The Real Options Approach to Evaluating a Risky Investment by a New Generation Cooperative: Further Processing

by

Michael D. Bailey
and
Thomas L. Sporleder[1]

Abstract

Farmers continue to be interested in opportunities for value added production through further processing. New Generation Cooperatives (NGCs) offer member commitment through up-front capital contributions on the part of members. For a potential start-up NGC, one of new and novel issues that face the management of an NGC is making project commitments against the total capital available, both equity and debt capital. Because of the up-front capital commitment by members, NGCs invite managers to make commitments in phases, rather than one initial go or no-go decision. Thus, the capital decision is complex and requires managerial vision in terms of an uncertain world beset by constant shifts in prices, interest rates, consumer tastes, and technology.

This paper considers a novel means of evaluating this investment decision, one that encompasses risk components mentioned above. When the outcome of an investment is least certain, real options analysis has the greatest potential analytic value. As time goes by and prospects for an underlying investment become clearer, the value of an option diminishes. The methodology of real options is novel because it encourages managers, at time t, to weigh equally all imaginable alternatives, good and bad.

A project's net present value (NPV) is simply the difference between the project's value and its cost. By definition of the NPV rule, managers should accept all projects with a net present value greater than zero. The distinction between real options and conventional decision-making arises in that the standard net present value rule does not take into account managerial flexibility over time. Flexibility is especially important when the project involves sunk cost investments that can never be retrieved.

Typically, investment in a new processing facility is a sunk cost, once the decision is made to build the facility. The analysis herein examines a NGC for corn tortilla chip processing, comparing both conventional NPV and real options analyses. PowerSim, a dynamic simulation model, is used is the analysis. This modeled investment is sunk, and the investment in a certain technology is sunk at the time the decision is made to construct the facility. The results indicate that the flexibility of managers is an important criterion for making decisions regarding sunk cost investments.

Graduate Associate and Professor and Income Enhancement Endowed Chair, Department of Agricultural, Environmental, and Development Economics, The Ohio State University. This paper was prepared for presentation at a session entitled *Cooperative Finance Issues* at the annual meetings of NCR-194 Research on Cooperatives, Las Vegas, NV, December 12-13, 2000.

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Farmers continue to be interested in opportunities for value added production through further processing. New Generation Cooperatives (NGCs) offer member commitment through up-front capital contributions on the part of members. For a potential start-up NGC, one of new and novel issues that face the management of an NGC is making project commitments against the total capital available, both equity and debt capital. Because of the up-front capital commitment by members, NGCs invite managers to make commitments in phases, rather than one initial go or no-go decision. Thus, the capital decision becomes more complex and requires managerial vision in terms of an uncertain world beset by constant shifts in prices, interest rates, consumer tastes, and technology.

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Typically, the constructed facilities are industry specific and considered sunk costs. “Sunk” means that the capital commitment cannot ever be completely recovered after the purchase decision is made (Dixit & Pindyck, 1994). Due to the irretrievable nature of such investments, even greater focus must be placed upon investment valuation.

The application of real options theory can be informative in assisting with a NGC's investment decision. For example, using real options to evaluate individual producer investment in NGCs has been suggested in earlier analyses (Sporleder & Zeuli, 2000).

Conceptual Foundations for NPV and Real Options

As a background for discussing the application of real options, it is essential to clarify the differences and similarities, between real option investment valuation and conventional decision analysis, or net present value (NPV).

A project's NPV is simply the difference between the project's value and its cost. By definition of the NPV rule, managers should accept all projects with a net present value greater than zero (Brealey, Myers, & Marcus, 2001). The extensive use of NPV is more than justified. Trigeorgis (1996) writes that, "In the absence of managerial flexibility, net present value (NPV) is the only currently available valuation measure consistent with a firm's objective of maximizing its shareholder's wealth" (p.25). Consensus now is that NPV is superior to other methods of valuation, such as payback period, accounting rate of return, and internal rate of return (Trigeorgis 1996, p. 25).

