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Land Development in Emerging Markets

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One of the most important issues in emerging markets is the timing and intensity of land development decisions and how these decisions affect property values. In these markets, newly developed office space and residential units often account for a substantial proportion of the aggregate supply of similar types of developed properties. In this article I use a real option model to study the land development problem faced by a central planner. The optimal capital intensity, the value of land and the post-development rents and property values in these markets are strikingly lower than the corresponding values in the markets where the demand is perfectly elastic. Furthermore, the optimal capital intensity and the value of land are most sensitive to the market demand conditions in the emerging markets experiencing the fastest growth or greatest uncertainty, or at times when interest rates or construction costs are lowest.

Keywords

Land value, Capital intensity, Equilibrium, Emerging markets.

Introduction

One of the most important issues in emerging markets is the timing and intensity of land development decisions and how these decisions affect property values. In these markets, newly developed office space and residential units often account for a substantial proportion of the aggregate supply of similar types of developed properties. A good example is the rapid development in the Finance and Trade zone at the heart of the Pudong business district located in Shanghai, China. Over a short period of time in the 1990s, a large number of office buildings and hotels were developed in that area. Office and hotel rents, declined substantially as a result of the rapid development.

It has been argued that rapid land development in Asia and especially in China is to accommodate domestic economic growth and increases in international trade. The steep declines in rents and property values have surprised many developers and investors. Existing land development models, focused on the U.S. and other developed markets cannot fully explain this negative impact on property values as the Asian markets exhibit two distinct characteristics. First, in developed markets, urban development typically takes place slowly. In Asia, high growth expectations have led to massive land development occurring within a short period of time and within a relatively small geographic region. Secondly, in developed countries the land development market is more competitive with a large number of developers competing for land. In Asia, land development decisions are often made by a few developers or by a central planner. These two characteristics of Asian markets make it important to study the land development problem in Asia and other emerging markets using an equilibrium setting which takes into account the adverse impact of increased supply on rents and property values.

In this article I study the land development problem faced by a central planner by generalizing the model of Capozza and Li (1994) to an equilibrium setting. By assumption, the market demand for the newly developed properties is negatively related to the rental rate for the developed assets. In addition, the demand is related to an exogenous factor which summarizes information such as the existing supply, the population and income growth in the development areas. The evolution of the factor over time depends on the expected growth and volatility of future rents.

The land development problem under the foregone assumptions is solved analytically. The optimal timing and capital intensity of land development are obtained explicitly. Comparative statics results provide important insights into the land development decision in the emerging markets. First, if demand is more elastic, i.e., land development has a small adverse effect on the post-development rents, then land will be developed at greater capital intensity and the value of land will be higher. However, land development could be deferred or hastened depending on the output elasticity. More importantly, the optimal capital intensity and the value of land are more sensitive to demand elasticity if the value of the land is higher. Consequently, the impact on the capital intensity and the value of land due to changes in the market conditions is most dramatic in areas experiencing the fastest growth or greatest uncertainty, or at times when interest rates or construction costs are lowest. These results help explain the variation in capital intensity and property values in China and other emerging markets.

Recent papers by Pindyck (1988), Dixit (1989), and Williams (1993), amongst others, illustrate the importance of analyzing capital investments in output market equilibrium. However, these researchers typically assume that development takes place sequentially at a fixed or maximum intensity. They often ignore the impact of variable intensity on the timing of investment and property values as illustrated by Capozza and Li (1994). Therefore, the results about the effects of changes in the market demand conditions on the optimal capital intensity and the value of land are novel features of this article.

The rest of the article is organized as follows. Section 2 describes the land development problem and presents analytic solutions. Section 3 discusses the comparative statics results. The last section concludes the article.

The Model

Consider the decision to develop a category of real assets such as single-family houses, apartment or office buildings by a central planner or a single developer. After the land is developed, the developer can sell per unit of rental space of the developed asset at the price $p(t)$ at time t. The net income (rental rate) that can be generated from the use of one unit of the capacity is $R(t)$.

