an investor in deciding whether the project is viable to be executed.

Scenario	A	B	C	D	E	F
PV of Hong Kong Disneyland	168	149	132	125	109	101
NPV of Hong Kong Disneyland	148	128	112	105	89	80

Source: Financial Services Bureau, HKSAR, 1999

Table I. Economic benefits of Hong Kong Disneyland under different scenarios (in HK$ billion)

Third, the use of scenario analysis is not without limitation. Scenario analysis can capture different risk levels by modifying the cashflow streams and have the value reflected in separate scenarios, but each scenario remains fixed on a single future outcome and investment plan. There is no clear way to reconcile, aggregate, or choose between scenarios for evaluation purpose.

Last but not least, although the quantitative approach using NPV and DCF rules is helpful in providing a rough estimate on the general economic benefits that the project will bring to Hong Kong in a quick glance, this approach is basically inadequate in capturing the operating flexibility that has added value to the project, and in realizing the induced opportunities which would not have happened without the existence of the project. In view of these, the use of OPT is considered to be a more appropriate approach than that adopted by the Government for the valuation of this project. Before we proceed to the valuation, the embedded option within the theme park must first be identified.

Investment options embedded in Hong Kong Disneyland

To demonstrate the importance of capturing the operating flexibility and development potentials imbedded in the project to hedge against the risk exposed, a quick review on the success and failure among the other Walt Disney theme parks is useful.

At present, there are four Walt Disney theme parks inside and outside the USA. They are Disneyland in California, Disney World in Florida, Tokyo Disneyland in Japan and Disneyland Paris in France. The first Disneyland was opened in 1955 in Los Angeles, California. It enjoys a long success because constant changes have been introduced to the park over the intervening periods in attracting visitors. Despite the success, the Disneyland fails to exercise adequate control over the surrounding environment due to the restriction of land access and the areas around the park are polluted.

When Disney World was built in Florida in the 1970s, Walt Disney Company took on 11,093 hectares of reclaimed swamp land to allow for control of surrounding environment and room for future expansion. With this management flexibility, the company has successively added attractions and other theme parks to the original theme park and turned Disney World into a vacation resort in a later stage. By now, the resort comprises four main theme parks, two water theme parks, and three minor theme parks. Tokyo Disneyland, opened in 1983, is located on a 46-hectare site of reclaimed land with adjacent land kept available for further expansion. Since Tokyo Disneyland appeals to Japanese passions such as cleanliness, order, outstanding service, and technological wizardry, together with the economic booms in the 1980s, these have made the park a huge success since opening. Along with the success, Tokyo Disneyland has exercised the option to expand its park by building the Disney Water World to celebrate its 15th anniversary.

To the contrary, Disneyland Paris did not receive as much favourable response as Tokyo Disneyland during the early years of its operation. It was opened in the early 1990s while the continent was in deep recession. The

recession had adversely affected the attendance of local visitors and visitors from the neighbouring countries. The spending patterns of visitors were very price conscious, contrary to the park's expectation. The problem was also exacerbated by the skimming pricing strategy adopted upon opening. The prices set for the park and hotels were aimed at meeting targeted revenue without considering the affordability for the visitors and the economic environment then. As a result, the hotel occupancy rate averaged only 50 percent. Furthermore, the company failed to anticipate the needs of family travelers. These travelers need not only reasonably priced accommodation but also the basic necessities and facilities. The 350-seat restaurant once needed to serve breakfast for 2,500 people. To summarize, the major reasons for the failure of Disneyland Paris in the early 1990s stems from the miscalculation of the pace of development and the lack of operating flexibility built into the development process in coping with the requirements of visitors and in response to fluctuations of the economic climate.

The unforeseeable risk and investment potentials of the execution of Hong Kong Disneyland are no less than those of the Walt Disney theme parks discussed above. It involves high development cost, low project near-term cashflows and a great deal of uncertainty in response to fluctuations in the economic environment. Following are the embedded options that can be captured in the project to reflect its potentials which help hedge against the unforeseeable changes in the economic environment:

- *The option to switch use.* This option is helpful to hedge against the risk of low occupancy in the hotels located within Hong Kong Disneyland in view of what happened in Disneyland Paris in the early 1990s. If the occupancy suffers from a sustained decline for some reasons, the management does not have to leave the rooms empty but switch them to alternative use, e.g. switching them to service apartments for overseas businessmen who come over to Hong Kong for short-term assignments. In order to meet this flexibility, the facilities required for the switching purpose should be built into the project (I_s). With a higher initial cost to build in the flexibility-to-switch during the development process, the Hong Kong Disneyland project would be more adapted to changing environment. As such, the investor can choose the maximum of the project's value in its present use (V) or its value in the best alternative use ($S\text{-}I_s$), i.e. max (V, $S\text{-}I_s$), if the project is equipped with the switch option.
- *The option to expand.* The value of a project may be derived not so much from its projected cashflows, but from unlocking the growth path of future opportunity that competitors cannot duplicate (Kester, 1984). Disney theme parks are considered to be the most prominent and sophisticated amusement parks which offer attractions to visitors all over the world. The developers are also aware of the importance of constant changes to be introduced to the park in order to keep it attractive to visitors. Therefore, a built-in flexibility that enables the developers to expand the development in pace with the economic

requirements is valuable. To serve this purpose, land and the relevant infrastructure are prerequisites for further expansion of a real estate development. With this built-in flexibility, the park may expand the scale of investment at a rate of (re) by incurring a follow-up investment outlay proportional to the total investment (re $\times$ TI), and the project value would be increased by max (re $\times$ V − re $\times$ TI, 0).