The distinction between real options and conventional decision-making arises in that the standard net present value rule does not take into account how "the ability to delay an irreversible investment expenditure can profoundly affect the decision to invest" (Dixit & Pindyck 1994, p.6). Net present value presumes one of two decisions: go or no-go. When the net present value of expected cash flows is positive the project gets a "go." The unfortunate aspect is that managers then concentrate on prospects for favorable outcomes, simply because the NPV methodology encourages this mind-set. Prospects for unfavorable outcomes receive less attention. In NPV analysis, certainty enjoys a premium—a situation unlikely for most projects.

The analysis herein examines NGC investment in a corn tortilla chip processing facility in Ohio. This investment is sunk, and the investment in a particular technology is sunk at the time the decision is made to construct the facility.

To gain further insight in the difference between real options and NPV, each method's basic assumptions are important: *deferral* and *reversibility*. In their work *Investment Under Uncertainty*, Dixit and Pindyck proclaim that being able to "delay an irreversible investment…undermines the simple net present value rule, and hence the theoretical foundation of standard neoclassical investment models." (p. 6)

Regarding the premise of investment deferral, net present value does not recognize the managerial alternative of waiting or delaying the start of a project, or phasing" a project. However, real options option recognizes that the decision *can* be deferred (Luehrman, July 1998). Concerning the assumption of investment reversibility, the NPV rule implicitly assumes that "either the investment is reversible" or "if the investment is irreversible, it is a now or never proposition" (Dixit & Pindyck, 1994).

Delaying an irreversible expenditure involves the issue of managerial contingency to alter course in the future. It is exactly this "managerial flexibility" that Bodie & Merton indicate is important in structuring the project analysis (p. 450), as it is often a source of additional value in the investment decision.

Because of these fundamental differences, an option approach to valuation of a sunk cost investment always will be greater than or equal to the NPV approach for valuing the same project. Luehrman (July 1998) indicates that NPV can sometimes be *identical* to a project's option value as well. The project's option value is the same as its NPV when time has run out, i.e. when the "real option" has expired. When there is no more time, uncertainty is a null and void issue. In the absence of uncertainty over time, both the real option value and the net present value are equal to the present value of the project assets less the expenditure required to obtain those assets. In options terminology, NPV is equal to the stock price (S) minus the exercise price (E), or NPV = S – E.

This similarity aids in clarifying where option valuation and NPV diverge: the recognition of uncertainty over time with respect to variability in prices, interest rates, consumer tastes, and technology. Real options invite managers to account those effects.

It is important to realize that the application of real options valuation need not be a great leap of faith, or a perilous abstraction from reality, for cooperative decision-makers. Managers, to a limited extent, "… intuitively use options, such as when they delay completing an investment program until the results of a pilot project are known" (Amram & Kulatilaka, 1999, p.18). Real options are inherently present in any investment project where management has the flexibility to alter its course, i.e. expansion, contraction, delay, or abandonment (Brealey, Myers & Marcus, 2001). The net result of uncertainty is, by not accounting for "managerial flexibility", the NPV of the project will be *underestimated* relative to the real options approach (Bodie & Merton 2000, p. 448).

Of course, the use of real options theory will not deem traditional NPV obsolete, or replace it entirely. It could be tempting to proclaim that real options are the end-all to investment analysis. To the contrary, real option valuation should ideally be applied as an additional analysis alongside current capital-budgeting systems, not as a surrogate for them (Luehrman, July 1998). What real options analysis does is increase the manager's overall understanding of the investment decision, and aids decision-makers in recognizing and accounting for areas of uncertainty that NPV does not.

NPV and Real Options Calculation

A real option refers to investment in real, or "brick and mortar" assets. Because the real option is similar to a European call option, investment techniques from financial markets to value the option are used (Dixit&Pindyck 1994). A sunk investment is analogous to a financial call option: The owner of the option has the right, but not the obligation, to pay an exercise price for an investment.

To quantify the investment payoff to the NGC further processing plant, a model is constructed which computes the value of the real option. The approach is based on the conceptual framework of the Black-Scholes option-pricing model (Black & Scholes, May/June 1973). Although other methods of options value calculation are available, including the Binomial Model, Black-Scholes is the most common method of analytical solutions because of its ease of use (Amram & Kulatilaka, 1999). Luehrman (July 1998, p.52), points out how the components of an option value transcribe from European call options to brick-and-mortar investments. The following variables are important to the analysis:

- **S**, the stock price, is the present value of the assets to be acquired,
- **E**, the exercise price, is the expenditure required to obtain those assets,
- **T**, the time to expiration, is the length of time that the decision may be deferred,
- $\mathbf{R_f}$, the risk free rate of return, is the time value of money, and

- **σ^2,** the variance of returns on stock, is a measure of the riskiness or uncertainty of the project.