Assumptions

By assumption, the rental rate per unit of the developed assets is

$$R(t) = x(t) - \frac{Q(t)}{x} \qquad (1)$$

where $x(t)$ is a state variable which summarizes information such as the existing supply of the developed properties, population growth and per capita income of the population (see, e.g., Capozza and Helsley (1989), Williams (1993)). $Q(t)$ is the aggregate demand for newly developed assets. It should be noted that $Q(t)$ is nonnegative and $R(t)$ changes with $x(t)$. x is a coefficient which determines the elasticity of the market demand for the developed assets with respect to the rental rate.[1] From (1), The larger is x , the

[1] According to the standard economics textbook, the demand elasticity is defined as

more elastic the demand for the units of the developed assets. If x goes to ∞, the rental rate approaches the state variable $x(t)$. In this case, the rental rate is exogenous and the developer is a price taker.

The state variable $x(t)$ is assumed to follow a Brownian motion (normal diffusion):[2]

$$dx = g dt + s dz \tag{2}$$

where z is a standard Wiener process. The constant drift g and standard deviation s capture the expected growth and volatility of future rents. Eq. (2) implies that for $s \geq t$,

$$E[x(s) \mid x(t)] = x(t) + g(s-t), \tag{3}$$

$$Var[x(s) \mid x(t)] = s^2 (s-t). \tag{4}$$

Net rents or cash flows are often assumed to follow the normal process in the urban economics literature (Capozza and Helsley (1990), Capozza and Sick (1991), and Capozza and Li (1994)). Hence, the results in this paper can be readily compared with those in the existing literature.

The Developer's Problem

Assume that the developer can choose to develop the asset at capital intensity, i.e., capital/land ratio k. Suppose that capital intensity, k, creates capacity or output according to the production function, $q(k)$, which is increasing and concave in k. If an investment, once undertaken, remains in one use permanently and the capital does not depreciate, then the value of the developed asset is

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$-(dQ/dR)(R/Q) = x(R/Q)$. As will be seen, $x(t)$ is assumed to be normal. The linear demand function (1) entails the mathematical tractability under the normality assumption. See Williams (1993) for a related demand function under the log-normality assumption. For ease of notation, x will be called "elasticity", which should be understood as $-(dQ/dR)$ in this paper.

[2]There are several advantages of a normal process over a lognormal process in the land development models. For example, real cash flows are allowed to be negative. The disadvantage is that negative prices of property are not rule out. See Capozza and Li (1994, footnote 14) for a detailed discussion.

$$P(t,k) = q(k)p(t), \tag{5}$$

where the price of output, p, is equal to the present value of the future rents:

$$p(t) = \mathrm{E}\left[\int_t^{\infty} R(s)\, e^{-r(s-t)} ds \mid x(t)\right], \tag{6}$$

where r is the discount rate for the rents.

The developer can choose the time of development, T, and intensity of development, k, to maximize the present value of net cash flows from the assets to be developed at time T:

$$W(x) = \max_T \mathrm{E}\left[V(x(T))\, e^{-r(T-t)} \mid x(t)\right], \tag{7}$$

where $V(x)$ is the intrinsic value of the land. The intrinsic value is the difference between the value of the developed asset, P, and the cost of development, ck, given by

$$V(x) = \max_k \left[P(t,k) - ck\right] \tag{8}$$

where c is a constant. Note that in (6) and (7), expectations are taken by assuming risk neutrality. Alternatively, the market price of risk could be accounted for by adjusting the drift term in the stochastic process for the state variable in (2).

