OPTION VALUE IN PRESALE OF REAL ESTATE PROPERTY

Sergio Rozenbaum[1], Luiz E. T. Brandão[2], Alexandre Rebello[3] and Graziela Fortunato[4]

Abstract

A common practice in real estate markets is the sale of housing development units before completion, and in some cases even before beginning of the actual construction, known as presale. Developers that choose to presell units are subject to default on the part of the buyers if market conditions become unfavorable. In recent years, court rulings in Brazil have established that developers must refund 70% to 90% of payments made if the buyer chooses to opt out of the sales contract. This configures an abandon option for the buyer and creates a contingent liability for the real estate developer. We determine the value of the option to abandon in the Brazilian real estate market and model this flexibility to opt out of the sales contract as an American type option. Our results indicate that the option value is substantial and can have important impacts on the profitability and exposure to risk of the real estate developer with potential consequences to the Brazilian real estate market.

.

Keywords: real options, abandonment option, real estate, presale.

[1]Doctoral Student, PUC-Rio, IAG Business School
Rua Marquês de São Vicente, 225, Gávea, Rio de Janeiro, RJ, Brazil

[2]Professor, PUC-Rio, IAG Business School
Rua Marquês de São Vicente, 225, Gávea, Rio de Janeiro, RJ, Brazil
brandao@iag.puc-rio.br, (55 21) 2138-9304

[3]Msc. Business, PUC-Rio, IAG Business School
Rua Marquês de São Vicente, 225, Gávea, Rio de Janeiro, RJ, Brazil

[4]Doctoral Student, PUC-Rio, IAG Business School
Rua Marquês de São Vicente, 225, Gávea, Rio de Janeiro, RJ, Brazil

1. Introduction

A common practice in real estate markets is the sale of housing development units before completion, and in some cases even before beginning of the actual construction, known as presale. The main justification for presale is to share some of the project risks with investors by reducing the amount of capital required for the project, and in the case of less capitalized developers, to also reduce the liquidity risk. Presale purchases may also be optimal for the investor especially if prices are expected to increase in the future, since it locks in the property price during the construction phase.

Real estate property development entails risks due to price volatility, since market demand may vary significantly by the time the completed units come to the market due to changes in local demand and to variations in macroeconomic factors such as interest rates. In addition, real estate units are long term assets with low liquidity and long maturity times for project completion, which tie in the developer's capital for long periods of time.

The use of presale as an investment strategy for real estate developers is common, particularly in South America and Asia (Chang and Ward, 1993), although there are some important regional differences. In Brazil developers are required to file with the authorities the complete specifications of the project, including detailed information on the quality and standards of the materials and trimmings that will be used, and to which they are legally binded. Once this is done, presale of units can commence, even if construction has not yet been started. During the construction phase developers typically receive only half of the price of the units, with the other half being received upon completion when the buyer refinances the unit with a commercial bank. The filing of the project specifications by the developer reduces the risk to the investor, and the final lump sum payment creates a strong disincentive for the developer to default during the construction phase, since he would be forfeiting a significant portion of the price of the unit.

In Asia, on the other hand, developers must usually complete a portion of the project before they are allowed to presell any of the units in order to provide the investor some level of assurance that the construction will be undertaken, with further progress payments tied to construction benchmarks up to the time of project completion. If the investor opts to default in his payments, he is required to pay a forfeiture charge. Investors still face the risk that developers might default and fail to complete construction or deliver a final product with inferior specifications if unfavorable market conditions prevail. This favors the choice of large and

established developers, and creates an strong entry barrier for new developers in this market (Lai, Wang and Zhou, 2004).

A housing unit is an asset that can be used for residential purposes or as an investment asset. In both cases, the developer that chooses to presell units is subject to the risk of default on the part of the buyer, be it either due to lack of capital to continue making the scheduled progress payments, or by choice, in case market conditions have changed in such a way that similar units become available for a much lower price and it becomes more advantageous to default on the current contract and enter into a new one. This alternative configures an abandon option for the buyer, and is available from the time of presale up to project completion, at which time the unit is delivered to the buyer, who then can use the unit as collateral to take on a mortgage on the house and pay off the remaining 50% of the purchase price to the developer.

Real estate developers, on the other hand, incur in a series of costs such as paid sales commissions, incurred taxes, legal title and registration costs whenever an investor chooses to abandon the real estate purchase during construction, plus the loss of liquidity and risk sharing created by the presale. Due to this, developers in Brazil historically took the position that an investor that opted to abandon a presale purchase forfeited all payments made up to that time. Consumer protection laws enacted in 1990 made it illegal for the developers to retain the total presale payments in case of default under the argument that no product had been delivered and no service had been rendered to the buyer that could justify this. Since the law did not establish a limit, developers then included clauses to the effect that only 10% to 20% of payments made would be refunded in case of default. Since then, many investors have successfully sued developers in court in order to be able to retrieve a greater percentage, and in recent years a consensus has been reached that developers must return 70% to 90% of payments received from presales if the investor wishes to cancel his contract (Filomeno, 2003; França, 2003; Rocha, 2002). This ruling guaranteed the right of the investor to recoup a major portion of this investment, and the result was that now the strike price for the option to abandon a housing unit presale was now established by law, turning this option into an unwritten but real clause in the presale contract.

