J Real Estate Finan Econ (2008) 36:81–102
DOI 10.1007/s11146-007-9077-z

Land Development: Risk, Return and Risk Management

Richard J. Buttimer Jr. · Steven P. Clark · Steven H. Ott

Published online: 9 August 2007

Abstract We model and examine the financial aspects of the land development process incorporating the industry practice of preselling lots to builders through the use of option contracts as a risk management technique. Using contingent claims valuation, we are able to determine endogenously the land value, presale option value, credits spreads and the effects of presales on debt pricing and equity expected returns. We show that using presales options effectively shift market risk from the land developer to the builder. Results from the model are consistent with the high rates of return on equity observed in empirical surveys; they also suggest that developers may be justified in pursuing projects with substantially lower expected returns to equity when a large number of lots can be presold. Additionally, we show that presales reduce default risk dramatically for leveraged projects and can support a considerable reduction in the cost of construction financing. Large debt risk premiums are justified for highly levered projects, which helps explain the use of mezzanine financing in the land development industry to reduce expected default costs.

Keywords Land development process · Preselling · Risk management · Real options

Introduction

The real estate development industry can be described as a multiphase process involving land (horizontal) development, followed by building (vertical) development,

The authors wish to thank an anonymous reviewer, participants at the 2006 Cambridge-UNC Charlotte Symposium on Risk Management and Property Derivatives, Dan Quan, Dean Paxson, and Tsur Somerville for helpful comments and suggestions. We gratefully acknowledge funding from the National Housing Endowment, the philanthropic arm of the National Association of Home Builders.

R. J. Buttimer Jr. (✉) · S. P. Clark · S. H. Ott
Belk College of Business, University of North Carolina Charlotte,
Charlotte, NC 28223-0001, USA
e-mail: buttimer@uncc.edu

S. P. Clark
e-mail: spclark@uncc.edu

S. H. Ott
e-mail: shott@uncc.edu

encompassed by the marketing phase of the development through the sale or leasing of the completed sites. For example, the residential production cycle begins when a land developer purchases a tract of land, receives appropriate regulatory approvals, constructs needed infrastructure over time, and subdivides the larger parcel into lots. Typically, the land developer then sells the finished lots to a third party homebuilder. After the homebuilder completes construction, the housing units are generally sold in the owner-occupied housing market. While all three phases of the housing industry are interrelated, each stage involves various risks which are allocated between landowners, land developers, and the homebuilders.

The land development phase is often identified as one of the riskiest phases of the real estate production process. Often, the developer must acquire land, expend upfront time and money in the regulatory process, and invest in needed infrastructure with uncertain costs before generating any positive cash flows.[1] One major risk of land development is reflected in the price volatility of the completed and subdivided lot prices, which are primarily affected by the market demand for the finished vertical development. Since the value of the land development project is primarily determined by uncertainty in both lot prices and the pace in which the lots are absorbed in the market, changing economic conditions and consumer preferences, and increasing competition are all critical concerns. If prices and absorption rates are below expectations, the developer is exposed to significant downside risk.

The risks inherent in land development can be directly observed in the return expectations of land developers. Surveys examining return requirements in the land development industry are limited, but Owens (1998) suggests land developers may require returns as much as 30% higher than those of residential homebuilders.[2] Similar and more recent surveys done by Korpacz/Price Waterhouse Coopers find comparable, although wider ranging and somewhat lower return expectations.[3]

Presales of subdivided lots are common strategies used to reduce the developer's exposure to downturns in market demand for completed lots. Presales involve the conditional sale of lots through options to third party homebuilders before the subdivision is completed. Homebuilders are often willing to purchase options because it provides an opportunity to lock-in a fixed price, stabilize future inventory needs and lockout competition for building sites. Land developers use presale options as a risk management technique in the land development process to reduce or shift some risk to the purchaser of the completed lots. Developers also use presale options to increase their equity in the projects through the collection of the presale

[1] Risk in the regulatory approval process often involves taking a parcel of land through the rezoning process, obtaining site and subdivision approval, and also obtaining construction permits. All of these steps must be complete before raw land development is allowed to move forward.

[2] Developer surveys conducted by Owens found internal rate of return requirements of 10% for residential homebuilders, 15–20% for development of zoned land, and 25–40% for development of raw land. Note that these returns are based a high degree of leverage which is commonly used in all phases of the development process.

[3] Return expectations vary widely from 12–25%. Relative to Owens (1998), the slightly lower return expectations observed recently are likely due to the current low return requirements driven by the current low interest rate environment.

option premium, thus reducing their need for and the cost of debt financing.[4] Developers and their financing institutions, and more recently investment banks that sell structured land development loans in the secondary market, recognize presales an effective method to reduce market risk.[5]

Previous research by Lai et al. (2004) identify that presales option contracts provide a benefit to limit risk because they allow the developer to commence construction, while limiting inventory costs and bankruptcy risk and reducing uncertainty about future demand.[6] They model the value of the presale contract and show that, in the presence of risk-neutral buyers and risk-averse developers, it is always optimal for a developer to presell units to mitigate price risk.

While the Lai, Wong, and Zhou paper provides an initial analysis of the risk management technique of presales, there are yet many unanswered questions to be addressed. In this paper, we also model the presale option value, but we incorporate two critical features of the development market. First, we include in the model the common practice of applying the option premium (or binder as it is referred to by the industry) as a reduction to the exercise price. We demonstrate how this practice changes the option pricing formula. Second, we also model the debt financing of land acquisition and construction expenditures and are able to determine endogenously the probabilities of builder and developer default in conjunction with debt valuation in the presence of bankruptcy costs. We also model the typical practice of developers using the option premiums to increase their equity investment in the project. This allows us to determine spreads on debt given a certain level of presales. Finally we determine expected returns to equity for various levels of presales and debt financing.

Our numerical results for expected returns on equity are consistent with the high rates of return observed in the empirical studies, but they also suggest that developers may be justified in pursuing projects with substantially lower returns to equity when option presales are prevalent. Additionally, we show that presales reduce default risk dramatically for highly leveraged projects, which supports a reduction in the spreads on construction financing. We also explain the use of mezzanine financing in the land development industry for highly-leveraged projects.

We proceed with our study as follows. In the next section we present the general economic environment of the development process and develop the financial model. In "Numerical Solutions and Analysis" we present solutions to the model for a variety of economic environments and parameter values and discuss the implications of these results. Finally, in the last section, we discuss our conclusions ("Conclusion").

