Are Patents Really Options?

BY DOUG KIDDER AND NISHA MODY*

Unfortunately for all of us, patents are not really options. Recently some scholars and practitioners have been promoting the idea that patents can be valued as real options.[1] While it is appealing to think of patents as options, they are options only in the vernacular sense that the patent holder isn't obligated to take any action. Patents are not options in the financial sense required to make use of financial option-valuation tools. Valuing a patent using a tool such as Black-Scholes will result in a meaningless value.

The problem, of course, is that in the world of option valuation, it is very difficult to establish whether or not a patent valuation tool has yielded the right answer. Any answer that results from an apparently reasonable methodology is generally accepted as a good answer.

In an ideal world, we'd be able to compare the results of valuing patents as options with the real-world value of patents to see whether the model worked. However, we live in the messy real world. In the body of this article we discuss the problems with applying real options theory to patents. To begin with, we first have to highlight some of the salient features of patents and options.

Patents vs. Innovation

Patents are strictly the legal right to exclude others from using the disclosed innovation. However, care must be taken not to confuse the patent with the innovation. The two are separate, albeit related assets, and their distinction is critical to valuing the patent. The value of a patent can be no greater than the value of the underlying innovation. If the innovation has no value, then the patent has no value. However, it is quite possible to have a very valuable innovation coupled with a worthless patent.

The gap between the value of a patent and the value of an innovation is bounded by the availability of non-infringing alternatives. Non-infringing alternatives can arise from a completely separate technology (e.g. fuel cells vs. lithium batteries) or from a poorly written patent that allows a trivial change to the innovation to be outside the patent.

Complementary Assets

Extracting value from an innovation requires the use of complementary assets: manufacturing plants, people, and distribution channels, for example. Absent the complementary assets, neither the innovation nor the patent has any current or future value. Patents are used by the innovator if the innovator has access to the complementary assets or licensed to the holders of the requisite complementary assets.

Patents as Options

Patents are thought of as options in the sense that they give the patent-holder the option 1) to preclude others from using the innovation or 2) to acquire or to utilize the complementary assets to extract money from the innovation.

On a superficial level, the rights of the patent owner fit the definition of an option; conveying the right but not the obligation to take some action. Similarly, the cash flows look correct for a patent – the patent holder has the right to fund a lawsuit with the expectation of a payback greater than the amount of the legal fees. The patent holder can wait to exercise the option to sue until it appears that the net payoff from a lawsuit is positive and/or maximized.

Options Background

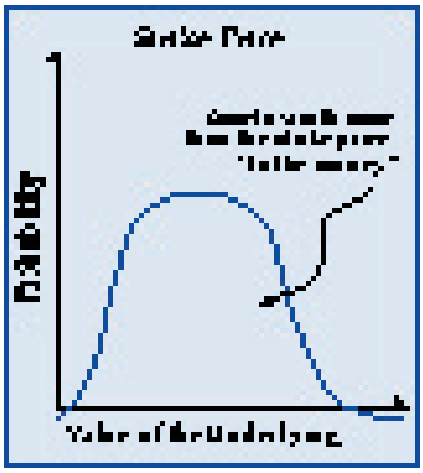
In the financial sense, options are the right but not the obligation to purchase a security at a predetermined price before a predetermined date. If today a share of IBM is trading for $100, I can purchase an option to buy a share of IBM in a month for $110. This is called an out-of-the-money call option. Out of the money meaning that the market price is currently lower than the strike price and call meaning I have the right to buy the share (as opposed to selling the share.)

In the general sense, call options are the right, but not the obligation, to purchase an underlying asset at a predetermined price.[2] The value of an option largely depends upon the variability associated with the price of the asset, and the length of time before the transaction may or may not take place. When the total

1. For a thoughtful overview of the different ways to value a patent, see: Ted Hagelin, "Technology and Legal Practice Symposium Issue: Valuation of Intellectual Property Assets: An Overview." *52 Syracuse Law Review 1133*, 2002. Recently patent valuation firms have been created. Some, like Patent & License Exchange, Inc., are advertising that they use the Black-Scholes method in their valuations. Victoria Slind-Flor, "IP Trends & Tech Etc.," *The National Law Journal*, August 28, 2000. Also see, "AgriHouse Receives $28 million patent asset valutation," *Business With*, September 6, 2000.