Equilibrium

In equilibrium, the aggregate demand for the newly developed assets Q must be equal to the aggregate supply of these units:

$$Q(t) = q(k). \tag{9}$$

Substituting (9) into (1) yields

$$R(t) = x(t) - \frac{q(k)}{x}. \tag{10}$$

This implies that the equilibrium rental rate will be adversely affected by the total rental units to be produced by developers. Under risk neutrality, expectation is taken inside the integral in (6). Using (3) and (10), the unit price of rental space, p, can be derived to be

$$p(t) = \frac{1}{r}[x(t) - \frac{q}{x}] + \frac{g}{r^2}. \qquad (11)$$

To maximize the intrinsic value given by (8) at time T, the optimal capital intensity, k^*, from (5) and (11), must satisfy the following first-order condition,

$$q'(k^*)\, p^* = c + [\frac{q'(k^*)}{r}][\frac{q(k^*)}{x}], \qquad (12)$$

where the superscript * denotes the value of a variable at the time of development, e.g., $p^* = p(T)$. Eq. (12) says that at the optimal intensity the expected marginal benefit of an extra unit of capital equals the marginal cost of capital plus the present value of the decline in rents due to the additional supply of the rental space from the development. Note that the first term on the right hand side of (12) is same as that in the model with exogenous rental rates (Capozza and Li (1994), eq (8)). The second term arises from the adverse impact on rents from new development as a result of the downward-sloping demand curve for rental space. If demand is perfectly elastic with $x = \infty$, this term vanishes.

The fundamental differential equation of optimal stopping for the problem (7) is an ordinary differential equation:

$$L[W] \equiv \frac{s^2}{2} W_{xx} + g W_x - rW = 0. \qquad (13)$$

The boundary conditions are

$$W(x^*) = V(x^*), \qquad (14)$$

$$W_x(x^*) = V_x(x^*), \qquad (15)$$

$$W(-\infty) = 0. \qquad (16)$$

$$W(x) \geq 0, \qquad (17)$$

Equations (14) and (15) are well-known continuity and smooth-pasting conditions. Equations (16) and (17) are non-negativity and limiting conditions, respectively. The solution to (13) subject to boundary conditions (14)-(17) is

$$W(x) = V(x^*)e^{-a(x^* - x)}, \quad (18)$$

where $$a = \frac{1}{s^2}[-g + \sqrt{g^2 + 2s^2 r}]. \quad (19)$$

The intrinsic value of land at the time of development satisfies

$$V(x^*) = \frac{q(k^*)}{ar}. \quad (20)$$

Since $x^*- x = g\,\mathrm{E}[T-t]$ (see Capozza and Li (1994)), (18) may be rewritten as

$$W(x) = V(x^*)\,e^{-(ag)\mathrm{E}(T-t)}. \quad (21)$$

In the limit as s goes to 0, a approaches r/g. In this deterministic case, the option value reduces to the present value of the intrinsic value at the time of development, $W(x) = V(x^*)e^{-r(T-t)}$. The stochastic case is a similar present value but the discount rate is lower, $ag < r$, and the intrinsic value at development point (20) is higher.

Equating the right hand sides of (8) and (20), and using (11) give the stochastic version of the deterministic first-order condition with respect to the conversion time,

$$q(k^*)R^* = rck^* + q(k^*)[\frac{1}{a} - \frac{g}{r}], \quad (22)$$

where $R^* = x^* - q(k^*)/x$. Eq. (22) says conversion will occur when the rent foregone by waiting an additional unit of time, $q(k^*)R^*$, is equal to the opportunity cost of the capital, rck^*, needed in the conversion, plus the premium arising from uncertainty. This premium is positive and vanishes as s goes to zero.

Assume now that the production function is concave and normalized: $q(k) = k^g$, $(0 < g < 1)$. From (10) and (22), the value of the state variable that triggers development, x^*, and the optimal capital intensity, k^*, satisfy:

$$x^* = (1/x)(k^*)^g + (rc)(k^*)^{1-g} + [\frac{1}{a} - \frac{g}{r}]. \quad (23)$$

Then substituting (23) into (12) and using (11) yield

$$f(k^*) \equiv (1/x)(k^*)^{?} + [\frac{(1-g)rc}{?}](k^*)^{1-?} - \frac{1}{a} = 0. \qquad (24)$$

Equations (23) and (24) jointly determine the optimal intensity of development, k^*, and optimal timing, x^*. For general values of g , k^* can be determined numerically from (22). Further, closed-form formulas are obtained for several special values of the output elasticity, g :

$$k^* = \left[\frac{2/a}{(1/x) + \sqrt{(1/x)^2 + (8rc)/a}}\right]^3 \quad \text{if } g = 1/3,$$
$$k^* = \left[\frac{1/a}{(1/x) + rc}\right]^2 \quad \text{if } g = 1/2, \qquad (25)$$
$$k^* = \left[\frac{2/a}{(rc/2) + \sqrt{[(\mathrm{rc})^2/4] + [4/(ax)]}}\right]^3 \quad \text{if } g = 2/3.$$

Given the optimal capital intensity, k^*, the optimal timing, x^*, can be obtained from (23).

