Paper from: *Brownfield Sites*, CA Brebbia, D Almorza & H Klapperich (Editors).
ISBN 1-85312-918-6

Proper risk management: The key to successful brownfield development

R. D. Espinoza[1] & L. Luccioni[2]
[1]*GeoSyntec Consultants, Columbia, Maryland, USA*
[2]*GeoSyntec Consultants, Huntington Beach, California, USA*

Abstract

Society benefits from the redevelopment of environmentally impaired properties, often referred to as brownfields. For most investors and developers, brownfield redevelopment projects are considered too risky and demand higher returns on the investment needed to cleanup and redevelop a contaminated property. This paper proposes a framework for hedging the risks associated with brownfield development and shows how the use of hedging mechanisms can positively affect the value of a brownfield investment opportunity, thus increasing the likelihood that the project will provide an attractive return on investment.

1 Introduction

Several incentives have been recently proposed and implemented to promote the development of brownfields (i.e., abandoned, idled, or underutilized environmentally impaired properties). These incentives consist of: (i) federal and state environmental regulations incentives (i.e., limitations on investors or developers liabilities); (ii) economic incentives (e.g., tax breaks, municipal and/or federal grants); and (iii) administrative incentives (e.g., faster review process of construction permit applications for brownfield projects).

Despite these incentives, investors and developers often find the development of greenfields (i.e., uncontaminated virgin land) more attractive than the development of brownfields. Investors and developers tend to identify the real or perceived risk related to environmental conditions as the main barrier to investing in brownfield development. Also, investors and developers require a considerably higher rate of return for brownfield redevelopment projects than for other real estate projects due to these environmental risks.

There are, indeed, several sources of risk associated with brownfield development. Environmental risks include the cost of remediation and third-party liability. Still, as with any other real estate development, the risks of property value change and time required to realize the investment (i.e., clean-up

Paper from: *Brownfield Sites*, CA Brebbia, D Almorza & H Klapperich (Editors).
ISBN 1-85312-918-6

and construction duration) are also risks inherent to brownfield development. Consequently, identifying and quantifying these risks requires the integration of expertise from different fields such as economics, engineering, and finance.

This paper presents a framework for hedging risks and calculating the value of a brownfield investment opportunity so that investor's return can be maximized. This framework is presented in the following three sections. Section 2 focuses on the sources of risks, the quantifications of these risks, and hedging mechanisms. Section 3 focuses on the valuation tools used by investors/developers to make investment decisions. Particular attention is given to taking into account both risk and managerial flexibility in making investment decisions. To illustrate these considerations, both net present value and real option valuation are presented in this section. Section 4 discusses two examples to illustrate the effect of risk hedging on investment decision-making.

2 Sources of risks

2.1 General

From the investors' point of view, risk can be classified as either diversifiable (i.e., private) or non-diversifiable (i.e., market) risk. Risk is classified as diversifiable if it can be eliminated by holding several investments with uncorrelated or negatively correlated risk profiles. A classical example of diversifiable (i.e., private) risk is an insurance policy that covers car accidents; insurance companies diversify this risk by insuring a large number of drivers. On the other hand, risk that is correlated with the overall macro-economy may not be diversified. A classical example of a non-diversifiable (i.e., market) risk is the risk associated with the change in price of a market index, such as the Standard and Poor's index. The risks associated with brownfield development usually comprise both private and market risks. In order to make appropriate investment decisions when dealing with brownfields (e.g., buy or lease a contaminated property, amount and type of insurance required), both sources of risk (i.e., market and private) should be included in the valuation analysis. Descriptions of both private and market risks related to brownfield projects are presented below.

2.2 Private risks

Private risks associated with brownfield development consist of technical, legal, and regulatory risks. Typical examples of private risk are the extent of contamination, the outcome of new cleanup technology, the time to complete the project [1], the liability claim from a third party, and changes in regulation.