In this article we determine the impact that this ruling has for the real estate investor, as well as the incremental cost the developer who is short the abandon put option. We model the right the investor has to cancel his presale contract as an American type abandon option with an exercise price equivalent to the percentage of payments returned by the developer and exercise

period of 24 months, which is a typical housing construction period in Brazil. This article is organized as follows. In the next section we review the relevant literature on the valuation of real estate project under conditions of uncertainty, and in section 3 we present the approach and real option model adopted. In section 4 we present the results and in section 5 we conclude.

2. Literature Review

Although the literature on the valuation of real estate property is extensive, the idea that these investments can be modeled as real option problems is recent. One of the pioneering works was that of Titman (1985) who analyzed the value of postponing urban development projects in Los Angeles, considering the impact of economic conditions and government monetary policy. In the same line, Quigg (1993) analyzed land prices in Seattle and tested a deferral option model. Williams (1991) proposed a model with price and cost uncertainty and modeled an option to abandon as an alternative to land development. Cappozza and Li (1994) developed a theorethical model that analyses how investment options interact in time and the value of commercial and residential projects. Grenadier (1996) introduced the concept of option games to explain the behavior of the real-estate market, associating the investment timing as a strategy to speed up or slow down project development rate. Cauley and Pavlov (2002) studied a specific residential market in *Los Angeles* modeling an option to sell using the value of the property less the mortgage debt as the underlying asset. Yavas and Sirmans (2005) and Bulan, Mayer and Sommerville (2004), examined real-estate transactions in Vancouver, Canada, and proved that competition reduces the value of the investment deferral option. Paxson (2005) developed a property model for hotels with eight distinct options such as the options to invest, expand, abandon, mothball and to manage services.

Sirmans, Turnbull and Dombrow (1997) were the first to document the practice of the presale system and atribute the lower presale sales price to the uncertainty over the future characteristics of the neighborhood, where prices gradually increase as more information about the neighborhood is revealed and construction progresses. The studies with hedonic models for price evaluation by Clapp (2004), Frew and Jud (2003) and Clapp and Giaccotto (2002) also analyse the perception of buyers in relation to the neighborhood, locale, amenities, interest rates. Other studies analyze the financial factors that influence the decision of real-estate investment such as liquidity (Cauley and Pavlov, 2002; Wang and Zhou, 2002) and construction costs (Guirguis and Giannikos, 2002; Anderson, 2005; Jud and Winkler, 2002), but do not discuss the

issue of optimal timing of the investment nor consider the option to abandon. Wang and Zhou (2002) and Bulan, Mayer, and Sommerville (2004) proposed the use of real option models to capture the uncertainties of real-estate investment.

In Brazil, Medeiros (2001) empirically tested the model by Williams (1991) for the real estate market of Rio de Janeiro, including construction time and taxes. Rocha *et al* (2007) use real options methods to analyze the real-estate market of Rio de Janeiro and determine the optimum time to invest in the different stages of the project, and calculate the maximum value to be paid for the exclusive rights of use of the land. Ribeiro (2004) showed that the use of real-options methods in the evaluation of real-estate incorporation projects can be feasible and intuitive and analyzed existing flexibilities and performed sensitivity analysis. In a work more closely related to ours Lai, Wang and Zhou (2004) describe current practices in Asia where the use of the presale system is widespread and value an European type option to abandon assuming the buyer makes up to three payments. They conclude that the presale system creates entry barriers into the local real estate market. Due to differences in the legal structure and practices, this model is not applicable to the Brazilian market. Our model also differs from Lai, Wang and Zhou (2004) in the sense that we consider 24 monthly payments during the two year construction period and model the flexibility to abandon as an American type option which has no analytical solution.

3. Model and Assumptions

We consider an investor who purchases a housing unit at time $t = 0$ in the presale system at the current market price. Under typical conditions in the Brazilian real-estate market this investor will pay 50% of the total value of the property during the construction period and the remaining 50% upon completion and delivery of the unit, at which time he will sell the unit at its current market price. The market value of the completed unit property is uncertain and is affected by diverse factors such as interest rates, inflation, growth in family income (Liang e McLemore, 2004) and others. Thus the investor's risk is characterized by the volatility of the property's value, and under these conditions, it is possible that during the construction period the total value of the property may drop to a such a level that it becomes more advantageous for the buyer to abandon the investment by canceling his contract and receive a portion of the payments already made than continue till the end.

