Empirical Testing of The Flexibility Value in Land Auction Prices

SHEN JIANFU and FREDERIK **PRETORIUS**
The University of Hong Kong

Abstract

This paper uses project level data of land auction prices in Hong Kong. It tests the hypotheses that the land auction price (real option premium) contains three sources of flexibility value: waiting to invest, the effect of direct interactions and the effect of financial structure. The OLS regression results show that the option premium embedded in the land price is not only related to real flexibility choices such as delaying investment as identified in traditional real option theory, but it also increases or decreases with the direct interaction of properties, their competition for firm resources and the firm's financial status. Firms with more investment properties located close to the auctioned land and with more internal funds would place a higher value on the land at auction; while more profitable firms and firms with less debt capacity would lower its estimate of option value embedded in the auctioned land prices as reflected in bidding. The interaction effect and financial structure in the firm have been confirmed in the empirical studies to influence the option premium in the land price. These results confirm the link between the project level predictions of real option theory and firm fundamentals.

Key Words: Flexibility Value; Real Option; Property Interaction; Financial Structure

European Real Estate Society 19th Annual Conference, 13th -16th June 2012

Empirical Testing of The Flexibility Value in Land Auction Prices

1. Introduction

Real option theory has been applied with various levels of success to several industries in both research and practice, including natural resources, R&D, real estate and others. Yet most studies continue to be concerned with single options and assume that option holder finances the investment totally with equity. Companies however may hold several real options simultaneously and ponder the investment decision for each option exercise neither from the overall firm perspective, and not in isolation nor without considering financing status. Essentially, real option value comes from the flexibilities embedded in the project. With the broader perspective, this option value is altered by the flexibility or inflexibility in the firm that potentially exercises the option. It is argued that the option value is not only determined by the project itself but also influenced by the firm specific aspects that may impact the exercise decisions. The effects of these aspects depend on their contributions to option exercise: it is positive if they provide more flexibility and negative if giving inflexibility. Some studies, like Moel and Tufano (Moel and Tufano, 2002)and Slade (Slade, 2001), have proposed and confirmed that "firm-specific managerial factors" influence the investment decision and project value of mines. The flexibility they identify as the managerial (operational) flexibility is the ability of the firm to temporarily shut or reopen a mine in favorable states. This paper follows this spirit to study project-level of investment decision and option value in the broader firm perspective. However, we investigate corporate flexibility other than managerial flexibility and we identify how flexibility value influences project value.

Through firm perspective, two additional factors, which may generate extra flexibility value, are considered in this paper in comparison with previous research. The *first factor* is the interaction among multiple real options, which may be named the portfolio effect. Trigeorgis (Trigeorgis, 1993a) argues that multiple options on one underlying assets may cause super-additive or sub-additive values according to the nature of the options. Brosch (Brosch, 2001) reviews interactions on both the real options level and on the real asset level, with the obvious expectation that these could also influence project value and exercise decision, which may lead to synergies, information sharing or cost reduction. In addition to the direct interactions, indirect interactions, caused by the correlations of underlying assets in multiple projects, would give flexibility to the firm. Moel and Tufano (Moel and Tufano, 2002) argue that the mining companies may have a large portfolio of mines and mining rights, in which the investment decision in one mine would affect others'. This paper also views the company as an entity that holds a portfolio of assets, including assets in place and growth options.

The *second factor* is the financial status and constraints that the firm faces. It departs from the assumption in real option theory that the option is always exercised with sufficient resource and available internal funds. It is possible that the firm may confront financial constraints and be forced to wait even if the option is ready to exercise. Boyle and Guthrie (Boyle and Guthrie, 2003) firstly impose financial frictions into a real option model and study the effects of financial constraints on investment timing and option value. As financial aspects are introduced, the project must be delayed when the firm cannot raise sufficient funds to meet exercise cost, or it is optimal to accelerate when the firm anticipates the lack of the future funds. In both scenarios financial status may reduce the option value. If the firm resorts to external funds by issuing debt or equity, it has to pay additional financial cost as the external funds may be more expensive, shown as finance hierarchies in Fazzari, Hubbard, Blinder and Poterba (Fazzari et al., 1988)and the option value is reduced by these additional costs Hirth and Uhrig-Homburg (Hirth and Uhrig-Homburg, 2010). So the value and exercise timing implied in real option theory are ideal states. The ability to finance the investment also plays important role in the investment decision.

One the other side, the firm with financial flexibility, with access to external funds and able to adjust capital structure with low cost, has the potential to seize optimal value from its projects. Trigeorgis (Trigeorgis, 1993b) argue that financial flexibility gives value to the equity holders because they have the default option on the debt and if the lenders provide capital with cost lower than equilibrium return. Thus operating flexibility as real option may interact with financial flexibility. Gamba and Triantis (Gamba and Triantis, 2008) argue that the value of financial flexibility is determined by the cost of external funds. This flexibility is expected to have substantial effect on the firm value, and it is reasonable to expect that the firm with financial flexibility would have higher expected value on the potential project.

This paper uses land auction prices to test the effects of interactions and financial aspects that link to firm fundamentals. It argues that the land price reflects not only the real option value embedded in the project but also the additional flexibility (inflexibility) values embedded in the firm. And because of the heterogeneity of asset structure and capital structure of firms, the value of this extra flexibility varies. The real option value is the same for all the participants in the auction as the land information is public. But the additional flexibility value is private and firm specific. The firm that wins the bid gives the highest price of the land at least partially due to its advantage from this additional flexibility. The price, given in the land auction, reflects the estimate of land value of each firm through the combined consideration of project characteristics and firm fundamentals. Our paper is concerned with land auction prices from the real option theory perspective rather than auction theory. It empirically confirms that the land price not only contains the option value at the project level but also is influenced by the flexibility in the firm.

This paper is arranged as follows. Section two introduces the background of land auctions in Hong Kong. The hypotheses and regression models are proposed in section three. Section four provides the description of data and regression results, followed by a conclusion.

2. Background and Related Literature Review

Hong Kong manages its land resources through a leasehold system, whereby the state (HKSAR Government) owns the land and leases it out through long leases.[1] Vacant or developable land is

[1] There are only one or two land parcels in freehold ownership in the whole Territory.

released to the market through auction (mainly) or tender. The auction process is transparent and the bidder offering highest price wins the land at auction. Before the auction, the information of the land at auction, like the site area, land use, the gross floor area and other details, has been documented and made known to the public. The Government would set a reserve price for each auction; only bids larger than the reserve price at the auction would be considered. We use the ratio between winning bid and reserve price to represent the option premium in the auctioned land. It is reasonable to argue that the firm which gains more flexibility from the project would have higher option premium.

Three sources of option value were identified in the Introduction, namely the option to delay embedded in the land, the interaction effects of the auctioned land with existing developable land and the financial flexibility (inflexibility) in the firm.

Development land has been theoretically treated as real option for some time. Several papers, like Titman (Titman, 1985), Cappoza and Li (Capozza and Li, 1994)and Williams (Williams, 1991) apply the real option framework to theoretically value vacant land. The flexibility embedded in the land could be the option to wait, to change the land use or to alter the capital density. The implications from real option theory is that the flexibility, like waiting to invest, altering land use and changing land density, has substantial value which is embedded in the land price and can be valued within an option pricing framework. Similar to financial option theory, the flexibility value is positively related with volatility of the underlying property price and interest rates, but negatively related with construction cost and forgone dividend.