Private risks can be either endogenous, if the uncertainty only gets resolved as the developer invests in the project and additional information is obtained (e.g., cleanup cost, time to project completion), or exogenous, if the uncertainty is independent of the developer's decision of going ahead with the project (e.g., change in environmental laws). Private risk is difficult to quantify due to the absence of observable market prices. For example, the cost of cleanup of a contaminated property is difficult to predict with a high degree of confidence due to technical, legal, and regulatory uncertainty. The evaluation of expected cleanup cost is complicated because each contaminated property is unique,

Paper from: *Brownfield Sites*, CA Brebbia, D Almorza & H Klapperich (Editors).
ISBN 1-85312-918-6

making it difficult to use standard statistical (i.e., actuarial) techniques commonly used to evaluate expected cost. Cost for third-party liability claims that may arise during the cleanup process resulting in costly legal battles are also difficult to estimate. Continuous changes of regulatory standards in response to scientific results and public pressure further complicate the valuation process. Nonetheless, a measure of the uncertainty concerning each of these issues can be obtained from technical experts on the subject (i.e., lawyers, engineers, toxicologists). The information thus obtained can be used in a systematic manner to provide a measure of the environmental uncertainty and the price associated with it.

Several insurance products have been recently created to help developers hedge against private risks. These insurance products fall into two main categories: (i) cleanup cost-cap products to hedge against risk associated with clean-up cost overrun, time to completion, and changes in regulation; and (ii) third-party liability products to hedge against legal risks. To quantify the cost associated with these insurance products, one can view buying insurance policies as buying (i.e., paying a premium) the right to sell a liability for a given price (i.e., the insurance contract amount) if the value of the liability increases. This view shows the parallel between buying an insurance policy and a put option (i.e., financial instruments that confer on the seller the right to sell a stock at a specified price) in the financial market. The usefulness of using financial-market concepts to price private risk will become more apparent as new financial products that allow trading of private risks (e.g., weather derivatives, emissions trading, etc.) are developed.

2.3 Market risks

The main market risks associated with brownfield development are the market value of the land and interest rates. Market risk is correlated with the general movement of the economy, and so there is a market where the prices of the underlying asset can be observed. Market risk is always exogenous (i.e., independent of the developer's decision of going ahead with the project). The value of the developed property changes with time depending upon economic conditions coupled with supply and demand of the real estate asset. A measure of the market risk regarding real estate prices is given by its price volatility (i.e., the standard deviation around a historical mean of the property). A proxy for market risk information for developed properties is tracked by regional Real Estate Investment Trusts (REITs). REITs are portfolios of real estate properties and are usually listed on the New York Stock Exchange. Put options on REITs located in the same region as the candidate brownfield property can be used to hedge the market risk regarding the value of land. Thus, if the market value of land in the target region decreases, the value of REITs decreases, and the value of the put option would increase. An example of this application is presented in Section 4.

3 Valuation tools

3.1 Overview

The primary objective of investors/developers is to maximize the return on their investments in real assets. To achieve this goal, investors and developers

Paper from: *Brownfield Sites*, CA Brebbia, D Almorza & H Klapperich (Editors).
ISBN 1-85312-918-6

evaluate investment opportunities using valuation tools. The net present-value (NPV) method is the method most widely used by corporations for valuing investments. Recently, a superior valuation technique, referred to as real option valuation (ROV), has emerged [2]. ROV explicitly captures the value of management flexibility and also accounts for variation in risk through the life of a project. Properly accounting for changes in risk is essential, because investors and developers require a rate of return on investment that reflects the risk of the investment. This section presents both NPV and ROV valuation techniques.

3.2 Net present value method

In the NPV method, future cash flows are discounted and compared to the present value of investment cost. The difference between the discounted future cash flow and the present value of the investment cost is called the net present value. Projects with positive NPV are considered to be profitable whereas projects with negative NPV are generally considered to be unprofitable.

If the value of a remediated and redeveloped brownfield is V, the initial investment is I_o, and k is the discount rate (also known as the hurdle rate, usually calculated as the average cost of capital), then the NPV can be calculated as:

$$NPV = \frac{V}{1+k} - I_o \geq 0$$

The hurdle rate (k) accounts for the risk associated with the uncertain future cash flow of selling the redeveloped property in the future. Because the risk associated with redeveloping a property is greater than the risk associated with depositing I_o in a fixed-rate-of-return bank savings account, k is greater than the risk-free interest rate (r). To account for the environmental risk usually associated with redevelopment of brownfields, the discount rate is further increased ($k_b > k > r$). Although the application of NPV is simple and straight forward, there are several problems with the use of this approach:

(i) Risk premiums are applied to k to account for environmental risks, even though environmental risks are private risks that can be diversified away.
(ii) The NPV method uses a constant discount rate, even though environmental projects risk profiles changes with time. Using a constant discount rate does not take into account the fact that technical uncertainties such as the cost of cleanup and time to completion get resolved (and therefore risk associated with these variables reduces significantly over time).
(iii) The NPV method ignores the manager's ability to shape the outcome of the investment result (i.e., the NPV method assumes that the decision is made at time t=0 and that management does not have any ability to reformulate the project if the initial results are unfavorable or if market conditions change).

