Thought Leadership

The Economic Analysis of Real Option Value

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The discounted cash flow method does not always completely capture the uncertainty of the future financial performance of a business, business ownership interest, or security that is the subject of a valuation analysis. In those instances, when the valuation purpose should take into consideration the owner/operator's ability to influence the future financial performance of the subject investment, then real option valuation (ROV) theory is a powerful analytical tool. ROV analysis is often used by corporate acquirers—and by other investors—who are more interested in the question "what is this investment worth to me?" than they are in the question "what is the market value of this investment?"

Introduction

The current market price of a publicly traded security may be inconsistent with the net present value cash-flow-based intrinsic valuation of that security's price. That is, the intrinsic valuation of the security (based on a discounted cash flow valuation analysis) may simply not support the apparently excessive public stock price of that security.

In such instances, some market analysts have argued that the generally accepted economic theory of business valuation and security analysis is flawed. Such market analysts would observe that the price at which a security changes hands is the best indicator of its market value.

So, when an Internet services company goes public at a stock price that cannot be reasonably explained by the present value of its expected future cash flow, the question arises: what is wrong with generally accepted business valuation and security analysis pricing theory?

Real option value (ROV) theory is a management (or investor) strategic planning tool that may be used to explain the "unreasonable" or "irrational" pricing that is observed in certain situations in the capital markets.

There have always been situations where investors have made investments at prices that cannot be justified by the intrinsic valuation of the subject investment. These investors are admired (particularly if they are successful) as risk takers who invest perhaps on a "hunch."

This discussion considers how ROV theory may explain some of that intuition. This discussion considers how investment risk takers can better handle uncertainty when they have the right—but not the obligation—to take some action in the future.

Discussion of Real Option Value Theory

ROV theory applies option pricing theory more broadly than does the typical application of financial option valuation (i.e., in the valuation of public company or private company stock options, warrants, grants, or rights). ROV theory is often used as an investment strategic tool.

Buyers of businesses or business ownership interests (including equity securities) may use ROV theory to justify their acquisition/investment pricing (or "overpricing") decisions.

The objective of this discussion is to introduce ROV theory and to proffer ROV theory as a possible explanation for certain capital market pricing phenomena.

When acquisition/investment prices cannot be rationally explained, it is not the generally accepted business valuation theory or approaches that should be challenged. The concept that is really under challenge is the definition of economic value. Investors who pay a price greater than intrinsic value—that is, the price that is can rationally be justified by the present value of expected future cash flow—may be paying what valuation analysts define as "investment value" rather than "fair market value."

That is, an "irrational" price may include components of the value that are brought to the subject investment by the particular investor/buyer.

ROV theory has obvious implications to the valuation analyst or the transactional financial adviser:

1. when using empirical transactional pricing evidence as a guideline indicator of investment fair market value,
2. when advising buyers/investors in the development of potential acquisition candidates, and
3. when pricing and structuring proposed acquisition/investment transactions.

ROV theory also has obvious implications to the valuation, transactional fairness, and other investment analysis of:

1. merger and acquisition transaction pricing;
2. initial public offering pricing;
3. capital budget investment decision making;
4. capital market investment decision making; and
5. lost profit analysis and other economic damages analysis related to securities fraud, lack of public disclosure, expropriations and condemnations, and other securities-related litigation claims.

Investment Value versus Fair Market Value

The various forms of the efficient market hypothesis essentially assume the following:

1. All appropriate information is available to investors.
2. Investors use that information when making their investment pricing decisions.

The price that an investor pays for any security investment incorporates the security holder's right to (1) invest, (2) wait, or (3) divest.

These are the "reactive" attributes of most financial instruments, including both publicly traded company and privately held company stock options.

However, ROV theory also involves "proactive" attributes of stock options, with which the security holder actually takes action to increase the value of the option itself.

With regard to virtually any investment decision, investors have the following choices:

1. Invest now
2. Take preliminary steps to invest later
3. Divest now
4. Take preliminary steps to divest later
5. Do nothing

Each investment choice creates a set of economic payoffs linked to further choices at a later time. This is the premise behind the proposition that all management investment, financing, and dividend decisions can be analyzed in terms of option pricing.

As one may expect, the Black-Scholes option pricing model is where ROV theory conceptually begins. Consideration of the Black-Scholes option pricing model helps to explain these otherwise inexplicable "irrational" investment pricing decisions.