Quigg (Quigg, 1993)uses a large sample of real estate transactions in Seattle to test option values. She constructs a theoretical framework similar to Williams (1991) and derives the formulas for land value (including the option value to wait) and the intrinsic value. The results show that the value of waiting embedded in the vacant land is approximately 6% of the land value. The accuracy of this estimate and test depends on the correctness of the theoretical model, which involves the appropriate application of the option valuation model and the estimates of model parameters, such as built property prices and construction cost. Groverstein, Kau and Munneke (Grovenstein et al.) apply the theoretical and empirical framework in Quigg to determine the land value and delay value of vacant land in Chicago. They reach similar results as Quigg and argue that delay option premiums of vacant land changes with zone and land use. This framework is also applied to testing option values in Hong Kong land prices by Chiang, So and Yeung (Chiang et al., 2006). They also calculate the option value and intrinsic value for vacant land through the option model, and test the validity of the option model through the comparison of market price of vacant land (auction price), intrinsic value and option value. They find that the option model gives more accurate estimates than a hedonic model. However, they point out that the land premium for vacant land may be attributed to the option value or, more likely, the market expectation of property price movements, as flexibility to delay is constrained by institutional arrangements.

Our empirical testing does not rely on the theoretical option pricing model to derive the intrinsic value. It is a reduced form function which tests the implications from real option theory, specifically if property volatility and interest rates positively influence the land price in contrast to the arguments from traditional NPV methodology. The first reason is that the research following Quigg's framework requires relatively accurate estimates of model parameters for option theory, like the price of potential underlying asset, volatility and construction cost. As real estate is not a divisible asset and generally there is no standardized unit prices, the parameters for valuation cannot be obtained precisely, which lead to biased estimation in option pricing models. In addition, the practical flexibility in land development is not as simple as the theory argues. Law, regulation and contractual arrangements would determine whether the land has some flexibility, while property is also heterogeneous in location, property use and others. These factors reduces the direct applicability of the option pricing model in land development, but the real option reasoning can still be used, as flexibility is important in practice.

The first argument is whether the option value exists in the land auction price, given that HK manages its land resources through long land leases and not freehold, unlike most real option studies in real estate development which assumes freehold. In the leasehold system, the land use is specified in the land lease before auction. Thus the option to change land use technically does not exist. The Government also places limitations on the maximum gross floor area. Usually developers would also build at the maximum allowable density due to limited developable land in Hong Kong, so the option to alter density is also practically non-existant. However, the option to delay is partially preserved in the auctioned land. The land is required to be developed in maximum 48 months after the auction. If the developer wants to delay more, some penalty would be levied by the Government, but it is clear that land development is not a perpetual call option under this circumstance. But we argue that even if constrained, there is still a value to delaying, which should reflect in the auctioned price. Chiang, So and Yeung (Chiang et al., 2006) regress the land auctioned price respectively with intrinsic value and option value of the land.

The second source of option value, resulting from portfolio effects and interaction of assets in the firm, has been studied in other industries like oil exploration but not much in real estate. Grenadier (1995) values the dynamic flexibilities from owning properties for which owners can choose the optimal tenant mix. He argues that two forms of flexibility, dynamic and static flexibility, are held by the building owners. The value of flexibility in a building can be decomposed into two categories: "the option value of dynamic optimization and the portfolio value of tenant diversification" (P360). The dynamic flexibility in real estate projects involves a series of options to adjust the tenant mix, for increasing or decreasing some tenant types, according to the evolving uncertainty, the relative value of rents in different land uses and the adjustment cost. The model derived in this paper reveals an optimal path to exercise sequential options as time progresses. The paper is related to property investment and is concerned with the real option portfolio in just one underlying asset. Yet when viewing the firm as portfolio holder of multiple assets, the firm may have to consider direct and also indirect interaction effect among assets.

In oil exploration industry, the information option and learning from one project can help resolve geological uncertainty and avoid the downside tail of the outcome distribution in another project (Dias, 2006, Smith and Thompson, 2008). In addition, two oil fields located together can share oil pipelines and other infrastructure, which save the total costs for development (Dias, 2006). The interactions can also be negative. In biotech industry, R&D projects competing with each other for the same product are substitutive and lead to sub-additive value summation (Vassolo et al., 2004, Girotra et al., 2007). The path-dependency in investment and knowledge accumulation in existing projects harm the value of the sequential projects because the resource should be kept putting into the previous projects rather than the new ones (Gunther McGrath and Nerkar, 2004).

The forms of interactions are associated with the industries and development activities, connecting to information spillover, cost sharing and price premium. The information spillover may occur when the company tentatively develops a small parcel of land to obtain market information that help make wiser decisions for remaining land. Sirmans, Turnbull and Dombrow (Sirmans et al., 1997)argue that with more houses the uncertainty of neighborhood development is resolved and thus the price discount of first house sold would disappear. The final effect is to increase prices for additional properties. In general, the interactions induce price and cost benefits.

Important interactions in real estate development are resulted from economy of scale, economy of agglomeration and positive locational externalities (Geltner et al., 2007). These three forces generate benefits for the production firms in a particular location. In other word, if the firms locate in nearby areas, they may reduce the fixed cost, share some common inputs and produce complementary products. One example is the development of industrial park for an industry with agglomeration economy (Rauch, 1993). The agglomeration economy can occur in residential and commercial areas, especially in a region with high population and density, such as Hong Kong.

To illustrate the interactions of properties in Hong Kong, Pretorius et al. propose the cases of internal and external agglomeration economies. Large-scale residential estates integrate recreational, shopping and social facilities, which may produce a premium of 15% above the price of non-integrated estates due to the internal agglomeration economy. Large property developments can benefit from this effect. Empirical study by Thorsnes (Thorsnes, 2000)confirms that internalizing neighborhood externalities through large development increases the lot prices. The consumers are willing to pay more for the amenities that are provided in a larger parcel of land. It appears that co-developed projects in a location can be designed into a large community by incorporating sport, recreational and cultural facilities, and this internal agglomeration economy can be controlled and achieved by the individual developer.

The agglomeration economy can also be external occurring in different locations that share some common facilities. It is not economically efficient to build specific facilities in each small estate; while when more and more estates are cumulated, some external facilities that can serve for the amenity demand may be offered in the neighborhoods. The conditions are that the neighborhood areas should reach a sufficient scale in populations and the facilities are convenient to access to. The urban and population density is necessary to generate the external agglomeration economy and this economy in turn influence the property value in the neighborhood area.

Although agglomeration economies and economies of scale in property development exist in the reality and in the theoretical literature, they are rarely empirically confirmed in the research, not to mention that they would be incorporated in real estate development decisions. Our study argues that the portfolio effects from the interactions of multiple assets would be another source of option value in the land. In the land auction, the firm that holds more properties in the same district and ongoing projects in neighboring areas, which may generate agglomeration economies and save construction cost by co-development, can enjoy flexibility from interactions and place a higher value on the land.

The indirect interaction among assets and projects also influences the investment decision of land and thus land value, especially when the firm has limited capital and faces financial constraints. The projects in a portfolio compete for resources which lead to sub-additive portfolio value (Vassolo et al., 2004). It also changes the investment timing for real options.