4 Empirical research conducted by Sirmans et al. (1997) suggests the discounted presale price is appropriate due to first mover disadvantages associated with being one of the first consumers to purchase a lot within a development. The first builder to purchase a lot in the subdivision does not know with certainty how the neighborhood will evolve over time and must be offered a price discount to compensate for this first mover disadvantage. As the neighborhood develops, future purchasers pay higher prices for finished lots because they are provided with more information regarding the neighborhood's characteristics.

5 Land development loans with presales to national homebuilders are beginning to be offered in the structured finance market, e.g., Terra LNR I Ltd, a $500 million offering by Barclays Capital.

6 Bankruptcy costs and the use of debt are not modeled in the Lai, Wong, and Zhou paper.

The Model

Basic Assumptions

We assume that the land developer purchases vacant land at time T_0 for an endogenously determined price L. We assume that the land has been entitled and is ripe for development and that construction commences immediately, requiring total construction outlays of K over the construction time.[7] Construction time, T_C, is known with certainty at time T_0, so the project will be complete at time $T=T_0+T_C$.

The developer can either sell lots to homebuilders at the construction completion time T at the then market price $P(T)$, or he can pre-sell lots to homebuilders at time T_0 using option contracts.[8] If a lot is pre-sold through an options contract, the homebuilder pays an option premium (referred to in the industry as a "binder") to the developer at time T_0, and the homebuilder then has the right, but not the obligation, to "take down" the lot (i.e. to exercise their option and buy the lot) at time T. As with any long option position, the homebuilder can walk away if they choose to do so. Option premiums received by the lot developer are used as equity, thus reducing the debt financing required to fund the project.

A unique feature of the land development market is that the option premium is credited against the strike price when the option is exercised, i.e. when the homebuilder exercises their option. Our model endogenously determines the binder (option premium) amount while explicitly incorporating the reduction in the strike price by the binder amount.

A second feature of this market is that frequently land developers will provide a discount in the strike price to early lot purchasers and then raise the strike prices over time. The strike price of any given contract is fixed, but the strike price often rises for new contracts. Our model explicitly allows for deterministically increasing strike prices.[9]

Let $\left(\Omega, F, \{F_t\}_{t\geq 0}, \mathrm{P}\right)$ be a filtered probability space. We define a market environment where lot prices P are spanned by traded financial assets and where a risk-free bond B exists so that standard contingent claims techniques are available for pricing. The lot price is assumed to be governed by the stochastic differential equation,

$$dP(t) = (\mu - \delta)P(t)dt + \sigma P(t)dW(t), \quad t\in[0, T], \tag{1}$$

[7] We assume that the option to wait to develop at a later date is valueless.

[8] In reality lots could be presold anytime during the construction period. Without loss of generality and for greater tractability in the debt pricing, we assume presales take place only at the commencement of construction.

[9] The practice of rising strike prices is also done to hold presale option prices relatively constant over the construction period to offset declines in the variability of lot prices as the project is completed and the level of success of the development becomes more certain. Because we are modeling European options, we are only concerned with the volatility of the distribution *at* the option exercise date.

where $\mu \in R$ is the drift of the completed lot price over time, $\delta \in R$ is the convenience yield for holding completed lots, $\sigma \in R$ is the constant volatility rate, and W is a standard Brownian motion under P. The price of the bond follows

$$dB(t) = rB(t)dt, \quad t \in [0, T], \tag{2}$$

where $r \in R^{+}$ is the risk free rate of return.

As is well-known, there are no arbitrage opportunities in such a market environment if and only if there exists a probability measure $\widetilde{\mathbf{P}}$ under which $P(t)e^{\delta t}/B(t)$ follows a martingale. On the probability space $\left(\Omega, F, \{F_t\}_{t \geq 0}, \widetilde{\mathbf{P}}\right)$ Eq. 1 becomes

$$dP(t) = (r - \delta)P(t)dt + \sigma P(t)d\widetilde{W}(t), \quad t \in [0, T], \tag{3}$$

where, for all $t \in [0,T]$

$$\widetilde{W}(t) = W(t) + \int_0^t \frac{\mu - r}{\sigma} du \tag{4}$$

is a standard Brownian motion under $\widetilde{\mathbf{P}}$.

Pricing Presale Options

The presale option used by the development industry differs from a standard call option in that the option premium is applied to the purchase price of the lot if the option is exercised, otherwise it is forfeited. Let $V(T_0, P(T_0); T_C)$ denote the time T_0 no-arbitrage price of a European presale option expiring at time $T = T_0 + T_C$. That is, it is the price (binder) that the homebuilder pays to the developer at time T_0 for the option to buy the lot at time T. We assume that the strike price is determined through negotiation between builder and developer, but we do not specifically model this process and take the strike price as exogenous. Given this, the payoff to the homebuilder of the presale option with strike price $X(T)$ at time T is

$$[P(T) - (X(T) - V(T_0, P(T_0); T_C))]^{+}.$$

Of course $V(T_0, P(T_0); T_C)$ is determined at time T_0 and is given by:

$$V(T_0, P(T_0); T_C) = e^{-rT_C}\widetilde{E}\left\{[P(T) - (X(T) - V(T_0, P(T_0); T_C))]^{+} | F(T_0)\right\}. \tag{5}$$

Evaluating the conditional expectation in Eq. 5, we have that V satisfies

$$V(T_0, P(T_0); T_C) = e^{-\delta T_C} P(T_0) \frac{N(d_1)}{1 - e^{-rT_C} N(d_2)} - e^{-rT_C} X(T) \frac{N(d_2)}{1 - e^{-rT_C} N(d_2)} \tag{6}$$

where

$$d_1 = \frac{ln(P(T_0)) - ln(X(T) - V(T_0, P(T_0); T_C)) + \left(r - \delta + \sigma^2/2\right) T_C}{\sigma \sqrt{T_C}}, \tag{7}$$

$$d_2 = \frac{\ln(P(T_0)) - \ln(X(T) - yP(T_0)) + \left(\mu - \delta - \sigma^2/2\right)T_C}{\sigma\sqrt{T_C}}. \tag{8}$$

and $N(\cdot)$ denotes the cumulative normal density function. Equation 6 can be solved for V using straightforward numerical methods.

Often the price of the presale option is quoted in terms of a percentage y of the lot value, then from Eq. 6 we have

$$y = \frac{e^{-\delta T_C} P(T_0) N(d_1) - e^{-rT_C} X(T) N(d_2)}{P(T_0)\left(1 - e^{-rT_C} N(d_2)\right)}. \tag{9}$$

where

$$d_1 = \frac{\ln(P(T_0)) - \ln(X(T) - yP(T_0)) + \left(r - \delta + \sigma^2/2\right)T_C}{\sigma\sqrt{T_C}} \tag{10}$$

$$d_2 = \frac{\ln(P(T_0)) - \ln(X(T) - yP(T_0)) + \left(r - \delta - \sigma^2/2\right)T_C}{\sigma\sqrt{T_C}}. \tag{11}$$

One implication of this is that increases in the time T_0 (risk neutral) probability of the presale option expiring in-the-money increases the option price relative to the lot value (i.e. y increases) thereby shifting more price risk from the land developer to the homebuilder (option purchaser). The developer will not purchase the lot only when the value of the land falls below the premium-adjusted strike so the developer is protected from price declines from $X(T)$ to $X(T)$–$P(T)$.