This option to abandonment will always be exercised whenever the property market value drops below the amount remaining to be paid plus the amount to be returned to the investor. The greater the amount returned to the investor, the more likely the option will be exercised, but if the option is not exercised by the end of construction, it expires and the investor loses this option. As the amount to be returned depends on the decision of the court decisions, we analyse for refund percentages between 0% and 90% in order to determine option value. We also assume that this percentage will be known at the option exercise time and that amounts owed are paid instantaneously.

As is standard in the literature we assume that the property's price (V) follows a Geometric Brownian Motion, in the form of Equation (1):

$$\frac{dV}{V} = \mu dt + \sigma dz \qquad (1)$$

Where:

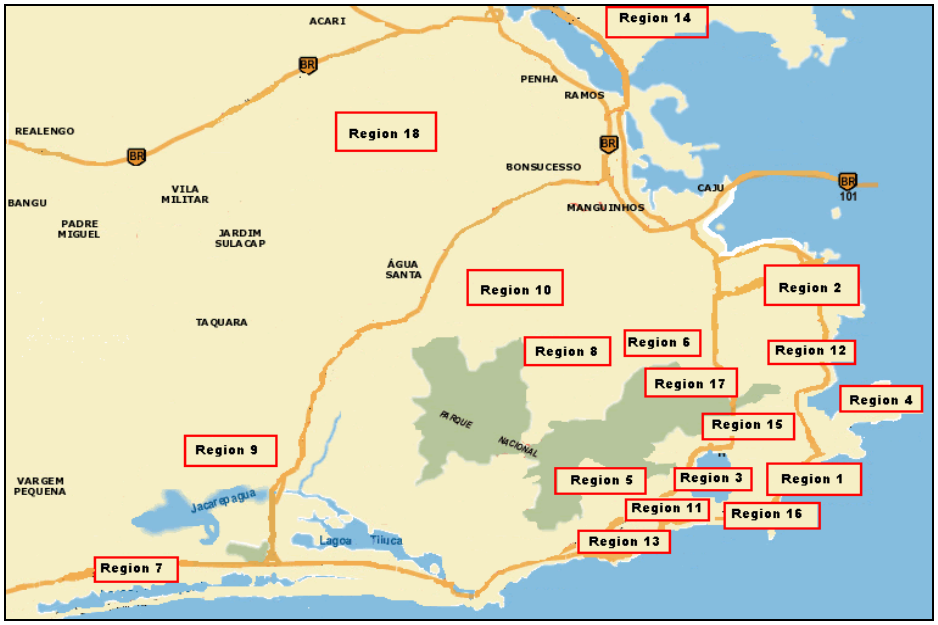
V	is the market price of the property;
dz	is the *Wiener* increment;
μ	is the expected growth in the property's value
σ	is the volatility of the property value.

For the purposes of this work, we considered that the object of our studies are the values of 1, 2, 3, and 4 bedroom residential units in real estate development projects spread out in 18 neighborhoods of the city of Rio de Janeiro, the second most populated city in Brazil, as illustrated in Figure 1[1].

We assume the investment will last for a period of two years, or 24 months, which corresponds to the average construction period of the real estate housing units in Rio de Janeiro. During this period no interest is charged on the values owed during construction (which correspond to 50% of the property's value) since these are prepayment towards the purchase of a real estate rather than mortgage payments. We also assume that the payment schedule involves an upfront payment of 10% of the total value of the property (time t = 0) followed by 24 equal and consecutive monthly installments of 1% of the total value, plus four semi-annual payments of 4% of the total value each.

[1] Andaraí/Grajaú, Barra/Recreio, Botafogo/Humaitá, Centro, Copacabana/Leme, Flamengo/Catete, Gávea, Ilha do Governador, Jacarepaguá, Jardim Botânico, Lagoa, Leblon, Laranjeiras/Cosme Velho, Madureira, Méier/Lins, Tijuca/Rio Comprido, Urca, Ipanema

Figure 1: Regions Analyzed in Rio de Janeiro



On the remaining 50% due at project completion and delivery of the unit, a 15.73% yearly interest rate is charged, which corresponds to the average interest rate of real estate credit lines in Brazil collected in December 2006, as illustrated in Table 1.

Table 1: Average Real Estate interest rates

Fonte	Taxa de Juros de Crédito Imobiliário	Taxa de juros	Indexador	2006	Total
ABMH	SFH	12%	TR	2.37%	14.37%
ABMH	SFI	13%	TR	2.37%	15.37%
ABMH	SFI	13%	IGP-M	3.50%	16.50%
ABMH	SFI	13%	INPC	2.18%	15.18%
ABMH	SFI	14%	TR	2.37%	16.37%
ABMH	SFI	14%	IGP-M	3.50%	17.50%
ABMH	SFI	14%	INPC	2.18%	16.18%
ABMH	SFI	15%	TR	2.37%	17.37%
ABMH	SFI	15%	IGP-M	3.50%	18.50%
ABMH	SFI	15%	INPC	2.18%	17.18%
ABMH	SFI	12%	INPC	2.18%	14.18%
ABMH	Construtora	12%	IGP-M	3.50%	15.50%
ABMH	Construtora	12%	INCC-M	4.73%	16.73%
ADEMI-RJ	Febraban	13.75%	TR	2.37%	16.12%
Banco Real	Banco Real	13%	TR	2.37%	15.47%
Banespa	Banespa	10.95%	TR	2.37%	13.32%
Bradesco	Bradesco	12%	TR	2.37%	14.37%
Gafisa	Gafisa	12%	TR	2.37%	14.37%
HSBC	HSBC	12%	TR	2.37%	14.37%
				Média	**15.73%**