The limited ability to finance has not been incorporated into the investment timing model in real option literature until recently. Boyle and Guthrie (Boyle and Guthrie, 2003) introduce financing constraints into real option models. Because of the constraints, the firms have to forgo some investments and also accelerate the investments in case the funding for future investment is insufficient, which lead to a suboptimal investment threshold and timing. The value of waiting to invest may thus not be captured. When the firm has a large portfolio of assets and projects, its resources should be allocated to the assets with higher return (or ongoing projects due to path-dependency) in priority to new projects. It is reasonable to expect that constrained firms may not gather sufficient resource for new project and thus lower its valuation of a new project. Moel and Tufano (2002) find that the operating cost of other mines and returns on assets in the previous year affect the mine closure decisions.

In real estate development, Geltner et al. (Geltner et al., 2007)discuss the constraints in practical real estate development (P794):

> "Developers usually face a capital or resource constraint in practice, or believe they do. That is, they can only do so many projects at once. This means they cannot do all the projects that appear to be financially feasible (and that they might think they would like to do, if they could,) As a result, developers are forced, in effect, to rank-order projects and consider feasible combinations of projects. It seems likely that a big part of what makes developers

successful is their ability to do this rank-ordering rationally, that is, to choose among mutually exclusive alternatives to pursue those that look best on the basis of the magnitude of the perceived profit or surplus."

Because of constraints and competition among corporate projects, the firm that had made a large capital expenditure before land auction or had high profitability on current properties, would have lower probability to place higher value for new project. We will test this competition relationship between existing assets and new projects.

The third source of option value comes from the firm's ability to finance the new project. In the presence of financial constraints and friction, internal funds are cheaper capital to invest by the firm (Fazzari et al., 1988). This lower cost capital facilates the firm to capture the embedded option value in the land, while the ability to access to capital market and gain cheap capital may generate additional flexibility value, which would be reflected in the land auction price. We will test the relationship between option premium and financial flexibility/inflexibility in the firm.

Land development requires large capital expenditure in land cost and construction cost. As discussed before, the ability to finance the investment may influence the value of real options. The land premium paid in the auction is also associated with the financing state of the firm. We can view the land premium in two ways. One the one hand, it is the value of the development opportunity in the future. In the real option framework with external financing, if the firm has sufficient internal cash or is able to access external capital with low cost at the timing of the option exercise, the firm can capture full option value rather than be forced to delay or accelerate the exercise. The firm with high potential financing ability places high bidding price for the auctioned land. On the other hand, the land premium is current investment. This investment is a large capital input as the land is very expensive in Hong Kong and typically represents more than 50% of completed property value. In the public auction, the firm that competes with others should be able to acccess finance quickly, or it will lose the development opportunity. The winner firm should have a strong financial state, whether it has sufficient internal funds (including the cash or properties that can be liquidated) or access to external capital market (mainly bank term and development loans in Hong Kong). Thus financial flexibility is important in the success at land auctions. We will examine the relationship between land auction price and financing ability of winner firm.

The effects of interactions and financial flexibility are firm specific and associated with firm fundamentals. The reserve price is formed purely on the land information. Yet the bidding price of the firm contains information both of land and firm states. As the firms are heterogeneous, the same parcel of land may be more valuable for some firms than others. It is argued that the firm with proprietary advantages is willing to pay more for the land as it can exercise the options better.

Land auctions involve the behavior of bidders. One important impact is the "winner curse" that the firm would overvalue the land to win the bid based on common information. Tse, Pretorius and Chau (Tse et al., 2011)test the winner curse in the land auction of Hong Kong. They find that the uncertainty of bid valuations reduce auction price and while the competition in the auction increase the price, which are consistent with the winner curse argument and other predictions in auction theory. However, we do not consider the winner curse of the auction in this paper, but the valuation and investment of land as real option. We link the auction outcome with the firm fundamental, following the intuition that the firm with advantage in development strategy and financial ability would have higher reserve value for the land. Ooi and Sirmans (Ooi and Sirmans, 2004)find that the excess return of the land auction can be attributed to the historical ability of the firm to create positive value in real estate development. Ooi, Sirmans and Turnbull (Ooi et al., 2006) argue that "differences in market information, access to capital, legal status as well as non-pecuniary preferences all affect the profitability of the parcel of land to that particular type of buyer, hence the bid rent and selling price" (P70).They test whether the developers with more "experience" adjust upwardly land auction price because they can gain more profits from the real estate project. But the empirical results do not support this experience effect.

The aims of this paper differ from these previous studies in land auctions. First, it is to test the implications of real option theory following the argument that land price contains option value. Second, it aims to test the implications of real options portfolio from the firm perspective. Third, as financial policy and state affect the investment and real option exercise, this paper investigates how the financial status of the firm impacts its valuation of the investment. Land auctions provide a good observation mechanism of how the firm estimates the value of market opportunity through the combination of public project information and proprietary firm information.

3. Hypotheses and Model Specification

As discussed before, this paper argues that land auction price contains three components of flexibility value. The flexibility value is defined as option premium measured by the ratio between auction price and reserve price. We develop hypotheses in three groups according to the sources of option value.

3.1 The implications from real option theory

Real option theory predicts that the price uncertainty of underlying asset increases the option value as the option holder has the ability to not exercise it if the market turns bad and still capture the upside benefits when the market is good. For the American-style option with dividends, the high dividend as opportunity cost reduces the waiting value. Because of the limitation of construction periods by the Government, the delaying value may not be significant in real estate development. However, the rental income is important even in the American perpetual call option, especially in real estate. The rent makes a large portion in the property price that makes the delay expensive. And the real estate project always takes time to complete meaning that some rental income has to be forgone.

Accordance with classic real option theory, we propose five hypotheses to test for its implications in land development.

Hypothesis One: the option premium in the auctioned land is expected to increase if the volatility of underlying property is large.

Hypothesis Two: the option premium is negatively related with rental yield of the underlying property.

Hypothesis Three: the option premium is positively related with interest rates.

Hypothesis Four: the option premium is positively related with property price.

Hypothesis Five: the option premium is negatively related with construction cost.

3.2 The implications of real options portfolio

The real options portfolio gives flexibility to the firm beyond the simple combination of individual projects. The firm with large assets in place and growth options is more flexible to decide which projects, how many projects and when the projects to be developed. As the previous review shows, the direct and indirect interactions occur in real estate development. We refer to positive interaction and competition effect respectively. They generate opposing effects on the land auction price. Here we propose hypotheses involving the portfolio effects and interactions.

Hypothesis Six: the option premium is expected to be positive with the amount of potentially interacting properties in the firm.

Hypothesis Seven: the option premium is reduced if the firm has made larger capital expenditure in other projects.

Hypothesis Eight: the option premium reduces if the firm has invested in assets with higher returns.

3.3 The implications of financial structure

Land acquisition and real estate development involve large capital expenditure. We consider internal and external funds for the firm. The internal funds include cash and properties that may be liquidated. Liquidated property refers to completed property held by the real estate firms that can be sold in the market without large loss. External funds in Hong Kong are mainly debt. The debt capacity is important for the firm to quickly capture growth opportunity like the auctioned land. The access to capital for real estate firms depends on existing capital structure and collateralized properties.

Hypothesis Nine: the option premium is positively related to the internal funds in the firm.

Hypothesis Ten: the flexibility value is positively related to asset sales in the firm.

Hypothesis Eleven: the flexibility value is positively related to preserved debt capacity in the firm.