3.3 Real option valuation

The real option valuation (ROV) technique overcomes the limitations inherent in the NPV method as listed above. The ROV is based on the option pricing theory developed by Black and Scholes [3] to price stock options. Mathematically, the value of the option is represented by a partial differential equation [4]. Cox, et.

Paper from: *Brownfield Sites*, CA Brebbia, D Almorza & H Klapperich (Editors).
ISBN 1-85312-918-6

al.[5], introduced a simple representation of the evolution with time of the value of the underlying asset (Figure 1).

Like their financial counterparts, a real option is the right, but not the obligation, to take an action (e.g., changing cleanup technology, buying the neighboring land, building a smaller/bigger structures) at a predetermined cost called the exercise price, for the life of the option. In the case of a put option, the option is the amount of money, or premium, to buy environmental insurance. The value of real options depends on six basic variables [2].

1. *The value of the underlying risky asset (S).* In the case of brownfield development, S is the value of land (Figure 1). If the value of land goes up, then the value of the option also goes up.
2. *The exercise price (X).* In the case of brownfields, X represents the amount of money invested to exercise the call option (e.g., to sell the cleaned property) or the threshold above which a cost-cap insurance will be triggered (Figure 1).

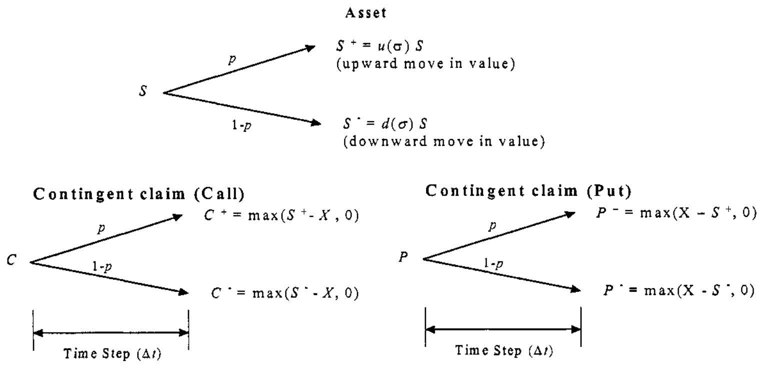

Figure 1 – Binomial Lattice Representation

3. *The time to expiration of the option (t).* This is the expected time to completion of the project or the duration of the insurance policy (Figure 2). As time to expiration increases, the value of the option increases.
4. *The standard deviation of the value of the underlying risky asset (σ).* The standard deviation represents the risk of the project and determines how high or low the asset value can be worth over the next period (Figure 1). The value of a call option increases with the risk of the underlying asset because the payoff depends on the value of the underlying asset exceeding the exercise price and the probability (p) of this occurring increases with volatility. For instance, the more volatile the cleanup cost, the higher the insurance premium.

5. *The risk free interest rate over the life of the option (r).* This is used to calculate the value of the option by discounting backwards to time 0. As the value of the risk-free rate goes up, the value of the option decreases. The proper selection of the risk-free interest rate (commonly based on the market for U.S. government debt instruments) is important. Usually, higher interest

Paper from: *Brownfield Sites*, CA Brebbia, D Almorza & H Klapperich (Editors).
ISBN 1-85312-918-6

rates are associated with longer-maturity debt instruments. The selected interest rate should match the time horizon of the cash flows for the project under consideration. For example, remediation expenses projected to occur in three years should be discounted using the yield of the three-year U.S. Treasury note. This discounting approach is consistent with U.S. Securities and Exchange Commission Staff Accounting Bulletin 92, and produces results that are suitable for financial reporting and disclosure.

6. *Cash flow from or to the asset during the life of the option.* The value of the option is affected by the amount of money that is continuously invested/received over the life of the option. For brownfields, this could represent the expenses associated with maintenance over the life of the option.

