ARTICLE

AN ANALYSIS FOR THE VALUATION OF VENTURE CAPITAL-FUNDED STARTUP FIRM PATENTS

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I. INTRODUCTION

The pattern of innovation in the United States is constantly shifting. The rise of the venture capital industry has lead to the emergence of startup firms

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founded to commercialize new technologies.[1] The rise of startup innovation is, in turn, challenging the in-house R&D model which has dominated American industry since the turn of the century.[2] As innovation moves outside the locus of large firms, a new market is emerging in the transfer of intellectual assets. Two trends suggest that this market will continue to grow as an alternative to venture capital funded commercialization.

First, there is a recognized breakdown in the effectiveness of in-house R&D in many industries.[3] The pharmaceutical pipeline is taking in increasingly larger sums of money and producing fewer and fewer drugs.[4] Traditional R&D giants are looking to revitalize their internal efforts.[5] Consequentially, firms are turning outside to find new ideas.

Second, there are a growing number of entrepreneurs who have stepped in to fill this need. There has been a growth of independent invention workshops, and in firms who actively search for inventors.[6] Industries such as semiconductors are turning to "fabless" commercialization models.[7] Independent private laboratories and universities are successfully raising revenue through licensing.[8] Commentators suggest that the true growth opportunity is not in idea generation, however, but in the role of intermediaries who are able to commercialize the abundant supply of new ideas.[9]

Venture capitalists are increasingly getting involved. The new potential of the R&D licensing market, coupled with the slump in the IPO market, has

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[1] PAUL A. GOMPERS & JOSH LERNER, THE MONEY OF INNOVATION: HOW VENTURE CAPITAL CREATES WEALTH 74-79 (2001).

[2] *See* Naomi R. Lamoreaux & Kenneth L. Sokoloff, *Intermediaries in the U.S. Market for Technology, 1870-1920* (NBER Working Paper 9017, 2002), at http://www.nber.org/papers/w9017.

[3] Howard Anderson, *Why Big Companies Can't Invent*, MASS. INST. TECH. TECH. REV., May 2004, at 56, 58.

[4] Stephen S. Hall, *Revitalizing Drug Discovery*, MASS. INST. TECH. TECH. REV., Oct. 2003, at 39, 40.

[5] *Id.* at 39.

[6] Evan I. Schwartz, *Sparking the Fire of Invention*, MASS. INST. TECH. TECH. REV., May 2004, at 32, 34; Jena McGregor, *The World is their R&D Lab*, 82 FAST COMPANY, May 2004, at 35.

[7] *See generally* Gred Linden & Deepak Somaya, *System-on-a-Chip Integration in the Semiconductor Industry: Industry Structure and Firm Strategies* (CCC Working Paper No. 99-2, Haas Sch. of Bus., U.C. Berkeley, 2000), *available at* http://ssrn.com/abstract=259878.

[8] Lawrence M. Fisher, *The New Architecture of Biomedical Research,* 33 STRATEGY+BUSINESS 1, 8 (2003).

[9] Kenan Sahin, *Our Innovation Backlog*, MASS. INST. TECH. TECH. REV., Jan. 2004, at 56, 56.

increased the attractiveness of using technology transfer as an exit strategy. Firms such as Cerian Technology Ventures have sprung up to assess and remarket the intellectual property of failed startup firms.[10] The Venture Capital Journal has recently run several articles discussing the potential of mining portfolio companies' patent portfolios for value.[11]

The investment community has traditionally been weary of patent-based transactions. The Harvard case study of Aberlyn Capital Management[12], for example, highlights the risks of using patent-backed loans. Often, unwary investors can end up stuck with a patent that is effectively worthless when the firm which created it failed. For these transactions to gain acceptance, their risks and rewards must be better understood. This requires a tool for valuing startup patents which incorporates the risks of technology transactions.

II. THE NEED FOR A PATENT ANALYSIS

This article addresses that need by devising an analysis for valuing portfolio company patent rights. The analysis is intended for investors seeking to utilize patents in firm valuations, as collateral for financing, or as an exit strategy. The valuation of patents is a complicated and speculative task. Much has already been written upon it. It has been addressed in several divergent bodies of literature: finance works valuing assets in the M&A context,[13] legal works addressing infringement damages,[14] and economic works valuing patents for use as data sources.[15] There is also a related body of industrial organization literature which addresses the effect of IP rights on startup firm commercialization.[16]

By focusing specifically on VC-funded startup firms' patents, this article

[10] Mike Allen, *Ailing Firms' Prized IP is Up for Sale*, SAN DIEGO BUS. J., Mar. 17, 2003, at 8.

[11] *See, e.g.*, Andrew J. Sherman & Paul Devinsky, *Leveraging the Intellectual Capital of Your Portfolio Companies*, VENTURE CAP. J., Mar. 2003, at 1; Thomas D. Halket, *To Do: Determine the Value of My Failed Startup's IP*, VENTURE CAP. J., Oct. 2002, at 43.

[12] Josh Lerner & Peter Tufano, *Aberlyn Capital Management: July 1993* (Harv. Bus. Sch. Case Study 9-294-083, 1997). *See also* GOMPERS & LERNER, *supra* note 1, at 36.

[13] *E.g.*, Robert B. Lamb, *The Role of Intellectual Property and Intangible Assets in Mergers and Acquisitions*, *in* INTELLECTUAL PROPERTY ASSETS IN MERGERS AND ACQUISITIONS, 2.1 (Lanning Byer & Melvin Simensky, eds. 2002).

[14] *E.g.*, Mohammad S. Rahman, *Patent Valuation: Impacts on Damages*, 6 U. BALT. INTELL. PROP. L.J. 145 (1998).

[15] *E.g.*, Browyn H. Hall, Adam B. Jaffe & Manuel Trajtenberg, *The NBER Patent Citations Data File: Lessons, Insights, and Methodological Tools,* at 14 (NBER Working Paper 8498, 2001).