4. Data and Variables

This paper aims to test flexibility value contained in the auction price, in three sources. To achieve this objective, it requires the data sets from land auctions, annual reports of winning companies and their related financial information. This paper mainly uses four categories of data set. The first data set is land auction information provided by EPRC Ltd[2], which gives detailed descriptions of land address, lot number, geographical district, auction date, land area, gross floor area, winning bid, the bottom price, winner company and other participants. We confine our data sample to auctioned land in residential use[3] from 1992-2011. Finally the whole data sample has totally 188 cases of land auctions in Hong Kong. The dependent variable is constructed as the ratio of winning price over reserve price. The lot number, property type and auction data are used to match the option testing data, like underlying property price, volatility, construction cost and others, in each land auction. The information of winner company and other participants, combined with auction data, is used to find data in DataStream and annual reports.

The second data set is to set up variables for the first source of option value. In classical real option theory, real option value depends on five basic variables, the value of underlying asset, the exercise cost, the volatility of underlying asset price, the expiration time of the real option, and risk-free interest rate. One more additional factor is the foregone cash flow if the option exercise is deferred. Correspondingly in real estate development, the basic variables are underlying property price, the volatility of this price, the construction cost, the contractual time for construction, riskless interest rate and rental yield. It is hard to determine the property price and construction cost of potential property. So we use indices provided by the Rating of Valuation Department in Hong Kong to proxy for property price[4]. This Department publishes average prices of private domestic each monthly and quarterly based on property class and district from 1982 to now[5]. With the land auction information, we obtain the unit property price of the potential building in the auctioned land. The property return and volatility are estimated from the property price indices. As we know the exact auction dates, we calculate the property

[2] It is a real estate information company providing service of property and land transactions data in Hong Kong. The information about land auction is gathered from the local newspapers.
[3] Land in residential use occupies a large portion of land in all auctions. We does not use the cases of industrial and hotel land because it is difficult to find other data, like property price, volatility and rental yield to match this data.
[4] This data can be found in the website of the Rating and Valuation Department: http://www.rvd.gov.hk/en/publications/pro-review.htm.
[5] The Department gives average prices and rents of residential house in five classes and three broad districts in the Hong Kong. The five classes include the floor areas of houses lower than 40 square meters, from 40 to 69.9 square meters, from 70 to 99.9 square meters, from 100 to 159.9 square meters and above 160 square meters. We select the median class, 70-99.9 square meters, as proxy property price for the underlying property for auctioned land. The three broad districts are Hong Kong Island, Kowloon and New Territories. For each land, we choose the property price in the median class of the land district.

return for the potential land project as log value of property price in previous period (monthly or quarterly) over the price one year ago (twelve months or four quarters). The volatility of property price is the standard deviation of property return[6] in past twelve months or four quarters. The Department also provides data about the private market yield for different property classes. We construct rental yield by averaging the private market yield in past four quarters in the median class.

The variable construction cost is constructed through Building Works Tender Price Index (BWTPI)[7] released by the Architectural Services Department[8]. This index can be used to estimate building cost. For each land auction, the construction cost is measured as the average BWTPI in past two years before the auction date (eight quarters) as the construction period may last for two years. The construction cost at the end of 1991 is taken as base value of 1. The construction costs afterwards are standardized by the construction cost at the end of 1991. We also construct cost yield as the log value of BWTPI this period over the value in previous year.

In addition to the variables of underlying asset price, volatility, foregone dividend and exercise price, we also construct variables for risk-free interest rate. We obtain monthly HIBOR and Hong Kong Inflation Rate from DataStream. The nominal discount rate and inflation rate for the auctioned land is the average of monthly HIBOR and inflation rate respectively in last twelve months. To control the effect of capital market, we also consider the variable for market return. The Hang Seng Indices, the principal Hong Kong Stock Exchange market indices, are used to calculate the stock market return in the auction dates. Table 1 summarizes the variables for option theory test.

The third data set is DataStream. We have the information of the winning companies and participants for each land auction, but we only include the auction cases that have solo and listed winning company. 79 cases in the all auctioned residential land satisfy these conditions. Through the auction date, we set the fiscal year for each auction and find the corporate information in the fiscal year and previous fiscal year from DataStream. The variables include some ratios like market to book value (MTB) and return on asset (ROA). Long term debt, Net Tangible Asset, Disposed Fixed Asset, Capital Expenditure are normalized by book assets in the same fiscal year to construct the variables LTD, NTA, DFA and CAPEX. The variable CF

---

[6] This return is calculated through the log value of current property price over past, monthly or quarterly.

[7] The introduction of this index in the website is: "Building Works Tender Price Index (BWTPI) is a quarterly index compiled by the Architectural Services Department as an aid to adjust building cost data for estimating purposes. It also provides an indication of the level of tender prices for new building works undertaken by the Architectural Services Department. The BWTPI does not reflect the level of tender prices for building services works. It is computed in a similar way to that used by the Royal Institution of Chartered Surveyors' Building Cost Information Service in the United Kingdom. The value in the first quarter of 1970 is taken to be the base index value of 100, and subsequent values are expressed in index form based on the first quarter 1970 value."

[8] The data can be downloaded in the website: http://www.archsd.gov.hk/archsd_home01.asp?Path_Lev1=5&Status=bwtpi.

representing cash flow is calculated by the sum of income after tax and Depreciation, Depletion and Amortization normalized by book asset.

Table 1: Project-level characteristics of auctioned land

	Land Price	Property Price	Option Premium	Rental Yield	Property Return	Construction Cost	Cost Yield	Market Return	Interest Rate	Inflation	Volatility
Mean	48834.63	52387.50	1.57	0.05	0.13	1.40	0.07	0.12	0.05	0.04	0.12
Median	31543.93	42658.00	1.49	0.05	0.14	1.36	0.10	0.16	0.05	0.03	0.11
Maximum	454194.70	133064.00	4.00	0.07	0.67	2.09	0.45	0.57	0.09	0.11	0.31
Minimum	5281.61	24726.00	1.00	0.03	-0.50	0.92	-0.33	-0.52	0.01	-0.05	0.03
Std. Dev.	56671.30	22604.27	0.42	0.01	0.25	0.37	0.19	0.24	0.02	0.05	0.06
No.	187	187	187	187	187	187	187	187	187	187	187

Land price is the winning price in auction divided by the constructible area f the land. Property price is the average unit property value in the district of auctioned land published by the Government. Option premium is the ratio of winning price over bottom price. Rental yield is property market yield. Property return is the log value of property price over previous year. Construction cost and cost yield are built from BWTPI. Market return is constructed by Hang Seng Index. Interest rate is one year HIBOR. Inflation is the CPI rate in Hong Kong. Volatility is the stand deviation of property return.

The fourth data set is constructed from annual reports in each listed company involved in land auctions from 1992-2011. In the annual report, most developers report progress state, location and total gross floor areas for the company about their investment properties, completed properties for sale and ongoing projects. According to location lot information, we collect the data of total gross floor areas of ongoing projects and holding properties[9] in the same geographical area[10] of the auctioned land. Some companies only list principal properties in the annual report. These companies are excluded from the sample as the details of properties and projects cannot be obtained. The variables, Investment Property and Ongoing Projects, are constructed by log value of 1 plus total gross areas in the same district and same fiscal year. The variables in at firm level are described in Table 2.