Disneyland in California has failed to exercise adequate control over the surrounding environment of the park because of the restrictive access to land. Unlike Disneyland, the developer of Disney World in Florida and Tokyo Disneyland were able to grasp the opportunity to acquire a vast piece of land in the surrounding area and were later able to expand the park into a holiday resort step by step when the time was right.

- *The option to defer.* In a changing environment, the optimal time for executing a real estate investment or expanding the existing development may not be the current time (Capozza and Sick, 1992; Quigg, 1993). The huge loss of Disneyland Paris in the early 1990s was partly attributed to the low occupancy of the hotels available. If the construction of some of the six hotels could have been deferred and they had been built progressively in pace with the rate of increase of attendance, part of the loss could have been mitigated.

  The option to defer the expansion project, Phase II, of Hong Kong Disneyland is considered valuable. The construction of Phase II would only be worthwhile if the full capacity of attendance to the park is reached and the necessary infrastructure including the transportation and power supplies are made sufficient. As such, the option to defer enables the development to be postponed for a certain time and benefit from resolution of uncertainty about the future business. Furthermore, instead of leaving the land idle while waiting for the optimal time for Phase II construction, part of the land can be used for recreational activities and part can be let out for economic activities (D) such as converted into temporary golf ranges and courses, open market and car parks. This option is particularly valuable when the right to defer is guaranteed by the Government without paying premium.

- *Strategic options in competitive environment.* Developers tend to exercise their options earlier than otherwise when competitors have access to the same option and the industry rivalry is intense. This is because most real investment opportunities are not tradable; the real option cannot simply be sold in the market. In many situations, the only effective response to pre-empt competitors is early investment. As seen in the case of Hong Kong Disneyland, the value of the project may derive not so much from the projected cashflows yielded directly from the park itself, but from the induced opportunities and from unlocking the growth path outside the park (Er). This strategic approach of building a tourism infrastructure is a confidence booster for the tourist industry in the territory. However, the competitors in the nearby areas like

Shanghai and Singapore are strong. An early exercise of this option is particularly important in order to get an early foothold in the industry to pre-empt competitors and to gain competitive advantage.

Equipped with this competitive advantage, the Government has also invested in a number of strategic initiatives to lay the groundwork for boosting the travel and tourist industries. The strategic projects being taken forward to enhance Hong Kong's attractiveness as an international tourist destination include Universal Studio, an international wetland park and others. In brief, Hong Kong Disneyland is equipped with strategic options that help diversify Hong Kong's economic base and raise its competitiveness in tourism to a world class standard.

Valuation of Hong Kong Disneyland by option pricing

The valuation model chosen for this study has adapted the binomial stochastic numerical analysis of Trigeorgis for its distinctive advantages offered over the other models. First, it can handle investment equipped with multiple options as opposed to most of the other models which focus on valuing individual options. Second, it can handle options with dividend payment in stochastic pattern which is considered superior over the financial option valuation model like Black and Scholes Formula in valuing operating options in real investment. Modifications are made to the model in order to meet the requirements of the investment project of the present study in which the instantaneous returns of the project are irregular as a result of seasonal fluctuation and the changing of environment.

The binomial option pricing model

Under the traditional NPV analysis, the static net present value of an investment, assuming that the investment must start immediately and without consideration of other management flexibility available, is a function of various parameters which include the total cost of the investment (TI), the stream of economic returns (C), the project life (T), and the risk-free interest rate (r), i.e.:

$$\mathrm{NPV}(S) = f(\mathrm{TI},\ C,\ T,\ r).$$

Based on the discussion in previous sections, real estate investments are often equipped with options to defer(d), expand(e), or otherwise switch(s) the use of a project at different stages during its operating life. Therefore, the expanded net present value of the project is a function of:

$$\mathrm{NPV}(E) = f(C,\ \mathrm{TI},\ T,\ r,\ d,\ e,\ s).$$

As such, the operating flexibility expands an investment opportunity's value by improving its upside potential while limiting its downside loss relative to the developer's initial expectations as given in the following equation:

$$\mathrm{NPV}(E) = \mathrm{NPV}(S) + \mathrm{NPV}(O),$$

where:

NPV(E) = expanded NPV of project with options;
NPV(S) = static NPV of project without options;
NPV(O) = NPV of options.

