INVESTIGATION OF THE VIABILITY OF DEVELOPER-ORIENTED REAL ESTATE PUT OPTIONS

A survey indicates that there is a potential need of specialized markets for originating real estate put options.

by Robert R. Trippi and Nadedjo Lare

Call options are financial contracts that confer upon their holder the right to buy an asset at a predetermined price on or before a certain date. Put options confer the right to sell an asset at a predetermined price on or before a certain date. Options of either type may or may not be exercised.

The use of options in the real estate industry has been the subject of a number of studies. In some involving real estate options, the aim has been to explore methods of improving market efficiency in terms of the liquidity of the instruments; in others, the focus has been on the normative pricing of such options.

This article reports on a study that investigates the marketability of three potential new classes of real estate options which ought to be of interest to income property developers:

- the option to sell a project upon future completion at the currently appraised value of the completed property
- the option to NNN (triple-net) master lease the entire project to the lessee at the current market rent
- the option to receive permanent financing of a predetermined amount at the currently prevailing interest rate (i.e., to secure a predetermined fixed-rate forward loan commitment)

In this study, the three options are considered to be exercisable at any time from the estimated date of project completion to their maturity dates. Such options are referred to as *at-the-money put options* from the standpoint of the developer-purchaser. More specifically, we consider only American spot options, i.e., options that may be exercised prior to their date of expiration and whose asset (sale price, rental income stream or loan) is deliverable immediately upon their exercise. These options are contrasted with options on commodity futures, for example. (For an overview of option concepts, see Cox and Rubinstein [5] or Jarrow and Rudd.[12])

Present institutions and instruments in many ways are deficient in offering the income property developer the means to adequately hedge against vacancy, liquidation and financing risks. For example, although master leases are commonly negotiated in advance of construction in the U.S. central city market, these leases imply that the owner has a legal obligation to deliver the space to the lessee. With an option, however, the owner may continue to attempt to lease space in the completed project to others. The option, then, is a form of insurance that

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may be used only if the owner is unable to rapidly lease space in the completed project on favorable terms. In our study, therefore, we test whether developers would be interested in presale and master lease options.

In most real estate markets, forward permanent loan commitments are available. In the past, it was occasionally possible to "lock in" the rate one or two years in advance (i.e., over the construction period for a major project). However, since interest rates have become highly volatile, "locking in" the rate of a loan commitment has become almost impossible today in most areas. A forward sale commitment cannot be unilaterally abrogated by the developer; so it differs from a presale option. In our study, we also hypothesize a possible perceived need for prespecified rate loan options.

Due to the uniqueness of each project and the lack of earnings history in the case of equity options on projects that are yet to be built, considerable documentation and diligence are required by the seller of each option. Existing organized options exchanges, such as those for stocks and other financial instruments, are simply not equipped for such documentation and diligence. Thus, our study also considers developers' preferences concerning the writers of new classes of real estate options.

The organization of the remainder of this article is as follows: A brief review of the literature related to real estate options is followed by an outline of the study's methodology. A summary and discussion of the survey results is followed by concluding remarks and suggestions for future research.

Related Literature

In the past 15 years, a large body of literature has developed for options on exchange-traded financial instruments such as stocks and commodities. Concurrently, the stagflation of the 1970s and the instability of the securities and commodities markets in the 1980s prompted many empirical studies that sought to find relationships between organized securities markets and real estate markets. Analogies were made, sometimes tenuously, between the instruments that were available in the organized securities and commodities markets and those that were used in the real estate industry. The studies discussed below, while not intended to provide an exhaustive review, are representative of the literature in the areas of real estate equity and mortgage instrument market efficiency and their relationships to options.

Gau, for example, examined the question of whether or not an efficient market paradigm should be adopted for the modeling and testing of real estate equity markets.[7] His examination of price series suggested that real estate markets were not efficient with respect to past price information (i.e., weak-form efficiency). However, the relationships he found were not strong enough to imply that accurate forecasting was possible. Corcoran attempted to explain the apparent paradox of rising rental fees and rising acquisition prices of commercial real property that existed in the 1980s.[4] He hypothesized that this phenomenon could be explained by a model that considered real estate as both a factor of production and an asset. Applying his two-market model to the commercial real estate market in the 1980s, Corcoran's explanation of the paradoxical 1980s' real estate market was that a production factor was an increased desire to hold real estate as an asset over and above those demands that normally would be associated with the rising demand for space. He concluded that the efficient market issue was important because most options models assumed at least weak-form efficiency.