Table 2 Firm level variables

Variable	Mean	Median	Standard Deviation	Observation
Lagged NTA	0.7634	0.7532	0.2067	72
Investment Property	8.3049	11.7508	6.0567	51
Ongoing Project	7.5769	11.6023	6.4913	51
Lagged ASSET	16.2884	17.4024	4.8860	72
Lagged CAPEX	0.0282	0.0142	0.0356	72
CAPEX	0.0242	0.0125	0.0346	72
CF	0.1654	0.0535	0.8799	69
Lagged CF	0.3763	0.0481	2.7122	72
Lagged DFA	0.0666	0.0531	0.0597	72
LTD	0.1577	0.1447	0.0815	69
Lagged LTD	0.1559	0.1271	0.0943	72
LTDC	0.0275	0.0228	0.0670	69
MTB	0.8986	0.8300	0.4739	72
Lagged MTB	0.9052	0.9700	0.4893	71
ROA	7.8093	6.0800	8.2493	69
Lagged ROA	6.9003	5.7200	4.6542	70

NTA represent net tangible asset scaled by the total book asset; Investment Property is the log value of 1 plus total gross floor areas of the investment property near to the auctioned land; Ongoing Project is the log value of 1 plus total gross floor area of nearby projects; Asset is the log value of total book asset value in the firm; CAPEX is the capital expenditure scaled by the total asset; CF is the cash flow which is the sum of income after tax plus depreciation, scaled by total asset; DFA is the disposed fixed asset scaled by total asset; LTD is long term debt ratio; LTDC is change of long term debt, calculated by the difference of long term debt current period and last period, scaled by total asset; MTB is market to book ratio; ROA is return on asset.

[9] Holding properties include the properties for sale and for investment, in residential or commercial use.
[10] Basically we have 18 districts in Hong Kong accordance with the administrative regions. These districts are Central and Western, Wan Chai, Eastern, southern, Yau Tsim Mong, Sham Shui Po, Kowloon City, Wong Tai Sin, Kwun Tong, Kwai Tsing, Tsuen Wan, Tuen Mun, Yuen Long, North, Tai Po, Sha Tin, Sai Kung, and Islands District.

5. Empirical Results

This section shows empirical results for the regressions to test the hypotheses constructed in the previous section. We argue that the land price contains three components of flexibility value. The value of real option embedded in the auctioned land is exogenous to the final land holder. Section 5.1 tests relationships between the option premium and project-related variables, predicted by the real option theory. Following sections explore the relationships between option premium and firm-specific variables as we argue that firm fundamentals would influence the value of real option.

5.1 Empirical Results for Testing Real Option Theory

The dependent variable, Option Premium is regressed against the variables in real option theory. We use OLS method and control the year effect as the land auctions occur between 1992 and 2011. The results are shown in Table 3.

Table 3
OLS regressions of the option premium on project-related characteristics and market condition

	Sign	(A)	(B)	©
Property Return	+	0.463045***	0.4382***	0.470458***
		(0.1511)	(0.1511)	(0.1606)
Rental Yield	-	-8.5907*	-9.0148*	-7.8308*
		(4.6811)	(4.7058)	(4.6106)
Construction Cost	-	-0.0187	-0.0117	-0.0547
		(0.1206)	(0.1190)	(0.1325)
Cost Yield	+	0.2429	0.2278	0.329354*
		(0.1621)	(0.1647)	(0.1971)
Volatility	+	0.0890	0.2170	0.2189
		(0.5333)	(0.5121)	(0.5171)
Interest Rate	+	2.1305	2.0627	1.7653
		(1.7546)	(1.7666)	(1.7004)
Inflation Rate				-0.7778
				(0.9370)
Market Return	+		0.266988**	0.259174**
			(0.1273)	(0.1268)
Intercept		1.799151***	1.76819***	1.807194***
		(0.3595)	(0.3539)	(0.3607)
N		187	187	187
Adjusted R Square		0.1004	0.1194	0.1165

The dependent variable is option premium, which is the ratio of winning price and bottom price. The signs show the positive or negative relationship predicted by the hypotheses. The variable Year is included to control some unobservable effects[11]. White standard errors are presented in parentheses. Significances at the 1%, 5% and 10% level are indicated by ***, ** and *, respectively.

Table 3 gives the regression results for testing the hypotheses in real option theory. The coefficients have expected signs as predicted by the real option theory. Column A of the table gives the simple specification, modeling the option premium as the function of property return, rental yield, construction cost, cost yield, volatility and interest rate. The results confirm the hypotheses that option premium increases with property price at 1% level of significance. The rental yield yet reduces the option premium because it is the opportunity cost for the auctioned land to delay. The coefficient is negative and significant at 10%. The other coefficients have consistent signs as predicted but not significant. The reason may be that these variables are constructed from the gross indices in the whole region and thus they are not sensitive to the option value of single project.

Column B adds the variable market return to the specification. The coefficient of property return is still the expected sign and significant at 1% level. The results also show that the market conditions also influence the land price in the auction. When the capital market is good, the land has greater value. The underlying reasons may be complicated, but it reinforces our intuition that the factors other than project related variables have impact on the land price and option premium. Column C adds the variable inflation rate in the regression. The coefficient is negative but not significant, but now the cost yield for the construction is positive and significant.

In summary, the regressions partially confirm the real option predictions of option value and some option related variable, especially property return and rental yield. With more accurate data, we could better assess (confirm) the predictions of real option theory. The land price in the auction contains the value of flexibility embedded in the land, which could be the flexibility to wait for development.

5.2 Empirical Testing of Portfolio Effects

Few studies have linked the real option to firm fundamentals. The firm that holds real option may make investment decisions and value options through the perspective of the firm rather than the individual project. As the firm usually simultaneously own multiple projects, the portfolio effect of multiple assets may be important in investment decision and valuation. We test two opposing portfolio effects: the positive interaction among projects and the completion of multiple projects.

The firm can enjoy positive interaction benefit if it has held investment properties or land near to the auctioned land. We use several variables to measure the potential of positive interaction. The first variable is net tangible assets in the firm. As the firm owns more net tangible asset, land or property, it would place higher bids on the auctioned land because it has more potential

[11] We also run the regressions of these model specifications by adjusting for clustering within year. The coefficients and significances do not change a lot.

to obtain positive interactions. This intuition is reasonable because Hong Kong is developed very densely in its three main urban districts and it only has limited number of real estate development firms that dominate property investment and development activities.

Another category of measure for positive interaction is related to the gross floor area of investment property and ongoing projects that fall in the exact small district of the auctioned land. The variable Investment Property and Ongoing Projects are constructed through the log value of the gross floor area of investment property and projects in the firm.

The competition effect in the portfolio results from the limited resource capacity of the firm for all projects. The effect should be negative because the once resources is put into one project, these resources could not be utilized for another one. In addition, because of path-dependence of large scale projects, the past investment would require more current investment to complete the existing projects, which means that the existing investment acts to reduce future or potential further investment. Similarly, the firm may also choose to continue to invest in high profitability existing assets rather than move to new projects.

We use several variables to detect the competition effect. The first one is a crude variable of total firm existing assets in the previous year, lagged return on assets. This variable has been included in the Moel and Tufano (2002) study to represent the overall profits for the firm to be used for current investment decisions. But this paper uses this variable to measure the profitability of existing assets in the firm. With higher profitability, the firm may not choose to invest in new projects. The second variable is capital expenditure in the previous year. If the firm has invested fixed capital for its existing projects, it may not be able to afford to invest in new projects.