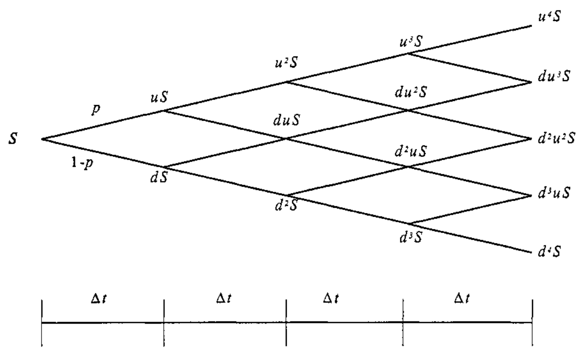

Figure 2 – Multi-step Binomial Lattice Representation

3.4 Decision management

Managers have long recognized that active management of projects that have a variety of types of flexibility adds value. In general, the greater the level of flexibility, the better chance a manager has to make a project profitable. This holds true for environmental projects, where recent changes in regulation allow for more flexibility while cleaning up and redeveloping a brownfield property.

In the past, cleanup of brownfields was driven by strict regulations with little regard for the potential use of the property or the general conditions of the surrounding environment. As a result, redevelopment of brownfields was limited by enforced strict cleanup. Recent changes in environmental regulations allow for more flexible approaches to achieving remediation goals that consider the future use of the property (i.e., commercial, agricultural, housing). Also, innovation in clean-up technology has allowed for faster and cheaper cleanups, providing greater flexibility to the remediation process. Risk based corrective action (RBCA) approaches to remediation have sparked redevelopment of contaminated properties. RBCA design can provide developers/owners with several alternatives for remediation depending upon the end use of the property and its corresponding exposure. These recent developments impact a greater amount of flexibility of brownfield project managers; therefore, brownfield

Paper from: *Brownfield Sites*, CA Brebbia, D Almorza & H Klapperich (Editors).
ISBN 1-85312-918-6

projects are more likely to be profitable than in the past. To calculate an accurate valuation of a proposed redevelopment project, these new sources, and other sources of management flexibility should be incorporated in the economic evaluation method for the project.

Flexibility needs to be considered in investment valuations to accurately reflect the value added due to the different alternatives available to the seller/buyer. By understanding and quantifying the value of flexibility, the value of contaminated properties can be increased. Unwilling sellers may identify the circumstances under which divesting of brownfields is optimal, municipalities can identify the appropriate incentives that may spark redevelopment of brownfield that otherwise may languish; buyers can develop an optimal investment rule.

Once project-related uncertainty and flexibility has been properly accounted for by using the appropriate valuation tool, like ROV, managers need to track the project to ensure that the appropriate decisions (i.e., the ones that maximize profits/minimizes loses) are being made over time. For example, depending upon market conditions and the environmental liability, it may be more convenient to lease a contaminated land (and keep the environmental liability with the landowner) than to purchase the land (and assume the environmental liability). The terms of a business buyout, a merger, or a brownfield site redevelopment can be structured to take into account the results of a new remediation technology.

4 Examples

4.1 Introduction

This section introduces two simple examples to illustrate the importance of quantifying and hedging the main risks associated with brownfield development. The first example shows the importance of the "hurdle" rate in the decision making process, thus emphasizing the need to properly determine and account for the "hurdle" rate. The second example shows, first, how hedging the main risks alters the attractiveness of the project and, second, how to price risks using ROV. For both examples, the NPV is used as the project valuation technique to help managers in the "go/no-go" decision-making process. Finally, the decision process illustrated in these examples is simplified for the sake of clarity and to illustrate the focus of this paper, which is the role of risk management in the decision-making process to invest in brownfield properties.

4.2 Example I – Effect of risk/discount rate

Let us assume that the annual weighted average cost of capital (WACC) of Land4Sale, a real estate developer, is 20 percent; investment of \$8.4 million is made at the beginning of the period; and that the average time to redevelop and sell a greenfield is two years. Land4Sale will develop this greenfield property only if the NPV is greater than zero, which means that the expected price of the redeveloped property needs to be \$12 million or more:

$$\text{NPV} = \frac{\$12\,\text{m}}{(1.2)^2} - \$8.4\,\text{m} = \$0\,\text{m}$$

Paper from: *Brownfield Sites*, CA Brebbia, D Almorza & H Klapperich (Editors).
ISBN 1-85312-918-6

Now, assume that, for contaminated properties, Land4Sale uses a "hurdle" rate of 40 percent (i.e., a 20 percent risk premium over the WACC to account for the environmental risk). The NPV of the project is –$2.3 million, which results in a "no go" decision:

$$\mathrm{NPV} = \frac{\$12\,\mathrm{m}}{(1.4)^2} - \$8.4\,\mathrm{m} = -\$2.3\,\mathrm{m}$$

To be considered viable, the expected price of the redeveloped property needs to be at least $16.5 million compared to $12 million in the case of the uncontaminated property.