ABMH - Associação Brasileira dos Mutuários da Habitação; ADEMI-RJ - Associação de Dirigentes de Empresas do Mercado Imobiliário do Rio de Janeiro; Febraban - Federação Brasileira de Bancos.

Considering that immediately after the delivery of the unit the developer has already received the total amount of the sale price, his financial involvement with the property ends, and the abandonment option expires, since the purchaser now has full ownership of the property.

To determine the volatility (σ) we analyzed the monthly historical series of real property prices between January 1995 and December 2005[2]. From the monthly prices, the monthly returns were obtained as indicated by Equation (2):

$$R_{it} = \left(P_{it} - P_{i(t-1)}\right) \Big/ P_{i(t-1)} \qquad (2)$$

where:

R_{it} is the property return i in month t;
P_{it} is the property price i in month t;
$P_{i(t-1)}$ is the property price i in month (t-1).

The volatility is calculated as the standard deviation of monthly returns, indicated by Equation (3) and presented in Table 2.

$$\sigma_i = \sqrt{E[(R_i - \overline{R}_i)^2]} \qquad \mathbf{(3)}$$

where:

Ri is the monthly return of property i;
$\overline{R}_i$ is the average monthly return of property i.

To calculate the value of the option to abandon the volatilities we considered the average volatility of each region and type and arrived at 10.13% per month. For comparison purposes we also assumed that the presale property at time 0 has a standard value of \$100. This value is referenced to month 24, at the end of the 2 year construction period, with payments distributed throughout the period as described previously. The interest rate of 15.73% that accrues on the remaining 50% on property after project completion corresponds to 7.87% in total. Thus the present value (V_0) of a property sold prior to the beginning construction phase for the price of \$100, will then be \$87.21 corresponding to the 10% down payment, 1% monthly installments, 4% semi-annual installments, the 50% remaining payment and 7.87% interest. The free risk tax (r) is the 2006 average long-term interest rate of 0.63% per month. The results for the value of the option are presented as a function of the average value of the property (\$100) for ease of

[2] SECOVI-RJ Sindicato de Empresas de Compra, Venda, Locação e Administração de Imóveis e dos Condomínios Residenciais e Comerciais no estado do Rio de Janeiro)

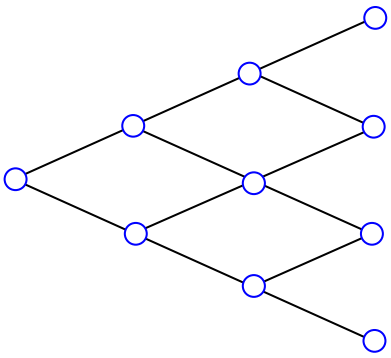
understanding. It is worth noting that the methodology used to obtain the property prices by SECOVI-RJ, involves collecting prices of properties of each type that were on sale during the data collection period, and which may vary in terms of location, state of conservation, garage space, etc.

Table 2: Standard Deviation of Average Monthly Returns of Residential Properties in Rio de Janeiro from January 1995 to December 2005.

Regions	Studio	1 Room	2Rooms	3Rooms	4Rooms	Average
Region 1	7.30%	6.20%	8.04%	8.22%	9.70%	**7.89%**
Region 2	8.36%	9.18%	8.20%	12.39%	6.76%	**8.98%**
Region 3	9.98%	10.25%	8.97%	8.11%	9.51%	**9.36%**
Region 4	10.11%	9.32%	9.24%	9.62%	8.59%	**9.38%**
Region 5	10.35%	10.60%	9.34%	9.09%	8.58%	**9.59%**
Region 6	11.26%	9.31%	9.19%	9.76%	8.99%	**9.70%**
Region 7	13.63%	7.92%	10.16%	9.82%	8.35%	**9.97%**
Region 8	12.73%	8.93%	8.24%	9.18%	10.99%	**10.01%**
Region 9	10.96%	10.04%	8.84%	11.31%	9.21%	**10.07%**
Region 10	10.77%	11.81%	12.45%	10.02%	6.93%	**10.40%**
Region 11	11.72%	15.42%	8.64%	9.20%	7.61%	**10.52%**
Region 12	10.90%	12.12%	10.55%	10.55%	8.83%	**10.59%**
Region 13	12.88%	16.93%	8.51%	7.13%	7.78%	**10.64%**
Region 14	10.79%	9.87%	10.93%	11.74%	11.15%	**10.90%**
Region 15	13.31%	12.89%	9.62%	7.63%	11.31%	**10.95%**
Region 16	10.79%	12.72%	13.38%	9.55%	9.13%	**11.11%**
Region 17	11.77%	15.30%	10.13%	9.45%	8.97%	**11.12%**
Region 18	12.54%	12.03%	11.54%	9.92%	9.66%	**11.14%**
Average	**11.12%**	**11.16%**	**9.78%**	**9.59%**	**9.00%**	**10.13%**