[16] Joshua S. Gans & Scott Stern, *The Product Market and the Market for 'Ideas': Commercialization Strategies for Technology Entrepreneurs*, 32 RES. POL'Y 333 (2003).

takes advantage of several simplifying assumptions which allow it to integrate the analyses of legal and industrial risks with standard valuation techniques. Primarily, it assumes that, should commercialization by the startup firm fail, the entrepreneur will raise revenues by patent licensing. Furthermore, it assumes that such licensing will be with an established competitor, as the failure of one startup to commercialize the innovation strongly suggests that any other startup which would make such an attempt would fail.

This analysis addresses one of the major problems facing venture capital investors by reducing some of the uncertainty of investing in startup firms. Because it is based on publicly available information – patent searches, royalty rates, and the like – the valuation can be performed without any input from the entrepreneur at all. When inventors show up looking for funding with nothing other than an idea and a business plan, the resale value of the idea should be as important as the projected value of their enterprise, because it is one of the few pieces of property which they can offer as collateral.

By lowering the transaction costs of a licensing transaction, this analysis opens up the possibility of out-licensing as an exit strategy. These exits have the potential to mitigate the cyclic nature of the venture capital industry by offering investors the ability to exit their investment without having to wait for external business cycles to rebound. These exits also ameliorate some of the illiquidity issues with startup investment. A startup firm increases the value of its patents during development by eliminating the technical risk associated with the underlying technology. Out-licensing of unused technology, or of future interests in patent rights, can serve as a rapid means of selling off some of the value created by the startup firm prior to the outright sale of the firm.

III. APPROACH

A patent is worth nothing on its own. It is nothing more than a property interest in a right to make or sell an invention. Any revenue which derives from the patent must come from sales of products containing the patented invention.

When a startup firm obtains a patent, it has two choices. First, it can make and sell the invention itself, using its patent monopoly to keep competitors out of the market while it acquires the resources needed to enter production. Alternatively, it can sell its patent rights to another company which has the resources necessary to commercialize the invention in exchange for royalties on the final sales.

There are, therefore, two potential measures of a patent's value. The first is the amount of profits that the patent owner could realize through making and selling the patented goods themselves. Computing this value is done by the *Analytical Approach*, which looks at the financial performance of

manufacturers of similar products to determine benchmark profits.[17] Alternatively, a patent can be valued as the price which a company wishing to commercialize the invention would be willing to pay for a license. This is the *Relief from Royalty* approach.[18]

For an investor in a startup firm, the *Relief from Royalty* approach is more helpful because it best approximates the resale value of the patent. This approach analogizes the patent asset to a piece of production equipment. An investor valuing the asset as collateral is more interested in the equipment's value on the market than in the future profits derived from the goods it produces. Profits from sales of patented goods depend on the business which will commercialize the patent, whereas future royalty streams represent the value which any owner of the patent can receive.

Three types of approaches are generally used to estimate future royalty streams. Just like startup firms, patents can be valued using Cost, Market-Comparables, and Income.[19] The most rudimentary valuation approach involves the use of historical costs such as the R&D and regulatory investment in acquiring the patent right.[20] Because the sunk costs in a patent bear almost no relation to the potential revenues from an invention, however, this method does not accurately reflect the potential resale price.[21]

A market-based approach looks to similar transactions as a source of the expected future value. In theory, this approach has great appeal to predicting licensing revenue because it is based on comparison to previous licensing deals. Furthermore, the legal standard for estimating a reasonable royalty is based in part on the prevailing market rate for technology.

However, several practical problems with this approach are often cited as its downfall. First, it is by definition impossible to identify a truly comparable

[17] *See* GORDON V. SMITH & RUSSELL L. PARR, VALUATION OF INTELLECTUAL PROPERTY AND INTANGIBLE ASSETS 224-27 (3rd ed. 2000).

[18] *Id.* at 222-24.

[19] *See generally* RICHARD RAZGAITIS, VALUATION AND PRICING OF TECHNOLOGY-BASED INTELLECTUAL PROPERTY, 119-120 (2003); Lamb, *supra* note 13; Michael J. Lasinski, *Valuation of Intellectual Property Assets in Mergers and Acquisitions*, *in* INTELLECTUAL PROPERTY ASSETS IN MERGERS AND ACQUISITIONS, 4.1 (Lanning Byer & Melvin Simensky, eds. 2002); Jeffery H. Matsuura, *An Overview of Intellectual Property and Intangible Asset Valuation Methods*, 14 RES. MGMT. REV. 33 (2004); Jonathan A. Barney, *A Study of Patent Mortality Rates: Using Statistical Survival Analysis to Rate and Value Patent Assets*, 30 AIPLA Q. J. 317 (2002); Robert Pitkethly, *The Valuation of Patents* (Judge Inst. Working Paper WP 21/97); Markus Reitzig, *Improving Patent Valuation Methods for Management* (Ctr. for Law, Econ., and Fin. Inst. at Copenhagen Bus. Sch., Working Paper 2002-09).

[20] Pitkethly, *supra* note 19, at 6.

[21] *See* Barney, *supra* note 19, at 323-24.

market transaction.[22] Patents are unique goods.[23] There will always be differences between other traded technologies and the one at issue. Furthermore, the dynamic of the technology transaction can vary significantly from transaction to transaction.[24]

The second significant shortcoming of the market-based approach is the scarcity of information on technology transactions.[25] The terms of these transactions are generally not made available to the public. Even when deals are announced, key pricing terms are often omitted.[26]

This difficulty, however, reflects the general informational scarcity in the venture capital industry. In fact, there is much more information available on patent transactions than for many other aspects of the venture capital industry. By focusing on licensing to established companies, this analysis generally focuses on interactions with publicly held firms. At least some firms consider licensing transactions sufficiently material to disclose them.[27] Furthermore, patent disputes do sometimes end up in the courts, where the terms of the litigated royalty rates become part of the public record.[28]

The use of market-comparables can be enhanced through the use of value characteristics.[29] Value characteristics are used in the valuation of private companies to serve as the basis for comparison with companies for which valuation data is available. An ideal value characteristic is easily quantifiable and serves as a good proxy for firm value.