Return to the Builder

Because we are interested in not only the endogenous pricing of the option, but also expected returns, we use risk-neutral probabilities to price assets and, then given that price, we use real (objective) probabilities to determine risk-adjusted returns. Using objective probabilities, the expected payoff of the option to the builder from a presale option with exogenous strike price $X(T)$ is

$$\begin{aligned} &E\left\{[P(T) - (X(T) - V(T_0, P(T_0); T_C))]^+ | F(T_0)\right\} \\ &= P(T_0)e^{(\mu-\delta)T_C} N\left(d_1^*\right) - (X(T) - yP(T_0))N\left(d_2^*\right) \end{aligned} \tag{12}$$

where

$$d_1^* = \frac{\ln(P(T_0)) - \ln(X(T) - yP(T_0)) + (\mu - \delta + \sigma^2/2)T_C}{\sigma\sqrt{T_C}} \tag{13}$$

$$d_2^* = \frac{\ln(P(T_0)) - \ln(X(T) - yP(T_0)) + \left(\mu - \delta - \sigma^2/2\right)T_C}{\sigma\sqrt{T_C}}. \tag{14}$$

Again using real probabilities, the risk-adjusted expected return of the option to the builder is[10]

$$\begin{aligned}&\frac{P(T_0)e^{(\mu-\delta)T_C}N\left(d_1^*\right)-(X(T)-yP(T_0))N\left(d_2^*\right)}{yP(T_0)}-1\\ &=\frac{e^{(\mu-\delta)T_C}}{y}N\left(d_1^*\right)-N\left(-d_2^*\right)-\frac{X(T)}{yP(T_0)}N\left(d_2^*\right)\end{aligned}$$

Return to the Developer

We assume that the developer purchases land at time T_0 for L, where $L$is determined endogenously below, and divides it into M indistinguishable lots (M is arbitrary, but once chosen remains fixed). The developer begins the presale process and the supply and demand of the market for the lots determines the number $m(0 \leq m \leq M)$ that are presold with options. The value of the development to the developer at time T is given by the $F(T)$-measurable random variable

$$(M-m)P(T)+mP(T)I_{\{P(T)\leq X(T)-yP(T_0)\}}+m(X(T)-yP(T_0))I_{\{P(T)>X(T)-yP(T_0)\}},$$

where I denotes the indicator function. Let V_t denote the value of the development to the developer at time $t\in[T_0,T]$. Then the time T_0 expected value (using real probabilities) of the development to the developer at time T is

$$\begin{aligned}E[V_T|F(T_0)] &= E\big[(M-m)P(T)+m(X(T)-yP(T_0))I_{\{P(T)>X(T)-yP(T_0)\}}\\ &\quad +mP(T)I_{\{P(T)\leq X(T)-yP(T_0)\}}|F(T_0)\big]\\ &=\left(M-m+mN\left(-d_1^*\right)\right)P(T_0)e^{(\mu-\delta)T_C}+m(X(T)-yP(T_0))N\left(d_2^*\right)\\ &=\left(M-mN\left(d_1^*\right)\right)P(T_0)e^{(\mu-\delta)T_C}+m(X(T)-yP(T_0))N\left(d_2^*\right).\end{aligned} \tag{15}$$

The developer must spend a total amount K for construction over the time interval $[T_0,T]$. Let $k(t)$ denote the rate of spending by the developer on construction at time t. We assume that construction outlays are made at a constant rate, so that $dk(t) = K/T_C dt$.

All Equity Expected Project IRR

If the developer finances the project entirely with equity, then the expected internal rate of return (IRR) for the project, r^*, satisfies

$$\begin{aligned}e^{-r^*T_c}E_{T_0}(V_T) &= (L-myP(T_0))+\int_{T_0}^{T}e^{-r^*(s-T_0)}\frac{K}{T_C}ds\\ &=(L-myP(T_0))+\frac{K}{r^*T_C}\left(1-e^{-r^*T_C}\right),\end{aligned} \tag{16}$$

[10] Real probabilities are sometimes called objective probabilities. Many studies use these probabilities in determining real (non value) measures such as expected time and probabilities of default. We calculate expected returns by using the risk-adjusted drift rate. For examples of this technique, see Shackleton and Wojakowski (2001, 2002).

or, after taking logarithms and simplifying,

$$r^* = T_C^{-1} ln\left[E_{T_0}(V_T) + \frac{K}{r^* T_C}\right] - T_C^{-1} ln\left[(L - myP(T_0)) + \frac{K}{r^* T_C}\right]. \tag{17}$$

Endogenous Land Price

Under the assumption that land development is supplied by a competitive market, all rents accrue to the land since land is the scarce factor. This allows us to determine the value of the land L endogenously by solving Eq. 16 for L using Eq. 15 under risk-neutrality. That is, L satisfies

$$L = e^{-rT_c}\widetilde{E}_{T_0}(V_T) - myP(T_0) - \frac{K}{rT_C}\left(1 - e^{-rT_C}\right), \tag{18}$$

where

$$\widetilde{E}_{T_0}(V_T) = (M - mN(d_1))P(T_0)e^{(r-\delta)T_C} + m(X(T) - yP(T_0))N(d_2). \tag{19}$$

Note that the value of land, while determined endogenously in the market, is unaffected by the number of lots presold, m, or the level of the strike price $X(T)$. This is because presales act only to shift risks from developer to builder and are priced accordingly.

We also assume that the equilibrium land price is determined by the most valuable development plan. If our developer's plan did not use the optimal K and T_C combination then other developers planning to develop optimally would offer more.[11] Since Eq. 18 precludes the developer from getting any rents, it is implicit in our model that the given parameters K and T_C correspond to the optimal development plan, and can thus be considered as characteristics of the particular parcel of land.

Default

Now we consider conditions under which it is optimal for a leveraged developer to default at time T. If the developer defaults on the balance of the debt due at time T, denoted as D_T, lenders receive a proportion γ of value of the developer's remaining lots (remaining after builder exercise if they chose to do so) in the project. In our framework, the optimal capital structure is *all equity* since we assume deadweight costs from leverage without any offsetting benefits. We assume that the land developer uses an exogenous level of debt financing due to liquidity constraints.