In a significant paper, Benjamin, Shilling and Sirmans examined the valuation of options to purchase condominiums in the form of nonrefundable deposit and purchase contracts.[2] Since this combination is analogous to a European call option (further discussed in Johnson and Wofford[14] and Shilling, Sirmans and Benjamin[19]), this study applied the Black-Scholes options pricing model, which employs a computer simulation to compare the prices generated by the model with actual real estate purchase contracts.[3] The study concluded that:

- The relationship between the current market values of the asset and the exercise price of the option is a major determinant of the option premium; i.e., the lower the market price in relation to the exercise price, the lower the value of the option.
- The implied volatilities of condominium prices are quite different depending on the phase of construction. The implied volatilities during the final stages of construction are much higher than those in the first or second phase of construction.
- The model consistently overprices the call option for options written during the early phases of condominium construction.

Kummer and Schwartz examined the appropriateness of securities options valuation methodologies for the valuation of real property purchase options by appraisers and investors.[15] Two methods for determining the fair market value of the real estate option were considered: the Black-Scholes options pricing model and the binomial options pricing (BOP) model. Because of the BOP model's simplicity and its sufficient level of accuracy, the authors concluded that it provided appraisers and investors with a practical instrument for real estate purchase options valuation. However, their study did not include empirical testing. Miller, Sklarz and Stedman discussed related issues, including the difficulties associated with making available *standardized* real estate equity options contracts, based on some index, that could be traded on one of the existing organized options exchanges for hedging and other purposes.[18]

Thygerson studied the interest rate risks that are inherent in the granting of fixed-rate mortgage loan commitments from the point of view of the lending institution.[20] He considered two approaches

in hedging against the risks involved in making forward mortgage loan commitments: the Government National Mortgage Assocation (GNMA) futures market and the Black-Scholes options pricing model. The objective was to establish the market value of a fixed-rate mortgage commitment. Thygerson's results suggested that the debt market met the efficiency tests necessary for the Black-Scholes model to be safely applied to the valuation of loan options.

Mortgages are subject to default as well as interest rate risks. Epperson, Kau, Keenan and Muller have developed an options model for the pricing of fixed-rate mortgage default insurance.[6] Existing mortgages are in essence compound put options because the borrower can either default or purchase a new option to default on at each payment date. Using standard compound options theory arguments, Epperson et al. were able to produce values of the default option, and hence the insurance, for a variety of loan-to-value and interest rate volatility scenarios.

Gau and Goldberg reviewed the economic effects of instruments such as variable-rate and short-term rollover mortgages, which essentially shift the interest rate risk from lenders to borrowers.[8] They then examined the potential for shifting this risk from the mortgage participants to the financial futures markets because neither party in most mortgage transactions is willing to bear significant levels of risk. As a solution, they proposed a mechanism for shifting risk to other parties outside of the real estate market. One such mechanism would be a debt option keyed to mortgage rates.

Hall argued that the option to prepay (i.e., refinance) a standard fixed-rate mortgage differs significantly from the standard financial option, especially from the borrower's point of view.[10] Therefore, in order to apply conventional options pricing models to the prepayment option, the unique characteristics of the mortgage contract must be taken into account. He suggested that Bartter and Rendleman's two-state option pricing model was suitable.[1] This pricing model holds that the value of the option is conditionally dependent upon the value of the underlying debt instrument, which can be determined at any point in time by applying an interest rate tree to discount future cash flows from the instrument.

Ward showed the near-equivalence of an indexed, shared-appreciation mortgage and an American call option.[21] By assuming that a risk-neutral portfolio could be constructed from the mortgage and that a security (such as an index) was perfectly correlated with real estate prices, one could value such mortgages. The lender would have to hold a number of such mortgages to be sufficiently diversified and to ensure that the total value of the properties on which he holds mortgages closely track the index.

It is important to note that most research done in the area of real estate options has been theoretical, or it has concerned existing options instruments. There have been few reported investigations on the market appeal of potential options products to real estate developers or investors. Issues related to laying off certain types of risks have been largely ignored, e.g., the risks associated with prolonged vacancy, the risk of not promptly selling a project at completion and the risk of credit tightening. Such risks could, at least in theory, be lessened by taking long positions on put options on the presale of buildings, on master leases or on take-out loans, if such options were available. The present study focuses on the appeal (marketability) of such options and the likely prices commercial developers would pay for them.