There are direct parallels in the economic variables of ROV theory and the six economic variables encompassed in the Black-Scholes option pricing formula. These economic variable parallels are presented in Table 1.

Table 1
Financial Option Pricing Models versus ROV Analyses
Parallels in the Component Economic Variables

Black-Scholes Option Pricing Model Economic Variables	Real Option Valuation Analysis Economic Variables
Time to expiration	Time to expiration
Risk-free interest rate	Risk-free interest rate
Exercise price	Present value of fixed costs
Stock price	Present value of expected cash flow
Uncertainty of stock price movements	Uncertainty of expected cash flow
Dividends	Value lost during decision period

ROV theorists refer to this phenomenon as "flexibility value." This is where the "investment value" standard of value—versus the "fair market value" standard of value—appears to come into play in ROV theory.

Investment value is often defined as "the value to a particular investor based on individual investment requirements and expectations."[1]

ROV theory seems to fit certain situations that are characterized by:

1. high levels of investment research and
2. high levels of investment development, manufacturing, and/or marketing.

For example, an investor may pay today's "irrational" price for the investment—and then the option buyer may use his/her influence to improve the economic value of the subject investment.

Financial Options versus Real Options

For example, as of the Tuesday, August 16, 2016, the stock market closing price of Facebook common stock was priced at $123.30. The publicly traded option (but not the obligation) to buy one share of Facebook common stock before January 20, 2017, for $110.00 per share was priced at $17.50.

In this case, the investor of the financial option on that day would receive a payoff of $13.30. However, that investor, having spent $17.50 on the option, would be "out of pocket" a total of $4.20. That $4.20 is the amount of the premium price charged for the right to wait to exercise the stock purchase option—if and when the Facebook share price increases.

"Real options" are not traded on organized stock market exchanges the way that financial options are. Real options are more analogous to a "valuation premise."

For example, real options may be applicable when valuing oil exploration licenses, mining patent claims, and other rights that are expected to be exercised later—after more information becomes available about the price of that economic right. After buying the license, the license holder can increase the value of that option several ways.

This real option is different from the typical financial option. This is because the holder of the real option can take several actions that influence the value of the security that underlies the subject option.

As a comparison, the holder of the financial option is not in a position to influence the value of the security that underlies the subject option.

In addition, apparently "irrational" acquisition prices may be explained by the application of ROV theory. For example, these irrational prices may relate to investments that are made in social media companies at a significant premium over what the expected net present value of future cash flow would indicate.

Corporate acquirers often expect that post-acquisition economic synergies will develop. Such expected post-acquisition synergies help to rationalize the significant price premium that is paid over the expected net present value of the target company's cash flow.

Some of the recent social media company initial public offerings (IPOs) indicate that enough investors share this expected synergy explanation that this investment value may have become market value. If and when the economic benefits of the expected synergies are not realized, these investors will presumably divest (probably selling at a more rational price than they bought it at).

Real Option Value "Flexibility Value"

ROV theory encompasses both expected net present value plus "flexibility value"—the change in expected net present value over the option's life.

The application of expected net present value sensitivity analysis—with the best-case, worst-case, and most-likely-case scenarios—does not incorporate the variance across different scenarios. Generally accepted sensitivity analysis procedures recognize the uncertainty with regard to economic outcome exists. However, such procedures do not capture the "flexibility value" inherent in the situation.

The "flexibility value" is something that company management can capture. This is how ROV theory can become a management strategic tool—as well as a possible explanation for certain capital market price dislocations.

Reactive flexibility, or the ability to quickly buy or sell an option, is encompassed in the typical financial option's market value.

Proactive flexibility, where the value of an option can be increased while the option is owned by directly affecting the option price before exercising the option, is part of real option value.

Both with financial options and with real options, the investor decides both:

1. whether to invest and
2. when to invest.

However, with real options, the investor also has other decisions. The investor in real options has the ability to directly influence the "levers" that affect the value of the option. In this way, real option holders operate under the investment value pricing premise—more than under the typical market value pricing premise.

As an example, a pharmaceutical company can increase the option value of a new drug product by obtaining a patent on the drug (and thereby affecting the expected life of the drug product's cash flow generation). Or, the pharmaceutical company can increase the value of the drug by increasing marketing expenditures related to the drug's rollout (and thereby affecting the expected revenue component of the drug product's cash flow generation).