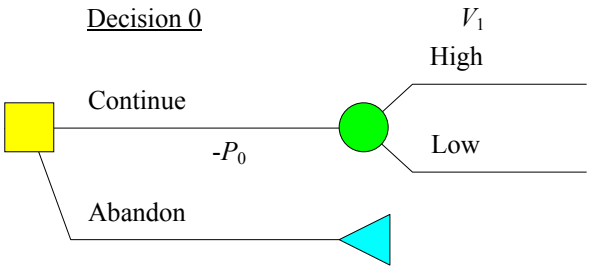
Given that the buyer can abandon the purchase of the property at any time during the construction period, the option is American. We use the Cox, Ross and Rubinstein (CCR, 1979) discrete binomial model to represent the stochastic diffusion process of the price, and model the option by inserting binary continuation or abandonment decision nodes in each of the twenty-four months of the construction period. Thus, at each monthly period the value of the property varies stochastically and we have simultaneously the option to continue or abandon the purchase of the property. As the values in each node are determined they are weighed by their probabilities and optimized in each decision node. For a more detailed description of this method we refer the reader to Brandão, Dyer and Hahn (2005). Figure 2 shows the binomial CCR model, where p is the up probability of an increase in value and u and d are respectively the up and down parameters, where $p = (1+r-d)/(u-d)$, $u = exp(\sigma)$ e $d = 1/u$.

Figure 2: CCR Binomial Model



In Figure 3 we can observe the model of the first of the 24 monthly periods of the construction phase. The initial decision (*Decision 0*) involves the decision to purchase or not the property unit. If the buyer opts not to purchase the property, no payments are made or received.

Figure 3: Model of the First Period

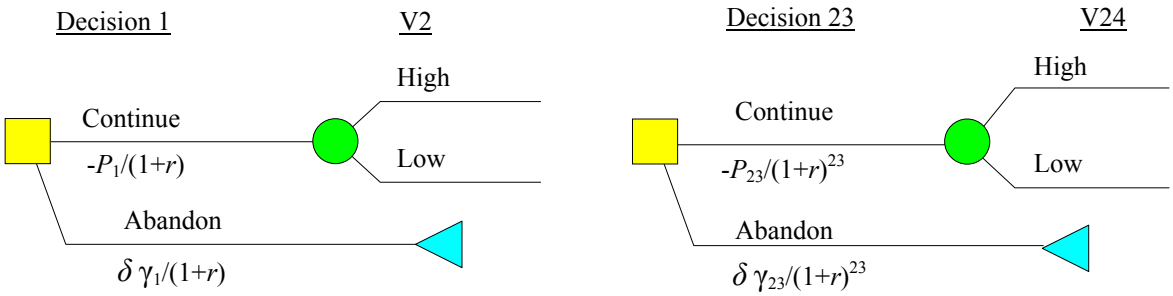


If a decision to purchase the unit is made, a down-payment of 10% of the total value represented by the variable P_0 is required, and the investor is now subjected to the uncertainty of the property price, as there is a probability p that the value V_0 of the property will increase in value by u and a probability of 1-p that it will decrease by a factor d. Thus, at the end of the first month, the value of the property will have evolved stochastically to $V_1 = V_0 u$ or $V_1 = V_0 d$, and the investor now has the option to continue holding the property or to abandon it.

Figure 4 illustrates this decision (*Decision 1*), which occurs at the end of the first month and beginning of the second. If he chooses to abandon, the investor receives a percentage (δ) of accumulated payments made (γ), where $\gamma_n = \sum_{t=1}^{n} P_{n-1}$ which in period 1 is only the initial down-payment of 10%. On the other hand, the decision to continue requires a payment of the first

monthly installment (P_1), and the value of the property continues to evolve randomly throughout the second month until it reaches values $V_2 \in \{V_0 u^2, V_0 ud, V_0 d^2\}$.