The most popular patent valuation method is the income approach.[30] This approach values the patent as the present value of future earnings.[31] The future income streams from a patent are computed using either a discounted cash flow ("DCF") or real options approach.[32] The DCF approach looks at the income stream derived over the life of the patent, and adjusts for the risks

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[22] *See* Pitkethly, *supra* note 19, at 7-8.

[23] Patents are only available for "new" and novel goods. *See* 35 U.S.C. §§ 101-102 (2000).

[24] Matsuura, *supra* note 19, at 2-3.

[25] Barney, *supra* note 19, at 323.

[26] *Id.*

[27] *E.g.*, CALLAWAY GOLF, 2003 ANNUAL REPORT, 2, http://ccbn.mobular.net/ccbn/7/668/720/.

[28] *E.g.*, Applied Med. Res. Corp. v. United States Surgical Corp., 435 F.3d 1356 (Fed. Cir. 2006)

[29] John Willinge, *A Note on Valuation in Private Equity Settings*, *in* VENTURE CAPITAL & PRIVATE EQUITY: A CASEBOOK 197, 197-99 (Josh Lerner & Felda Hardymon, eds., 2002).

[30] *See* Pitkethly, *supra* note 19, at 8-17.

[31] *Id.* at 8.

[32] *See id.* at 8-17.

involved in income production.[33] The real options approach considers the technology as an option which the owner may exercise if and when the costs of implementation are outweighed by the benefits of patent use.[34] The DCF method is best suited for this application. Royalty streams are easily valued as a series of annual payments. Furthermore, the technique is well-suited to capture the effect of the duration and risks of the transaction. Because of the compound assessments of risk in this calculation, a potential future expansion would be to use some form of Monte Carlo simulation.[35]

Patent valuation techniques have been applied to a wide variety of situations, from M&A valuation to infringement royalties. The choice of technique is governed by the context of the valuation. This article performs the valuation in the eyes of a venture capitalist or other investor who has secured the rights in a patent from an entrepreneur in exchange for financing. This article assumes that the entrepreneur has failed to turn a sufficient profit, and that the investor chooses to cease commercialization of the invention and instead raise revenue through licensing.

This article will first calculate future royalties using market-comparables. The article defines a series of value characteristics to be used in comparing comparable transactions. Once royalty streams are calculated, the paper will find their net present value, capturing the risks of the licensing transaction in the discount rate.

A number of factors affect the success of patent licensing. They can be categorized as Legal, Technical, and Industrial. Legal risks stem from the quality of the patent itself and the nature of the relief which the courts will grant. Technical risks reflect the quality and value of the underlying technology. Industrial risks characterize the difficulties of finding a buyer for the licensed technology, and look at the organization of firms within the industry.

Each of these risks will be explored below. For each factor, risks are identified for use in determining the discount rate and value characteristics are defined for use in comparable analysis.

IV. LITIGATION DAMAGES AND PATENT QUALITY

A patent is nothing more than a set of legal rights. In order to understand the value of a patent, one must first understand exactly what those rights entitle their holder to do. The patent grant conveys nothing other than the right to "exclude others from making, using, offering for sale, or selling the invention

[33] *Id.* at 8.

[34] *Id.* at 10.

[35] Willinge, *supra* note 29, at 202-03.

throughout the United States."[36] It does not convey any positive right to practice the invention itself. Therefore, the ultimate basis for the value of a patent is the legal damage award that one can receive from an infringer.

A potential licensee should be willing to pay no more for a license he stands to lose in a patent lawsuit. That is sum of the probability-discounted infringement damages and the cost of litigation:

$$ROYALTY \le (LITIGATION RISK \bullet DAMAGES) + LITIGATION COST$$

A. Damages

A patent owner is entitled to both monetary and injunctive relief. Monetary relief compensates the patent owner for past infringement, and injunctive relief prevents future infringement. The statutory provision for monetary damages grants "damages adequate to compensate for the infringement, but in no event less than a reasonable royalty for the use made of the invention by the infringer."[37] In practice, this translates into damages for *Lost Profits* and/or a *Reasonable Royalty*. It is noteworthy that, with the exception of design patents, the patent owner is not entitled to disgorge the profits that the infringer has earned.[38]

Lost profits compensate for economic damages that the patent owner experienced due to unlawful competition. In the licensing context, however, the patent owner is not engaged in an enterprise which utilizes the patent. Consequentially, the owner has no profits to have lost, and is only eligible to receive a reasonable royalty. Methods for determining the royalty rate and base will be developed below.

In addition to monetary compensation for past infringement, the patent owner can often obtain an injunction prohibiting the infringer from continuing to manufacture the infringing product. Injunctions are offered at the court's discretion.[39] There is a considerable risk that a patent owner engaged in royalty generation will not be viewed as a sympathetic candidate for an injunction against infringers. In eBay v. Mercexchange, the Supreme Court recently retracted the Federal Circuit's liberal standard for the use permanent injunctions in patent cases, emphasizing a return to the traditional equitable standard.[40] The application of this doctrine to patent owners engaged in royalty generation creates additional risk for such licensing practices. Although the opinion deferred to the desire of sympathetic patent holders, such

[36] 35 U.S.C. § 154 (2000).

[37] 35 U.S.C. § 284 (2000).

[38] *See* 35 U.S.C. § 289 (2000); *cf.* 35 U.S.C. § 284.

[39] 35 U.S.C. § 283 (2000).

[40] Mercexchange, L.L.C. v. eBay, Inc., 126 S.Ct. 1837, 1840-41 (2006).

as "university researchers or self-made inventors" to license their patents,[41] the concurrence noted the rise of an industry which uses patents "primarily for obtaining licensing fees."[42] Consequentially, the potential for a permanent injunction in this instance is low.

Because of the low likelihood of receiving a permanent injunction, and the lack of lost profits, damages can simply be computed as the product of the royalty rate and royalty base summed for each potential licensee:

$$DAMAGES = \Sigma ROYALTYRATE \bullet ROYALTYBASE$$

1. Royalty Rate

The calculation of reasonable royalties is the subject of much litigation. The courts generally apply the standard of "the hypothetical negotiations between willing licensor and willing licensee."[43] Such a negotiation is presumed to be an arms-length negotiation between parties who have not yet resorted to litigation.[44] The reasonable royalty is, as defined, basically the market rate for the technology license.[45]

2. Royalty Base

The scope of the royalty base is normally determined under the Entire Market Value Rule.[46] The rule dictates what sales can be included in a royalty base for damages. Final product sales are included in the royalty base, so long as (1) the patented component works as an integral component of the final product, and (2) the benefits of the patented feature drive customer demand for

[41] *Id.* at 1840.

[42] *Id.* at 1842 (J. Roberts, concurring).

[43] Fromsom v. Western Litho Plate & Supp. Co, 853 F.2d 1568, 1574 (Fed. Cir. 1988).

[44] *See id.*

[45] There is an obvious circularity in that the negotiated royalty prior to litigation will be discounted to reflect the uncertainties of litigation. The courts are not blind to this, and have occasionally increased royalty damages so as provide an incentive for infringers to avoid litigation, though not always without controversy. *See* Panduit Corp. v. Stahlin Bros. Fibre Works, Inc., 575 F.2d 1152, 1158 (6th Cir. 1978) ("The setting of a reasonable royalty after infringement cannot be treated . . . as the equivalent of ordinary royalty negotiations among truly 'willing' patent owners and licensees. . . . [T]he infringer would have nothing to lose and everything to gain if he could count on paying only the normal, routine royalty non-infringers might have paid."). *See also* Stephen H. Kalos & Jonathan D. Putnam, *On the Incomparability of 'Comparables': An Economic Interpretation of 'Infringer's Royalties',* 9 J. PROPRIETARY RTS. 2 (1997).

[46] *See* Rite-Hite Corp. v. Kelley Co., 56 F.3d 1538, 1549 (Fed. Cir. 1995).

the final product.[47] For example, a patented LCD display licensed for use in car stereos would have a claim on stereo sales, but probably not the final price of every car sold with the units.

B. Litigation Costs

The excessive expense of patent litigation has a significant effect on parties' license valuation. The cost of litigating a patent case has been estimated from $1.25 to $4 million, depending on the size of the suit.[48] Economic losses due to a preliminary injunction are not likely to be an issue, because, as discussed above, courts rarely grant such injunctions.[49]

C. Litigation Risk

The final component of this analysis is the projected litigation outcome. This analysis uses the historical probability of plaintiff victory to predict infringer behavior. It ignores, for the sake of simplicity, the potential effects of differing expectations on the outcome of litigation.

Empirical studies suggest that the probability of patentee victory is just over 50% at the time the complaint is filed.[50] This serves as the starting point in predicting litigation outcomes. However, refinement can be achieved by

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[47] *Id.*

[48] According to the AIPLA, in 2005, the average patent suit with between one and twenty five million dollars at stake cost $1.25 million to bring through discovery, and $2 million to litigate fully. For cases with over $25 million in suit, these costs rose to $3 and $4 million. *See* Am. Intell. Prop. L. Ass'n, Report of the Economic Survey 2005, at 22-23. *See also* Jonathan Levin & Richard Levin, *Benefits and Costs of an Opposition Process*, *in* PATENTS IN THE KNOWLEDGE-BASED ECONOMY, at 120, 122 (Wesley M. Cohen & Stephen A. Merill, eds., 2003).

[49] *But see* Jean O. Lanjow & Josh Lerner, *Tilting the Table? The Use of Preliminary Injunctions*, 44 J. L. & ECON. 573 (2001).

[50] *See* Kimberly A. Moore, Judges, Juries, and Patent Cases-An Empirical Peek Inside the Black Box, 99 MICH. L. REV. 365, 385 (2000). One area of future expansion is to further quantify litigation outcomes with refined empirical data. Moore has, for example, undertaken a number of empirical studies of the patent litigation process which, although primarily focused on identify systemic trends in the federal courts, could be used as a basis for refining litigation outcome predictions. For example, she has studied outcome variability based on issues considered, litigation strategies, such as filing a declaratory judgment and forum selection, and jury prejudice towards party characteristics, such as party size and nationality. *See id.*; Kimberly A. Moore, *Populism & Patents* (forthcoming) (on file with author); Kimberly A. Moore, *Empirical Study of Willful Infringement*, 14 FED. CIR. B.J. 227 (2004); Kimberly A. Moore, Xenophobia in American Courts, 97 NW. U. L. REV. 1497 (2003); Kimberly A. Moore, *Forum Shopping in Patent Cases: Does Geographic Choice Affect Innovation?*, 729 N.C. L. REV. 907 (2001).

further unpacking the litigation process. A patent trial first adjudicates the *validity* of the patent, and then determines if *infringement* has occurred. In order to obtain a patent, the patentee must persuade the patent office that his invention meets certain legal standards.[51] The patent office's determination of validity, although presumed to be correct,[52] can be challenged during the litigation process.[53] If a patent is found invalid at trial, then it can generally not be enforced again. Conversely, a trial court's finding of validity, though not binding in future cases, is a good indication of the patent's validity.

Therefore, the outcome of any previous litigation for a patent can have a significant impact on its value. If a patent has been previously found invalid, the chance of winning is effectively zero.[54] If it has been found valid and infringed, its chances of future litigation success are greatly increased.[55]

If the patent has not been subject to prior litigation, there are several legal risks that can still be identified. The liberal granting of patents by the PTO has sometimes put it ahead of the courts in offering protection to rapidly advancing technologies. For example, patents granted on modified living organisms were not upheld until the landmark case of *Diamond v. Chakrabarty*,[56] and business methods were not patentable until *State Street Bank*.[57] Furthermore, the cursory examination given by the government during the application process often fails to find anticipating prior art which might be uncovered during litigation. Other issues, such as the potential risk of the first-inventor defense for business methods,[58] will also need to be analyzed and catalogued.

V. PATENT SCOPE

The previous section addressed the potential size of damages which a patent holder might recover from an infringer. In this section, the number of potential infringers against which a legally sound claim exists is evaluated. A patent is,

[51] *See* 35 U.S.C. §§ 101-103 (2000) (setting out the various conditions for patentability).

[52] 35 U.S.C. § 282 (2000). "The presumption of validity is based on the presumption of administrative correctness of actions of the agency charged with examination of patentability." Applied Materials, Inc. v. Advanced Semiconductor Materials Am., Inc., 98 F.3d 1563, 1569 (Fed. Cir. 1996).

[53] *See, e.g.*, Quad Envtl. Tech. Corp. v. Union Sanitary Dist., 946 F.2d 870, 876 (Fed. Cir. 1991) ("the courts are the final arbiter of patent validity and, although courts may take cognizance of, and benefit from, the proceedings before the patent examiner, the question is ultimately for the courts to decide, without deference to the rulings of the patent examiner.")

[54] Edward F. Sherry R David J. Teece, *Royalties, Evolving Patent Rights, and the Value of Innovation*, 33 RES. POL'Y 179, 181 (2004).

[55] *Id.* at 182.

[56] 447 U.S. 303 (1980).

[57] State St. Bank & Trust Co. v. Signature Fin. Group, 149 F.3d 1368 (Fed. Cir. 1998).

[58] *See* 35 U.S.C. § 273 (2000).

ultimately, nothing more than a legal document which describes and claims a piece of technology space for the owner. Therefore, two patents on comparable subject matters may be written in such a manner as to claim vastly different sizes of the technology space. Furthermore, the courts may interpret two facially similar patents very differently in light of other legal doctrines and policies. Consequentially, the scope of the patent right itself dictates the size of the patent's market for licensees.[59]

The most fundamental conception of the scope of a patent grant is the actual size of the claimed technology space. Drawing a parallel to real property, the value of a patent is directly related to its size in the same manner as the value of a piece of land is related to its acreage. There are several reasons why a large patent is more valuable than a small one. First, a large patent may cover multiple technologies. The purchaser of a license would be enabled to commercialize several inventions. Because exclusive licenses can be granted for specific applications of a patent, several exclusive licenses can be carved out of a broad patent. Furthermore, a broader patent is more difficult to invent around.

A. Subjective Approach: Identifying Applications and the Royalty Base

A three-step process can be used to measure the ultimate scope and reach of a patent. First, the claimed technology is identified, and any limitations in the claims are noted. This gives the overall claimed technology space. Next, the fields of use which intersect with the claimed space must be identified. Finally, the scope of the royalty base is determined under the Entire Market Value Rule.[60]

A patent applicant will claim as much of the technology space as is possible without stepping on the bounds of previous patents. To differentiate previous patents, the applicant will add limitations restricting what he claims. Because the claims are verbal descriptions of complex technologies, they must be interpreted to ascertain what they cover. During litigation, the court construes the exact scope of a patent's claims.[61] When a patent has not been litigated, the most effective approach is to assemble a panel of experts, comprising patent attorneys, managers, and scientists, to read the document and reflect upon the content of its claims.[62]

A patent can reach beyond its literal scope through the doctrine of

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[59] *See* Joshua Lerner, *The Importance of Patent Scope: an Empirical Analysis*, 25 RAND J. ECON. 319 (1994) (examining the impact of patent scope on firm value).

[60] *Supra* note 46 and accompanying text.

[61] Markman v. Westview Instruments, 517 U.S. 370, 372 (1996).

[62] Lerner, *supra* note 59, at 320.

equivalents.[63] The doctrine essentially states that a defendant will be found to be infringing if his technology is an "equivalent" of the patented technology.[64] This extension is broadest when patents are written in new and open fields, but can be limited by procedural complications during the application process.[65] Therefore, a legal analysis should also include an analysis of the patent's prosecution history.

Any product that contains all of the elements in a patent claim will infringe the patent.[66] Therefore, once the scope of the claims is established, all potential infringing uses should be listed. For example, a patent covering LCD technology may have applications in the PDA field, the computer monitor field, and the aeronautical instrument field. Once these have been identified, the most promising applications should be retained for more detailed analysis.

Finally, the scope of the royalty base should be determined under the Entire Market Value Rule,[67] which dictates what sales can be included in damages.[68]

B. Statistical Approaches

Given the cost of the qualitative approach,[69] and its limitations when considering large numbers of patents, experts have made numerous attempts to correlate quantifiable patent data with the size of the protected technology. These statistical approaches are useful for comparing the relative scope of patents in comparable transactions.

Research suggests that claim breadth is correlated with the Patent Office's assignment of field codes.[70] When a patent application is considered by the government, it is assigned a classification to a particular technology area. If a patent covers a broad area of technology it might be assigned to several classifications.[71] Empirical analysis has shown that when a patent is assigned to multiple categories it is likely to be more economically valuable, and, consequentially, to have a greater scope.

Citation data can also be used as a measure of claim scope.[72] When a patent applicant comes across a piece of prior art, such as a scientific publication or

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[63] *See* Graver Tank & Mfg. Co. v. Linde Air Products Co., 339 U.S. 605 (1950).

[64] Warner-Jenkinson Co. v. Hilton Davis Chem. Co., 520 U.S. 17, 21 (1996). *See also* Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 535 U.S. 722, 733 (2002).

[65] *Festo*, 535 U.S. at 734-35.

[66] Key Mfg. Group, Inc. v. Microdot, Inc., 925 F.2d 1444, 1449 (Fed. Cir. 1991).

[67] *Supra* note 46 and accompanying text.

[68] *Supra* Sec. 4.1.2.

[69] Lerner, *supra* note 59, at 320.

[70] *See id.*; Lanjow & Lerner, *supra* note 49, at 599.

[71] Lerner, *supra* note 59, at 320.

[72] Hall, Jaffe & Trajtenberg, *supra* note 15.

another patent, which is closely related to the idea the applicant is patenting, he must include a citation to it in his application, and explain to the examiner why his invention is not anticipated by it.[73] The number of these citations made outside of the patent's class has been developed as another measure of the breadth of the patent claims.[74] This measure, termed "Originality" measures the number of citations made outside of the patent's class, and the number of classes cited:

$$ORIGINALITY = 1 - \sum_j^n s_j^2$$

Where n is the total number of patent classes that the patent cites, and s is the proportion of those citations the patent makes in a given class j. [75]

Patent citation counts can be generated in many of the available on-line databases.[76] There have been numerous refinements upon basic counts. One such refinement is the *weighted count*, which weighs the value of each citation received by the number of citations that that the citing reference itself receives.[77] A *generality* index, like the originality index, measures the proportion of citations received that fall outside the patent's field.[78] A final measure, derived from the theory that more fundamental technologies are more innovative, looks at the proportion of *scientific* papers to which the patent cites.[79]

VI. TECHNOLOGY QUALITY AND IMPORTANCE

Assuming that the patent affords adequate protection, the next determinant of patent value is the value of the underlying technology that it represents. While the quality of an innovation is a qualitative notion, some metrics do exist that can afford a framework for analysis. The most ready framework is the measure of technical risk employed in an industry. The quality of an invention can also be measured using patent statistics.

A. Technical Risk

Every R&D project is an exercise in overcoming technical risk of failure.

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[73] *Id.* at 14-15.

[74] *Id.* at 21-22.

[75] *See id.* at 21; Manuel Trajtenberg, Adam B. Jaffe & Rebecca Henderson, *University versus Corporate Patents: A Window on the Basicness of Invention*, in TRAJTENBERG & JAFFE, PATENTS, CITATIONS & INNOVATIONS 63 (MIT Press, Cambridge, 2002).

[76] *E.g.*, Dephion Research Intellectual Property Network Database, http://www.delphion.com/.

[77] Manuel Trajtenberg, *A Penny for your Quotes: Patent Citations and the Value of Innovations*, 21 RAND J. ECON. 172, 174-75 (1990).

[78] Hall, Jaffe & Trajtenberg, *supra* note 15, at 21-22.

[79] *Id.*

Although an innovation must be "enabled"[80] and be "useful"[81] before the Patent Office grants a patent, it does not necessarily follow that the commercially viable embodiment of the invention will work. Many industries have a series of milestones to quantify the risk that an invention will fail. For example, the pharmaceutical industry has a regimented series of milestones through which a drug application must pass. Pharmaceutical compounds must go through preclinical testing, multiple phases of clinical trials, and finally approval by the FDA before they are ready for commercial sale.[82]

Technical risk is just as important in licensing as it is in commercialization because royalties are generally based upon licensee sales. It will ultimately be factored into the overall discount rate for the royalty stream. Venture capitalists will demand rates of return as high as 50% for technologies which have not been reduced to prototype, and 30% for technologies ready for commercial rollout.[83]

Further, there is a considerable variation of risk from industry to industry. A patented computer program, for example, is almost guaranteed to work, while a patented pharmaceutical has a long series of tests to undergo before entering the market.

B. Patent Statistics

Patents that represent better ideas should be more valuable. Drawing from the requirements for patentability,[84] an invention which is exceedingly non-obvious or useful has a greater potential to be a breakthrough idea. The most reliable means of measuring such inventive novelty is, as discussed above, a qualitative assessment of the patent document.[85] Nonetheless, patent citations developed during prosecution can also be used as value characteristics.

As developed above, patent citations indicate closely linked technologies.[86] A patent that has been cited many times is, therefore, relevant to many subsequent inventions. Not only does this indicate that it has a broader scope, but also that others have felt it beneficial to continue along the cited patent's line of research. In general, the more heavily cited patent is more technologically important, and would therefore be likely to be cover a commercially valuable invention.

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[80] 35 U.S.C. § 112 (2000).

[81] 35 U.S.C. § 101 (2000).

[82] *See* PhRMA, Inside R&D, http://www.innovation.org/index.cfm/nonav/Inside_R_&_D.

[83] *See* SMITH & PARR, *supra* note 17, at 556.

[84] *See* 35 U.S.C. §§ 101-102 (2000).

[85] *Supra* Sec. 5.2.

[86] *See supra* note 73-74 and accompanying text.

VII. TECHNOLOGY MARKET CONCERNS

The previous sections have addressed metrics for measuring the quality of a patent itself to derive patent value. Aside from its inherent value, the price which a patent commands on the market is ultimately also affected by characteristics of the market itself. This section addresses measures of the size of the market for a particular patent license.

It is assumed that the patent owner has been unable to achieve success commercializing the patent in a startup firm, and has resorted to raising royalties through licensing. It is further assumed that the potential customers for such licenses are established firms in the relevant industry. Given the current amount of available venture capital funding, as well as the propensity of venture capitalists to actively assist promising investments with financial and management resources, it is assumed that the failure of a startup firm is due to the ineffectiveness of the startup mode of commercialization, and that there would be no benefit in licensing the technology to another startup firm.