Research Methodology

The data for the study came from a mail questionnaire survey of 1,200 randomly selected commercial real estate developers in the United States. The instrument and cover letter were pretested for content validity with development executives from six San Diego development firms, who provided valuable suggestions for improvement. The final version of the survey required about five minutes to complete. This final version contained 15 questions, several of which were repeated for each type of option, resulting in a total of 23 questions. Every question could be answered by placing a checkmark beside one of a series of multiple choice answers (e.g., job title) or beside a number on a predetermined scale (e.g., the acceptable percentage of loan principal to be paid for a loan option). The mailing included a cover letter explaining the purpose of the study, what was meant by the term "put option" and an inducement for completing the instrument, which consisted of a report of the tabulated results. The mailing produced 91 usable replies.

An attempt was made to determine if there was significant bias related to the degree of interest in real estate options among non-responders by telephoning 50 of the individuals who had not responded to the mail survey but who had not moved or been otherwise unavailable. Nearly 70% of these individuals indicated that they simply had been too busy to respond to the mailing, and 20% indicated that the activities in which they were engaged within their respective firms were not appropriate for the survey. In addition to increasing the sample size by 36, this telephone survey showed that the distribution patterns in this latter group did not differ markedly from the mail respondents on the key questions related to an expressed interest in put options for risk reduction. The follow-up telephone survey therefore indicated that non-response bias was not a significant problem. Overall, the respondents identified themselves as either president (60%), vice president of finance (31%), controller (1.6%) or operations manager (5.5%) of their respective development companies.

In addition to subjecting the response data to various statistical tests, the Black-Scholes options valuation model was used to compute the implied volatilities for the mean survey prices of the three types of put options at three different maturities. In

this phase of the study, the following assumptions were made: (1) the interest rate was set at 11%, which was roughly the rate on construction loans during the period of the study; (2) the exercise price of the call was assumed to be equal to the current value of the asset; (3) dividends were not considered; and (4) the options were, as required by the Black-Scholes model, of the European type.

Results And Discussion

Tables 1-3 display the results of one-way ANOVA for repeated measures that test for mean differences in acceptable costs for options maturities at 3, 9 and 18 months. These results reflect the percentage of the market value of a completed project for a put option on a presale and on a master lease (Tables 1 and 2), and the percentage of the loan amount for a put option on a take-out loan (Table 3). The cumulative distributions of the reported acceptable costs of the options are shown in Figures 1-3. Table 4 shows in sigma values the variation in implied volatilities for the three options maturities which were computed using the Black-Scholes options model.

The survey results shown in these tables and figures indicate that, as expected, the respondents are willing to pay significantly more for options with long maturities than for options with short maturities. This finding is in accordance with conventional options pricing models for securities which hold that the longer the duration of an option, the greater the value of the option. However, the survey results also indicate that the Black-Scholes valuation model does not fit well when it is applied to the prices developers are willing to pay for the various put options because, as Table 4 demonstrates, considerably greater annualized implied volatilities result for options with longer maturities. In our case, the Black-Scholes assumption of a European-type option (i.e., one that can be exercised only at maturity) is a poor one. Each of the three types of options as defined are of the American-type (i.e., they can be exercised at any time from the completion of the project to the maturity of the option). Furthermore, the effective dividend (carry cost) on each option is negative. Put options with negative dividends have a high likelihood of early exercise, and therefore they are poor candidates for European pricing. These difficulties limit any application of the Black-Scholes options pricing model in our study, and they are probably responsible for the observed conflict in implied volatilities for options at the various maturities (see the note).

Tables 5 and 6 show the relative degree of interest and the perceived value of the proposed options for hedging purposes. There is a significant difference between the mean values and the values obtained on the "not interested" scale in Table 5, indicating that the respondents as a group are definitely interested in the possibility of buying all three

TABLE 1

One-Way ANOVA for Mean Prices* Corresponding to Three Different Durations of a Put Option on a Presale of a Project at Completion (No. = 98)

Source	Degrees of Freedom	Sum of Squares	Mean Square	F	Significance
Between subjects	97	1986.54			
Within subjects					
Treatments	2	259.35	129.68	66.67	$p<.0005$
Error	194	377.31	1.94		
Total	293	2623.20			

Means Representing the Percentages of Project Market Value Developers Would Be Willing to Pay for Options:

Option Duration	No.	Mean (%)	Standard Deviation
3-month option	98	1.54	2.34
9-month option	98	2.56	2.54
18-month option	98	3.84	3.52

The Scheffe tests for differences between the individual means reveal that:

1. Respondents are willing to pay significantly more for a 9-month put option than for a 3-month put option ($p < .0005$).

2. Respondents are willing to pay significantly more for an 18-month put option than for a 9-month put option ($p < .0005$).

**Prices are reflected as percentages of the project market value.*

TABLE 2

One-Way ANOVA for Mean Prices* Corresponding to Three Different Durations of a Put Option on a Master Lease of a Building at Completion (No. = 89)

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F	Significance
Between subjects	88	1482.82			
Within subjects					
Treatments	2	156.07	78.04	28.94	p<.0005
Error	176	474.59	2.70		
Total	266	2113.48			

Means Representing the Percentages of Project Market Value Developers Would Be Willing to Pay for Options:

Option Duration	No.	Mean (%)	Standard Deviation
3-month option	89	1.74	2.45
9-month option	89	2.82	2.58
18-month option	89	3.61	3.09

The Scheffe tests for differences between the individual means reveal that:

1. Respondents are willing to pay significantly more for a 9-month put option than for a 3-month put option ($p < .0005$).

2. Respondents are willing to pay significantly more for an 18-month put option than for a 9-month put option ($p < .0005$).

**Prices are reflected as percentages of the project market value.*

TABLE 3

One-Way ANOVA for Mean Prices* Corresponding to Three Different Durations of a Put Option on a Take-Out Loan (No. = 88)

Source	Degree of Freedom	Sum of Squares	Mean Squares	F	Significance
Between subjects	87	1137.91			
Within subjects					
Treatments	2	102.30	51.15	31.01	p<.0005
Error	174	287.04	1.65		
Total	263	1527.25			

Display of Means Representing the Percentages of Take-Out Loan Amount Developers Would Be Willing to Pay for Options:

Option Duration	No.	Mean (%)	Standard Deviation
3-month option	88	1.11	1.85
9-month option	88	1.81	2.10
18-month option	88	2.64	2.93

The Scheffe tests for differences between the individual means reveal that:

1. Respondents are willing to pay significantly more for a 9-month put option than for a 3-month put option ($p < .0100$).

2. Respondents are willing to pay significantly more for an 18-month put option than for a 9-month put option ($p < .0010$).

3. Respondents are willing to pay significantly more for an 18-month put option than for a 3-month put option ($p<.001$).

**Prices are reflected in percentages of loan amount.*

FIGURE 1

Cumulative Distribution of Percentage of Project Value Developers Are Willing to Pay for Put Options on Presale of Project

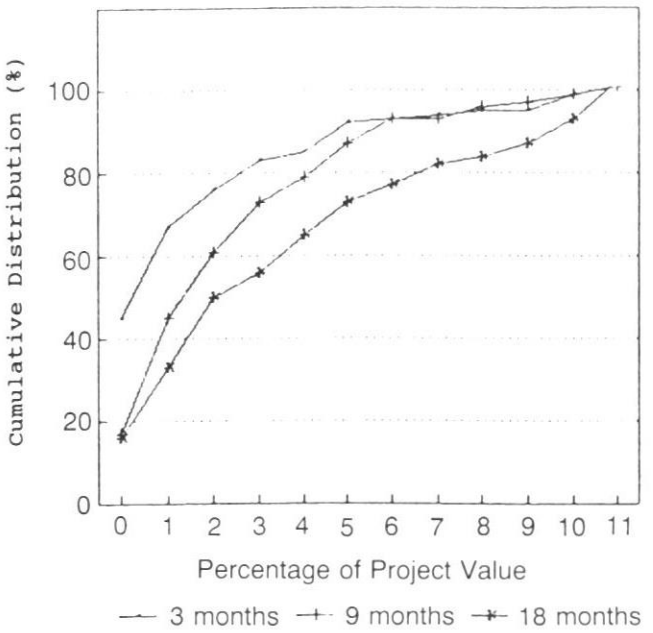

FIGURE 2

Cumulative Distribution of Percentage of Project Value Developers Are Willing to Pay for Put Options on Master Leases