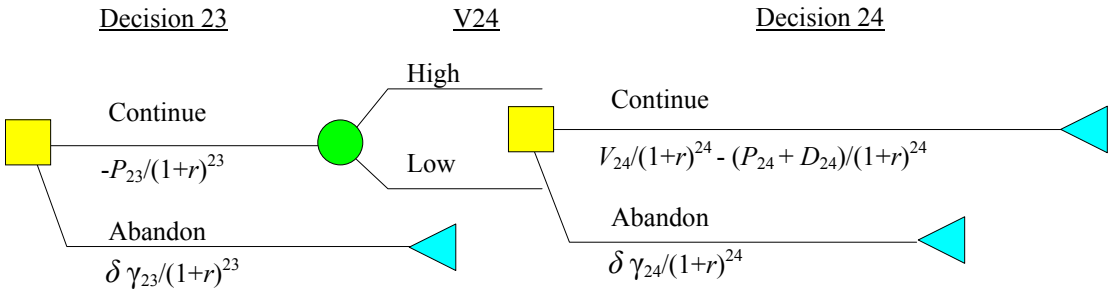
Figure 4: Model of Periods 2 and 24



This module can be replicated with minor modifications for all the remaining periods, from t=1 to t=23, where at each period the investor decides whether to pay installment due and continue or abandon the unit and receive back a percentage δ of the accumulated payments already made. This decision is conditional on the evolution of the property price: if the price falls to a point where the value of the remaining payments is greater than the current price of the property less the amount that will be refund, the abandonment option is optimal in case. At each semester the investor pays the semi-annual installments such that at time periods t=6, 12, 18 and 24 these will also be added to the payments P_n to compute γ_n.

At the end of the construction period at t=24, the investor pays the final installment with includes the semi-annual payment plus the last monthly installment (P_{24}), and also the remaining 50% of the property price (D_{24}) plus the 15.73% annual interest that accrues on this portion. As the objective of the buyer upon acquiring the property is one of investment, then his cash flow at the time of project completion includes an input equivalent to the sale of the property at the market price V_{24}, which will be known at that time. Should the property price fall in value and the investor decide to abandon the purchase at this moment, he will receive from the developer a percentage (δ) of the amounts already paid (γ_{24}), as illustrated in Figure 5.

Figure 5: Model of Period 24 and final Decision



4. Results

The average price volatilities for each neighborhood and property sizes shown in Table 2 were used as input parameters for the model. The percentage of refund varied from 0% to 90%, which is the maximum allowed by the courts. The simulation of these values resulted in 138 runs of the model generating the option value for each of these cases, and the results are shown in Table 3, where the value of the abandonment option is expressed as a percentage of the property's original value (100).

Table 3: Option Value as percentage of Property Price

		Percentage of Refund					
	Volatility	**0%**	**10%**	**30%**	**50%**	**70%**	**90%**
Region 1	7.89%	2.0%	2.6%	3.9%	5.5%	7.7%	10.4%
Region 7	9.97%	3.8%	4.5%	6.2%	8.3%	10.7%	13.7%
Region 9	10.07%	3.9%	4.6%	6.3%	8.4%	10.8%	13.9%
Region 11	10.52%	4.3%	5.1%	6.9%	9.1%	11.5%	14.6%
Region 18	11.14%	4.9%	5.8%	7.6%	9.9%	12.4%	15.6%
Average	**10.13%**	**4.0%**	**4.7%**	**6.4%**	**8.5%**	**10.9%**	**14.0%**

The results show that, considering an average volatility as 10.13% and a refund rate of 70%, the value of the abandonment option is 10.9% of the value of the property. Performing a similar analysis for Region 11, for example, and assuming a refund rate of 90%, we obtain an option value of 14.6%. For the average of all neighborhoods and housing sizes (volatility 10.13%), the value of the option varies from 4.0% to 14.0% of the total value of the property, assuming a refund rate of 90%. This value is the average gain that an investor is entitled to due to the obligation that the developers now have to refund the buyer of a major portion of the amounts paid if he decides to opt out of his housing purchase.

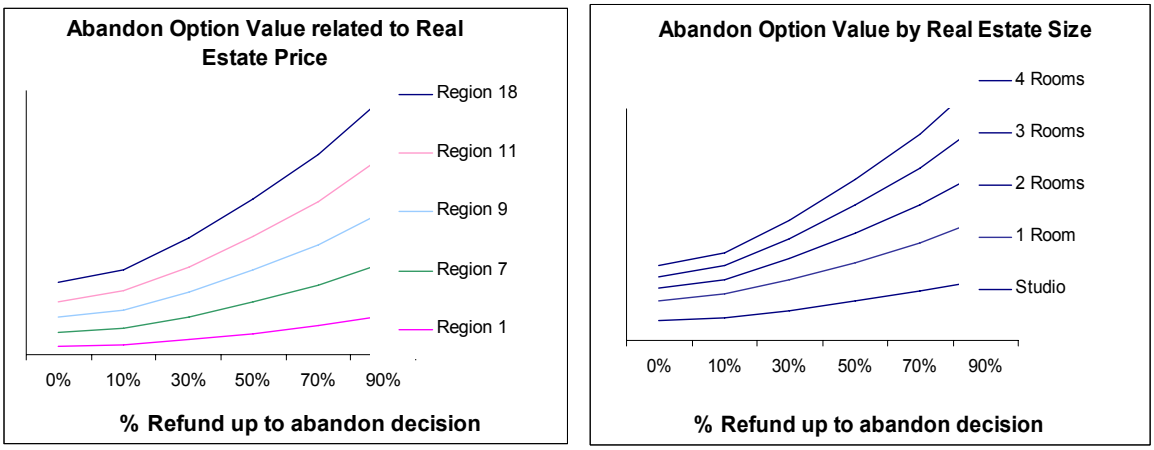
Table 3 also shows that, as expected, option value increases with volatility. In region 1, for instance, which has the lowest price volatility of all neighborhoods (7.89%), option values are in the range of 2.0% to 10.4% depending on the refund rate. On the other extreme is region 18 with the highest volatility (11.14%) and so are the option values, which were between 4.9% and 15.6% of the property's value.