Table 4
OLS regressions of option premium on variables of positive interaction

	Sign	[A]	[B]	[C]	[D]
Lagged MTB		-0.0190	0.0357	0.0086	-0.0117
		(0.1016)	(0.1247)	(0.1205)	(0.1343)
Lagged NTA	+	0.585687*		0.7981	1.008656*
		(0.3365)		(0.5045)	(0.5431)
Investment Property	+		0.025185***	0.023282***	
			(0.0068)	(0.0069)	
Ongoing Project	+				-0.0064
					0.0076
Lagged LTD		1.0794	1.293129**	2.024715**	1.822833*
		(0.7201)	(0.5883)	(0.9017)	(1.0159)
Lagged Asset		-0.0193**	-0.0067	-0.0117	-0.0185*
		(0.0086)	(0.0066)	(0.0086)	(0.0097)
Intercept		1.254946***	1.172815***	0.5871	0.8397
		0.3208	0.1966	0.4686	0.5142
N		71	50	50	50
Adjusted R-squared		0.0405	0.1500	0.1906	0.0556

The dependent variable is option premium. The signs show the positive or negative relationship predicted by the hypotheses. NTA and LTD represent the ratio of net tangible asset over total asset and long term debt ratio respective. Investment Property and Ongoing Project are log value of gross floor area of investment properties and under developed projects of the firm in the district of auctioned land. White standard errors are presented in parentheses. Significances at the 1%, 5% and 10% level are indicated by ***, ** and *, respectively.

Table 4 reports the regression results of option premium on the variables of positive interaction. The specification in Column A includes variables of firm characteristics and uses net tangible assets in the firm to represent the potential interacted properties. The results show that net tangible asset in previous year enhances the option premium, as the coefficient for Lagged NTA is positive and significant at 10% level. The specification in Column B includes the nearby properties as the potentially interacted assets and reaches similar results as Column A at 1% level of the significance. The R-squared increases substantially because the investment properties are more accurate variable than net tangible asset as they are the properties locate in the same region as the underlying asset of auctioned land. The results indicate that if the firm holds potentially interacting assets, it is willing to pay higher prices for the land at auction. Our explanation is that the firm can obtain positive interaction benefits from its existing assets and the potential property at the auction.

Column C includes both net tangible asset and investment properties in the specification. The results show that the investment property has a very significant and positive coefficient. The variable net tangible asset has a positive coefficient but it is not significant. it seems that the investment property is a better proxy for the potentially interacted asset. Column D models the specifications of option premium on ongoing projects that the firm has around/close to the auctioned land. The interaction of co-development cost saving only occurs among the properties or projects located in the neighborhood. Yet, in Column D, the coefficient for ongoing projects is negative and not significant at any level. The possible reason is that the variable of ongoing project cannot precisely represent the projects that may be co-developed with auctioned land. It only represents the under-developed projects in the same region. The competition effect among existing projects and new project dominates the co-development effect of multiple projects because co-development rarely occurs in two nearby parcels of land even in Hong Kong[12].

Table 5
OLS regressions of option premium on variables of competition effect

	Sign	[A]	[B]	[C]
Lagged MTB		0.2071	0.1854	0.0150
		(0.1259)	(0.1196)	(0.1056)
Lagged ROA	-	-0.0347***		
		(0.0104)		
Lagged ROA*Lagged NTA	-		-0.0439***	
			(0.0124)	
CAPEX	-			-2.8482***
				(1.0638)
Lagged NTA	+	0.940301***	1.217281***	0.770895**
		(0.3486)	(0.3611)	(0.3711)
Lagged LTD		1.942175***	2.043421***	1.485062*
		(0.6701)	(0.6601)	(0.7811)
Lagged Asset		-0.0284***	-0.0284***	-0.0209***
		(0.0084)	(0.0082)	(0.0085)
Intercept		1.0575***	0.849994***	1.118706***
		(0.2888)	(0.2932)	(0.3554)
N		69	69	71
Adjusted R-squared		0.1632	0.1655	0.1014

The dependent variable is option premium. The signs show the positive or negative relationship predicted by the hypotheses. NTA, LTD and CAPEX represent the ratio of net tangible asset over total asset, long

[12] We observe from the annual report that some companies would clearly claim to co-develop two nearby projects as a strategy to save cost. But this kind of case is not so common. And the data for ongoing project includes all under-developed projects in the district of auctioned land. It is obvious that most of these projects would not be able to be co-developed with auctioned land because of geographical conditions.

term debt ratio and capital expenditure over total asset respective. Because the competition effect occurs when the firm faces financial constraints, the regressions include the long term debt ratio of this year and last year to control the effect of financial structure in the firm. White standard errors are presented in parentheses. Significances at the 1%, 5% and 10% level are indicated by ***, ** and *, respectively.

Table 5 reports the competition effect on the option premium. As argued before, other existing projects or investment would affect the investment decision and valuation of new project. Column A in Table 5 presents the simple specification, only including lagged ROA. The coefficient for the lagged ROA is negative and significant at 1% level. This indicates that the profitability on existing property would reduce the firm's valuation of new projects as the firm may continue to put the resource in existing properties. The competition for constrained resources within firm would make the new project not so attractive because the firm may not be able to shift resources from existing projects and properties to new projects. The firm is not willing to pay a too high price for a parcel of auctioned land if it has already held some other profitable properties.

Column B adds the interaction term of lagged ROA and lagged net tangible asset. In Table 4, the lagged net tangible asset is shown to be positive with option premium as the firm may obtain the positive interaction from existing properties and new project. Yet the competition effect leads to a negative impact of existing assets on new project. The interaction term would capture this effect. The coefficient for this interaction term is negative and significant at 1% level. It again confirms the competition effect between the existing assets and new projects.

The model specification in Column C uses capital expenditure to measure the investment status of the firm. If the firm has made a large amount of capital expenditure in the year, it may not have much interest in winning the bid because it cannot afford to develop the new project. The coefficient for capital expenditure is negative as predicted and significant at 1% level. The competition for firm resources leads to a lower value estimate in the auctioned land.

In summary, we find evidence for positive interactions and the competition effect in the firm, which may influence the firm's estimate of future development options. The firm would place higher value on the auctioned land if it can obtain positive interaction between its existing properties and a potential new project. In contrast, the competition for resources among existing projects and a new project leads to lower value for the new project. The empirical results show that the competition within the firm would decrease the valuation of a new project and a lower option premium for the land at auction.

5.3 Empirical Testing of Financial Structure

In the ideal state, the financial structure of the firm would not influence the firm value and its investment decision. Yet in imperfect capital markets, the firm finances its investment with different costs as with a financial hierarchy (Fazzari, Hubbard, and Petersen, 1988). The internal funds have cost advantage over external funds. The following studies propose to show the sensitivity of investment-resources (investable cash flow) as evidence of financial constraints.

The empirical tests are concerned with firm level investment data. However, this paper goes further to investigate the project level investment and firm fundamental data. It links the literature of investment to real option theory, by expanding the assumption in real option theory that the real option is financed and exercised in all equity circumstances.

Real option theory should consider the effect of financial structure because, unlike the holder of a financial option, the firm who owns real option cannot always borrow the funds to exercise option at risk free interest rate. The financial cost to execute a real option adds additional cost to the exercise price of real option. As the internal funds have lower capital cost, the firm with more cash flow would save capital cost in executing a real option and thus have a higher estimated value of its real option. The internal funds is not the only source of financial flexibility. The firm may also sell its assets, use debt capacity, cut dividends or issue equity to finance its investment. The real estate firms in Hong Kong rarely issue the dividend or equity[13]. This paper focuses on the effect of internal funds, asset sales and debt capacity on real option value. Simply, the firm with more financial flexibility and access to capital markets with lower capital cost would have higher estimated value of the real option, which leads to larger option premium.