4.3 Example II – Effect of risk hedging

4.3.1 No risk hedging

Now, let us assume that Land4Sale is interested in buying a brownfield that can be redeveloped for commercial purposes. As in the previous examples, Land4Sale expects to sell the redeveloped property for $12 million in two years. The expected cost of cleanup is $5 million (for simplicity, assume that $2.5 million is paid at the end of the first year and $2.5 million is paid at the end of the second year) and the expected cost overrun cost is 20 percent (i.e., $1 million) of the estimated cleanup cost. The risk free interest rate is 10 percent. If the property is sold for $1.5 million, should Land4Sale invest in the brownfield?

The net present value of the project is:

$$\mathrm{NPV} = \frac{\$12\mathrm{m}}{(1.4)^2} - \frac{\$2.5\mathrm{m}}{1.1} - \frac{\$2.5\mathrm{m}}{(1.1)^2} - \frac{\$1.0\mathrm{m}}{(1.1)^2} - \$1.5\mathrm{m} = -\$0.5\mathrm{m}$$

The expected value of the property is discounted at 40 percent because of the environmental risks present in addition to the usual real-estate risks. The expected cost of cleanup is discounted using the risk-free interest rate because the uncertainty in the cleanup cost is accounted for by the cost overrun variable. The expected cost overrun is also discounted using the risk-free rate because the uncertainty associated with cost overrun is already accounted for through the 40 percent discount rate applied to the expected value of the property. Based on NPV, Land4Sale should reject this investment opportunity.

4.3.2 Risk Hedging

Land4Sale management is now evaluating the investment opportunity presented in Section 4.3.1 under the scenario where the main risks (i.e., cost overrun and price of land) are hedged. To hedge the risk associated with cost overrun, Land4Sale decides to buy a cost-cap environmental insurance policy. The insurance premium may be estimated as follows: the estimated cost overrun (i.e., $1.0 million) is assumed to follow a stochastic process represented by the binomial distribution shown in Figure 3. For simplicity, two time steps (one year each) are selected. After two years, the possible outcomes of the cost overrun are shown by Figure 3a. The insurance premium P (i.e., $0.28 million) is then computed using ROV (with a risk neutral probability p = 0.52) by working backwards (i.e., right-to-left) through the binomial tree shown in Figure 3b and using the risk free interest rate (i.e., r = 10 percent) to discount through time.

Paper from: *Brownfield Sites*, CA Brebbia, D Almorza & H Klapperich (Editors).
ISBN 1-85312-918-6

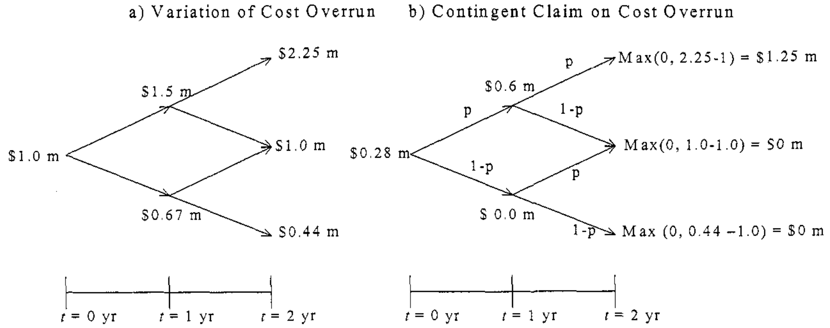

Figure 3 – Lattice Representation of Cost Overrun

To hedge against changes in the price of land, Land4Sale decides to buy a put option to protect itself against a drop in land prices below $12 million. The price of put option is determined as follows: the price of land is assumed to vary stochastically with time (Figure 4a shows the different values that land price can take over a period of two years). The value of the put option (i.e., $0.6 million) is estimated using ROV from Figure 4b, $p = 0.82$ and $r = 10$ percent.