2. For the ensuing discussion all the options discussed are technically American Call Options. For the sake of convenience, we will just refer to them as options.

Doug Kidder is a principal at LECG. Nisha Mody is a a Ph.D. from USC and a Senior Economist with CapAnalysis in Los Angeles.



amount of variability increases, the value of the option increases. For a stock option, this makes intuitive sense – the more volatile the price of the stock the more likely that option will be in the money in the future. Likewise, the longer the term of the option, the more likely that option will be in the money. However, if the option never gets into the money, the option owner loses no more than the cost of the option.

The value of options comes about largely because there is no downside risk to the option beyond the initial cost, but the upside reward is unbounded. As the spread in the potential future value of the asset increases, the value of the option increases. The option value increases, *ceteris paribus*, if: the current value of the asset increases; the distribution of the change in the stock price (e.g. the volatility of the stock price) increases; the strike price is lowered; the risk free interest rate increases; or the time to expiry of the option increases.

An option is a transfer of risk between the asset holder and the option holder. The asset holder accepts the certainty of money today and gives up the potential upside to the option holder. The option holder has exchanged certainty for a risky upside.

Real Options

Real options is the term for options on real assets (as opposed to financial securities). Real options are primarily used as tools in a financial manager's tool kit to hedge risk and to capitalize upon arbitrage opportunities. Recently, however, real option theory has been employed in valuations of patents. This work has primarily relied upon the Black-Scholes model.

Black-Scholes

The Black-Scholes[3] model determines the value of a call option as a function of:

- S, the current stock price;
- N(d1), the variability in the underlying stock price;
- K, the option's strike price;
- r, the risk-free interest rate;
- t the time until exercise; and,
- N(d2) is the variability in the stock price at exercise.

As the stock price S and the variability of the underlying stock price N(d1) increase, the value of the option increases. As the strike price, K, and the variability in the stock price at exercise N(d2) increase, the value of the option decreases.

Options Theory as Applied to Patents

At first glance, it appears that a patent can be valued as an option: there is a separation between the underlying asset and the option (the innovation and the patent), there is no obligation to use the patent, a patent cannot cost the owner more than the price of the patent or the price of creating the patent through research and development, and a great many options and patents expire worthless.

Practitioners using options theory to value patents generally link the value of the patent to the value of some underlying business project – e.g. a new product covered by the patent. The underlying project provides the data to use in the Black-Scholes model.

When applied to patents, S is the value of the project cash flows, K is the investment cost of the project, N is the distribution of the project values, and t is the time left to invest.[4]

Patents are not an Option on a Business Project

The most fundamental problem considering patents as options comes from the selection of the underlying asset. As it is used today, the underlying asset is considered to be the business project that utilizes the patent. However, this is inappropriate.

Consider two parallel worlds. In the first world, a company discovers a process innovation that will reduce the cost of building x-widgets by 10%. They decide not to obtain a patent on that innovation, but proceed to build a new x-widget factory that is a rousing success. In the second world, the company discovers the same innovation and builds the same factory, but chooses to patent the innovation. The value of the patent is the difference between the values of the projects in these two worlds. The existence of the patent is not required to build the factory, nor has it reduced the uncertainty around the returns from that factory.

What the patent has created is the opportunity to sue other companies using the innovation. The results of that suit (assuming that the patent is valid and infringed) are either a withdrawal from the market by the infringer or a royalty paid to the patent-holder. In these cases, either the infringer will lose or the patent holder will gain. That loss or gain can be quantified as the value of the patent.

Unlike a financial option, there is no risk transfer from the patent. The patent doesn't sell off part of the potential outcomes from the underlying project in exchange for certainty

3. More technically, the Black-Scholes equation for the value of a call is:
$= SN(d_1) - Ke^{-rt}N(d_2)$;
where:
S is the current stock price;
$N(d_1)$ is the normal distribution of change in the underlying stock price;
K is the option's strike price;
e^{-rt} is the formula to change something into present value using a continuously compounding, risk free, interest (r); and,
$N(d_2)$ is the normal distribution of the change in the stock price at the exercise time.
A good discussion of the Black-Scholes model can be found on page 578-580 of Brealey and Myers, *Principles of Corporate Finance*, Fifth Edition, 1996.