These actions by the corporate owner/investor in the drug would also positively affect the value of the equity positions of the other stakeholder/investors in the pharmaceutical company itself.

Going back to the social media company example, let's assume that a certain strategic buyer pays an irrational price for a social medial company controlling (but less than 100 percent) ownership interest in the social media company's equity.

Then, the strategic buyer may use its influence to directly improve the value of its investment in the social media company. This direct influence serves to increase the economic value of the investment for all of the social media company's other stockholder/investors.

Those other company stockholder/investors may realize that increase in the economic value of their ownership interest:

1. when the strategic buyer tenders for the balance of the social media company equity,
2. when another buyer acquires the entire social media company (and buys out both the strategic buyer and the noncontrolling investors), or
3. when some other liquidity event occurs.

The Value of Management on Real Options

This attribute of ROV theory is an indication of the ability of company management to use its skill and/or its operational control to improve the value of an option—before that time at which management has to exercise that option.

Table 2 presents numerous examples of strategies and tactics that company management could employ that may directly affect the economic value of real options.

In order to illustrate the influence that such management actions may have on real option valuation, Table 2 lists such management actions in categories according to the corresponding Black-Scholes financial option pricing model valuation variables.

Management can increase the subject company value by improving the value of the company's real options. For instance, company management can take action to:

- increase expected operating cash inflow,
- decrease expected operating cash outflow,
- increase the uncertainty of expected cash flow,
- extend a business opportunity's expected remaining useful life,
- reduce the value that may be lost while waiting to exercise the real option, and
- increase the risk-free interest rate.

The subject company cash flow can be increased by:

1. increasing the average selling price per unit through increasing the number of units sold or
2. commercializing complementary business opportunities.

The subject company cash outflow can be reduced by:

1. lowering the operating costs per unit through economies of scale or
2. combining either operating or selling, general, and administrative expenses with expenses already being incurred for other business operations.

Greater uncertainty of expected cash flow increases the real option value. In contrast, greater uncertainty would have a negative effect on the expected net present value of cash flow. Therefore, why would a rational company manager encourage uncertainty? Net present value investment analysis assumes the following:

1. That the subject investor is fully invested
2. That the economic value of the company's cash flow simply fluctuates based upon its expected cash flow and its cost of capital

Table 2
The Impact of Management Actions
On the Value of Real Options

Black-Scholes Option Pricing Model Valuation Variables	Management Actions That May Influence Real Option Value
Time to expiration	Extend the duration of the option Maintain any regulatory barriers Signal its ability to exercise Innovate to hold on to a technology lead
Risk-free interest rate	Monitor the impact of changes in the risk-free interest rate
Exercise price	Reduce the present value of fixed costs Leverage economies of scale Leverage economies of scope Leverage economies of learning
Stock price	Increase the expected present value of future cash flow Develop new marketing strategies Develop new alliances with low cost suppliers
Uncertainty of stock price movements	Increase the uncertainty of expected cash flow Extend a business opportunity into related markets Encourage complementary products, product innovations, and product bundling
Dividends	Reduce the value lost by waiting to exercise Create implementation hurdles for competition Lock up key resources

However, when a company manager/investor has bought an option, the manager is not fully invested. The manager can always exercise when the company's value increases, but the manager's exposure to the downside is limited.

As a result, the manager/investor option holder wants to increase uncertainty—and then the manager/investor will either:

1. exercise the option at the maximum value or
2. not exercise the option at all.

Management could implement an option-based strategy that could increase the uncertainty of the investment's expected future cash flow. An example would be:

1. to make a limited strategic investment in a new market (i.e., to make a "bet" on a new market) and then
2. to wait for the company's competition to better define that market.

In a situation where the market potential appears attractive but is undefined, investment by the company's competitors may be encouraged. Then, the manager/investor either (1) exercises at the top (i.e., at the maximum value) or (2) gets out (i.e., doesn't exercise the option) after the new market information is collected.

The option's exercise period can be extended by, for example, relaxing the terms of the company ownership structure, by obtaining an advantageous government license (e.g., a patent) or regulation, and by raising or extending barriers to entry.

Long-term customer contracts, long-term favorable supplier contracts, domination of distribution channels, or the acquisition of other intangible assets can also extend the option's life.

The value lost while waiting to exercise the option is limited when the subject investment is not paying dividends during the option holding period. In financial options, value is lost during the holding period when dividends are paid to the owners of the underlying security but not to owners of the derivative security—that is, the option holder.