Thus, applying these variables in the Black-Scholes formula will comprise the model that values the real option. The Black-Scholes option formula uses the variables defined above in the following way (following Bodie & Merton, p. 451):

(1) $C=N(d_1)S - N(d_2)Ee^{-rT}$

(2) $d_1 = [\ln (S/E) + (r + \sigma^2)/2]/ \sigma\sqrt{T}$

(3) $d_2 = d_1 - \sigma\sqrt{T}$

Amram & Kulatilaka (p.121) offer the following interpretation for the groups of terms in the right-hand side of equation 1: **$N(d_1)S$** represents the expected value of the current underlying asset, if the current value is greater than the investment cost at expiration. **$N(d_2)$** represents the risk neutral probability that the current value of the underlying asset will be greater than the cost of investment at expiration. Finally, **Ee^{-rT}** represents the present value of the cost of investment. Where **E =** expenditure required to acquire the project's assets and **e** is the base of the natural logs; **r** = risk free rate of return; and **T** = length of time the decision may be deferred.

For this research, the model also concurrently applies conventional decision analysis. The model calculates the NPV of the NGC's investment in the processing plant. Using the same available data used to calculate the real option value, the model also calculates NPV using:

(4) NPV = PV- Initial Investment (p. 166 Brealey, Myers & Marcus 2001)

where:

PV=Present Value of the completed plant (what it is worth), and Initial Investment= Present Value of Cumulative Investment Outlays (what it costs).

PowerSim Methodology

This research project uses PowerSim Constructor 2.5 to develop the simulation model. PowerSim Constructor 2.5 is computer software used to build a model that represents the elements of a system and how those elements interact with one another (Swire-Thompson, et al).

Swire-Thompson, et al (p.1) indicate that the development of dynamic economic simulation software, such as PowerSim Constructor 2.5 and PowerSim Solver 2.0, enables managers to experiment with different investment strategies under a variety of future scenarios (PowerSim Corporation 1996). PowerSim 2.5 Constructor and PowerSim 2.5 Solver are used as the model's foundation because of the software's ability to simulate the dynamic complexities of the NGC's investment analysis, and optimize within the parameters of those dynamic complexities (PowerSim Corporation 1996, p. 11).

A Case Example

In the case of this Ohio NGC, two different sized tortilla chip-producing operations are examined. A four-line plant, with each line rated at processing 3200 lbs/hr, is capable of producing 78.62 million pounds of tortilla chips per year (McBeth).

A plant with two lines is capable of producing 39.312 million pounds of tortilla chips per year (McBeth).

Either sized chipping operation would be located on a fifteen-acre site in a small northwest Ohio town, with existing municipal utilities and wastewater disposal access. The real estate is valued at $18,500 per acre, or $277,500 for the site.

A four line tortilla chip operation would require $9 million in construction costs for 100,000 ft^2 of warehouse and office space, and 50,000 ft^2 for processing space (Wyandot, Inc). Construction costs for a two-line plant would entail $6 million for 67,000 ft^2 of office and warehouse space and 33,000 ft^2 for processing space (Wyandot, Inc).

The costs of actual processing equipment would be $8,561,417 for a four-line operation, and $4,847,570 for a two-line tortilla chip operation. Additional costs for grain storage equipment would be $66,600 for a four-line plant and $33,300 for a two-line plant (Engle).

Exclusive of the real estate purchase, total capital outlays for the four-line plant are $17,628,017, and total investment costs for the two-line facility are $10,880,870

Analytic Results of Investment Decision

The NGC's investment decision in the processing facility was evaluated as a real option, and through NPV analysis, assuming a phased decision process is considered. Theoretically, the NGC could choose from the following alternatives:

- buy real estate, construct facilities, and purchase equipment, all in **t;**

- delay all expenditures until **t+1;** or
- purchase real estate in **t**, construct facilities and purchase equipment in **t+1.**

In the context of the model, the analysis focuses on the latter alternative. The investment was framed as a two-phase decision. At time **t**, the NGC purchased the fifteen real estate site for $277,500. After the purchase of the real estate, the NGC has the alternative to build the facilities (either two- or four-lines) and purchase the processing equipment in **t+1**.

