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# Pricing strategies for leasing non-public-use land

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ABSTRACT

Setting a price for leasing non-public-use land is flexibility available to government authorities. Therefore, this study employs a stochastic optimization model incorporating relevant parameters of pricing strategies for leasing non-public-use land based on real option analysis (ROA). This pricing model is distinct from existing literature, which is not based on the developer's perspective. In particular, the exercise prices of "option to lease" are land ownership values under similar conditions. Among the 12 cases in which superficies rights of commercial lands were awarded in Taiwan, this empirical investigation found that the leasing of seven cases was more valuable than land ownership values. This study also suggests pricing strategies for leasing superficies rights under different scenarios and provides new insights for leasing non-public-use land from the perspective of the government.



## 1. Introduction

The government owns the development rights to non-public-use land, and this gives government authorities the flexibility to determine the optimal leasing prices. Therefore, this study employs real option analysis (ROA) to provide a pricing model that incorporates rents, expected rate of growth in land prices, land ownership values, uncertainty, and royalties. In addition, this model incorporates uncertainty into the evaluation for leasing non-public-use land, especially as the process of leasing such land is ambiguous.

Non-public-use land can be regarded as an asset income from the government authorities' perspective. In the existing pricing literature, land prices are usually regarded as raw materials, and they are priced based on the differences between building prices and building costs from the perspective of land development/real estate investments (Leishman, Jones, & Fraser, 2000). Thus, discussions regarding asset income from the perspective of government authorities have been limited.

The traditional income method is one type of land pricing method from the perspective of income (Özdilek, 2012). Previous studies on land pricing have primarily focused on farmland with the parameters consisting of land rents (Burt, 1986) and expected rate of growth in land prices (Pederson & Khitarishvili, 2002). However, these discussions on pricing farmland did not incorporate uncertainty into the models (Davis, 1996). In addition, Capozza and Sick (1991) indicated that simple land values (land ownership values) are equivalent to long-term lease values (land leasing values) under the non-consideration of redevelopment option values. Furthermore, royalties are one of the important economic factors in public land management, especially in regard to economic sustenance (Keiter, 2005). Such research has inspired this study to construct a model for pricing non-public-use land based on the following parameters: rents, expected rate of growth in land prices, land ownership values, uncertainty, and royalties.

The leasing of non-public-use land is an important option for government authorities. As the government owns the development rights to non-public-use land, the concept of leasing land development rights to private developers is similar to "option to lease" (i.e., option to develop). This characteristic is analogous to the American call options, which can be exercised at any time (Regan et al., 2015). Hence, using ROA is more suitable for pricing and evaluating the leasing of non-public-use land as well as essential under the consideration of uncertainty.

Some studies on land development/pricing that have used ROA primarily assumed future rent yields as a stochastic variable. In addition, they evaluated land use conversions (Capozza & Helsley,

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1990; Capozza & Li, 1994; Capozza & Sick, 1994) and examined option premiums on vacant land (Chiang, So, & Yeung, 2006; Grovenstein, Kau, & Munneke, 2011; Quigg, 1993; Sing and Patel, 2001; Titman, 1985; Tsekrekos & Kanoutos, 2013; Williams, 1991). Shen and Pretorius (2013) provided the American call option model for pricing land, which incorporated firm financial factors while Yao and Pretorius (2014) added variables with respect to penalty factors in order to estimate the call option values for 10 cases of developed real estate projects in Hong Kong. In previous studies on land pricing/development from the ROA perspective, the call option values on vacant land, which were obtained by differences between the underlying values of projects and building costs (exercise prices), were usually proxies for pricing vacant land. However, to date, no studies have explicitly used ROA to create a pricing model for leasing non-public-use land.

Therefore, this study uses ROA to construct a pricing model for leasing non-public-use land that incorporates the following parameters: rents, expected rate of growth in land prices, land ownership values, uncertainty, and royalties. In particular, the exercise prices of "option to lease" are land ownership values under similar conditions. Using 12 cases of commercial superficies rights in Taiwan, this study empirically investigates the introduced ROA model's effect on pricing non-public-use land and further compares the differences between ROA and the traditional net present value (NPV) method. Moreover, this study suggests relevant pricing strategies based on the model's implications and Taiwan's pricing experiences.