Comparative Statics

The comparative statics are presented in this section. Most of the comparative statics results must be calculated numerically since the solutions (23) and (25) are complicated functions of the model parameters. Numerical computations, however, have the advantage of revealing magnitudes of the comparative statics results. Tables 1-5 report the calculated values for the following six variables: the optimal timing variable, x^*, the hurdle rent, R^*, the optimal capital intensity, k^*, the optimal output density, q^*, the hurdle land value, V^*, and the option value of land, W. In each of the tables, the comparative results for demand elasticity, x , and one of the five following parameters, g, s, r, c and g are reported. In this way, it may be seen the conditions under which the timing and intensity of land development and option value of land are most sensitive to the demand elasticity parameter.

The top portion of Table 1 gives the base values of each of the model parameters. In particular, the output elasticity in the production function is assumed to be $\gamma = 2/3$. The middle of the table reports the computed values of each of the six variables for alternative values of demand elasticity and the expected growth of rents. First of all, for each given value of demand elasticity, all variables of interest, in particular, the post-development hurdle rent, R^*, capital intensity, k^*, and the option value of land, W, increase in

Table 1: Comparative Statics Results for Demand Elasticity and Expected Growth of Rents

Base Value					
Initial Value	Growth Rate	Std. Dev.	Interest Rate	Const. Cost	Output Elasticity
x	g	s	r	c	g
0.50	0.07	0.10	0.06	10.00	2/3
	Demand Elasticity, x				
	1	5	10	20	∞
	Expected growth g = 0.02				
Timing, x^*	0.84	0.97	1.02	1.07	1.17
Hurdle Rent, R^*	0.51	0.77	0.88	0.98	1.17
Capital Intensity, k^*	0.19	1.00	1.70	2.51	4.63
Output Density, q^*	0.33	1.00	1.42	1.85	2.78
Intrinsic Value, V^*	2.73	8.33	11.85	15.39	23.15
Option Value of Land, W	1.39	3.28	4.15	4.88	6.10
	Expected growth g = 0.07				
Timing, x^*	1.59	1.86	2.00	2.14	2.54
Hurdle Rent, R^*	0.65	1.17	1.46	1.75	2.54
Capital Intensity, k^*	0.92	6.28	12.49	22.04	69.60
Output Density, q^*	0.94	3.40	5.38	7.86	16.92
Intrinsic Value, V^*	19.39	70.01	110.71	161.70	348.04
Option Value of Land, W	8.00	23.35	32.90	42.72	66.88
	Expected growth g = 0.12				
Timing, x^*	2.47	2.84	3.06	3.30	4.12
Hurdle Rent, R^*	0.81	1.56	2.00	2.48	4.12
Capital Intensity, k^*	2.13	16.22	34.65	66.83	314.60
Output Density, q^*	1.65	6.41	10.63	16.47	46.26
Intrinsic Value, V^*	56.29	217.94	361.50	560.14	1573.37
Option Value of Land, W	21.46	69.21	103.13	142.12	266.72

the expected growth in rent. This result extends the finding of Capozza and Li (1994) who study the case with demand elasticity, $g = \infty$. Second, all of the variables also increase in demand elasticity for each given value of the expected growth of rents. From the inverse demand function (8), if demand is more elastic, land development has a small adverse effect on the post-development rents. Hence, a more elastic demand implies higher optimal capital intensity and higher option value of land. As a result, development is deferred. More importantly, most of the variables, including the hurdle rent, capital intensity, and the option value of land, are more sensitive to demand elasticity if rents are expected to increase at a faster rate. For example, as the demand elasticity, χ, doubles from 5 to 10, the hurdle rent, capital intensity and the option value of land rise by 14 percent, 70 percent, and 27 percent, if the expected growth of rents $g = 0.02$. In contrast, for the same change in the demand elasticity, the hurdle rent, the capital intensity, and the option value of land increase by 28 percent, 113 percent and 49 percent, respectively, if the expected growth of rents $g = 0.12$.