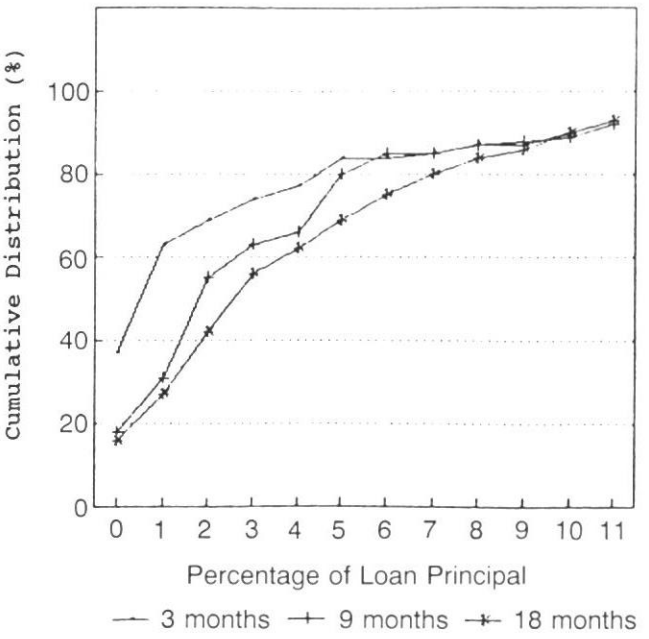

FIGURE 3

Cumulative Distribution of Percentage of Loan Principal Amount Developers Are Willing to Pay for Put Options on Take-out Loans

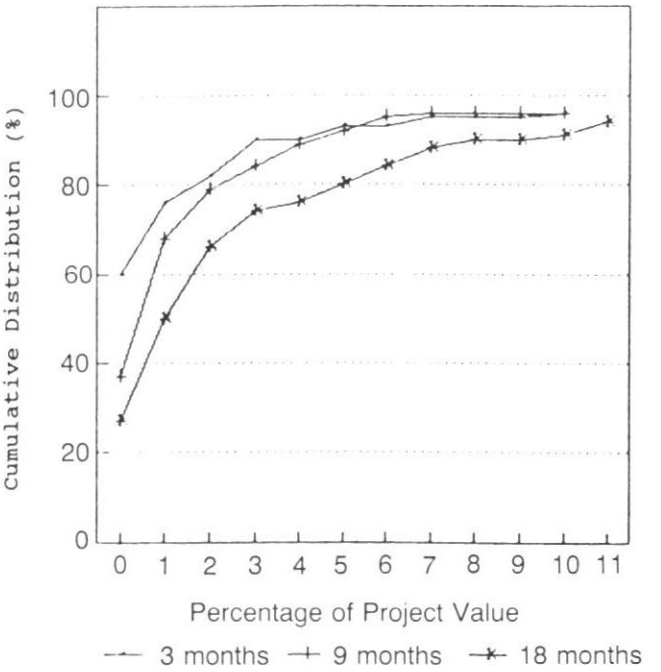

TABLE 4

Implied Sigmas from the Black-Scholes Model that Give Put Prices Corresponding to the Mean Prices Developers Are Willing to Pay for Three Different Types of Put Options at Three Different Durations

Options	3 months	9 months	18 months
Presale	.1425	.1750	.2175
Master lease	.1450	.1825	.2075
Take-out loan	.1025	.1305	.1700

kinds of options. This finding suggests that the potential exists for developing markets for instruments that cover the three types of risk considered here. There is a significant deviation from the neutral point (which stands for "no opinion") about the extent of agreement respondents have on the abilities of the options to protect against risk; the mean response falls in the "agree" portion of the scale for each type of option as a "good hedge" (Table 6). This finding suggests that the respondents are confident that the options will protect their firms against risks. It also indirectly confirms respondents' interest in these options and suggests that strategies to promote the sale of such options to developers will be most successful if they stress the "good hedge" aspects of the instruments.

TABLE 5

Degree of Interest in Three Kinds of Put Options; Together with Test for Deviation of Mean Response from the "Not interested" Scale Value

Type of Put Option	No.	Mean	t-ratio for Standard Deviation	t-ratio for Deviation from Zero	Significance
On sale price	126	1.6587	1.075	17.33	$p<.0005$
On master lease	126	1.4683	1.025	16.08	$p<.0005$
On take-out loan	125	1.7040	.951	20.04	$p<.0005$

Scale values: 3 = very interested; 2 = interested; 1 = slightly interested; 0 = not interested

TABLE 6

Student's t-tests for Deviation from the Neutral Point* of Response Means on the Hedging Abilities of Three Kinds of Put Options (No. = 126)

	Mean	Standard Deviation	t test	Significance
An option on the sale price is a good hedge.	3.7143	.987	8.13	$p<.0005$
An option on a master lease is a good hedge.	3.8016	.858	10.49	$p<.0005$
An option on a take-out loan is a good hedge.	3.8730	.800	12.25	$p<.0005$