This empirical investigation found that, among the 12 cases in which superficies rights of commercial lands were awarded in Taiwan, the leasing of seven cases were more valuable than land ownership values. Compared to the traditional NPV method, the developed ROA model is convincing since it offers the optimal leasing price while considering uncertainty and management flexibility. Moreover, based on the implications of the model and Taiwan's pricing experiences, this study also proposes helpful pricing strategies for leasing superficies rights. For example, in areas with high growth in land prices, the government should focus on land rents, promote lease rates, and reduce royalties at the beginning of a lease. Conversely, in areas with low growth in land prices, the land rents that would be created by location conditions in the future are somewhat low, and the government should price the lease terms based on higher royalties and lower land rents.

The remainder of this study is organized as follows. Section 2 provides the superficies rights land valuation model framework; Section 3 presents the empirical investigation. Section 4 presents the analyses and implications of the 12 cases of completed leasing superficies rights, and their analyses and implications on pricing strategies of leasing superficies rights. Section 5 describes the sensitivity analysis with respect to leasing price under various parameters. The conclusions are presented in the final section.

## 2. Materials and methods: the framework for pricing superficies rights

This study constructs a stochastic optimization model for leasing superficies rights that includes land prices as a stochastic variable since it is assumed that land rents during the lease period are based on land values multiplied by the fixed lease rate. Overall model formulation is similar to that shown by Dixit and Pindyck (1994), Grenadier (1996), and Yao and Pretorius (2014).

Before developing a full model, it is important to note that future land values on superficies rights are uncertain. More specifically, since land values are primarily determined and changed by location conditions or political factors over time, they are difficult to predict, which makes the land values on leasing superficies rights $X(t)$ (hereafter $X(t)$ is replaced by $X$ to simplify) uncertain during the lease periods. As per Dixit and Pindyck's (1994) concept, let $X$ evolve according to the following geometric Brownian motion process (GBM), which is the continuous-time formulation of the random walk equation:

$$dX = \delta X dt + \sigma X dz \tag{1}$$

where $\delta$ is the instantaneous conditional expected percentage change in $X$ (i.e.,., land price growth rate on leasing superficies rights), $\sigma$ is the instantaneous standard deviation of land price each year (which can be interpreted as land price volatility), and $dz$ is the increment of a standard Weiner process. Here we also assume $\delta < r$ for the convergence in which $r$ is the risk-adjusted discount factor.

First, it is assumed that the government cannot earn any fiscal income if the superficies rights are not completed. Second, we can now derive fiscal income that can be made after the completed leasing superficies rights. Once the superficies rights are completed, the government obtains fiscal income (leasing values) $L(t_0)$ at time $t_0$ during the lifetime of lease period $T$, starting from time $t_0$ to time $t_0 + T$. In order to simplify the complexity of the model, it is assumed that the royalties cannot be paid in installments by the private real estate developer. Thus, it must be paid at the beginning of the lease. In addition, the consideration of building residual value and land redevelopment value are ignored in the future (Capozza & Sick, 1991). Such NPV of leasing superficies rights to the government after the completed leasing is as follows:

$$\begin{aligned} S(t_0) &= E\left[F + \Phi q \int_{t_0}^{t_0+T} X e^{-r(T-t_0)} dt - O\right] \\ &= \underbrace{F + \left[\frac{\left(1 - e^{-(r-\delta)T}\right)\Phi}{r-\delta}\right] Xq}_{L(t_0)} - O \end{aligned} \tag{2}$$

where $F$ is the figure submitted by the successful bidder (i.e., private real estate developer) at the beginning of the lease, $q$ is the lease area, $\Phi$ is the lease rate, and $O$ is the exercise price of leasing superficies rights.

The government can either lease superficies rights or simply wait. The value of "option to lease," $V$, more accurately reflects the value of the timing of leasing superficies rights by considering leasing management flexibility. The government hopes to maximize its values of "option to lease" at $t_0$ by selecting the optimal exercise time $\lambda$ in the future. When the NPV method recommends that leasing superficies rights is negative NPV at $t_0$, the ROA suggests that the government should wait until the optimal time, $\lambda > t_0$, rather than lease at time $t_0$. This means that the government will wait to lease superficies rights until optimal exercise timing $\lambda$ is obtained by comparing the value $S(\lambda)$ for all time $\lambda \in [t_0, \infty]$ in order to maximize fiscal income for leasing superficies rights. The value function of "option to lease," which can be gained by the completed leasing superficies rights, is as follows:

$$V = \max_{\lambda \geq t_0} E\left[S(\lambda) e^{-r(\lambda - t_0)}\right] \tag{3}$$

In order to solve the equilibrium differential equation in (2), the Bellman equation is as follows:

$$rV(X)dt = E[dV] \tag{4}$$

Using Ito's Lemma, we obtain the following: