Valuing Intellectual Property: The Art, the Science and the Meaning of the Mean

DR. ALEX ARROW AND
*DR. NIR KOSSOVSKY**

Determining the present value of intellectual property rights to a future technology or product is a daunting task to some and a source of livelihood for others. Licensing executives and their advisors disagree on the standard and most straightforward method to perform such calculations. A conversation overheard between three IP valuation players is indicative of the most recent thinking on this subject. Any similarities to actual people or institutions, past or present, are purely coincidental.

Edgar Jones, a veteran consultant for IP Valuations, LLP, a leading intellectual property consultancy specializing in litigation support services, was relaxing at a bar after finishing a long day of highly quantitative testifying and had just ordered a Knob Creek, "neat," when the discussion between the two executives to his left caught his attention.

"Value is that which a willing buyer and seller have agreed upon as the basis for the exchange of money and intellectual property rights," declared a man wearing a blue banker's pinstripe suit.

"Yes, of course, that would be market value," replied his female colleague in a British accent. "But with intellectual property, how often is value established through this market mechanism of yours?"

Jones, whose previous seven hours were comprised of a grueling cross-examination, was responding quickly to the alcohol in the Knob Creek. "No more than 5 percent," he volunteered, uninvited.

"How's that?" asked the man.

"I've done some modeling in the past," Jones continued to his two new conversation buddies, "and I estimate that the present value of the worldwide pool of useful intellectual property—and I refer mostly to patents, which is my area of expertise—is approximately $5 trillion. Licensing and assignment revenue comprises no more than $200 billion. That probably includes derivatives such as some of the more recent securitizations. In practice, therefore, we have to rely on expert appraisals of value for most intellectual property."

"It seems to me you could extrapolate from the 4 percent you observe to derive market values for the remaining 96 percent," said the man. "Statistically speaking, $200 billion is a reasonable sampling."

"In my opinion," expert witness Jones pronounced, "the method of comparables is difficult to apply in practice because intellectual property is, by definition, unique. This uniqueness challenges the basic premise of the comparables technique—that the previous transaction and the present one are, in fact, comparable! The specific conditions under which the previous transaction occurred may have influenced the settlement price, and the background market conditions were most likely different."

"Would you agree that value is market-sensitive?" asked the woman, intrigued by the opportunity to learn from someone other than her usual conversation companion.

"Yes."

"Yet you suggest that 'the specific conditions under which a previous transaction occurred'—the conditions of what one might call a market-based transaction—make it not a useful proxy. Is this not a contradiction?"

"Not at all," replied Jones confidently. "The previous transaction is a singular event. Such an event may or may not be a 'market event' in the way your colleague described earlier. When I say 'market conditions,' I refer to broad economic indicators such as the performances of the global stock markets or interest rates. Broad public market data would be the ideal proxy, but, of course, are simply not practical to apply to intellectual property."

The man, silent for the last minute, now turned fully to face Jones. "I am confused. You agree with me that transactional precedents would be ideal indicators of value, but you conclude that IP transactions of the past are inappropriate to be used as proxies. You propose that because each one is

**Dr. Arrow is the EVP and managing director of TRRU® Metrics, and Dr. Kossovsky is the chairman and CEO, both of The Patent & License Exchange, Inc. (pl-x) in Pasadena, California.*

unique they are not sufficiently liquid to yield useful data; you agree with my colleague that market data would be an ideal indicator of value, but you conclude that you have no practical way to use those data. Are you advocating a subjective alternative?"

"Not at all. Subjectivity is a necessary impurity, of course, but any valuation authority must strive for objectivity at all times. Stochastic methods, to be exact, are the most objective method available today."

"Stochastic?"

"Probabilistic. Chance. Monte Carlo." Jones could sense from the confused look on the man's face that he would need to provide an explanation.

Patiently, Jones began, "The most commonly used valuation model is?"

"Discounted cash flows," replied the man.

"And the biggest problem with discounted cash flows?"

"The future cash flows of a piece of raw, undeveloped technology are uncertain," stated the man, conclusively.

"Exactly. But we know from past experience that with similar products arising from a previous intellectual property asset providing similar public benefits, the public is willing to pay a certain price—within limits. And the size of the public, or that portion of the public that purchased the previous similar products, is roughly the same," Jones went on. "We can therefore establish a mean estimate of cash flows and statistically model the range of cash flows that might be expected. We then use objective statistical modeling—effectively, a computer-simulated role of the dice—to generate an unbiased distribution of present values. Using further statistical tools, we then select the mean, or expected value, as the most reasonable estimate of present value."

The man was notably impressed. "Yes, I can see how software simulations using a die roll to select an outcome from a statistical distribution removes much subjectivity. How do you set the boundary conditions for the die roll?"

"Observable data only," said Jones, pleased that his listeners clearly appreciated the objectivity of Jones' Monte Carlo methodology. "We look back over time, and see what cash flows have been associated with comparable technologies. We adjust for some of the differences between these previous technologies and the one we are valuing, of course, but as the public is basically paying for benefits, the cash flows can be reasonably expected to be similar in both distribution and mean value."

"I see how these many observations provide you with data that are more 'market-like,'" said the woman. "But as these dice-generated data are centered around historical, previous technologies, which are presumably susceptible to—how did you put it—'the specific conditions under which a previous transaction occurred', do they not suffer from what you argued was a lack of sensitivity to current market conditions?"

"A minor impurity," quipped Jones. The Monte Carlo method captures market activity by virtue of the range of values upon which the calculations are based. The fact that the data are not up-to-the-moment yields a small but acceptable error. If you were asking me what would be the ideal, it would be up-to-the-moment market data, of course. But I don't think such a thing is practical."

"Going back to your historical observations," said the man, "how does that differ from the 'comparables' that you argued were inappropriate?"

"There is a significant difference. The 'comparables,' as you say, were few in number. By contrast, the cash flow payments generated by the Monte Carlo method represent a great many events. The increase in number corrects for idiosyncrasies that would be prominent in a small sampling."

"But are not the cash flows generated by each roll of the dice based on proxies—historical transaction proxies, that is—for the IP under consideration?" queried the woman. By now, both listeners were thoroughly engrossed in the unplanned lesson they were receiving from Jones.

"Another minor impurity," replied Jones. "The reality is that proxies are necessary evils. The art in valuation is in identifying appropriate proxies. The science of valuation is in using objective, repeatable, transparent methodologies. The objectivity and transparency of the Monte Carlo method is an obvious strength."

"It's been many years since I studied statistics," said the man. "I don't quite understand how this works. I understand how you set the boundary conditions for your die-roll-based estimates of future cash flows, but how many times do you roll the dice? For instance, if you rolled the dice once, you might get an extremely high or extremely low number. Would you accept that as your expected future cash flow? And if you rolled the dice twice, you might get one extreme and one fairly average value. Would you average the two?"

"As I said," replied Jones enjoying an opportunity to educate, "the method is objective. And being computer-based, repeat cycles represent no additional labor. Therefore, you run the simulation at least 30 times for statistical accuracy. In fact, with today's computational power, I often run it 300,000 times to achieve the greatest statistical significance." A bartender approached the trio looking to sell more drinks but was waved away by all three participants.

"Is it not true that the more frequently you run the model, the

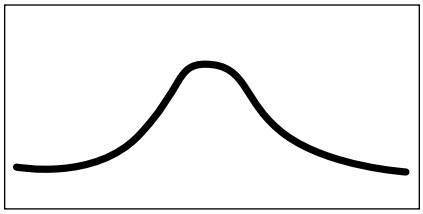
more likely the result will turn out equal to the mean value of the cash flows you defined when you set the boundary conditions based on your proxies?" asked the woman.

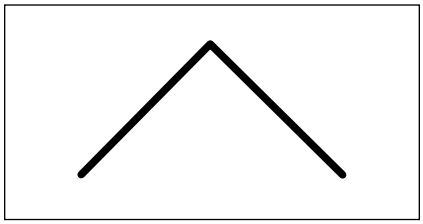
"Yes, of course," Jones replied.