Following the binomial option pricing model, the dynamics of market demand for the theme park result in a series of up and down values ($V_{t,s}$) in each state (s) over time (t) throughout the project life and cumulating overtime as seen in Figure 1. The operating flexibility allows adjustments, e.g. the economic rents and leakages (Amram and Kulatilaka, 1999), of the project values at each period in response to the altered market.

This valuation approach is broadly categorized into four main steps.

First, factors affecting the projected economic returns (C) throughout the project life (T) and the risk-free interest rate (r) must be specified. Other factors like investment outlays (TI) are also required. Additional cashflows and leakages (i.e. economic rents (Er)) of the embedded options and their timing must also be identified.

The second step involves the calculation of the parameters such as the standard deviation (σ), the possibilities of the upward (p) and downward ($1 - p$) movements of the project values (Capozza and Sick, 1992). For the preliminary sequential calculation of the possibilities of upward and downward movements, the method proposed by Trigeorgis is adapted in the present study because it benefits from high level of efficiency compared to other models (Trigeorgis, 1991).

Let the value of the underlying asset (V) follow a diffusion process of the form:

$$\frac{dV}{V} = \alpha dt + \sigma dz,$$

where α is the expected return on the project value V, dt is differential time interval, σ is the standard deviation of the project value V and dz is a standard Wiener process.

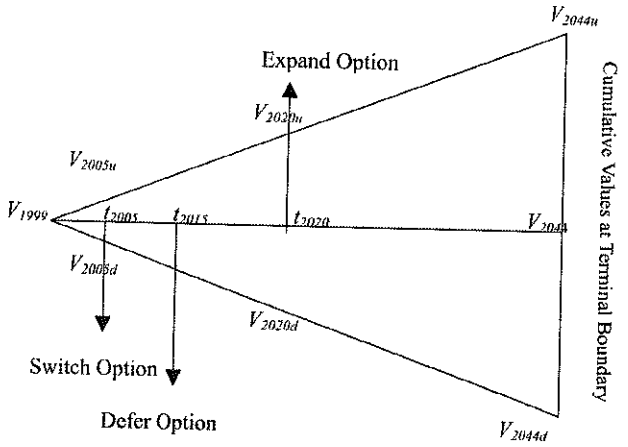

Figure 1.
Hong Kong Disneyland with multiple options

Let $X \equiv \ln V$ and impose risk neutrality to the pricing process, hence:

$$dX = \ln \frac{V_{t+dt}}{V_t} = (r - \frac{1}{2}\sigma^2)dt + \sigma d\hat{z},$$

with r being the risk-free rate and $d\hat{z}$ being the risk-neutral Wiener process.

Further let $K \equiv \sigma^2 dt$ and $\mu \equiv \frac{r}{\sigma^2} - \frac{1}{2}$, the key variables for the sequential algorithm of the binomial tree can be determined as follows (where T is the project life and N is the number of intervals):

- Time-step: $K = \sigma^2 \frac{T}{N}$;
- Drift: $\mu = \frac{r}{\sigma^2} - \frac{1}{2}$;
- Stage-step: $H = \sqrt{K + (\mu K)^2}$;
- Probability: $p = \frac{1}{2}(1 + \mu \frac{K}{H})$.

The third step involves determination of the cumulative terminal boundary values based on the projected economic returns cumulative over time. The terminal boundary values of the binomial tree are determined as:

$$Vt, s = e^{X_{0,0}+nH},$$

where n is the net number of up moves less down moves reaching the final level.

Having the terminal boundary values, the underlying up (u) and down (d) values of the project ($V_{t,s}$) of each state over time without options can be worked out using the DCF method as follows:

$$V_t = (p \times V_{t,u} + (1 - p) \times V_{t,d})/(1 + r).$$

The fourth step follows a backward iterative process to incorporate the induced benefits and any economic leakage (Er) and values of the real options at appropriate time. During the backward iterative process starting from the end and working backward, at each time a real option is encountered, option value is revised from E to E' with reference to the options described earlier:

- Switch option: $E = \max(S - I_s, V)$;
- Defer option: $E' = E + \max(D - (V - TI), 0)$;
- Expand option: $E' = E' + \max(\text{re} \times V - \text{re} \times TI, 0)$;
- Strategic options: $E' = E' + Er$.

Valuation of Hong Kong Disneyland

Following are the different cases with and without the possible options drawn for analysing the value of the project using the binomial option pricing approach described above.

Case 1: Base case of Hong Kong Disneyland. The base case is referred to the valuation of Hong Kong Disneyland without considering any options. To start with the analysis of the base case using OPT, the underlying up and down values of the project in each period and the NPV*(S)* are worked out following steps 1, 2 and 3 elaborated in the model. The values of the parameters, i.e. TI, *C*, *T*, *r*, are estimated based on the data collected from the Financial Services Bureau on scenarios A and F. However, in order to rectify the limitation of using the income-to-business receipt ratios to work out the value added in measuring the profitability and feasibility of the project, the operating margin yielded in the Disneyland theme parks in the USA of 23.8 percent is taken as a reference in the present study for estimating the expected income generated. As a result, the project value is found to be a loss of HK–$1.4 billion. A detailed description of the analysis is contained in Appendix 3.