**The neutral point is reflected by a scale value of 3.*
Scale values: 5 = strongly agree; 4 = agree; 3 = uncertain; 2 = slightly disagree; 1 = strongly disagree

Table 7 shows the expressed types of options that are most likely to meet developers' needs. Although there are significant differences in respondents' degree of belief in the value of the various options, there is considerable faith that each will meet at least some perceived need. The lower percentage of respondents who attribute a high value for options on take-out loans may be due to the following factors:

- Since the actual interest rate on the loan was not specified, the respondents may feel somewhat uncertain about the meaning of this alternative.
- The risk of not promptly selling a speculative project upon completion and the risk of prolonged vacancy are potentially more devastating than the risks associated with volatile interest rates.
- This type of risk coverage already partially exists in the form of individually negotiated, forward loan commitments from savings and loan and other lending institutions. Most lenders do not, however, commit to a forward rate, and many make the loan amount indirectly contingent upon the then prevailing rate. The latter is the result of the lenders' "debt coverage ratio" rules which force an inverse relationship between the loan amount and the interest rate at the time of funding.

TABLE 7

Chi-square* Frequency Analysis of Choices of Types of Options Chosen as "Most likely to Meet Developers' Needs"

	Frequency Chosen	Frequency not Chosen	Percentage (%) Chosen
Presale option	91	20	82
Master lease option	64	47	56
Take-out loan option	52	59	47

**Chi-square (d.f. 2) = 30.57, $p < .00001$.*

Table 8 illustrates respondents' relative preferences for the potential writers of options. There are

significant differences in these preferences, with insurance companies being the most desirable sources from which to buy options (78%), followed by commercial banks (63%) and real estate brokerage firms (21%). These findings suggest that if markets for such options are developed, insurance companies and commercial banks would be favored to play major roles as the writers of the options, which might lead to new and promising business niches for these institutions.

TABLE 8

Chi-square* Frequency Analysis of Developers' Preferences for Three Types of Sources for Options

	Frequency Chosen	Frequency not Chosen	Percentage Chosen
Insurance companies	82	25	78
Commercial banks	71	41	63
Real estate brokers	24	88	21

Chi-square (d.f. 2) = 77.13, p < .00001.

Table 9 shows the correlations between respondents' interest in options and their faith in options as protection against risk. There is no significant correlation between a respondent's degree of interest and either the size of his firm or number of years he has been in the real estate business. If the risks are perceived similarly by developers regardless of the sizes of their companies, then options should be designed to appeal to a market that includes both the large and small developers. There is no significant relationship between a developer's expressed degree of involvement in decision-making and either his degree of interest in buying options or the prices he is willing to pay for them.

TABLE 9

Pearson r's for Relationships Between Developers' Degree of Interest in Options and Their Extent of Agreement on the Ability of the Options to Protect Against Three Types of Risks

	No.	r value	Significance
Presale option	126	.4958	p<.0005
Master lease option	126	.5157	p<.0005
Take-out loan option	125	.5261	p<.0005

Tables 10 and 11 show the correlation between company activities and a respondent's degree of interest in presale and master lease options. Pearson r's are significant only for those firms whose activities include shopping center development. There is no significant correlation between company activities and the degree of interest in take-out loan options.

TABLE 10

Pearson r's for Relationships Between Developers' Company Activities and Their Degree of Interest in Put Options on a Presale

Activity	N	r value	Significance
Development of shopping centers	126	.2809	p = .001
Development of office buildings	126	.1308	p = .144 (NS)
Development of residential income projects	126	.1169	p = .192 (NS)
Development of industrial buildings	126	−.0061	p = .946 (NS)

TABLE 11

Pearson r's for Relationships Between Developers' Company Activities and Their Degree of Interest in Options on Master Leases

Activity	No.	r value	Significance
Development of shopping centers	126	.3148	p < .0005
Development of office buildings	126	.1535	p = .086 (NS)
Development of residential income projects	126	.1655	p = .064 (NS)
Development of industrial buildings	126	−.0226	p = .802 (NS)

Table 12 shows the correlations between respondents' degree of interest in the three kinds of options and the amounts they are willing to pay for each. Attempts at multivariate analysis, such as regressing the price respondents are willing to pay as a dependent variable against combinations of other variables, have been disappointing. This is consistent with the many pairwise Pearson r's that have been found to be insignificant.