Define a random variable m^* to be the number of lots "taken down" by builders at time T. Before the developer makes a default decision it is necessary to determine m^*, which is the number of lots on which homebuilders have exercised their options. We assume that homebuilders always exercise in-the-money options and choose not

[11] We also assume that the land is valued in a market where the developer could potentially purchase the development project without leverage, which is the optimal capital structure in this setting since we assume deadweight cost from leverage. Later we will assume that the land developer uses debt financing in the presence of bankruptcy cost due to liquidity constraints.

to exercise otherwise. Any options on lots left unexercised means that these lots revert to the developer. Thus,

$$m^* = \begin{cases} m & if \quad P(T) > X(T) - yP(T_0) \\ 0 & if \quad P(T) \leq X(T) - yP(T_0). \end{cases}$$

Once $m*$ is determined, it is optimal for the developer to default on the debt at time T if

$$P(T) < P^*\left(r_d^*, m^*\right) \equiv \frac{D_T\left(r_d^*\right) - m^*(X(T) - yP(T_0))}{M - m^*},$$

provided $M - m^* > 0$. When $M - m^* = 0$, default is optimal if and only if $D_T\left(r_d^*\right) - M(X(T) - yP(T_0)) - C > 0$. If the developer defaults the lender would receive the value of the developer's remaining lots, $M-m*$, less any deadweight costs.

Now define the events

$$A \equiv \{P(T) > X(T) - yP(T_0)\}$$

and

$$B \equiv \left\{P(T) \geq P^*\left(r_d^*, m^*\right)\right\}.$$

In words, A is the event that builders exercise options, and B is the event that the developer does not default. Thus $A \cap B$ is the event that options are exercised and the developer does not default. The event $A^c \cap B$ is the event that the developer does not default even though options expire out-of-the-money. The event $A \cap B^c$ is the event that options are exercised, yet the developer still defaults. Finally, $A^c \cap B^c$ is the event that options expire out-of-the-money and the developer defaults. Let P_{def} denote the maximal time T market price of a lot in order for developer default to be triggered.

If the developer defaults, the lender receives an asset with market value $\gamma\left(M - m^*\right)P(T) \quad (0 \leq \gamma \leq 1)$. The price of insurance guaranteeing the lender's losses in the event the developer defaults is the price of a put option paying off

$$\left(D_T\left(r_d^*\right) - m^*(X(T) - yP(T_0)) - \gamma\left(M - m^*\right)P(T)\right)$$

in the event that the developer defaults. When valuing this put, we must consider two cases.

Case 1. $A \cap B^c = \varnothing$, which will be the case if and only if $P^*\left(r_d^*, m\right) \leq X(T) - yP(T_0)$. In this case, the developer never defaults when builders exercise options. Within case 1, there are two possibilities that must be considered.

Case 1.a First, if $X(T) - yP(T_0) > P^*\left(r_d^*, 0\right)$ then builder exercise always reduces $P*$ and consequently

$$P^*\left(r_d^*, m\right) < P^*\left(r_d^*, 0\right) < X(T) - yP(T_0)$$

So in this case, $P_{\text{def}} = P^*(r^*, 0)$, and the value of the put guaranteeing the lender's losses is given by

$$\begin{aligned} V^{PUT}\left(r_d^*\right) &= e^{-rT_C}\widetilde{E}_{T_0}\left[D_T\left(r_d^*\right) - \gamma MP(T)|P(T) \leq P^*\left(r_d^*, 0\right)\right] \\ &= e^{-rT_C}D_T\left(r_d^*\right)N\left(-g_2\left(r_d^*, 0\right)\right) - e^{-\delta T_C}\gamma MP(T_0)N\left(-g_1\left(r_d^*, 0\right)\right), \end{aligned} \tag{20}$$

where

$$g_1\left(r_d^*, 0\right) = \frac{1}{\sigma\sqrt{T_C}}\left[ln\left(\frac{P(T_0)}{P^*\left(r_d^*, 0\right)}\right) + \left(r - \delta + \sigma^2/2\right)T_C\right], \tag{21}$$

and $g_2\left(r_d^*, 0\right) = g_1\left(r_d^*, 0\right) - \sigma\sqrt{T_C}$. Note that $N\left(-g_2\left(r_d^*, 0\right)\right)$ is the probability under the risk-neutral measure that the developer defaults.

Case 1.b The other situation in which builder exercise and developer default can never coexist is when

$$P^*\left(r_d^*, m\right) < X(T) - yP(T_0) < P^*\left(r_d^*, 0\right).$$

Here $P_{\text{def}} = X(T) - yP(T_0)$ and

$$\begin{aligned} V^{PUT}\left(r_d^*\right) &= e^{-rT_C}\widetilde{E}_{T_0}\left[D_T\left(r_d^*\right) - \gamma MP(T)|P(T) \leq X(T) - yP(T_0)\right] \\ &= e^{-rT_C}D_T\left(r_d^*\right)N(-d_2) - e^{-\delta T_C}\gamma MP(T_0)N(-d_1). \end{aligned} \tag{22}$$

Case 2. $A \cap B^c \neq \varnothing$, which will be the case if and only if $P^*\left(r_d^*, m\right) > X(T) - yP(T_0)$. In this case, developer default can occur despite the fact that builders exercise their options. This will be the case whenever

$$X(T) - yP(T_0) < P^*\left(r_d^*, m\right) < P^*\left(r_d^*, 0\right)$$

or

$$X(T) - yP(T_0) < P^*\left(r_d^*, 0\right) < P^*\left(r_d^*, m\right).$$

Either way $P_{\text{def}} = P^{*\left(r_d^*, m\right)}$. Thus the fair value of the put is

$$\begin{aligned} V^{PUT}\left(r_d^*\right) &= e^{-rT_C}\widetilde{E}_{T_0}\Big[D_T\left(r_d^*\right) - m(X(T) - yP(T_0))1_A \\ &\quad -\gamma(M - m1_A)P(T)\Big|P(T) \leq P^*\left(r_d^*, m\right)\Big] \\ &= e^{-rT_C}D_T\left(r_d^*\right)N\left(-g_2\left(r_d^*, m\right)\right) - e^{-rT_C}m(X(T) - yP(T_0)) \\ &\quad \left(N(d_2) - N\left(g_2\left(r_d^*, m\right)\right)\right) - e^{-\delta T_C}\gamma MP(T_0)N\left(-g_1\left(r_d^*, m\right)\right) \\ &\quad + e^{-\delta T_C}\gamma mP(T_0)\left(N(d_1) - N\left(g_1\left(r_d^*, m\right)\right)\right), \end{aligned} \tag{23}$$

where

$$g_1\left(r_d^*, m\right) = \frac{1}{\sigma\sqrt{T_C}}\left[ln\left(\frac{P(T_0)}{P^*\left(r_d^*, m\right)}\right) + \left(r - \delta + \sigma^2/2\right)T_C\right], \tag{24}$$

and $g_2\left(\overset{*}{r}_d, m\right) = g_1\left(\overset{*}{r}_d, m\right) - \sigma\sqrt{T_C}$.
Now the equilibrium cost of debt for the developer, $\overset{*}{r}_d$, satisfies

$$e^{-\overset{*}{r} T_C} D_T\left(\overset{*}{r}_d\right) + V^{PUT}\left(\overset{*}{r}_d\right) = e^{-rT_C} D_T\left(\overset{*}{r}_d\right). \tag{25}$$