Case 2: Hong Kong Disneyland project value with option to switch. We then proceed to work on the valuation of the investment with options. As discussed earlier, the project can be equipped with the option to switch use part of its hotel rooms to their best alternative use if the attendance rate does not meet the forecast. As full capacity is assumed in scenario A, the option to switch is applied only to scenario F. The occupancy rate in scenario F is estimated to be 0.72, the vacancy rate is therefore 0.28. Assuming the rooms left vacant due to low attendance can be let out at a rate similar to that charged by local hotels (of HK$250/day) with similar offers *(S)*, but with an extra cost of 0.5 percent of the total construction costs (I_s) to install the necessary fixtures and facilities for the converted use, the overall value of the project is slightly increased to HK$–1.2926 billion. A detailed description of the analysis is contained in Appendix 4.

Case 3: Hong Kong Disneyland project value with option to defer Phase II. Hong Kong Disneyland is granted a right by the Government to acquire the adjoining 54 hectares of land to build a second theme park within 30 years upon completion of the first park in 2015 when the target capacity of 10 million attendees is reached. Based on the Government's estimation, the target will be reached by 2020 in scenario A. It is thus worthwhile to defer Phase II from 2015 to 2020. On the other hand, Phase II will never get off the ground in scenario F as the number of attendees will not meet the target throughout the period of "right to build" from 2015 to 2034.

While the land reserved for Phase II development may be left idle waiting for expansion, part of it can be let out for temporary economic uses like setting-up of golf ranges, open market and car parking to generate an income to the investment (*D*). To work out the project value with the option to defer, it is assumed that a third of the reserved land can be used for temporary economic activities at a rent of HK$5/m^2/month. The annual rental income per hectare is thus HK$0.6 million, and the project value with the option to switch and defer is

found to be HK–$1.1226 billion. A detailed description is of the analysis contained in Appendix 5.

Case 4: Hong Kong Disneyland project value with option to expand. It is the master plan of the Government to build the park progressively into a holiday resort like that of Disney World. For expansion purpose, Hong Kong Disneyland is granted a right to expand for construction of Phase II. The option to expand is projected to take place in 2020 in scenario A when the targeted capacity is reached. To work out the value of the project which is equipped with the option to expand, it is assumed that the operating business receipts as well as the construction costs of the superstructure are estimated to be 80 percent (re) of that of the base case. The expected project life is only up to 2044 based on the assumption that the existence of the second theme park relies on the existence of the first theme park. With inclusion of all the three options into the project – option to switch, defer and expand – the value of Hong Kong Disneyland is calculated to be a gain of HK$0.8274 billion. A detailed description of the analysis is contained in Appendix 6.

Case 5: Hong Kong Disneyland project value with strategic options. The value of the project may derive not so much from the projected cashflows generated directly from the park as shown in the base case, but rather from the induced economic benefits in related industries which include retail, hotel and airliner in Hong Kong. The infrastructure and experience gained from the construction of Hong Kong Disneyland can also unlock future strategic opportunities and can place the area at a competitive advantage over its neighbouring cities. The competitive advantages include enhancing the international image of Hong Kong as a cosmopolitan city; helping transfer Walt Disney's strong edge in quality standard technological innovation, staff training and environment alertness to the economy; and pre-emptive advantage over other competing cities in East Asia like Shanghai and Singapore.

In the present study, we confine the value of the strategic options to the induced benefits gained from the related businesses outside the park without considering the new strategic investment opportunities available. This is because there is a lack of available data at this stage to quantify the economic benefits generated from future investment opportunities by introducing new projects like Fisherman's Wharf and Universal Studio which are already in plan. The induced economic benefits are estimated by taking out the business receipts generated within the theme park from the total receipts induced by Hong Kong Disneyland to the territory estimated by the Government. They are the added income generated from additional spending of the attendees on the various categories of goods and services produced by the sectors concerned outside the park, plus the induced spending on the further range of economic activities in support of such sectors. These include consumption items of shopping, hotel accommodations, eating out and services provided by local airlines, etc.[1]. The induced strategic economic benefits yielded have drastically enhanced the value of the project to HK$28.3774 billion. A detailed description of the analysis is contained in Appendix 7.

Impact of real options on the project value

Table II provides a summary of the results in evaluating the project with and without real options. In the absence of any operational flexibility, the NPV(*S*) of undertaking the project is HK$–1.4 billion. When the development is equipped with the option to switch use part of its facilities, the loss of the project is then mitigated to a negative expanded NPV(*E*) of HK$–1.2926 billion. The value of this option is HK$0.1074 billion, which represents a 7.7 percent saving of the loss value and 0.56 percent[2] of the gross development value.