The real option holder is economically advantaged when dividends aren't expected to be paid until after the exercise of the option. The structure

of preferred stock instruments held by venture capitalists have characteristics consistent with ROV theory. This is because the preferred stock agreements specifically limit the payment of dividends before the rights conveyed to the preferred stockholders are exercised.

Further, value lost to business competitors can be increased when the early market entrant effectively pays "dividends" by:

1. expanding market share,
2. locking up key customers, or
3. lobbying for regulatory constraints.

While any particular manager/investor cannot increase the risk-free rate, any increase in the risk-free rate negatively affects the expected present value of future cash flow. However, an increase in the risk-free rate positively affects the option value. This is because such a rate increase reduces the present value of the option exercise price.

Sensitivity Analysis of Real Option Value

The issue of where management should devote its attention to real option investments can be explored by the application of a sensitivity analysis. By using the following example, the effect on the option value of a 10 percent increase in each of the six variables indicates where management's attention should be focused.

In our example, an oil company has the opportunity to acquire from the government a five-year license on an oil field exploration. Let's assume that the present value of the expected cash flow generated from the oil field production is $500 million. And, the present value of the cost to develop the oil field is $600 million.

The net present value of the investment opportunity is calculated as follows:

$500 million – $600 million = negative $100 million

Based on this simple net present value analysis, the company obviously would not make this oil field investment.

Under ROV theory, however, the value of uncertainty is recognized. When analyzing the investment as if it were an option, other valuation factors should be considered.

The variability of oil prices, the improvement of field development and exploration methods, the cost of keeping the option active, and the deferred dividend payout all become part of the ROV of the investment.

We can apply the Black-Scholes financial option pricing model to this illustrative oil field investment opportunity, as follows:

$$\text{Call value} = S \times N(d_1) - Ee^{-rt} \times N(d_2)$$

where:

- S = Stock price
- E = Exercise price
- $N()$ = Value of cumulative normal distribution at the time point ()
- d_1 = $[\ln(S/E) + (r + 0.5\sigma^2)t] / \sigma\sqrt{t}$
- d_2 = $d_1 - \sigma\sqrt{t}$
- ln = Natural logarithm
- r = Short-term risk-free rate (continuously compounded)
- t = time to expiration, in years
- e = Base of natural logarithms
- σ = Annual standard deviation of return (usually referred to as volatility)

Using an assumed 30 percent standard deviation around the expected growth rate of the value of operating cash inflow, a $15 million per year investment to keep the option open (i.e., a 3 percent dividend payout during holding period), and a 5 percent risk-free rate, the ROV of the oil field investment is positive $100 million. This ROV is calculated as follows:

$$\{(500e^{-0.03\times5}) \times (0.58)\} - \{(600e^{-0.05\times5}) \times (0.32)\}$$

In the case of the Facebook financial option price situation introduced earlier, the present value of the financial option investment was negative $4.20. And, the investor was paying for the privilege of waiting until more complete information became available.

In this somewhat analogous oil field investment example, the $200 million spread (between negative $100 million and positive $100 million) is the price premium associated with waiting for more complete information.

In ROV theory, the results of a net present value analysis may be misleading. This is because the holder of the real option has the "flexibility" to influence the components of value. Therefore, the ROV begins to bear a resemblance to the investment value premise of value.

Real Option Value Implications for Management

When evaluating the oil field investment as a real option, changes in the life of the lease, the value lost during the holding period, and an increase in the risk-free rate have less effect than the other valuation variables.

If management could influence the variables by, say, 10 percent, the immediately obvious choices would be to increase the expected cash inflow, to reduce the fixed costs, and to increase the level of uncertainty. This conclusion can be reached by quantifying the percentage impact on the estimate ROV valuation as management changes each ROV valuation variable by 10 percent.

This analysis is summarized in Table 3.

Therefore, in this example (as in many situations), it is more important for management to focus on increasing revenue than on decreasing costs. However, even when there are other management activities that appear to be more powerful, management's ability to influence the other variables should not be overlooked.

For example, a significant 10 percent combined return can be achieved by:

1. extending the duration plus
2. limiting the costs to hold the option.