In general, the study reveals the following:

- The more the developers are interested in buying each type of option, the more they agree that the option is a good hedge against risk. This finding is consistent with the general principle that a business person is likely to show interest in an investment which offers a valued protection.
- In general, respondents whose companies are

engaged in the development of shopping centers are significantly more interested in the idea of purchasing options of all types than are those whose companies are primarily engaged in other activities (Table 10). Engagement or nonengagement in other types of activities (development of offices, income-producing residential properties, industrial complexes and others) is not highly correlated with an interest in any one of the three types of options. This suggests that targeting of new options products to companies that develop shopping centers may be a good strategy, at least initially.

- Respondents who are most interested in seeing that the various 9-month and 18-month options are regularly available also are willing to pay more for these options (Table 12). This reflects genuine understanding and concern about the risks involved, and it further supports the potential of a viable market in these types of risk-ameliorating instruments.

TABLE 12

Pearson r's for Relationships Between Developers' Degree of Interest in Seeing Options Regularly Available in the Real Estate Market and the Amounts They Were Willing to Pay for Them

	No.	r value	Significance
Presale option:			
3 months	96	.1673	p = .103 (NS)
9 months	98	.2848	p = .004
18 months	99	.3307	p = .001
Master lease option:			
3 months	88	.1381	p = .200 (NS)
9 months	90	.4047	p < .0005
18 months	91	.4038	p < .0005
Take-out loan option:			
3 months	94	.1559	p = .133 (NS)
9 months	96	.2623	p = .010
18 months	93	.3024	p = .003

Conclusions

The primary purpose of this study is to determine whether options on the presale of income property projects upon completion, on master leases and on take-out loans are instruments for which there may exist a latent market. This study, which concentrates on the demand side exclusively, reveals that developers as a group do express a high level of interest in the potential availability of the three types of put options discussed. The study also establishes a rough distribution of the prices that developers are willing to pay for such options.

Although some developers use interest rate futures instruments and ad hoc presale and lease arrangements to hedge risk, these methods for the most part are available only to large firms that build prime trophy properties. Even then, these instruments are not satisfactory, because they are costly (e.g., entailing disproportionate sales and leasing commissions) and result in the loss of upside potential in favorable markets. Although there is plenty of anecdotal evidence of a latent demand for risk-ameliorating options, we believe that this is the first study to attempt, admittedly crudely, to assess the magnitude and sources of that demand.

We have dealt only with the viability of primary markets for the three types of options. These can be easily standardized with respect to life and strike price but not with respect to dollar amounts or property location. Liquid secondary markets may or may not develop, but they are most likely to develop for the loan option. However, competition may easily emerge in the market for writing the primary options, much as competition occurs among potential underwriters of initial public offerings of stock. Our results suggest that most developers prefer to deal with insurance companies and commercial banks as sources from which to purchase options. These institutions also are capable of laying off at least part of the risk of option writing through diversification across property type and geographical location and through hedging in other financial markets.

Further Research

An obvious area for future research would be to focus on the supply-side and determine the degree to which potential options writing institutions might be interested in writing these types of options and the range of prices they might charge to do so. The results of a supply-oriented study would measure the extent to which the price distributions of potential options writers and buyers overlap and would thus determine the feasibility of establishing markets that specialize in the origination of such options. Another area of possible further research would be to duplicate the present study in different geographical regions, for example, in Europe. This would enable comparisons across financial markets that have different institutional structures.

(A copy of the entire questionnaire and accompanying materials is available from the authors upon request.)

NOTES

The original assumptions of the Black-Scholes model are violated for these options, since a riskless hedge cannot easily be created against movements in price for the underlying asset (except possibly for the take-out loan type option, where interest rate futures or forward contracts can be rolled over). However, since Kummer and Schwartz, Johnson and Wofford and Shilling, Sirmans and Benjamin have all discussed Black-Scholes equity options pricing, we thought it would still be of some interest to see whether the model's formula would produce consistent implied volatilities.

Several factors may be responsible for the poor fit of the Black-Scholes model here, including the possibility of early exercise, the lack of risk neutrality and the absence of normal logarithmic distributions of the terminal asset price; Geltner (1989) discusses the deficiencies of analytic options pricing models in the context of raw urban land. However, the Black-Scholes formula may be interpreted as the mathematical expectation of the present value of an option on an Wiener-diffusion-return asset, whether or not a riskless hedge can or cannot be created. Thus, there is some justification for examining the implications of the Black-Scholes model for illiquid assets, making the assumption that either

investors are risk-neutral or the capital asset pricing model-type assumption that the price movement process is non-systematic and diversifiable and therefore has no risk premium. Even if investor preferences are such that risk aversion exists, the Black-Scholes model provides lower bounds on actual put values for known volatilities, or equivalently, upper bounds on implied volatilities when option prices are given.