The results also show that the option to defer the operation of the project increases the value of the investment by HK$0.1773 billion, i.e. from HK–$1.4 billion to HK–$1.2227 billion. The amount represents a saving of 12.66 percent of the loss value of the base case and 0.92 percent of the gross development value. It is found that both the option to switch and option to defer help the project to mitigate its loss. By adding the option to expand, the project value is expanded to a positive NPV(*E*) of HK$0.56 billion. The value of the option to expand is HK$1.96 billion which increases the gross value of the project by 10.13 percent.

As mentioned above and as shown in Table II, the most notable result is the economic benefit yielded from the strategic options. The induced economic income from the related industry outside the park has expanded the project value to a NPV(*E*) of HK$26.15 billion. The value of the option is then HK$27.55 billion. The gross project value, without deducting the construction outlays of approximately HK$20 billion, has more than doubled from HK$19.33 billion in the base case to HK$49.11 billion.

It is interesting to find that the economic benefits generated by Hong Kong Disneyland in this study using OPT approach is much less compared to the results generated by the Government despite the options having added value,

NPV(*S*) of base case			
–1.400			
	NPV(*E*) of project with one real option		
Switch use(*s*)	Defer(*d*)	Expand(*e*)	Strategic options (Er)
–1.2926	–1.2227	0.5600	26.1500
0.1074[a]	0.1773	1.9600	27.5500
	NPV of project value with accumulative options		
s	sd	de	sdeEr
–1.2926[b]	–1.1226	0.8274	28.3774
–1.2926[c]	1.1153	0.8447	28.3947
0.1074[a]	0.2774	2.2274	29.7774

Table II.
Project value with options (in HK$billion)

Notes: NPV(*S*) of base case = –1.400. [a] Option value NPV(*O*). [b] Project value NPV(*E*) derived from combined option values. [c] Project value NPV(*E*) derived from sum of option values

HK$148 billion in scenario A and HK$80 billion in scenario F against HK$28.38 billion obtained in this study (see Table III). As discussed earlier, the Government used the income-to-business receipt ratios to work out the project returns without considering the corresponding operating expenses to be incurred, and it therefore undoubtedly amplified the net value of the project. Yet, the operating profit margin of 23.8 percent (based on the profit margin estimated from the Disney theme parks in the USA) used in the present study to work out the estimated return of the project is considered to be a more accurate indicator in gauging the viability of the project. When the operating margin is used to replace the income-to-business receipt ratios in the static NPV approach adopted by the Government, the values of the project in scenario A and scenario F are substantially reduced to HK$40 billion and HK$17 billion respectively.

It should also be noted that real options interact with each other to various degrees so that the combined value of multiple options may not be their sum. As shown in Table II, although the NPV(*E*) with the option to switch alone is HK$–1.2926 billion and the option to defer alone is HK$–1.2227 billion, the combined value of the project with both options is HK$–1.1226 billion (less than their sum of HK$–1.1153 billion) indicating that a negative interaction exists.

The degree of negative interaction between various combinations of options depends on the type of options involved. In general, there is a small overlap and minimal negative interaction between the options to defer and expand or the options to expand and switch use. If combined values are the same as their sum, then it shows that they have no interaction effect on each other at all. Furthermore, the relative degree of being in or out of the money would exert different magnitudes of interaction on the value of the next option (Trigeorgis, 1993b).

In the case of Hong Kong Disneyland, the combined value of the investment NPV(*E*) with multiple interactions of all four options exercised is HK$28.38 billion against their sum of HK$28.39 billion. However, the difference is considered not significant in this analysis since 92 percent of the NPV(*E*) comes from the economic rents generated from the strategic options among the four types of options.

NPV(S)		
Scenario A	Scenario F	OPT
148[a]	80[a]	
40[b]	17[b]	28.38[b]

Notes: [a] Economic incomes are adjusted using income-to-business ratios.
[b] Economic incomes are adjusted using operating margin of 23.8 percent

Table III.
Comparison of economic benefits of Hong Kong Disneyland between static NPV and OPT approach (HK$billion)

Conclusion

This study has successfully extended the application of OPT in real estate investment with reference to the case studying the development of Hong Kong Disneyland in which the cashflows are in irregular pattern as a result of seasonal fluctuations and the changing of environment. It has formulated a comprehensive approach to quantifying the value of the various options embedded in real estate projects and showing how these options interact within and outside the development process. It is not surprising that the project value is found to be negative in the base case as the construction outlay for infrastructure is huge compared to the construction outlay for the superstructure of the theme park. However, after taking into account the options to switch, defer and expand, the value of the project is greatly enhanced. When further strategic options are taken into account, the value of the project is substantially increased and becomes attractive.

In addition, the binomial option pricing model applied in this study offers several distinct advantages over the static NPV model adopted by the Government. The model is able to capture the uncertainty of the future business development in different scenarios to be reflected in a single value for evaluation purpose. It is suitable for handling anticipated discrete cashflows which follow an irregular flow pattern at a result of seasonal fluctuation and the changing of environment. And it is considered to be more efficient (Trigeorgis, 1991), compared to other stochastic models developed by finance experts and mathematicians like the Black-Scholes Formula.