The intuition of Eq. 25 is that the present value at time 0 (at the developer's cost of debt) of the maturity value of risky debt plus the time 0 premium for insurance against default on the risky debt equals the present value at time 0 of the maturity value of risky debt as if it were risk-free.

Expected Return on Equity With Possible Default on Debt

There are several distinct cases to consider corresponding to the cases in the previous section in deriving the expected terminal value of the development to the leveraged developer at time 0.

Case 1.a If $M - m > 0$, and

$$P^*\left(\overset{*}{r}_d, m\right) < P^*\left(\overset{*}{r}_d, 0\right) < X(T) - yP(T_0),$$

then expected terminal value of the development to the leveraged developer at time T_0, $\widehat{V}_T$, is

$$\begin{aligned}\widehat{V}_T &= E[(M-m)P(T)1_B + m(X(T) - yP(T_0))1_{A\cap B} + mP(T)1_{A^c\cap B}] \\ &= e^{(\mu-\delta)T_C}(M-m)P(T_0)N\left(g_1^*\left(\overset{*}{r}_d, 0\right)\right) + m(X(T) - yP(T_0)) \\ &\quad N\left(min\left\{d_2^*, g_2^*\left(\overset{*}{r}_d, 0\right)\right\}\right) + e^{(\mu-\delta)T_C} mP(T_0) max\left\{N\left(g_1^*\left(\overset{*}{r}_d, 0\right)\right) - N\left(d_1^*\right), 0\right\}.\end{aligned} \tag{26}$$

Case 1.b If $M - m > 0$, and

$$P^*\left(\overset{*}{r}_d, m\right) < X(T) - yP(T_0) < P^*\left(\overset{*}{r}_d, 0\right).$$

then expected terminal value of the development to the leveraged developer at time T_0, $\widehat{V}_T$, is

$$\begin{aligned}\widehat{V}_T &= E[(M-m)P(T)1_B + m(X(T) - yP(T_0))1_{A\cap B} + mP(T)1_{A^c\cap B}] \\ &= e^{(\mu-\delta)T_C}(M-m)P(T_0)N\left(d_1^*\right) + m(X(T) - yP(T_0))N\left(d_2^*\right).\end{aligned} \tag{27}$$

Case 2 If $M - m > 0$, and

$$X(T) - yP(T_0) < P^*\left(\overset{*}{r}_d, m\right) < P^*\left(\overset{*}{r}_d, 0\right)$$

or

$$X(T) - yP(T_0) < P^*\left(\overset{*}{r}_d, 0\right) < P^*\left(\overset{*}{r}_d, m\right).$$

Then expected terminal value of the development to the leveraged developer at time T_0, $\widehat{V}_T$, is given by

$$\begin{aligned}\widehat{V}_T &= E\left[(M-m)P(T)1_B + m(X(T)-yP(T_0))1_{A\cap B} + mP(T)1_{A^c\cap B}\right]\\ &= e^{(\mu-\delta)T_C}(M-m)P(T_0)N\left(g_1^*\left(r_d^*, m\right)\right) + m(X(T)-yP(T_0))\\ &\quad N\left(min\left\{d_2^*, g_2^*\left(r_d^*, m\right)\right\}\right) + e^{(\mu-\delta)T_C}mP(T_0)max\left\{N\left(g_1^*\left(r_d^*, m\right)\right) - N\left(d_1^*\right), 0\right\}.\end{aligned} \tag{28}$$

Case 3 If $M-m=0$ and $D_T\left(r_d^*\right) - M(X(T)-yP(T_0)) \leq 0$, then expected terminal value of the development to the leveraged developer at time T_0 is

$$\begin{aligned}\widehat{V}_T &= E\left[M(X(T)-yP(T_0))1_A + MP(T)1_{A^c}|F(T_0)\right]\\ &= M(X(T)-yP(T_0))N\left(d_2^*\right) + e^{(\mu-\delta)T_C}MP(T_0)N\left(-d_1^*\right).\end{aligned} \tag{29}$$

Case 4 If $M-m=0$ and $D_T\left(r_d^*\right) - M(X(T)-yP(T_0)) > 0$, then expected terminal value of the development to the leveraged developer at time T_0 is

$$\widehat{V}_T = 0 \tag{30}$$

Expected Return on Equity

Now let $\widehat{r_e}$ denote the developer's expected return on equity from the project when default is possible. Then

$$\begin{aligned}&(1-\alpha_1)(L-myP(T_0)) + (1-\alpha_2)\frac{K}{\widehat{r_e}T_C}\left(1-e^{-\widehat{r_e}T_C}\right)\\ &= e^{-\widehat{r_e}T_C}\left\{\widehat{V}_T - \alpha_1 e^{r_d T_C}(L-myP(T_0))N\left(h^*\right) - \alpha_2\frac{K}{r_d T_C}\left(e^{r_d T_C}-1\right)N\left(h^*\right)\right\}.\end{aligned} \tag{31}$$

where

$$h^* = \begin{cases} g_2^*\left(r_d^*, 0\right) & if \quad P_{def} = P^*\left(r_d^*, 0\right)\\ d_2^* & if \quad P_{def} = X(T) - yP(T_0)\\ g_2^*\left(r_d^*, m\right) & if \quad P_{def} = P^*\left(r_d^*, m\right)\end{cases}$$

So $\widehat{r_e}$ satisfies

$$e^{\widehat{r_e}T_C} = \frac{\widehat{V}_T - \alpha_1 e^{r_d T_C}(L-myP(T_0))N\left(h^*\right) - \alpha_2\frac{K}{r_d T_C}\left(e^{r_d T_C}-1\right)N\left(h^*\right) + (1-\alpha_2)\frac{K}{\widehat{r_e}T_C}}{(1-\alpha_1)(L-myP(T_0)) + (1-\alpha_2)\frac{K}{\widehat{r_e}T_C}} \tag{32}$$