Real Option Value as a Strategic Management Tool

The importance of ROV theory is that it introduces a mechanism to systematically think through the components of an investment's value. ROV theory may provide a means to challenge the premise behind the generally accepted net present value method of investment valuation. This is because, unlike an ROV analysis, the net present value method relies on the fixed, multiyear investment period model at a fixed cost of capital.

Under the fair market value standard of value, the value indication is typically based upon static investment plans. That method may provide one indication of value at a certain point in time. However, that value does not necessarily incorporate the full vision of the owner/operator management.

Using ROV theory, it is possible for management to analyze—and to affect—private investment opportunities more dynamically.

Management can, after consideration of subsequent information, change the course of an investment or even abandon a project after it has been launched. Managers who rely on a static long-term investment projection may find it more difficult to change course quickly.

ROV strategies are distinguished from the net present value methods because they encourage uncertainty and, therefore, risk. Management's outlook shifts from fear of uncertainty to gain from uncertainty. A wider range of possible management actions based upon learning from new information is translated into value.

Information that is not yet available at the time of the investment makes ROV more of a strategic management tool than an investment valuation tool.

ROV theory takes the shackles off of management which is typically motivated to only make incremental investments. For example, under ROV theory, management would not be obligated to use the same low cost of capital appropriate to analyze an incremental investment in the option value

Table 3
Real Option Value Percentage Change

Black-Scholes Option Pricing Model Valuation Variables	Real Option Value Valuation Variables	Option Value % Change Due to a 10% Change in Each Variable
Time to expiration	Time to expiration	6
Risk-free interest rate	Risk-free interest rate	4
Exercise price	Present value of fixed costs	16
Stock price	Present value of expected	26
Uncertainty of stock price movements	Uncertainty of expected cash flow	11
Dividends	Value lost during decision period	4

analysis of a newer, less entrenched investment opportunity.

ROV theory tries to correct the subjective bias toward incremental investment in established projects by justifying an objective bias toward the advantages available from new information. For example, ROV theory may help company management to justify an investment that just keeps the company "in the game."

Multistage investment policies become more attractive when the project is uncertain and expensive to pursue. Management can make simultaneous investments in multiple opportunities. Even though this investment strategy reduces the upside, it also minimizes the downside.

This kind of leverage distinguishes ROV strategies from the more common risk-reduction diversification strategies.

ROV theory provides some financial structure to help management follow the old rule: maximize the opportunity while minimizing the obligation.

The Facebook financial option buyer has protected the right to buy that share even if the price skyrockets, but the option buyer is protected if the price falls below the exercise price.

ROV strategies incorporate the feature of options into real market investments. They discourage the use of static net present value measures for "go/no-go" investment business decisions.

Real Option Value Analysis versus Net Present Value Analysis

ROV theory challenges the validity of net present value investment valuation methodology. According to ROV theory, the net present value methodology does not adequately capture the expected future cash flow and the cost of capital of many investment opportunities.

For the valuation analyst, ROV theory includes elements of investment value as distinguished from fair market value. This is because, to a great extent, ROV theory is based upon the opportunity that the option holder has to influence the value of the option after acquiring it.

ROV theory may provide insights into the traditional interpretation of the alternative levels of value and into the alternative definitions of investment value, fair market value, and fair value.

Implications of Real Option Value Theory

ROV theory has at least three important implications for valuation analysts, for transactional participants, and for investors:

1. Guideline security purchase/business acquisition transactions that are used to estimate market value indications may have been consummated based on ROV theory valuations.
2. In the negotiation and pricing of acquisition or divestiture opportunities, it is appropriate to consider simultaneous, multistage investment analyses—where the buyer can influence the value at a later point in time. This perspective may allow the buyer to compete for the investment opportunity at higher bid prices.
3. The analysis of the pricing and structuring of acquisitive investment transactions may benefit from the consideration of real option variables, thereby:
   a. giving the investors proprietary rights and
   b. escalating financial obligations with expiration dates.

Summary and Conclusion

ROV theory includes a noteworthy departure from the typical net present value investment analysis. This is the power of real options: ROV theory encourages uncertainty and risk. ROV theory changes the way that investment opportunities are valued by—and are influenced by—manager/investors. In summary, ROV theory changes the way in which value is created.

Footnote:

1. International Glossary of Business Valuation Terms (http://bvfls.aicpa.org/Resources/Business+Valuation/Tools+and+Aids/Definitions+and+Terms/International+Glossary+of+Business+Valuation+Terms.htm).

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