To conclude, the study has demonstrated how OPT can be applied to quantify the values of various types of options that a theme park project has in enhancing its upside potential as well as reducing its downside risk in different economic conditions. The numerical analysis also showed how these options increase the value of the investment in the valuation process and their interaction effects. The option-based valuation approach can integrate both capital budgeting and strategic planning with a view to maximizing value and provides valuable insights to real estate investors.

Notes

1. The data are based on the study, "Assessment of the contribution of tourism to the Hong Kong economy", conducted by the Economic Analysis Division, HKSAR, 1999.
2. The gross project value of the base case is HK$19.33 billion.

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(See over for Appendices.)

Appendix 1.

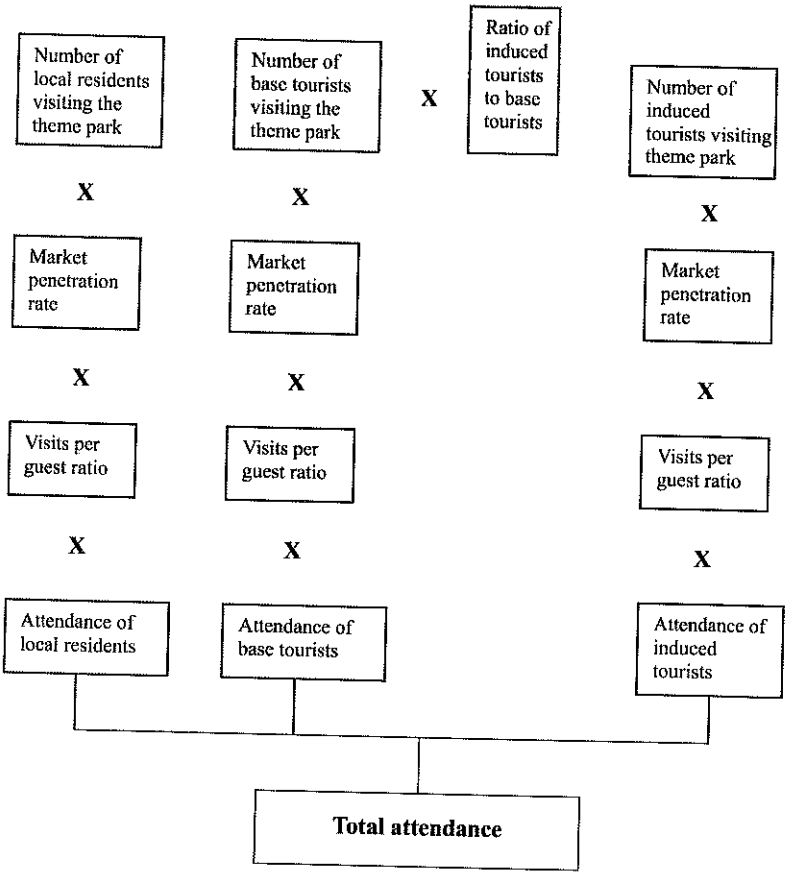
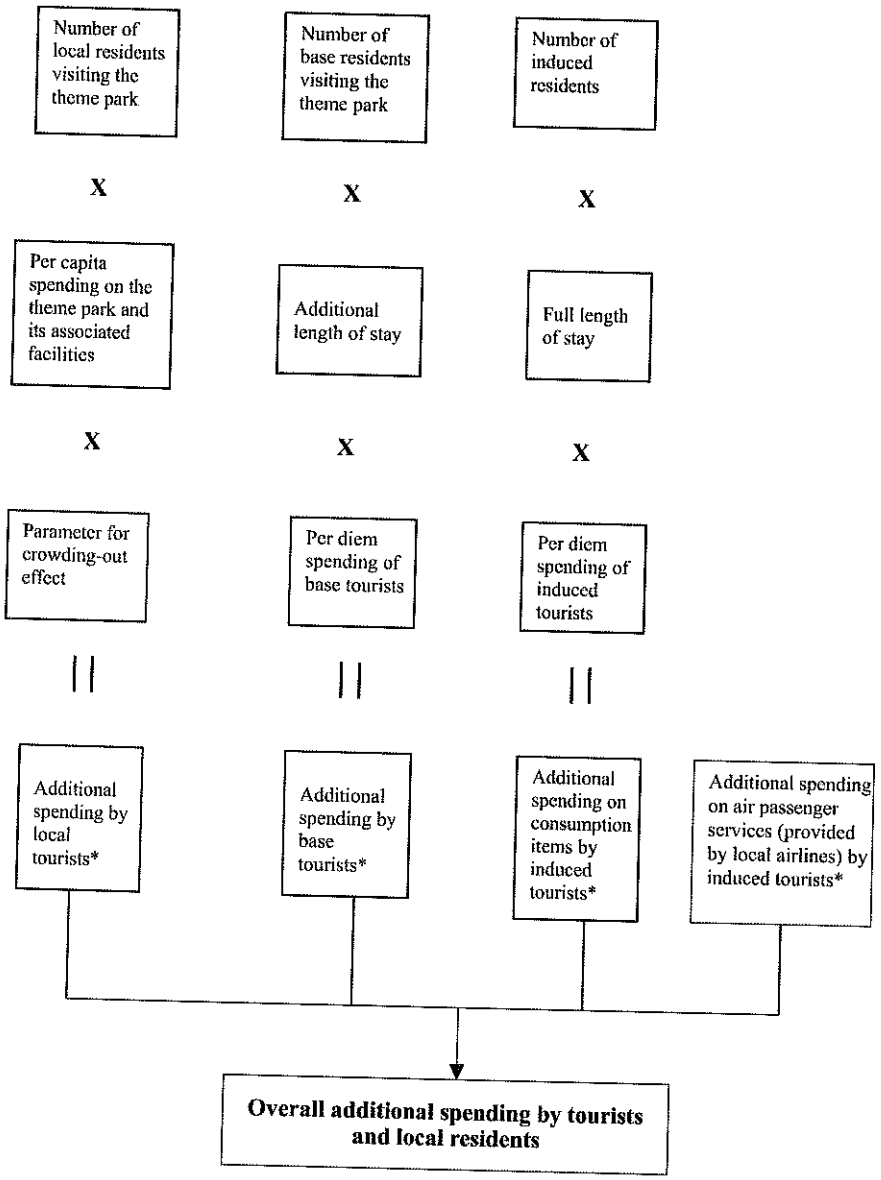