The procedures for valuing the investment in a four-line plant are discussed below, but the results for both sizes are presented as well. To compute the NPV of the investment in the four-line plant, outlays are subtracted from the present value of the assets. The present value of the four-line plant is the sum of the initial outlay (real estate purchase) and the second expenditure (facilities and equipment) discounted for one year. A discount rate of 12% per year was chosen.

(5) $PV_{\textbf{PROJECT ASSETS}} = (\$277500 + \$17628017) / (1+ .12) = \$15,987,068.75.$

From the $PV_{\textbf{PROJECT ASSETS}}$, we will then subtract the phase one and phase two investments. The phase one investment of $277,500 is not discounted, as it is an immediate expenditure. The phase two investment, $17,628,017 one year from now, needs to be discounted to present value. Because the value of the expenditure needed for buildings and equipment is known with relative certainty, as we already know the prices, we need to discount with a risk free interest rate. A riskless interest rate of 6% is used.

(6) $NPV_{4\ LINE} = PV_{\textbf{PROJECT ASSETS}} - PV_{\textbf{PHASE}\ \text{TWO INVESTMENT}} - PV_{\textbf{PHASE ONE INVESTMENT}}$

(7) $NPV_{4\ LINE} = \$15,987,068 – \$17,628,017/(1+.06) - \$277,500 = -\$920,635.90$

Following similar calculations for the two-line plant, with phase one investment in real estate being identical, and the same discount rate and riskless rates chosen:

(8) $NPV_{2\ LINE} = PV_{\textbf{PROJECT ASSETS}} - PV_{\textbf{PHASE}\ \text{TWO INVESTMENT}} - PV_{\textbf{PHASE ONE INVESTMENT}}$

(9) $NPV_{2\ LINE}$ = \$9,962,830 – \$10,880,870/(1+.06) - \$277,500 = - \$579,641.30

The computed NPV for both sizes of chipping operations is negative.

In this example, the NGC has the right, but not the obligation, to proceed with phase two of the project. If member support is weak or new information comes to management, the cooperative can choose not to construct the facilities and purchase the equipment, thus abandoning the project at some future time. The \$277,500 purchase of the real estate is implicitly the purchase of a managerial option. As they are dependent upon member approval for the project, the cooperative's managers would be making a *contingent decision* to further invest in the plant.

The exercise price is the nominal sum of outlays, or \$17,628,017. The stock price is the present value of the NGC's project assets, or \$15,987,068. The riskless interest rate used is the same as was chosen for the NPV calculation, 6%. The time of expiration is at phase two, or one period from now. A typical range of standard deviation to use for manufacturing assets can be from 30%-60% per year (Luehrman 1998). Given that tortilla chip production assets would have lower than average systematic risk, as compared to pharmaceuticals or advanced avionics production assets, a conservative standard deviation of 0.2 was chosen, Table 1.

TABLE 1: BLACK-SCHOLES VARIABLES FOR FOUR-LINE PLANT

S	E	R_f	T	σ
$15,987,068	$17,628,017	0.06	1	0.20

The following diagram, derived from one panel in the PowerSim model, demonstrates the call option calculation for a four line processing plant. The Black-Scholes equation, and its input variables (**S**, **E**, **r**, **T**, **σ),** has been transcribed into the diagram. Behind each graphical object seen in the diagram is an equation level that mathematically defines the relationships between each variable. PowerSim (1996) offers the three following definitions to model users (p.12): The circles are auxiliary variables, which contain "calculations based upon other variables". The diamonds represent constants, variables whose fixed values are used for calculating auxiliaries. The arrows are information links, which transmit information to auxiliaries about the values of other variables. Ultimately, the auxiliary variable in the center of the diagram labeled **C** warrants the most interest. That variable reports the value of the call option for the particular investment.