A. The Technology Market

The probability of finding a licensee is much higher if there is a healthy market for the licensed technology. A large body of literature exists which describes the factors that give rise to such a market, and its effect on the commercialization strategy of startup firms.[87] For the purposes of valuation, it is assumed that, of two patents of comparable scope and quality, the one for which a larger and more efficient market exists will be able to generate more income for its owner.[88] Using the framework derived by Gans and Stern[89], this

[87] *See generally* James J. Anton & Dennis A. Yao, *The Sale of Ideas: Strategic Disclosure, Property Rights, and Contracting*, 69 REV. ECON. STUD. 513 (2002); Ashish Arora, Andrea Fosfuri, & Alfonso Gambardella, *Markets for Technology and their Implications for Corporate Strategy*, 10 IND. & CORP. CHANGE 419 (2001); Gans & Stern, *supra* note 16; Joshua S. Gans, David Hsu & Scott Stern, *When Does Start-Up Innovation Spur the Gale of Creative Destruction?* (NBER Working Paper 7851, 2000); Charles W. Hill, *Strategies for Exploiting Technological Innovations: When and When not to License*, 3 ORG. SCI. 428 (1992); Gary P. Pisano, *The Governance of Innovation: Vertical Integration and Collaborative Arrangements in the Biotechnology Industry*, 20 RES. POL'Y 237 (1991); David J. Teece, *Competition, Cooperation, and Innovation: Organizational Arrangements for Regimes of Rapid Technological Progress*, 18 J. ECON. BEHAV. & ORG. 1 (1992); David J. Teece, *Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy*, 15 RES. POL'Y 285 (1986); David J. Teece & Henry W. Chesbrough, *When is Virtual Virtuous?: Organizing for Innovation*, *in* MANAGING HIGH-TECH INDUSTRIES (Harv. Bus. Sch. Press, 1999).

[88] Arora, Fosfuri & Gambardella, *Markets for Technology*, *supra* note 87, at 427; Atul Nerkar & Scott Shane, *When Do Start-Ups that Exploit Patented Academic Knowledge Survive?*, 21 J. IND. ORG. 1391, 1393-95 (2003); Timothy F. Biesnahan & Manuel

analysis focuses on the effectiveness of patents as a means of appropriability and the distribution of complimentary assets.

B. Excludability Effectiveness of Patents

Patents that cannot effectively block commercialization by others, even if enforced, are of little value. The actual preclusive effect of a patent varies considerably with the nature of the technology which it covers. For example, a patent on a chemical compound may be sufficient to prevent an infringer from practicing a technology, whereas a patent on a mechanical product may be designed around with considerable ease. Consequently, the overall effectiveness of patents also varies from industry to industry. Cohen, Nelson, and Walsh[90] performed a survey of executives to determine the relative effectiveness of patents in various industries. They have found, for example, that pharmaceutical and medical patents are effective while software patents are not.

Several factors affect the effectiveness of patents to prevent appropriation.[91] First, infringement must be detectable. Patents on technologies whose use is hard to detect in a finished product are, therefore, difficult to enforce. Furthermore, the patent must be difficult to invent around.[92] Pharmaceutical patents are, for example, particularly valuable because of the fact that a described chemical embodiment often has properties which cannot be replicated by similar compounds. Patents are also more effective when their enforcement is less costly than other means of protection, such as secrecy and lead time.[93] Finally, patents are more effective if the technology is such that the knowledge needed to execute it can be *codified*, or easily memorialized and transferred, and thus less effective in industries where most of the know-how necessary to commercialize a product is tacit and cannot be controlled through patent enforcement.[94]

Trajtenberg, *General Purpose Technologies: 'Engines of Growth'?*, 65 J. ECONOMETRICS 83, 84 (1995).

[89] Gans & Stern, *supra* note 16.

[90] Wesley M. Cohen, Richard R. Nelson & John P. Walsh, *Protecting their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (Or Not)* (NBER Working Paper 7552, 2000).

[91] *See* Anthony Arundel, *The Relative Effectiveness of Patents and Secrecy for Appropriation*, 30 RES. POL'Y 611 (2001); Cohen, Nelson & Walsh, *supra* note 90.

[92] Hill, *supra* note 87, at 431.

[93] Arundel, *supra* note 91, at 612-13.

[94] *See* Teece, *Profiting from Technological Innovation*, *supra* note 87, at 287. The Enablement Requirement, 35 U.S.C. § 112 (2000), mandates that a patent be sufficiently detailed to facilitate the practice of the underlying technology, so, in theory, all patents should perfectly codify the necessary knowledge. However, enablement is evaluated in

C. Complimentary Assets

The distribution of complimentary assets in an industry has a significant impact on the ability of a patent owner to profitably out-license. Complimentary assets are the technologies and organizations which are necessary to bring the patented technology into commercial existence.[95] One of the key benefits of licensing a technology is to capitalize on the profits of a firm better suited to take advantage of the technology than the inventor.

Several types of complimentary assets are required to commercialize an invention.[96] *Complimentary technologies* are the downstream technologies directly needed to bring an innovation to market. These include manufacturing, distribution, and marketing. *Prior technologies* include existing product platforms in which the innovation must operate. For example, an improvement in LCD technology must interface with existing computer monitor technology in order to be sold. Finally, *enabling technologies* are convergent technologies that might be integrated with the innovation in future product applications. Small LCD displays capable of replacing CRT's had to be integrated with microprocessor and software innovations in order to create the PDA market. For profits to be realized, these assets must all be brought together, along with the license, within the boundaries of the same firm.[97]

A technology can be either specific or general with regard to these complimentary assets.[98] A general technology can be commercialized through many different pathways, thus creating many potential downstream licensees. A more specialized technology, on the other hand, will have fewer licensees to choose from. Consequently, a patent which covers many different applications can be commercialized by more firms, and should, therefore, be easier to market.