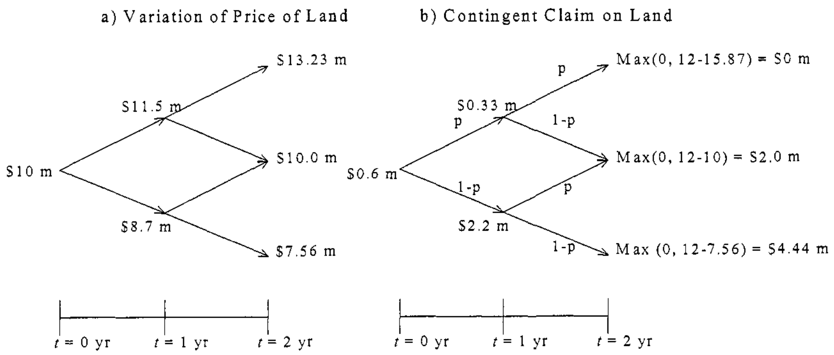

Figure 4 – Lattice Representation of Land Price

As in the previous examples, Land4Sale expects to sell the redeveloped property for $12 million in two years. The expected cost of cleanup is $5 million (for simplicity, assume that $2.5 million is paid at the end of the first year and $2.5 million is paid at the end of the second year) and the expected cost overrun cost is 20 percent (i.e., $1 million) of the estimated cleanup cost. The risk free

Paper from: *Brownfield Sites*, CA Brebbia, D Almorza & H Klapperich (Editors).
ISBN 1-85312-918-6

interest rate is 10 percent and the value of the contaminated property is $1.5 million.

Assuming for simplicity that the only risks inherent to the project are cost overrun and the change in the price of land, the net present value of the project can now be recalculated, including the premiums for cost-cap insurance ($0.28 million) and property value insurance ($0.6 million), as:

$$NPV = \frac{\$12\,\mathrm{m}}{(1.1)^2} - \frac{\$2.5\,\mathrm{m}}{1.1} - \frac{\$2.5\,\mathrm{m}}{(1.1)^2} - \frac{\$1.0\,\mathrm{m}}{(1.1)^2} - \$1.5\mathrm{m} - \$\,0.28\mathrm{m} - \$0.6\mathrm{m} = \$2.4\,\mathrm{m}$$

The expected value of the property is discounted using the risk-free interest rate because of all the risks have been hedged. The expected cost of cleanup is discounted using the risk-free interest rate because the uncertainty in clean cost is accounted for by the cost overrun variable. The expected cost overrun is now discounted using the risk-free rate because Land4Sale bought a cost-cap insurance policy. The cost of the insurance premium and buying the put option are included in the NPV calculation. Based on a NPV valuation considering insurance premiums, Land4Sale would accept this investment opportunity.

5 Closing

The value of risk hedging techniques and using proper project valuation techniques were presented in a very simple framework in this paper to emphasize the importance of the concepts. The main conclusion of this paper is that brownfield redevelopment may be an attractive investment if proper risk management and valuation techniques are used.

The importance of using the proper "hurdle" rate and valuation techniques (i.e., ROV) that account for managerial flexibility was emphasized because it is important in management decision-making during the "go/no go" project decision, but also because it provides managers with key management rule throughout the life of the project.

Finally, as environmental risk becomes traded (e.g., emissions market), and market prices for these type of risks become available, the advantage of using valuation techniques (i.e., ROV) that are similar to techniques that are commonly used in the financial markets will become increasingly apparent.

6 References

[1] Majd, S., and Pindyck, R. S. Time to Build and Investment Decisions, Journal of Financial Economics, Vol. 18, pp 7-27, 1987.

[2] Copeland, T and Antikarov, V. "Real Options: A Practitioner's guide", Texere, New York, 2001.

[3] Black, F. and Scholes, M., The Pricing of options and corporate liabilities, Journal of Political Economy 81, pp. 637-659, 1973.

[4] Hull, J. Options, Futures and Other Derivative Securities, 4th Edition, Prentice-Hall, 2000.

[5] Cox, J., Ross, S., and Rubinstein, M. Option Pricing: A simplified approach, Journal of Financial Economics 7, No. 3, pp. 229-263, 1979.