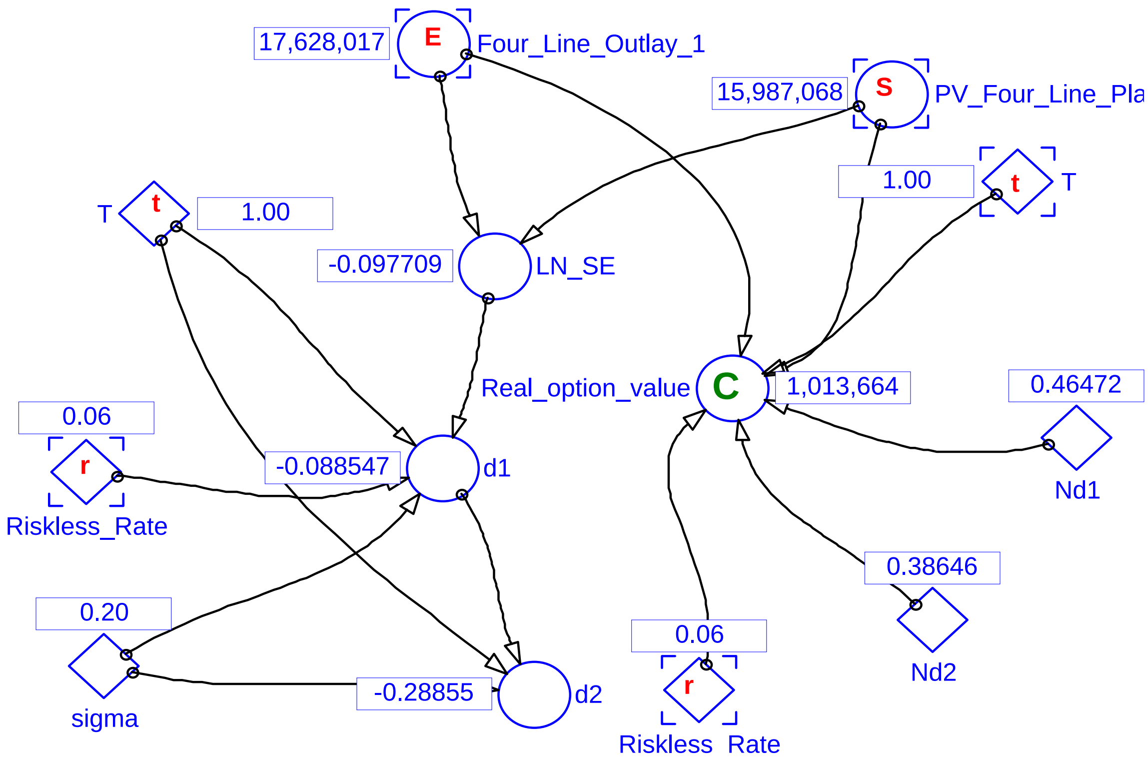

Figure 1. Value Calculation Panel from PowerSim Model of Real Options

Using Table 1 values and the Black-Scholes equation for call option pricing, the call option (**C**), or in this case the "managerial option", has a value of $1,013,639. Subtracting the price paid to "purchase" the option, $277,500; from the option value results in $736,139.22 value for the option.

(10) Real Option Investment Value = Value of Real Option- Cost of Real Option

(11) Real Option Investment Value = $1,013,639 - $277,500 = $736,139.22.

Viewed as a real option, the NGC's investment in a four-line production plant is valued at $736, 139.22

For the real option value calculation of the two-line plant, the same riskless interest rate and standard deviation were chosen, Table 2. The exercise price is the nominal sum of outlays, or $10,880,870. The stock price is the present value of the NGC's project assets, or $9,962,830.

TABLE 2: BLACK-SCHOLES VARIABLES FOR TWO-LINE PLANT

S	**E**	**R_f**	**T**	**σ**
$9,962,830	$10,880,870	0.06	1	0.20

Using Table 2 values and the Black-Scholes equation for call option pricing, the call option (C), or in this case the "managerial option", has a value of $670,657.76. Subtracting the price paid to "purchase" the option, $277,500; from the option value results in an investment value of $393,157.76:

(12) Real Option Value of Investment = Value of Real Option - Cost of Real Option

(13) Real Option Value of Investment = $670,657.76 - $277,500 = $393,157.76.

Viewed as a real option, the NGC's investment in a two-line production plant is valued at $393,157.76

Other Considerations: First Mover Advantages

In general, the real options approach places an economic value on managerial flexibility, which is often in the form of waiting or delaying a decision on investment to some future time period. The business literature theory that seems counterintuitive to waiting or delaying decisions is often called the "first mover" advantage.