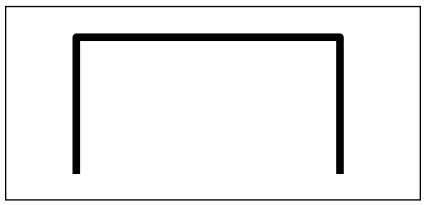
"So therefore, is it not true that this model is both influenced by the cash flows you observed (and adjusted) from the previous technologies (the comparables), as well as the implicit assumption that the potential future cash flows for the current technology are normally distributed?" she queried.

"Yes to the first, but no to the latter," said Jones triumphantly, as he was starting to get concerned that the woman might be getting the better of him. "The software allows the user to define the shape of the curve. A normal distribution for future cash flows is just one of many distributions one can select when using the Monte Carlo method."

Conveniently, the filmy mess from spilt drinks on the bar counter-top allowed Jones room to trace out three curves of various shapes with his index finger. He used this makeshift chalkboard and drew the shapes carefully, as the man and the woman watched. Jones then pointed to each shape as examples of different distributions of future cash flows that could be used as inputs into a Monte Carlo simulation.







"Does this curve-picking process not adversely impact the objectivity we all seek as the ideal?" continued the woman. "In other words, if you pick one of these curves and tell the computer running your dice-rolling that the results should be distributed as such, aren't you inserting your own subjectivity into the simulation, since you are the one picking the curve?"

"An impurity," of course. "But the reality is that potential outcomes are often normally distributed and it is the goal of the valuation process to approximate reality," Jones concluded. For this reason, I often pick the first curve, the normal distribution, when creating the inputs to run a Monte Carlo simulation.

"I do remember one thing from my statistics course," the man interjected, "—that the normal distribution is symmetric and it extends infinitely in both directions."

"To be sure," agreed Jones. He pointed to the first of the three figures again. "I've tried to draw it symmetrically, and I've made the two tails extend very far in either direction." He pointed to the two ends. It was generally understood by the three of them that while the bar space allowed Jones to draw a fairly accurate representation of the normal curve, it did not allow him to make the two sides infinitely long.

"Yes, but does the range of potential future cash flows from a new technology run infinitely in both directions?" asked the man. "I mean, certainly, the potential is infinitely high—there's no telling how high future revenues could be—but how could the potential run infinitely low? Cash flow cannot be less than zero. Put another way, your return on investment in new technology will never be less than negative 100 percent— a complete flop. The normal distribution is quite different from the reality in this way."

"Well, yes," admitted Jones, "but other than for that it's a pretty good approximation."

"Furthermore," now the man seemed to be working up momentum, "are future outcomes for new technologies symmetric about a mean? It would seem to me that they are not. Most technologies turn out to be nearly worthless, and a few of them are very valuable, right?"

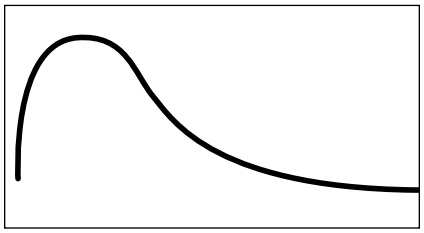
"Right," agreed Jones.

"So how is that symmetric?"

"Well.."

"Perhaps a better curve to model IP returns would look like this." Now it was the man's turn to push his finger along the countertop and draw a curve.

"This is a log-normal distribu-



tion," commented the man. "It reflects the fact that most technologies will turn out to have low values, a few of them will have very high values, and none of them will be worth less than zero. If we are talking about approximating reality, standards and objectivity, wouldn't a log-normal curve be the one to use?"

"An interesting point," conceded Jones. "I suppose a mathematical system using log-normal value distributions of observed data would increase objectivity."

"I think this has been helpful,

Mr…"

"Jones, Edgar Jones. IP Valuations, LLP," he offered, extending his business card.

"Thank you, Edgar. Jeremiah Bolton here," said the man. As the trio began their first actual introductions, they noticed that a small crowd had gathered around them at the bar, spectators of the heated discussion. "I'm the CFO of Large Bank out of Richmond. As I was saying, I think this has been helpful, but I want to recap. Recapping helps me remember things. If I heard you right, you believe that in the ideal, market-driven, up-to-the-moment data of artfully selected proxies of value distributed in a log-normal distribution and subjected to a Monte Carlo simulation of at least 30 cycles would yield a reasonable indication of value for IP?"