Table 4: Valor da opção sobre o valor do imóvel de diferentes tamanhos

		Percentage of Refund					
Size	**Volatility**	**0%**	**10%**	**30%**	**50%**	**70%**	**90%**
Studio	11.34%	5.1%	6.0%	7.8%	10.2%	12.7%	15.9%
1 Room	11.30%	5.1%	5.9%	7.8%	10.1%	12.6%	15.8%
2 Rooms	9.30%	3.2%	3.8%	5.5%	7.4%	9.7%	12.7%
3 Rooms	9.24%	3.2%	3.8%	5.4%	7.3%	9.6%	12.6%
4 Rooms	8.70%	2.7%	3.3%	4.8%	6.6%	8.8%	11.7%

We can also analyze how option value changes as a function of property size, ranging from studio to 4 bedroom units, as shown in Table 4 where we can observe that the smaller units are the ones that have the highest option value with values ranging from 5.1% to 15.9% for studio size units to 5.1% and 15.8% for one bedroom units, always assuming refund rates ranging from 0% to 90%. Because larger units have lower volatility, they also have lower option value. In Figure 6, we can observe how the value of the option changes relative to the neighborhoods in the city of Rio de Janeiro and also in relation to unit size different levels of refund rates.

Figure 6: Option Value as a function of Neighborhood and unit size



5. Conclusion

The real-estate property market in Brazil and Rio de Janeiro is characterized by the widespread use of the presale system where the buyer makes periodic payments towards the future delivery of a real estate property unit that has not been completed, and in many cases, not even yet in construction. Given that there is significant volatility in property prices, and the presale system favors investors who believe market prices will be higher in the future, there may be incentives in this model for the buyer to default on his commitments if market values fall. In the past, buyers would forfeit all payments already made towards the purchase of the property if they defaulted or opted out of their contracts, but in recent years legal rulings have made it clear that the courts understand that the buyer is entitled to a refund rate at relatively high levels of 70% to 90% of the monies paid, and by doing so created an abandon option for real estate investors. This creates a contingent liability for the developers with may of significant value.

In this article we analyze the effect of this option on the incremental cost to a real estate developer in the city of Rio de Janeiro using the real options method. We assume the flexibility

to abandon is an American type option and model the solution as a discrete binomial lattice, and obtain the model parameters from housing sales market data considering different neighborhoods and unit sizes.

Our results show that the value of the option to abandonment is relatively high and can have a significant impact on the profitability of a real estate developer if market conditions become depressed. For the average neighborhood of Rio the option value assuming a refund rate on the low end of the scale of 70% was close to 10% of the value of the property, which is significant. This implies that the presale system may not reduce the risk to the developers as much as before, since the developers will most probably be saddled with illiquid property if there is a serious downturn in the market at the same they are being called to refund the buyers, as investors exercise their option to abandon an unprofitable investment. With this information, one alternative is for the developer to offer product customization for their clients, such as customized kitchens and cabinets, since these costs are non refundable and increase the option exercise price for the buyer. For the investor, this information is also valuable since it allows him to make optimal decisions and negotiate better conditions with the developers if necessary.

One of the limitations of this work relates to the volatility parameter used in the model, as the accuracy of the data of Brazilian real estate prices is low. One of reasons is that unlike the United States, there are no publicly available records of actual real estate transactions, nor are there periodic value assessments for tax purposes. Due to this, the data on property prices from SECOVI-RJ use price series that may relate to different properties which can cause distortions in the sample and tend to increase measured volatility.

6. References

BRANDAO, L., E.; DYER, J. S.; HAHN, W., J. Using Binomial Decision Tree to Solve Real-Option Valuation Problems. **Decision Analysis**, v.2, n.2, p.69-88, 2005.

BULAN, L.; MAYER, C.; SOMERVILLE, T. C. **Irreversible Investment, Real Options, and Competition: Evidence from Real Estate Development**. In: AFA 2004 San Diego Meetings, 2004.

CAPPOZZA, D.; LI, Y. The Intensity and Timing of Investment: The case of Land. **The American Economic Review**, v.84, n.4, p.889-904, 1994.