Table 1 Base case model parameters

Parameter	Base case value
$P(t)$ spot price of the completed lot	P_0=100
μ is the drift of the completed price over time	μ=0.08
δ is the cash flow yield from the completed lot	δ=01
σ is the constant volatility rate	σ=0.125
K is the construction cost to complete the lot for sale to the builder	K=80
T_c is the time to construction completion	T_c=1
X is the exercise price of the builder's option to purchase the completed lot	$X = Pe^{r_d T} = 105.13$
M is the total number of lots	Normalized to M=1
m is the percentage of lots presold	m=0, 25, 50, 75, 100%
α_1 is the percentage of the initial cash flow financed, i.e., the land purchase price less any option binder deposits received	α_1=80%
α_2 is the percentage of construction costs financed	α_2=80%
γ is the percentage of lot value retained by lender upon developer default	γ=70%
r_d the risk-free rate	r_d=5%

or

$$\widehat{r}_e = T_C^{-1} ln\left[V_T - \alpha_1 e^{r_d T_C}(L - myP(T_0))N(h^*) - \alpha_2 \frac{K}{r_d T_C}\left(e^{r_d T_C} - 1\right)N(h^*) + (1-\alpha_2)\frac{K}{\widehat{r}_e T_C}\right] - T_C^{-1} ln\left[(1-\alpha_1)(L - myP(T_0)) + (1-\alpha_2)\frac{K}{\widehat{r}_e T_C}\right] \tag{33}$$

The next section provides the results from the numerical solution of the model described above.

Numerical Solutions and Analysis

Table 1 presents the base case parameters from which we can derive and compare results. We normalize the completed lot price at time zero, P_0, to be 100. We set the drift term of the lot price, μ, to be 8%, and the convenience yield, δ, is set to be 1%.[12] The drift rate represents a 3% premium over the risk free rate, which is set to 5%, to account for the relatively low *market* risk inherent in residential land ownership.[13] The convenience yield on the lot price reflects the value of keeping completed lots in inventory less any ownership costs, such as property taxes, for

[12] The convenience yield reflects the value of keeping completed lots in inventory for *both* the developer and the builder, less any ownership costs, such as property taxes, etc., for holding the property.

[13] Land or lot prices, especially those entitled for residential construction, are not highly correlated with market returns, so a lower risk premium relative to other commercial real estate is justified. According to surveys and historical data, commercial built properties have a risk premium of approximately 4–5%.

Table 2 Expected return on unlevered and levered equity for varying values of price volatility σ

m, percentage of lots presold (%)	Base case					
	σ=0.10; option value= y=7.94%		σ=0.125; option value=y=10.52%		σ=0.15; option value= y=13.02%	
	Unlevered (%)	Levered (%)	Unlevered (%)	Levered (%)	Unlevered (%)	Levered (%)
0	9.90	26.21	9.90	22.74	9.90	17.59
25	9.06	23.17	9.08	21.21	9.11	18.31
50	8.14	19.46	8.17	18.40	8.21	16.81
75	7.15	15.13	7.16	14.52	7.20	13.64
100	6.07	10.14	6.04	9.62	6.03	8.98

holding the property. The volatility of the price process for completed lots, σ, is set to 12.5% which is in the range of reported results for residential real estate.[14]

Construction costs are set to be equal to 80% of the total completed lot value or \$80. This is chosen such that land values represent approximately 20% of the completed lot value which is common in the residential industry. Because the problem is homogenous of degree one in both M, the number of lots, and m, the number of lots presold, we normalize M to be equal to 1. We vary the number of presales, to vary from 0 to 100%.

Debt financing is set to be α_1=80% of the initial cash out of pocket, i.e., the land purchase costs *less* any proceeds from the sale of presale options, and α_2=80% for the financing of the construction costs. Upon default the lender is assumed to take back the property and receive γ=70% of its then market value. Finally, the presale option exercise price is normalized to be the initial lot price increased by the risk free rate over the time of construction, which is set to one year.

Tables 2, 3, and 4 display results for varying levels of lot price volatility. The option value as a percentage of the lot value (denoted as y as shown in Eq. 9) is increasing in volatility and ranges from 7.94 to 13.02% (the initial lot value is \$100, so the value of the option is simply 100 times y). In Table 2 for the base case, σ= 12.5%, the levered (unlevered) expected rates of return vary from 22.74% (9.90%) with no presales to 9.62% (6.04%) for the case where all lots are presold. The reduction in expected returns declines with increases in the level of presales to reflect the shifting of market risk from the developer to the lot purchaser. Note that the returns in the case of no presales are similar to those reported in return surveys (see Korpacz/Price Waterhouse Coopers 2006). What is interesting is that these high returns are only justified when there is no risk management involved, i.e., no presales for the project. Note that levered returns decline for all levels of presales as volatility is increased. This is due to the lender taking more of the equity return to

[14] See Cannon et al. (2006). Note that the model input represents the volatility of the developed land (lots); thus, as an option, raw land (pre construction) would have greater volatility.

Table 3 Spread on construction financing in basis points for varying values of price volatility σ

m, percentage of lots presold (%)	Base case		
	σ=0.10; spread in bps on debt	σ=0.125; spread in bps on debt	σ=0.15; spread in bps on debt
0	51	171	364
25	29	98	209
50	16	54	117
75	8	29	63
100	4	15	32

compensate them for the additional default risk on the debt as volatility in property prices increases.[15]

These results show that writing this type of call option reduces the risk to the developer. This is because of the unique way these binders are written with the premium reducing the strike price. The developer will abandon their option only when the value of the land falls below the premium-adjusted strike. If *X* is the "stated" at-the-money strike, and *P* is the option premium, the developer is protected from price declines from *X* to (*X*–*P*) so that they only bear the risk of declines *greater* than (*X*–*P*). This clearly reduces their risk.

Table 3 shows the endogenously determined spread on the debt financing over the risk free rate for varying levels of presales. For the base case, spreads on debt are 171 basis points with no presales and only 15 basis points when all lots are presold. Presales decrease spreads for two reasons. First, presales reduce the probability of developer default on the debt because of the probability of lot purchases [i.e., the exercise of the option(s) by the builder(s)] increases and this lowers the probability of developer default on the debt. Second and equally as important, with more presales less upfront financing is needed as the option premium from the presales is used by the developer to increase their equity investment into the property. Table 3 also shows that as volatility is increased (decreased), spreads on debt increase (decrease) accordingly to reflect the increase (decrease) in risk. Table 4 shows that although the probability of default increases with property price volatility, chances of default are significantly lowered in the presence of additional presales.