Table 2 reports the variables of interest for alternative values of demand elasticity and volatility of rents. First, as in other option models of land prices, a higher volatility of rents implies deferred development, higher capital intensity, and higher option value of land for each given value of demand elasticity. Second, for each given level of volatility, more elastic demand also implies more delay in land development, more capital intensive land development, and higher option value of land. Further, the sensitivities of the capital intensity and the option value of land to demand elasticity increase in the level of volatility. However, unlike the expected growth in rents, the level of volatility does not appear to have any positive impact on the sensitivity of the hurdle rent to demand elasticity.

The comparative statics results for demand elasticity and interest rates are given in Table 3. First, for each level of demand elasticity, higher interest rates imply lower capital intensity and lower option value of land but earlier land development. These results are consistent with those reported by Capozza and Li (1994). The perverse effect of interest rates on the timing of investment is further analyzed by Capozza and Li (1996) in a model with a more general production function. Second, the lower the interest rate, the more sensitive are the timing and intensity of land development, and the option value of land to demand elasticity.

Table 4 reports the option value of land and other variables of interest for alternative values of demand elasticity and the construction cost. In the model of Capozza and Li (1994) who assume perfectly elastic demand, $g = \infty$, the size of the construction cost does not affect the timing of investment even though the capital intensity and the value of land are inversely related to the construction cost. Capozza and Li attribute puzzling result to the restrictive form of Cobb-Douglas production function. The result here, however, shows that finite instead of infinite elasticity of demand may resolve the puzzle. For each of the finite, level of demand elasticity, the computed values suggest that a higher hurdle rent is required to offset the higher cost of construction. In addition, the hurdle rent, capital intensity and the option value of land are more sensitive to demand elasticity if the construction cost is lower.

Table 2: Comparative Statics Results for Demand Elasticity and Volatility of Rents

	Base Value					
	Initial Value	Growth Rate	Std. Dev.	Interest Rate	Const. Cost	Output Elasticity
	x	*g*	*s*	*r*	*c*	*g*
	0.50	0.07	0.10	0.06	10.00	2/3
		Demand Elasticity, *x*				
		1	5	10	20	∞
		Volatility *s* = 0.05				
Timing, *x**		1.49	1.74	1.88	2.02	2.39
Hurdle Rent, *R**		0.59	1.10	1.37	1.65	2.39
Capital Intensity, *k**		0.85	5.80	11.45	20.06	61.49
Output Density, *q**		0.90	3.23	5.08	7.38	15.58
Intrinsic Value, *V**		17.76	63.69	100.28	145.72	307.49
Option Value of Land, *W*		7.72	22.34	31.32	40.48	62.55
		Volatility *s* = 0.10				
Timing, *x**		1.59	1.86	2.00	2.14	2.54
Hurdle Rent, *R**		0.65	1.17	1.46	1.75	2.54
Capital Intensity, *k**		0.92	6.28	12.49	22.04	69.60
Output Density, *q**		0.94	3.40	5.38	7.86	16.92
Intrinsic Value, *V**		19.39	70.01	110.71	161.70	348.04
Option Value of Land, *W*		8.00	23.35	32.90	42.72	66.88
		Volatility *s* = 0.15				
Timing, *x**		1.75	2.03	2.18	2.33	2.76
Hurdle Rent, *R**		0.75	1.29	1.59	1.90	2.76
Capital Intensity, *k**		1.01	7.04	14.13	25.22	83.19

Output Density, q^*	1.01	3.67	5.85	8.60	19.06
Intrinsic Value, V^*	22.02	80.20	127.60	187.75	416.02
Option Value of Land, W	8.45	24.98	35.43	46.33	73.94