Investment deferral may not always be the correct alternative. Luehrman (p.64) points out the possibility that “competitive preemption…would offset some or all of the sources of value associated with waiting.” The benefits of waiting must be tempered by the risk of not being a first mover. In other words, managers and their firms cannot wait indefinitely. Bounds placed on the window of decision-making opportunity regarding an investment in further processing may involve preemption by other firms. Nakata and Sivakumar (1997) suggest first mover advantage as having a foundation of preemptive or technological.

However, not all analysts agree. Lieberman and Montgomery (1988, p.52) indicate that the concept of first-mover advantage may be too general and definitionally elusive to be useful. The authors still maintain this conceptual concern today (Lieberman and Montgomery, 1998). Also, there are opposing viewpoints on whether or not first mover advantage, if obtained, is sustainable. In a recent study, Makadok (1998) maintains that first mover and early mover advantages in a market with low barriers to entry and low barriers to imitation *can* be sustained. To the contrary, Daveni (1994, p. 233) contends “All advantages erode. As competitors copy an advantage, it is no longer an advantage. It is simply a cost of doing business”.

Whether or not first-mover advantage is sustainable, the overall concept is vital in assigning an economic value to investment deferral. With the inclusion of first-mover advantage, investment timing analysis becomes all the more crucial to project success. There are two specific parameters of equations 1 and 2 above relevant to the first mover advantage discussion.

The parameters are time (T) and variance (σ^2). The value of the real option moves in the same direction as these parameters. That is, as uncertainty increases as measured by σ^2, for any given T, the real option value increases. Similarly, for any given σ^2, as T increases the value of the option increases. Each of these parameters is implicitly tied to the notion of the first mover advantage.

Consider T a function of preemption. That is, as managers perceive the risk of preemption increasing, T decreases, or time to expiration declines for the real option. This is a clear relationship although difficult to quantify or apply to a particular situation.

Also, consider σ^2 a function of preemption. By investing early in a market, the firm buys a growth option. The growth option is more sensitive to uncertainty than is the option to wait. This means the value of preemption (i.e. not waiting) increases as uncertainty increases.

Conclusions and Implications

Unlike net present value measurements, real options analysis explicitly recognizes the flexibility inherent in most capital projects and the value of flexibility. To managers familiar with stock options, real options should look familiar. A stock option captures the value of an investor's opportunity to purchase stock at a later date at a set price. Similarly, a real option captures the value of a company's opportunity to start, increase the scope, restrain the scope, defer, or abandon a capital investment, depending on the investment's prospects at time t.

When the outcome of an investment is least certain, real options analysis has the greatest potential analytic value. As time goes by and prospects for an underlying investment become clearer, the value of an option diminishes. The methodology of real options is novel because it encourages managers, at time t, to weigh equally all imaginable alternatives, good and bad.

Encouragement of phased decision-making, rather than a go or no-go at a particular point in time is especially relevant for NGCs and their managers. In the NGC, equity capital of producers is committed up front to the project under consideration. Managers therefore have a special obligation to commit equity capital only to projects that have the greatest probability of success.

For both the two line and four line plants, the real option value of the investment is clearly higher than the net present value of the investment. This extra value from the real option captures the value of management's contingent flexibility. For the four-line plant the NPV was -$920,635.90 and the option value was $736,139.22. After the option values are computed, a credibility check is warranted, based upon whether or not the computed values appear "realistic"(Amram & Kulatilaka, 1999).

The analysis indicates considerable difference between the NPV and the real options approach applied to the value added further processing example. The real options approach indicates an investment in either size chipping operation is warranted. Equally important to the number computed for the real options approach is the additional wisdom gained about the investment decision overall. In essence, the process is just as important as the results.

Nonetheless, the potential for cooperative applications of real options is certainly robust. Thorough investment analysis is as essential to cooperatives as it is to any IOFs, since managers of both are obligated to be wise stewards of stakeholder resources. If the overall application of real options is in its relative infancy (Amram & Kulatilaka, 1998), than the use of real options applied to cooperatives is barely past conception. Further research is necessary in applying real options specifically to cooperatives.

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