4. R. Pitkethly. *Valuation of Patents*, Oxford Intellectual Property Research Centre, Presentation.

today. The patent-holder has paid for the patent through investments in R&D and attorneys fees. What he has received is the ability to decide at some point in the future to sue other companies. However, there is no certainty about the gain or loss from those suits.

The use of the Black-Scholes formula to calculate the value of a patent rests on the confusion between the patent, the innovation and the business project. The innovation adds value to the business project—but it is not the entire value of the business project. The profits from the project need to be allocated out to the innovation, the brand, distribution capability, manufacturing capability, capital, etc. The innovation is simply one of the complementary assets required to obtain that stream of profits.

In the case of a really novel innovation, it can be argued that the bulk of the profits from the underlying business project should be allocated to the innovation since the innovation is the scarce resource. The patent is a way to enhance the uniqueness of the innovation – but it by no means guarantees the uniqueness of the innovation.

Extracting value from the patent can be done either through reducing competition in the market and taking the profits directly, or through licensing competitors. In either event, the patent is not an option in the financial sense – it is an asset from which value can be extracted.

Problems with the Black-Scholes Formula

Using the Black-Scholes formula, the value of a patent should increase, *ceteris paribus*, if the cash flows from the underlying project increase, if the investment costs of the project decrease, if the uncertainty of the project value increases, if the risk free interest rate increases, and if more time is allowed.

Some of these relationships between patent value and variables make sense. If project cash flows increase, value will increase. Similarly, if project costs decrease, then the value will increase.

However, other relationships are not logical. Unlike a true option an increase in the uncertainty of the project cash flows will not lead to an increase in the value of a patent. If the underlying project has less certain cash flows, then the patent is not any more valuable. There is value to the timing option—waiting until the project cash flows are more certain—but there is no additional value to the patent itself.

In addition, the Black-Scholes formula assumes a normal distribution for the changes in values of the underlying asset. However, it is most likely that the underlying distribution of the value of an innovation is approximately exponential.[5] Thus the formula oversimplifies an essential component of the valuation. In the case of patents, there is a relationship between the value of the patent yesterday and the value of a patent today.[6] A patent is more likely to systematically gain and retain value, whereas the value of an option is less predictable and less dependent on the value of the option from the day before.

Finally, the model is static. Black-Scholes was developed to be a financial instrument to inform someone whether it was economically worthwhile to exercise an option. The formula represents a value for the option at one point in time. It does not account for future values or cumulative cash flows. Exercising an option is a one-time event where the transaction is fully understood and realized at a set point in time. There is no investment in the asset until the option is exercised and then the exact value of the asset is known. In the case of a patent, investment can (and usually does) happen long before any return on investment is realized. Also, all of the return on the investment does not come immediately but rather over (often times) many years.

While we have not seen such an approach advocated anywhere, it is certainly possible to use a lawsuit as the underlying asset to be valued using Black-Scholes. However, the difficulties discussed when the underlying asset is a business project arise in this context as well. Increasing uncertainty regarding the outcome of the lawsuit does not increase the value of the patent. In fact, the outcome of a lawsuit will only determine whether the patent has value (is valid) or does not (is not valid). The outcome is essentially a binary variable—one that determines *whether* the patent has value not *what* that value is.

Whether the underlying asset is a business project or a lawsuit, it is quite possible to exercise the patent option and lose substantial amounts of money. This is not possible with a financial option as, at the moment of exercise, the value of the asset is known with certainty while with a lawsuit or a business project, the future cash flows are uncertain and quite possibly negative.

Conclusion

There has been much hope and hype recently about the use of options valuation techniques to value patents. However, the reality is that standard options valuation tools are not applicable for valuing patents.[7] Patents are a complementary asset in a business project, but they are not an option on that project. The Black-Scholes model assumes a normal distribution of value and estimates an increase in the value of the patent when the technology is less certain or further from commercialization.

While practitioners can use Black-Scholes to value patents in the sense that a number results from the application of the model, that number has only an accidental relationship to the true value of the patent.

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5. Harhoff, D., Sherer, F., Vopel, K. "Citations, Family Size, Opposition and the Value of Patent Rights – Evidence from Germany," Prepared for the *NBER Productivity Program Meeting*, March 1998.
6. Technically speaking, this means that the value of a patent at time t is correlated with the value of the patent at time t-1.
7. It is quite possible that some more complex option valuation technique is appropriate.