CAULEY, S. D.; PAVLOV, A. D. Rational Delays: The Case of Real Estate. **Journal of Real Estate Finance and Economics**, v.24, n.1/2, p.143-165, 2002.

CLAPP, J. M.. A Semiparametric Method for Estimating Local House Price Indices. **Real Estate Economics**, v.32, n.1, p.127-160, 2004.

CLAPP, J. M.; GIACCOTTO, C. Evaluating House Price Forecasts. **Journal of Real Estate Research**, v.24, n.1, p.1-26, 2002.

COX, J. C.; ROSS, S. A**.;** RUBINSTEIN**,** M. Option Pricing: a Simplified Approach.. **Journal of Financial Economics**, v.7, n.3, p.229-263, 1979.

FILOMENO, J., G., B. **Da Cláusula Penal no Direito do Consumidor**. 2003. Ministério Público do Estado de São Paulo (*online*).: http://www.mp.sp.gov.br/pls/portal/docs/PAGE/CAO_CONSUMIDOR/DOUTRINAS/DA%20CL%C3%81USULA%20PENAL%20NO%20DIREITO%20DO%20CONSUMIDOR.MHT

FRANÇA, C. **STJ: Desistência de imóvel não causa perda total de parcelas pagas**. Superior Tribunal de Justiça (*online*). 2003. http://www.stj.gov.br/webstj/noticias/detalhes_noticias.asp?seq_noticia=8950

FREW, J.; JUD, D. G. Estimating the Value of Apartment Buildings. **Journal of Real Estate Research**, v.25, n.1, p.77-86, 2003.

GRENADIER, S. R. The Strategic Exercise of Options: Development Cascades and Overbuilding in Real Estate Markets. **The Journal of Finance**, v.51, n.5, p.1653-1679, 1996.

GUIRGUIS, H. S.; GIANNIKOS, C. I.; ANDERSON, R. I. The US Housing Market: Asset Pricing Forecasts Using Time Varying Coefficients. **The Journal of Real Estate Finance and Economics**, v.30, n.1, p.33-53, 2005.

JUD, D. G.; WINKLER, D. T.; The Dynamics of Metropolitan Housing Prices. **Journal of Real Estate Research,** v.23, n.1/2, 2002.

LIANG, Y.; McLEMORE, R. A Housing Appreciation - The Three Fundamental Drivers. **Real Estate Finance**, v. 21, n.1, p.3-11, 2004.

LAI, R., N.; WANG, K.; ZHOU, Y. Sale Before Completion of Development: Pricing and Strategy. **Real Estate Economics**, v.32, n.2, p.329-357, 2004.

MEDEIROS, P. Y., **Aplicação de Opções Reais no Mercado Imobiliário Residencial com Enfoque na Cidade do Rio de Janeiro**. Rio de Janeiro: Pontifícia Universidade Católica do Rio de Janeiro, 2001,108p. (Masters Thesis, Department of Economics).

PAXSON, D. A. Multiple State Property Options. **The Journal of Real Estate Finance and Economics**, v.30, n.4, p.341-368, 2005.

QUIGG, L. Empirical Testing of Real Option – Pricing Models. **The Journal of Finance**, v.48, n.2, p.621-641, 1993.

RIBEIRO, F. S. M., **Avaliação de Projetos de Incorporação Imobiliária sob Incerteza – Uma abordagem por Opções Reais.** Rio de Janeiro: Pontifícia Universidade Católica do Rio de Janeiro, 2004, 96p. (Masters Thesis, Business School)

ROCHA, E. **STJ: Desistência de compra de imóvel não causa a perda total das parcelas já pagas**. Superior Tribunal de Justiça (*online*). 2002. Disponível em: http://www.stj.gov.br/webstj/Noticias/detalhes_noticias.asp?seq_noticia=5479

ROCHA, K., SALLES, L., ALCARAZ, F., SARDINHA, J. A., TEIXEIRA, J. P., **Real Estate and Real Options – A Case Study.** Emerging Markets Review, v.8, n.1, p.67-79, 2007.

SIRMANS, C., F.; TURNBULL, G., K.; DOMBROW, J. Residential Development, Risk and Land Prices. **Journal of Regional Science**, v.37, n.4, p.613-628, 1997.

TITMAN, S. Urban Land Prices Under Uncertainty. **The American Economic Review**, v.75, n.3, p.505-514, 1985.

WANG, K; ZHOU, Y. **Equilibrium Real Options Exercise Strategies with Multiple Players: The Case of Real Estate Markets**. In: Asia Conference on Efficiency and Productivity Growth, 2002.

WILLIAMS J. Real State Development as an Option. **Journal of Real Estate Finance and Economics**, v.4, n.2, p.191-208, 1991.

YAVAS, A.; SIRMANS, C.F.; Real Options: Experimental Evidence. **Journal of Real Estate Finance and Economics**, v.31, n.1, p.27-52, 2005.