Table 3: Comparative Statics Results for Demand Elasticity and Interest Rates

Base Value					
Initial Value	Growth Rate	Std. Dev.	Interest Rate	Const. Cost	Output Elasticity
x	*g*	*s*	*r*	*c*	*g*
0.50	0.07	0.10	0.06	10.00	2/3
	Demand Elasticity, *x*				
	1	5	10	20	∞
	Interest Rate *r* = 0.04				
Timing, *x**	2.14	2.40	2.56	2.76	3.71
Hurdle Rent, *R**	0.57	1.09	1.42	1.81	3.70
Capital Intensity, *k**	1.96	16.71	38.63	82.55	750.97
Output Density, *q**	1.57	6.54	11.43	18.96	82.62
Intrinsic Value, *V**	71.31	297.22	519.55	862.00	3756.55
Option Value of Land, *W*	28.97	104.63	167.06	249.03	644.73
	Interest Rate *r* = 0.06				
Timing, *x**	1.59	1.86	2.00	2.14	2.54
Hurdle Rent, *R**	0.65	1.17	1.46	1.75	2.54
Capital Intensity, *k**	0.92	6.28	12.49	22.04	69.60
Output Density, *q**	0.94	3.40	5.38	7.86	16.92
Intrinsic Value, *V**	19.39	70.01	110.71	161.70	348.04
Option Value of Land, *W*	8.00	23.35	32.90	42.72	66.88
	Interest Rate *r* = 0.08				
Timing, *x**	1.32	1.56	1.67	1.77	1.95
Hurdle Rent, *R**	0.70	1.18	1.40	1.59	1.95
Capital Intensity, *k**	0.49	2.68	4.59	6.88	13.03
Output Density, *q**	0.63	1.93	2.76	3.62	5.54
Intrinsic Value, *V**	7.36	22.70	32.52	42.55	65.17
Option Value of Land, *W*	3.07	7.34	9.36	11.06	13.98

Table 4: Comparative Statics Results for Demand Elasticity and Construction Cost

Base Value					
Initial Value	Growth Rate	Std. Dev.	Interest Rate	Const. Cost	Output Elasticity
x	*g*	*s*	*r*	*c*	*g*
0.50	0.07	0.10	0.06	10.00	2/3
	Demand Elasticity, *x*				
	1	5	10	20	∞
	Construction Cost $c = 8$				
Timing, *x**	1.54	1.77	1.90	2.05	2.54
Hurdle Rent, *R**	0.55	1.01	1.27	1.56	2.54
Capital Intensity, *k**	0.99	7.48	15.86	30.30	135.90
Output Density, *q**	0.99	3.82	6.31	9.72	26.43
Intrinsic Value, *V**	20.46	78.66	129.84	199.92	543.73
Option Value of Land, *W*	8.80	28.09	41.60	56.95	104.49
	Construction Cost $c = 10$				
Timing, *x**	1.59	1.86	2.00	2.14	2.54
Hurdle Rent, *R**	0.65	1.17	1.46	1.75	2.54
Capital Intensity, *k**	0.92	6.28	12.49	22.04	69.60
Output Density, *q**	0.94	3.40	5.38	7.86	16.92
Intrinsic Value, *V**	19.39	70.01	110.71	161.70	348.04
Option Value of Land, *W*	8.00	23.35	32.90	42.72	66.88
	Construction Cost $c = 12$				
Timing, *x**	1.64	1.93	2.07	2.21	2.54
Hurdle Rent, *R**	0.75	1.32	1.61	1.89	2.54
Capital Intensity, *k**	0.85	5.29	9.90	16.30	40.28
Output Density, *q**	0.89	3.04	4.61	6.43	11.75
Intrinsic Value, *V**	18.39	62.43	94.85	132.23	241.72
Option Value of Land, *W*	7.29	19.62	26.48	32.96	46.45