"That seems right, Jeremiah," answered Jones a bit bowled over by the banker's command of the subject.

"What about the discount rate?" Jeremiah continued. "If each roll of the dice is followed by a discounted cash flow calculation to obtain a present value, you need to tell the computer what discount rate to use. You don't do Monte Carlo simulations for that too, do you?"

"I don't think that would make sense," replied Jones. "Estimating risk through a probability function would be hard to justify. There are industry standard discount rates, or course, for different technology areas, and again, there is the art of valuation here. Many people take pride in picking the right discount rate for each assignment, and I am one of them."

"Edgar, my name is Amelia," said the woman. "What you say about discount rates intrigues me as well. In view of your other opinions, would not an observed market-driven measure of risk, adjusted up-to-the-moment, be the ideal way to set the discount rate?"

"Yes, of course. But again, there is no practical way to measure this."

"So that I'm still on the same page with you two," said Jeremiah, "I'm hearing that you believe that in the absence of an actual transaction and price discovery, the ideal indication of value for an undeveloped intellectual property asset would be:

- an objective software-driven calculation, using
- artfully chosen, market-driven, up-to-the-minute proxies of technology value based on cash flows,
- distributed in a log-normal manner and discounted by
- observed market-based, up-to-the-minute estimators of risk."

Jeremiah counted off the points on his fingers to keep track of them.

"In the ideal, that's about right," replied Jones. "But in the absence of up-to-the minute market values, the discounted cash flow method incorporating Monte Carlo simulations is the most sophisticated solution available today."

"If you are looking for up-to-the-minute proxies of cash flow, it seems to me you would turn to what we all agreed is the most liquid market—the stock market," concluded Jeremiah. "Aren't data from the stock market more like the ideal cash flow proxy than cash flows from previous IP transactions, which you told us suffer as inputs to your Monte Carlo process because they are old, few in number and, of course, the result of 'the specific conditions under which a previous transaction occurred'?"

"Yes, but a stock price is not a proxy for technology cash flow," responded Jones. "And you would need a corresponding measure of risk." The eyes of the spectators darted back and forth between Edgar Jones and Jeremiah Bolton as if they were tracking the tennis ball in a Wimbledon match.

"But in a small company whose product pipeline is entirely in one specific niche field—a "pure play" company—enterprise value is an accepted proxy of technology value, and of course, market 'beta' is a financial standard," replied Jeremiah. "Remember that in a small company with minimal revenue, minimal history and a product pipeline that is specific to a single niche area, enterprise value—that is, market cap minus book value—is an excellent proxy for the value of a the average product in a specific niche area. It is an estimate determined by the collective wisdom of the world's markets. And it is updated every day, for every niche area. Beta is really a no-brainer, financially. It is a measure of risk based on actual, observed behavior, which would seem more reasonable than even the most artfully chosen discount rate."

"This is interesting from a theoretical perspective, of course," noted Jones. The alternative method you've hinted at, Jeremiah, sounds like an adaptation of the Black-Scholes options pricing model and I can see some merit in using financial market data. I'm bringing up the Black-Scholes formula because it is the result of deducing the present value of a right to an asset with highly uncertain future returns that are log-normally distributed. In fact, that's the way you derive the formula —from the log-normal distribution and the right to invest capital to obtain the underlying asset." Jones was extremely pleased with himself for remembering this derivation, and so, too, were a couple of the bar spectators.

"Ironically," Jones continued as if in an epiphany, "a patent is, financially speaking, a call option on the underlying technology to which its owner has rights. So there is, if you will, an innate attractiveness to the formula. But…" Jones stopped. "I

don't even know why I'm talking about this because the simple fact is that creating a system to calculate up-to-the-minute data for cash flow proxy value and risk is technically impossible today. Otherwise, you can be sure my colleagues at IP Valuations would have already done so."

"Interesting," said the woman. "Jeremiah and I must be off." As the trio broke up, the barroom conversation returned to more prototypical repartee. And the bar countertop ceased being used as a makeshift chalkboard, allowing the bartender to sell more drinks.