In Tables 5, 6, and 7 we show results for varied levels of debt financing. Table 6 shows that as debt financing increases from 75 to 80% and eventually to 85%, the spread on debt increases dramatically to reflect an increasing probability of default, which of course increases the expected costs of default. Table 6 shows that probabilities of default increase significantly as debt financing increases, e.g., less than 1% in the 75% financing case to 12% in the 85% financing case with no presales. To reflect greater default potential, the spread on debt with no presales goes from 44 basis points with 75% debt to 171 basis points with 80% debt. With 85%

[15] Developers could maximize property value by taking on no debt and avoiding default costs. However we assume that capital constraints exist in the private equity market and that debt financing is required for private land developers. As most land/lot developers are local privately-held developers, equity capital is scarce and they often need large of amounts of debt, thus the use of presale options to increase equity and reduce credit spreads. Modeling the optimal capital structure for a land developer would involve additional structure that is beyond the scope of this paper and is left for future work.

Table 4 Probability of builder exercise and probability of developer default for varying values of price volatility σ

m, percentage of lots presold (%)	Base case (probability of builder exercise=82.65% in all cases)		
	σ=0.10 (probability of developer default) (%)	σ=0.125 (probability of developer default) (%)	σ=0.15 (probability of developer default) (%)
0	0.71	3.01	7.16
25	0.38	1.65	3.98
50	0.20	0.88	2.17
75	0.10	0.45	1.13
100	0.04	0.22	0.55

debt the spread increases at an increasing rate to 625 basis points. The very large risk premium required by lenders when debt levels exceed 80% loan-to-value helps explain the use of mezzanine financing in the land development industry as a substitute for high cost debt and equity. This form of debt bridges the gap between the amount primary mortgage lenders can provide at a reasonable interest rate and the equity investment in the project. Because mezzanine financing is structured with its collateral as the equity owners' interest in the ownership entity instead of the underlying property itself, this reduces instances where the property must be sold upon default and where default costs are incurred. Mezzanine lenders, often real estate operators in their own right, take control of the ownership entity in default and attempt to operate the property without defaulting on the first mortgage, thereby often avoiding foreclosure and sale. This structure reduces the effective cost of all debt by minimizing expected default costs as the amount of leverage increases.

As with increasing volatility, the increasing spread on debt depresses expected levered equity returns as default costs eat up the return to equity. Lowering leverage from 80 to 75% lowers the cost of debt yet essentially *maintains* expected levered returns at 22.74%. Levered returns decline significantly for debt levels above 80%, again providing incentive for mezzanine financing in the case where constraints on raising equity exist. Since high levels of debt are typically used in the land development industry despite its cost (as shown in this table), it is evidence of the high cost of raising private equity capital as an alternative.

In Tables 8, 9, and 10 we vary the time to completion for the project. The presale option value as a percentage of the lot value is shown in Table 8. As with standard options, value is increasing in time and ranges from 3.89 to 31.22%. In the case of T= 2, the high option value significantly reduces the amount of needed debt financing as

Table 5 Expected return on levered equity for varying values of debt financing α_1=α_2

m, percentage of lots presold (%)	α_1=α_2=0.75; expected levered equity return (%)	α_1=α_2=0.80; expected levered equity return (%)	α_1=α_2=0.85; expected levered equity return (%)
0	22.54	22.74	8.79
25	20.02	21.21	15.79
50	16.94	18.40	16.51
75	13.30	14.52	13.94
100	9.04	9.62	9.01

Table 6 Spread on construction financing in basis points for varying values of debt financing $\alpha_1=\alpha_2$

m, percentage of lots presold (%)	$\alpha_1=\alpha_2=0.75$; spread in basis points on debt	$\alpha_1=\alpha_2=0.80$; spread in basis points on debt	$\alpha_1=\alpha_2=0.85$; spread in basis points on debt
0	44	171	625
25	24	98	340
50	12	54	192
75	6	29	107
100	3	15	58

presales are made and the binders are used as an equity infusion into the project. This increased equity reduces equity risk and also levered equity returns as is shown in Table 8. Increasing the time to complete the project also increases the cumulative variance of completed lot values, which in turn increases the probability of a low lot price and eventual developer default. Table 10 shows that with no presales, default is less than 1% for a six month option, 3% for a one year option and nearly 10% for an option of 2 years. The increasing cumulative variance is also illustrated in Table 9 in the increasing financing spreads. Note however, that the probability of *builder* exercise (shown in Table 10) of the presale option increases with time as the positive drift of completed property prices overcomes the increase in cumulative volatility.[16]

In Tables 11 and 12, we vary the risk-adjusted drift rate of the completed property price over time. The drift rate plus the convenience yield reflects the risk-adjusted required unlevered return on the equity. Thus, returns on levered equity increase as the risk adjusted unlevered returns (and unlevered risk premiums) increase. In today's low risk premium environment, it is likely that return on levered equity are closer to the 15–20% range for development projects without presales as is shown in Table 11 for the $\mu=0.07$ and the base case $\mu=0.08$ results.

Because risk adjusted returns do not affect debt pricing or option values, spreads remain the same as in the base case and are therefore not shown in Tables 11 and 12.[17] However Table 12 shows that *real* probabilities of builder default decrease with increases in the drift rate as the likelihood of very low property prices is mitigated. *Real* builder exercise probabilities also increase with the risk adjusted drift rate.

In Tables 13, 14 and 15 we vary the convenience yield. The convenience yield reflects the value of keeping completed lots in inventory for *both* the developer and the builder less any ownership costs, such as property taxes, for holding the property. As convenience yield increases, less of the property's risk adjusted return comes from appreciation (growth) on the completed property price. Therefore, the probability of default by the builder increases slightly over the range of convenience yields that we have chosen to compare. This is reflected in slightly increased spreads on the debt financing. Also the value of the option declines as the growth component decreases (as the convenience yield increases).

[16] Builder exercise prices are held constant across the scenarios.

[17] This is because risk-neutral pricing results are not affected by the risk adjusted return parameters.