Table 5 provides the comparative statics results for demand elasticity, x. First, for the given base values of parameters, higher output elasticity implies more capital intensive land development at a later date and hence higher intrinsic value of land. However, only with high levels of demand elasticity, the increase in the intrinsic value of land due to the increase in the output elasticity is large enough to result in an increase in the option value of land. Second, the results show that the effect of demand elasticity on the timing of land development depends on the level of output elasticity. With a low level of output elasticity, *g* = ?, an increase in the demand elasticity hastens land development. If the output elasticity is ½, the change in the demand elasticity does not affect the timing of land development. However, if the output elasticity is ? , more elastic demand defers land development. The result for the case of *g* = ? is consistent with the finding of Williams (1993) who assumes a constant return to scale. Nevertheless, the post-development hurdle rent, the optimal capital intensity, and the option value of land rise with demand elasticity for any level of output elasticity. The increase in the hurdle value, capital intensity, and the option value of land are more impressive if the output elasticity is higher.

Table 5: Comparative Statics Results for Demand Elasticity and Output Elasticity

		Base Value			
Initial Value	Growth Rate	Std. Dev.	Interest Rate	Const. Cost	Output Elasticity
x	*g*	*s*	*r*	*c*	*g*
0.50	0.07	0.10	0.06	10.00	2/3
		Demand Elasticity, *x*			
	1	5	10	20	∞
		Output Elasticity *g* = 1/3			
Timing, *x**	1.02	0.78	0.73	0.71	0.68
Hurdle Rent, *R**	0.34	0.59	0.64	0.66	0.68
Capital Intensity, *k**	0.31	0.82	0.92	0.98	1.04
Output Density, *q**	0.68	0.93	0.97	0.99	1.01
Intrinsic Value, *V**	13.98	19.22	20.02	20.44	20.86
Option Value of Land, *W*	9.14	15.34	16.57	17.25	17.96
		Output Elasticity *g* = 1/2			
Timing, *x**	1.30	1.30	1.30	1.30	1.30
Hurdle Rent, *R**	0.53	0.99	1.13	1.21	1.30
Capital Intensity, *k**	0.60	2.38	3.11	3.61	4.23
Output Density, *q**	0.77	1.54	1.76	1.90	2.06
Intrinsic Value, *V**	15.87	31.73	36.27	39.06	42.31
Option Value of Land, *W*	8.29	16.57	18.94	20.40	22.10
		Output Elasticity *g* = 2/3			

Timing, *x**	1.59	1.86	2.00	2.14	2.54
Hurdle Rent, *R**	0.65	1.17	1.46	1.75	2.54
Capital Intensity, *k**	0.92	6.28	12.49	22.04	69.63
Output Density, *q**	0.94	3.40	5.38	7.86	16.92
Intrinsic Value, *V**	19.39	70.01	110.71	161.70	348.14
Option Value of Land, *W*	8.00	23.35	32.90	42.72	66.89

Conclusions

In this article, an urban land development model is developed for the emerging markets where a central planner must determine the timing and intensity of land development. When land development adversely affects post-development rents, the optimal capital intensity and the value of land in these markets are strikingly lower than the corresponding values in the markets where demand is perfectly elastic. As the results show, the impact on the optimal capital intensity and the value of land from changes in demand conditions is most dramatic in areas experiencing the fastest growth or greatest uncertainty, or at times when interest rates or construction costs are lowest.

The findings in the paper help explain the cyclical movements of property values in many fast growing Asian and other emerging markets. These markets are characterized by high growth expectations and high volatility of future growth in income and population. The results here show that when rapid urban development takes place according to the high expectations, these markets are most at risk when the market conditions turn unfavorably.

The models developed in this paper are based on many simplifying assumptions. For instance, I assumed that there is a central planner or a single developer who makes the land development decisions. In addition, I assumed that the interest rate is constant. Models of sequential and incremental investments have been developed in the literature (see Dixit and Pindyck (1994) for a review). Capital investment with stochastic interest rates is analyzed by Ingersoll and Ross (1992). In future research, one may extend this paper by relaxing these assumptions to explain further the puzzles in the Asian and other emerging country's real estate markets.

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