The internal fund is measured in cash flow following the investment literature. The asset sale is proxied by the disposed fixed asset in the firm as some real estate firms would sell its investment properties to obtain sufficient capital resources. The debt capacity is hard to measure although some studies have shown that debt capacity plays a key role in investing in new opportunities. It can be analogous to a real option as the firm can keep the debt capacity unused when it does not have good growth opportunities but use the capacity when it holds some potentially profitable projects. The firm with larger debt capacity would facilitate the exercise of real option.

[13] The firm data in another paper of ours support this argument.

Table 6
OLS regressions of option premium on variables of financial structure

	Sign	[A]	[B]	[C]	[D]
Lagged Cash Flow	+	0.034061***		0.032729***	
		(0.0050)		(0.0079)	
Cash Flow	+		0.105965***		0.107662***
			(0.0154)		(0.0150)
Asset Sale	+			1.0430	
				(4.1777)	
Lagged MTB		-0.0157	-0.0197	-0.0116	0.0053
		(0.0970)	(0.0965)	(0.1018)	(0.0966)
Leverage					0.1685
					(0.3048)
LTD		-1.4957**	-1.4872**	-1.5024**	
		(0.6914)	(0.6927)	(0.7144)	
LTDC	-				-1.3075**
					(0.6444)
Lagged LTD		1.311896*	1.310176*	1.311516*	
		(0.6787)	(0.6788)	(0.7096)	
Lagged Asset		-0.0100	-0.0105	-0.0102	-0.0099
		(0.0077)	(0.0079)	(0.0080)	(0.0075)
Intercept		1.705706***	1.71283***	1.702196***	1.646993***
		(0.1610)	(0.1613)	(0.1641)	(0.1613)
N		69	68	66	68
Adjusted R-squared		0.139199	0.1378	0.1213	0.1338

The dependent variable is option premium. The signs show the positive or negative relationship predicted by the hypotheses. Cash Flow is the sum of income after tax and depreciation. Asset Sale is the disposed fixed asset in the firm. Tobin's Q is measured by the market to book value. Leverage is the debt ratio. LTD and LTDC represent the ratio of long term debt and the change of long term debt. White standard errors are presented in parentheses. Significances at the 1%, 5% and 10% level are indicated by ***, ** and *, respectively.

Table 6 reposts the regression results of option premium over the variables of financial structure. The Column A and B models the specification of the option premium over internal funds. In Column A, the coefficient for lagged cash flow is positive and significant at 1% level. It confirms the hypothesis that the option premium increases with the internal funds as the funds has lowest capital cost. Column B reports similar results by replacing previous cash flow with current cash flow. The explanation for the result can be attributed to investment literature and real option theory. The price for obtaining land in the auction is a corporate investment which is directly influenced by the cash flow at the beginning of the period. The result in Column A and B is consistent with the finding of investment-cash flow literature. The land price also can be seen as the option value of the auctioned land. This option value is determined by the exercise price (construction cost) in the future. It is the financial structure in the future when the land is developed that affects the land option value. We use the cash flow at the end of this year as the predictor for future cash flow. It means that cash flow in the firm with a capital cost advantage increases the option premium of auctioned land.

With the same logic, we include asset sales, measured as disposed fixed assets in the firm, in the model specification. The results in Column C indicate that the coefficient of asset sales is positive but not significant. The possible reasons may be that the funds from asset sales is not the main capital resource for the land investment and development; or the current amount of asset sales is not a good predictor for future sales because the asset sale is not a consistent action or behavior of the firm.

The ratios of long term debt this year and last year are included in the model in Column A, B and C. It is interesting to observe that the current long term debt has a negative effect on the option premium while the past long term debt increases the option premium[14]. The explanations may be complicated. Previous long term debt may provide additional funds for the firm to win the land auction. The use of current long term debt means that in the future the firm may not be able to obtain debt financing for the construction cost of the auctioned land. The exhaustion of debt capacity influences the future financing cost and then reduces the current option value. This implication will be tested in Column D.

The specification in Column D incorporates the change of long term debt in this period and current leverage. The increase in LTDC means that this period has borrowed much more long term debt than last period. The debt capacity has been used and in near future the firm may find it difficult to finance with debt, which leads to larger capital cost for executing the land development. By controlling the current cash flow, the Column D shows that the coefficient for LTDC is negative and significant at 10% level. It means that the debt capacity is important for the option exercise and affects the option value. The firm with less debt capacity would have lower option premium.

In summary, the financial structure is another factor that would impact the real option value, but this factor is largely ignored in the real option theory. The internal funds in the firm would increase option premium because the firm can freely use it to obtain the option and exercise the option optimally. Debt capacity also plays important role in real option valuation. The firm with more flexibility, with large cash flow or easy access to capital markets, would enjoy fully the option value of the project.

5.4 Robustness Tests

[14] The positive coefficients of lagged long term debt are also shown in Table 4 and 5.

The previous tests confirm that the land auction price contains flexibility value from three sources. The option value embedded in the land is common to all the participating firms. But the flexibility value of portfolio effect and financial structure is different across the firms because of various firm fundamentals. If this flexibility varies in the firms, then the firm with more specific flexibility value is more likely to win the land auction as it has a higher estimate of the value of the land. We use a dummy variable of winning to do the robustness tests of our hypotheses.

The participants in all the land auctions can be found in the dataset from EPRC Ltd. The variables of firm fundamentals are obtained in the same way for all the participants, which have been described previously. The probit discrete-choice model is employed to test whether the firm fundamentals identified in the hypotheses influence the investment decision in land auctions and its final result. The model specifications are similar in previous tests except that the dependent variable is the auction result of the participants.

Table 7
Probit analysis of winning probability on variables of portfolio effect

	Sign	[A]	[B]	[C]	[D]
Lagged NTA	+	1.082367*		1.546688**	
		(0.6181)		(0.7610)	
Investment Property	+		0.042468**		
			(0.0185)		
Lagged ROA*Lagged NTA	-			-0.0396	
				(0.0257)	
Lagged ROA	-				
Lagged CAPEX					0.0018
					(0.0035)
Lagged LTD		-0.3516	-1.1509	-0.6051	-1.5368
		(1.2290)	(1.8693)	(1.2911)	(1.0867)
Lagged MTB		-0.1983	-0.4182	-0.0301	-0.1402
		(0.1924)	(0.2503)	(0.2320)	(0.1844)
Lagged Asset		-0.0196	-0.0061	-0.0192	-0.0194
		(0.0248)	(0.0306)	(0.0247)	(0.0272)
Intercept		-0.6157	0.0748	-0.8653	0.2846
		(0.6775)	(0.6041)	(0.7673)	(0.4677)
N		207	132	203	207
N Dep=0		136	83	134	136
N Dep=1		71	49	69	71
McFadden R-squared		0.0257	0.0589	0.0369	0.0154

The dependent variable is dummy variable of win in the land auction. The signs show the positive or negative relationship predicted by the hypotheses. All the independent variables are the same as previous regressions except that the data sample includes all participant companies. Huber-White standard errors are presented in parentheses. Significances at the 1%, 5% and 10% level are indicated by ***, ** and *, respectively.

Table 7 report the probit analysis results of the winners in land auctions on the firm fundamentals and on portfolio effects. Following the hypotheses, the firm with more positive interaction can enjoy higher land option value and thus has larger probability to win the land auction. Yet the competition effect in the firm would reduce the land value and make the firm less likely to acquire the land. The results support the predictions of positive interactions. The coefficients on net tangible assets and investment properties are positive and significant at 5% and 1% level respectively. It means that if the firm holds a large amount of tangible asset or investment properties near to the location of auctioned land, it would place higher bids for the land and will be more likely to win the auction. The land price and auction result are influenced by the property portfolio in the participant firms.