Figure A1.
Summary of methodology for assessing attendance

Note: Attendees broadly comprises "base tourists" who would have come to Hong Kong anyway but will spend additional time in Hong Kong to visit the theme park, induced tourists from mainly the Mainland China and Taiwan who come specially to visit the theme park, and local visitors

Source: Financial Services Bureau, HKSAR (1999)

Appendix 2.



Source: Financial Services Bureau, HKSAR (1999)

* Incomes are adjusted based on the income-to-business receipts ratios in the respective industries

Figure A2.
Summary of methodology for assessing total additional spending

Appendix 3. Case 1: base case (without option)

(1) The values of the parameters, TI, C, T, r are estimated based on the data collected from the Financial Services Bureau and they are listed as follow:

- Yearly returns, C = based on Government estimates and adjusted by use of operating margin of 23.8 percent.
- Discount rate, $r = 4$ percent.
- Project life, $T = 40$ years.
- Construction outlay for base case, TI = HK$20.73 billion.
- Standard deviation of project value, $\sigma = 0.4399$ (as calculated).
- Probability of upward changes of business, $p = 0.4358$ (as calculated).
- Probability of downward changes of business, $1 - p = 0.5642$ (as calculated).

(2) The project, upon completion of Phase I, consists of a Disney theme park (the Magic Kingdom), two to three theme resort hotels to be opened in 2005 with 1,400 hotel rooms, and four to five hotels with up to 2,100 rooms upon completion in 2015. It also includes a 2.8 hectares retail, dining and entertainment areas.

(3) Several more assumptions are required for this calculation:

- Assume hotel accommodations are built progressively in the following way:
  - 1,400 rooms in total will be available in 2005 (opening);
  - 1,750 rooms in total will be available in 2010;
  - 2,100 rooms in total will be available in 2015 (upon completion of Phase I).
- Income includes spending of visitors in the theme park plus spending of those who stay within the resort area of HKD. The latter includes spending on the hotel accommodation, dining and other associated services.
- Incomes to the theme park (the Magic Kingdom) is estimated by using the number of visits × the average spending per visit estimated by the Government at HK$680.
- Incomes from those who stay in the theme hotels and use the facilities such as restaurants and others:
  - number of people staying in the hotels are estimated by number of rooms available × an estimate of 1.5 people stay in each room on average;
  - the average spending includes meals and accommodation at present rate of $250 and $400 per person per day;
  - for scenario A, i.e. full occupancy of hotel accommodation. Spending in Scenario A is: number of rooms × number of people staying × costs on meals and accommodation;
  - for scenario F, occupancy rate is assumed at an average of 0.72, based on the attendance rate in F to the attendance rate in A. Spending in scenario F is then: number of rooms × number of people staying × occupancy ratio × costs on meals and accommodation.

The results (in HK$billion) show that:

- PV of construction outlays: 20.7300.
- PV of project: 19.3300.
- NPV of project: –1.4000

Appendix 4. Case 2: HKD project value with option to switch

(1) To hedge against the risk of low occupancy rate which had happened in Euro Disneyland, an option to switch use part of the hotel rooms should be embedded in HKD project.

(2) In the short term, part of the hotel rooms can be switched to service studios to accommodate those overseas employees if there is a low occupancy.

(3) In the long term, service apartments that are made available to accommodate family travelers can be switched to flats renting to local employee families if there is a low occupancy in the long term.

(4) Full capacity is assumed in scenario A and, therefore, switch options is applied only in scenario F.

(5) As the occupancy rate in scenario F is 0.72, the vacancy rate is then 0.28.

(6) Switch option is applied in scenario F throughout the project life.