Other options pricing models have been developed which relax the Black-Scholes type assumptions. For example, riskless hedges cannot, in general, be created for assets with jump returns. Merton[16,17], Johnson and Stulz, [13] Harriff, Brill, and Trippi [11] and others have created options models for such assets relying on these weaker arguments. (see also Cox and Rubinstein.[5])

REFERENCES

1. Bartter, Brit J. and Rendleman, Jr. Richard J. "Two-State Option Pricing," *The Journal of Finance* 34:5 (Dec, 1979): 1093–1110.
2. Benjamin, John D., Shilling, James D. and Sirmans C. "Contracts as Options: Some Evidence from Condominium Developments," *AREUEA Journal* 13:2 (1985): 143–152.
3. Black, Fisher and Scholes, Myron. "The Pricing of Options and Corporate Liabilities," *Political Economy* 81:3 (May/Jun, 1973): 637–654.
4. Corcoran, Patrick J. "Explaining the Commercial Real Estate Market," *The Journal of Portfolio Management* (Spg, 1987): 15–21.
5. Cox, J. and Rubinstein, M. *Option Markets* (Englewood Cliffs, NJ: Prentice-Hall, 1985).
6. Epperson, James F., Kau, James B., Keenan, Donald C. and Muller, Walter J. "Pricing Default Risk in Mortgages," *AREUEA Journal* 13:3 (Fall, 1985): 261–272.
7. Gau, George. "Efficient Real Estate Markets: Paradox or Paradigm?" *AREUEA Journal* 15:2 (Sum, 1987): 1–12.
8. Gau, George and Goldberg, Michael A. "Interest Rate Risk, Residential Mortgages and Financial Futures Markets," *AREUEA Journal* 11:4 (1983): 445–461.
9. Geltner, David. "On the Use of the Financial Option Price Model to Value and Explain Vacant Urban Land," *AREUEA Journal* 17:2 (1989): 143–157.
10. Hall, Arden R. "Valuing the Mortgage Borrower's Prepayment Option," *AREUEA Journal* 13:3 (1985): 229–247.
11. Harriff, R., Brill, E. and Trippi, R. "Pricing Options on an Asset with Bernoulli-Jump Returns," Working Paper F–151, School of Business Administration, California State University, Long Beach.
12. Jarrow, Robert A. and Rudd, Andrew. *Option Pricing* (Homewood, IL: Dow-Jones Irwin, 1983).
13. Johnson, H. and Stulz, R. "The Pricing of Options with Default Risk," *The Journal of Finance* 42:2 (Jun, 1987): 267–279.
14. Johnson, Larry J. and Wofford, Larry E. "On Contracts as Options: Some Evidence from Condominium Developments," *AREUEA Journal* 15:1 (1987): 739–741.
15. Kummer, Donald R. and Schwartz, Arthur L. "Valuing Real Estate Property Purchase Options," *The Real Estate Appraiser and Analyst* (Jan-Feb, 1980): 13–17.
16. Merton, R. "Option Pricing When Underlying Stock Returns Are Discontinuous," *Journal of Financial Economics* 3:1 (Jan-Mar, 1976): 125–144.
17. Merton, R. "The Impact on Option Pricing of Specification Error in the Underlying Stock Price Returns," *The Journal of Finance* 31:2 (May, 1976): 333–350.
18. Miller, Norman G., Sklarz, Mike and Stedman, Barry. "It's Time for Some Options in Real Estate," *The Real Estate Securities Journal* 9:1 (1987): 42–54.
19. Shilling, James D., Sirmans, C. F. and Benjamin, John D. "On Option-Pricing Models in Real Estate: A Critique," *AREUEA Journal* 15:1 (1987): 742–752.
20. Thygerson, Kenneth J. "Hedging Forward Mortgage Loan Commitments: The Option of Futures and a Future for Options," *AREUEA Journal* 6 (1978): 357–369.
21. Ward, C. W. R. "Returns from the Indexed Mortgage: An Option Pricing Approach," *Journal of Business Finance and Accounting* 14:1 (Spg, 1987): 109–121.