Table 7 Probability of builder exercise and probability of developer default for varying values of debt financing $\alpha_1=\alpha_2$

m, percentage of lots presold (%)	Probability of builder exercise=82.65% in all cases		
	$\alpha_1=\alpha_2=0.75$ (probability of developer default) (%)	$\alpha_1=\alpha_2=0.80$ (probability of developer default) (%)	$\alpha_1=\alpha_2=0.85$ (probability of developer default) (%)
0	0.70	3.01	12.07
25	0.36	1.65	6.30
50	0.18	0.88	3.41
75	0.08	0.45	1.82
100	0.04	0.22	0.94

Table 8 Expected return on levered equity for varying values of time to completion T

m, percentage of lots presold (%)	Base case		
	$T=0.5$; $y=3.89\%$ (expected levered equity return) (%)	$T=1$; $y=10.52\%$ (expected levered equity return) (%)	$T=2$; $y=31.22\%$ (expected levered equity return) (%)
0	27.38	22.74	18.04
25	24.75	21.21	20.59
50	21.88	18.40	19.39
75	18.78	14.52	14.60
100	15.47	9.62	5.38

Table 9 Spread on construction financing in basis points for varying values of time to completion T

m, percentage of lots presold (%)	Base case		
	$T=0.5$ (spread in basis points on debt)	$T=1$ (spread in basis points on debt)	$T=2$ (spread in basis points on debt)
0	44	171	319
25	31	98	117
50	22	54	28
75	16	29	6
100	11	15	1

Table 10 Probability of builder exercise and probability of developer default for varying values time to completion T

m, percentage of lots presold (%)	Base case		
	T=0.5 (probability of builder exercise 58.39%) (probability of developer default) (%)	T=1 (probability of builder exercise 82.65%) (probability of developer default) (%)	T=2 (probability of builder exercise 99.21%) (probability of developer default) (%)
0	0.42	3.01	9.87
25	0.30	1.65	4.05
50	0.21	0.88	0.66
75	0.14	0.45	0.11
100	0.10	0.22	0.01

Table 11 Expected return on levered equity for varying values of expected growth rate in price μ

m, percentage of lots presold (%)	Base case		
	μ=0.07; y=10.52% (expected levered equity return) (%)	μ=0.08; y=10.52% (expected levered equity return) (%)	μ=0.09; y=10.52% (expected levered equity return) (%)
0	15.40	22.74	29.78
25	15.06	21.21	27.12
50	13.58	18.40	23.04
75	11.23	14.52	17.65
100	8.12	9.62	10.93

Table 12 Probability of builder exercise and probability of developer default for varying values expected growth rate in price μ

m, percentage of lots presold (%)	Base case		
	μ=0.07 (probability of builder exercise 80.53%) (probability of developer default) (%)	μ=0.08 (probability of builder exercise 82.65%) (probability of developer default) (%)	μ=0.09 (probability of builder exercise 84.63%) (probability of developer default) (%)
0	3.60	3.01	2.50
25	2.01	1.65	1.35
50	1.09	0.88	0.71
75	0.56	0.45	0.35
100	0.28	0.22	0.17

Table 13 Expected return on levered equity for varying values of convenience yield δ

m, percentage of lots presold (5)	Base case		
	δ=0; y=14.52% (expected levered equity return) (5)	δ=0.01; y=10.52% (expected levered equity return) (5)	δ=0.02; y=8.21% (expected levered equity return) (5)
0	22.59	22.74	22.90
25	21.42	21.21	21.24
50	18.33	18.40	18.68
75	13.72	14.52	15.33
100	7.67	9.62	11.24

Table 14 Spread on construction financing in basis points for varying values of convenience yield δ

m, percentage of lots presold (%)	Base case		
	δ=0 (spread in basis points on debt)	δ=0.01 (spread in basis points on debt)	δ=0.02 (spread in basis points on debt)
0	171	171	171
25	80	98	110
50	36	54	70
75	14	29	43
100	5	15	26

Table 15 Probability of builder exercise and probability of developer default for varying values of convenience yield δ

m, percentage of lots presold (%)	Base case		
	δ=0 (probability of builder exercise 91.04%) (probability of developer default) (%)	δ=0.01 (probability of builder exercise 82.65%) (probability of developer default) (%)	δ=0.02 (probability of builder exercise 74.79%) (probability of developer default) (%)
0	3.02	3.01	3.01
25	1.34	1.65	1.88
50	0.56	0.88	1.15
75	0.21	0.45	0.69
100	0.07	0.22	0.40

Generally, the model results discussed above are consistent with the high rates of return observed in the empirical surveys; however, they show that risk management of market risk through presales can substantially lower risk and required equity returns. The reduction of default risk as a result of presales can also justify lower spreads on construction debt financing in the presence of presales.

Conclusion

In this paper we have developed a contingent-claims model of the land development process which incorporates many of the unique features of this market. For example, we have developed a closed-form pricing model for a call option on lots where the option premium is used to reduce the strike price. Similarly, we have incorporated the use of presales and demonstrated that these are an effective way of reallocating market risk from the developer to the builder.

The model is rich enough to provide a theoretical understanding of a number of phenomena that have been observed in the market. Specifically the model demonstrates that

- using options contracts to pre-sell lots reduces risk to the developer by shifting some market risk to the lot purchaser. Under the option contract, the lot-purchaser bears the risk of the property declining in value from the strike price down to the strike price less the option premium, with the developer retaining the risk of any further declines. This shifting of risk justifies the developer accepting lower returns on presold projects.
- the high rates of return observed in empirical studies are consistent with the level of risk taken by developers. The model also suggests that developers may be justified in pursuing projects with substantially lower returns to equity when presales are prevalent.
- the reduction in risk to the developer through the use of options contracts also justifies construction lenders charging lower spreads on pre-sold projects. This is due to two effects: the inherently less risky nature of the project and the increased equity which the option premiums provide for the project.
- lenders rationally demand very high risk premia when loan-to-value levels exceed 80%, and this demonstrates the prevalence of mezzanine financing in such cases.
- the real probability of the developer default is a nonlinear, decreasing function of pre-sales.

Future extensions to the model could include explicitly incorporating the process through which the developer and homebuilder determine the strike price, incorporating and endogenous optimal capital structure, and determining an optimal number of lots for the homebuilder to "take down."

References

Cannon, S., Miller, N. G., & Pandler, G. S. (2006). Risk and return in the U.S. housing market: a cross-sectional asset-pricing approach. *Real Estate Economics, 34*(4), 519–552.

Lai, R. N., Wong, K., & Zhou, Y. (2004). Sale before completion of development: pricing and strategy. *Real Estate Economics, 32*(2), 329–357.

Owens, R. W. (1998). Subdivision development: bridging theory and practice. *The Appraisal Journal*, 274–281.

Korpacz/Price Waterhouse Coopers. *Korpacz Real Estate Investor Survey.* 2006.

Shackleton, M., & Wojakowski, R. (2001). On the expected payoff and true probability of exercise of European options. *Applied Economic Letters, 8*, 269–271.

Shackleton, M., & Wojakowski, R. (2002). The expected return and exercise time of Merton-style real options. *Journal of Business Finance and Accounting, 29*(3), 541–555.

Sirmans, C. F., Turnbull, G. K., & Dombrow, J. (1997) Residential development risk and land prices. *Journal of Regional Science, 37*(4), 613–628.