(7) To start the calculation, several assumptions are made as follows:

- Assume the rate per room for the best alternative use is similar to those offered in the market at present at $250 per day.
- Assume an extra cost of 0.5 percent of the construction outlays is necessary to install the required facilities for later switching purposes, i.e.: total construction costs in hotel buildings × vacancy rate × extra cost of 0.5 percent.
- The value of the switch option is: [room rate per day × 365 days × (room available × vacancy rate) × operating margin] less the extra construction cost.

The results (in HK$billion) show that:

- PV of construction outlays with switch option: 20.73 + 0.0026 = 20.7326.
- PV of project with switch option: 19.4400.
- NPV of project with switch option: –1.2926
- Switch option value: 0.1074.

Appendix 5. Case 3: project value with option to defer

(1) The master plan of the Government is to build the theme park into a holiday destination, like that of Disney World. However, the construction of Phase II would only be worthwhile if full capacity of attendance to the park is reached.

(2) As such, an option of a total of 30 years to buy adjoining 54 hectares of land for a second theme park is granted. The option will lapse after the first 20 years (2024) if it has not been exercised. However, HKD may have further two five-year extensions of which the second is conditional upon the original targeted capacity of 10 million visits not being reached but the secondary targeted capacity of 8 million being reached.

(3) The option to defer enables the expansion to be postponed for a certain time and benefit from the resolution of uncertainty about the business in terms of attendance. Therefore, Phase II development would be executed only if the demand increases sufficiently. If the demand does not meet the target, Phase II development would not be proceeded with so there will be saving on the corresponding construction outlays.

(4) In the meantime, instead of leaving the land idle before the optimal time for Phase II construction, part of the land could be utilised for recreational activities and part could be rented out for economic activities such as setting up of golf ranges, open market and car parking, which are similar to the present uses of the disused old Kai Tak Airport.

(5) Based on the figures provided by the Government, Phase II construction should be deferred until 2020 when visits to HKD are over 10 million in Scenario A. For Scenario F, the expansion should be deferred throughout the full period of "right-to-build" from 2015 to 2034. Therefore, defer option should be applied during the periods:

- between years 2015-2019 in Scenario A;
- between years 2015-2034 when the option lapses in Scenario F.

(6) The estimated site area fpr Phase II is 54 hectares.

(7) It is assumed that:

- one-third of the land reserved can be used for economic activities at a rent of HK$5/sq m^2/month;
- annual rental income per hectare = $5 × 12 month × 10,000 = 0.6 million.

The results (in HK$billion) show that:

- PV of construction outlays outstanding: 20.7326.
- PV of project with switch and defer options: 19.6100.
- NPV of project with switch and defer options: –1.1226.
- Switch and defer options value: 0.2774.
- Defer option value: 0.1773.

Appendix 6. Case 4: project value with option to expand

(1) The master plan of the Government is to build the theme park into a holiday destination, like that of Disney World in Florida as discussed in previous case.

(2) Option to expand will take place only in year 2020 when the targeted capacity of 10 million visits is reached in scenario A. However, defer option will still be exercised in scenario F as the targeted capacity is not reached.

(3) To start with the calculation, several assumptions are made for the option to expand to work:

- Assume the construction costs (superstructure and facilities) and the operating income of the second theme park is 80 percent of the project value of the base case.
- The project life of Phase II is up to 2044 based on the assumption that the existence of the second theme park relies on the existence of the first theme park.
- Assume the construction of Phase II takes five years and operation starts in year 2025.

(4) The value of expand option is: (base case project value × rate of expansion) less (construction costs of superstructure and related facilities of base case × rate of expansion.

The results (in HK$billion) show that:

- PV of construction outlays outstanding: 20.7326.
- PV of project with switch, defer and expand options: 21.5600.
- NPV of project with switch, defer and expand options: 0.8274.
- Switch, defer and expand options value: 2.2274.
- Expand option value: 1.9600.

Appendix 7. Case 5: project value with strategic options

(1) The value of the project may derive not so much from the expected cashflows generated directly from the theme park, but rather from inducing related economic benefits outside the park and unlocking future strategic opportunities in tourist industry in Hong Kong. The projects in plan to expand the tourist industry include:

- Adventure Bay attraction at Ocean Park;
- Cable car system on Lautau Island;

- International wetland park;
- Fisherman's Wharf;
- Universal Studio.

(2) However, it is difficult to estimate the economic benefits of the strategic opportunities by introducing new projects and the pre-emptive advantages. In the present study, we confine the value of the strategic options to the induced economic benefits gained from the related industries estimated by the Government.

(3) The value of the strategic option is: annual induced economic benefit = annual total business receipt brought to HK estimated by the Government – Annual business receipt brought to the resort in the base case.

The results (in HK$billion) show that:

- PV of construction outlays outstanding: 20.7326.
- PV of project with switch, defer, expand and strategic options: 49.1100.
- NPV of project with switch, defer, expand and strategic options: 28.3774.
- Switch, defer, expand and strategic options value: 29.7774.
- Strategic option value: 27.5500.