Column C of Table 7 reports the result whether the profitability of other projects and properties in the firm affects the likelihood of winning the land auction. The coefficient of the interaction term, Lagged ROA*Lagged NTA, is negative, which fits with the prediction; yet it is not significant, in which the p value is 12.34%. The variable Lagged CAPEX in the Column D has an opposing sign with the hypothesis and it is very insignificant. As discussed before, the lagged capital expenditure may not be a good measure for the competition effect.

The probit analysis results for the financial structure are also not good and significant as the hypotheses predict, although the sign for the Cash Flow is consistently positive and significant at 1% level. We do not report these results in the paper. The possible reason is that we delete the participant firms that are not listed in the stock exchange or cooperate with others in the land auction. The remaining companies in the sample are all big and sophisticated companies in Hong Kong. They may all have powerful financial resources and capacity to win the land auction. The differences of financial structure within these firms are not determinant factors in land auction.

In all, the robustness tests show that the positive interaction would determine the auction results. The firm with more net tangible asset and investment properties around the auctioned land would be more likely to win the land auction. The competition effect and financial structure are not significant in determining auction results, although cash flow would determine the auction results.

6. Conclusion

In this paper, we extend the classic real option theory from project level to firm level, by incorporating portfolio effects and financial structure. We identify three sources of flexibility value in the land development: the flexibility to wait for investment embedded in the land, the portfolio effect among the land and existing assets in the firm, and the financial flexibility (inflexibility) of the firm to employ the real flexibility in land development opportunities. The option premium of auctioned land, defined as winning price over reserve price, is used to regress against classic option related variables, variables for portfolio effect and financial structure.

The empirical results largely support the predictions of classic real option theory. The property volatility and interest rate have positive relationships with option premium in the land price. As the flexibility value embedded in the land increases, the firm would offer higher bids in the auction in comparison with reserve price. Apart from the classic implications from real option theory, this paper also confirms that the portfolio effect and financial structure in the firm influences the land option premium. Positive interaction between the potential project in the auction and existing properties generates positive synergy for the firm, which in turn increases the option premium in the firm. The robustness tests also show that the positive interaction is a determining factor in the firm to win the auction. The competition effect, due to the resource constraints in the firm, leads to lower option premium. The valuation of one project is influenced by the relevant projects within the firm through direct interaction or indirect interaction. The financial flexibility in the firm, which can be characterized as sufficient internal funds and large preserved debt capacity, also is shown to impact the option premium.

Very few papers have connected the real option theory to firm fundamentals. The extension of real option into the firm level would integrate the traditional real theory with investment literature and portfolio theory and capital structure theory for the firm. Both theoretical models and empirical studies are required to fill this gap.

Reference:

BOYLE, G. & GUTHRIE, G. 2003. Investment, uncertainty, and liquidity. *The Journal of finance,* 58**,** 2143-2166.

BROSCH, R. 2001. Portfolio-aspects in real options management. *Working Paper Series: Finance and Accounting*.

CAPOZZA, D. & LI, Y. 1994. The intensity and timing of investment: The case of land. *The American Economic Review,* 84**,** 889-904.

CHIANG, Y. H., SO, C. K. J. & YEUNG, C. W. S. 2006. Real option premium in Hong Kong land prices. *Journal of Property Investment & Finance,* 24**,** 239-258.

DIAS, M. 2006. Real Option Theory for Real Assets Portfolios: the Oil Exploration Case. *10th Annual International Conference on Real Options.* New York: Department of Industrial Engineering, PUC-Rio.

FAZZARI, S. M., HUBBARD, R. G., PETERSEN, B. C., BLINDER, A. S. & POTERBA, J. M. 1988. Financing Constraints and Corporate Investment. *Brookings Papers on Economic Activity,* 1988**,** 141-206.

GAMBA, A. & TRIANTIS, A. 2008. The Value of Financial Flexibility. *Journal of Finance,* 63**,** 2263-2296.

GELTNER, D., MILLER, N. & CLAYTON, J. 2007. *Commercial real estate analysis and investments,* Mason, Ohio, Thompson South-Western.

GIROTRA, K., TERWIESCH, C. & ULRICH, K. 2007. Valuing R&D projects in a portfolio: Evidence from the pharmaceutical industry. *Management Science,* 53**,** 1452-1466.

GRENADIER, S. 1995. Flexibility and tenant mix in real estate projects. *Journal of Urban Economics,* 38**,** 357-378.

GROVENSTEIN, R. A., KAU, J. B. & MUNNEKE, H. J. Development Value: A Real Options Approach Using Empirical Data. *The Journal of Real Estate Finance and Economics***,** 1-15.

GUNTHER MCGRATH, R. & NERKAR, A. 2004. Real options reasoning and a new look at the R&D investment strategies of pharmaceutical firms. *Strategic Management Journal,* 25**,** 1-21.

HIRTH, S. & UHRIG-HOMBURG, M. 2010. Investment timing, liquidity, and agency costs of debt. *Journal of Corporate Finance,* 16**,** 243-258.

MOEL, A. & TUFANO, P. 2002. When Are Real Options Exercised? An Empirical Study of Mine Closings. *Review of Financial Studies***,** 35-64.

OOI, J. T. L. & SIRMANS, C. 2004. The wealth effects of land acquisition. *The Journal of Real Estate Finance and Economics,* 29**,** 277-294.

OOI, J. T. L., SIRMANS, C. & TURNBULL, G. K. 2006. Price formation under small numbers competition: evidence from land auctions in Singapore. *Real Estate Economics,* 34**,** 51-76.

QUIGG, L. 1993. Empirical testing of real option-pricing models. *The Journal of Finance,* 48**,** 621-640.

SIRMANS, C., TURNBULL, G. & DOMBROW, J. 1997. Residential development, risk, and land prices. *Journal of Regional Science,* 37**,** 613-628.

SLADE, M. E. 2001. Valuing Managerial Flexibility: An Application of Real-Option Theory to Mining Investments. *Journal of Environmental Economics and Management,* 41**,** 193233.

SMITH, J. & THOMPSON, R. 2008. Managing a Portfolio of Real options: Sequential Exploration of Dependent Prospects. *The Energy Journal,* 29**,** 43-62.

THORSNES, P. 2000. Internalizing Neighborhood Externalities: The Effect of Subdivision Size and Zoning on Residential Lot Prices* 1. *Journal of Urban Economics,* 48**,** 397-418.

TITMAN, S. 1985. Urban land prices under uncertainty. *The American Economic Review,* 75**,** 505-514.

TRIGEORGIS, L. 1993a. The nature of option interactions and the valuation of investments with multiple real options. *Journal of Financial and quantitative Analysis,* 28**,** 1-20.

TRIGEORGIS, L. 1993b. Real Options and Interactions With Financial Flexibility. *Financial Management,* 22.

TSE, M. K. S., PRETORIUS, F. I. H. & CHAU, K. W. 2011. Market Sentiments, Winner's Curse and Bidding Outcome in Land Auctions. *The Journal of Real Estate Finance and Economics***,** 1-28.

VASSOLO, R., ANAND, J. & FOLTA, T. 2004. Non-additivity in portfolios of exploration activities: a real options-based analysis of equity alliances in biotechnology. *Strategic Management Journal,* 25.

WILLIAMS, J. T. 1991. Real Estate Development as an Option. *The Journal of Real Estate Finance and Economics,* 4**,** 191-208.