The complimentary assets may be specialized or generic with regard to their applications.[99] Specialized complimentary assets are only instrumental to commercializing a small number of applications, whereas generalized complimentary assets can be adapted to many uses. Retail distribution networks are generic with regard to what they can distribute, whereas high-throughput drug-screening equipment is limited to pharmaceuticals.

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light of an individual having ordinary skill in the art, and it is that, tacit, skill which determines if an invention can be practiced. Consequently, Teece's argument could be recast to state that patents are more effective when the novel claim is more scarce than the ordinary skill needed to practice it.

[95] *See, e.g.*, Hall, *supra* note 4.

[96] *See* Teece, *Competition, Cooperation, and Innovation*, *supra* note 87, at 13.

[97] *See generally* Teece, *Competition, Cooperation, and Innovation*, *supra* note 87.

[98] *See* Teece, *Profiting from Technological Innovation*, *supra* note 87, at 288-90.

[99] *Id.* at 289-90.

Complimentary asset distribution drives the market for patent licenses. The market is strongest when there are a large number of firms with complimentary assets, and when those assets are specialized with regard to what they can be used to produce. When there are a relatively small number of firms situated to commercialize an innovation, the strength of the patentee's monopoly is diminished by the low supply of partners. Likewise, when the complimentary assets are specialized, manufacturers are less able to work around the patentee's monopoly by producing different goods.

Industry concentration is another factor determining price.[100] In concentrated industries, a small number of firms hold a large percentage of the assets. These firms are larger and more established, and are less likely to adopt external technologies to secure a competitive advantage. Firms in a fragmented industry are more sensitive to competitive pressures and more prone to turn outside for help.

D. Adverse Selection

The factors that affect the ability of a patent-holder to find licensees also often affect the success of a startup firm. In fact, factors such as the presence of a large number of firms with the necessary complimentary assets to develop a technology work against the startup firm. Likewise, startup firm failure is more likely in concentrated industries, when the firm must compete with entrenched incumbents for market share. In these industries, there is a greater risk that the startup would fail because of competitive pressures, rather than because of the inadequacy of its technology. Consequently, these situations mitigate some of the adverse selection risk in purchasing a technology which could not be commercialized by its inventor.

VIII. TECHNOLOGY PULL

Even when a potential market for a technology exists, the price commanded by the licensor depends on demand. Many established firms shy away from the external acquisition of technology. The "not invented here" syndrome is probably the biggest impediment to a successful licensing operation. The literature suggests several conditions that make it more likely that firms would look to external innovations in lieu of internal R&D.[101] These situations are often transient, and external technology sourcing is often not a viable long-term business model for these firms.[102] However, when these situations arise,

[100] Gans & Stern, *supra* note 16, at 336-38.

[101] *See* Scott K. Swan and Brent B. Allred, *A Product and Process Model of the Technology-Sourcing Decision*, 20 J. PROD. INNOV. MGMT. 485 (2003); Teece & Chesbrough, *supra* note 87.

[102] Swan & Allred, *supra* note 101, at 486, 493.

the value of a licensed technology can rapidly increase.

External sourcing is driven primarily by high competitive intensity. In new product spaces in particular, the race for the first-mover advantage can put development time at a premium. Off-the-shelf innovations, while perhaps less desirable than internally designed products, can be implemented much more quickly. Furthermore, cost pressures in some industries do not support active in-house R&D. In such situations, firms seeking innovative expansion must look outside to fill their needs.

Firms also resort to external sourcing in the face of dynamic product changes because their core R&D efforts cannot keep pace with external technical advances. In such situations, external sourcing serves as a stopgap to fill the product pipeline until internal R&D assets can be retooled to react to the new technology trends. External sourcing is reemerging in light of the perceived failure of in-house R&D to generate radical breakthroughs.[103] The pharmaceutical industry, for example, is cultivating external relationships in light of the inability of in-house R&D efforts to fill their product pipeline. Finally, external sourcing is a more viable option when the patented invention is autonomous.[104] Autonomous inventions, such as a spark plug, can generally be commercialized on their own, whereas systemic innovations, like a rotary engine, must be integrated with other developments. The costs of managing integration with external suppliers and customers may often outweigh the benefits of external sourcing.

IX. TECHNOLOGY LIQUIDITY

There is potential risk of patent illiquidity due to the high transaction costs of a licensing deal. Specifically, there are often difficulties in locating a prospective purchaser, and, once a purchaser has been identified, communicating and allocating the risks of commercialization.

Technology transfers are plagued by uncertainty and information asymmetry.[105] Neither party fully knows if the project can be successfully commercialized, though the seller does have a much better idea than the buyer.[106] Rather than probing the economic implications of these problems, this analysis will make the assumption that these problems can best be ameliorated, much as they are in the venture capital industry, through

[103] *See* McGregor, *supra* note 6; Anderson, *supra* note 3.

[104] *See* Teece & Chesbrough, *supra* note 87.

[105] *See* Zeckhauser, Richard, *The Challenges of Contracting for Technological Information,* 93 PROC. NATL. ACAD. SCI. 12743 (1996)

[106] *See* ASHISH ARORA, ANDREA FOSFURI, & ALFONSO GAMBARDELLA, MATKETS FOR TECHNOLOGY: THE ECONOMICS OF INNOVATION AND CORPORATE STRATEGY 93 (MIT Press, Cambridge, 2001).

reputation and informal networks.

Prior works have identified several factors which correlate with reduced transaction costs. Affiliation with venture capitalists is an indication of successful communication because of their perceived contacts with technology buyers.[107] Prior dealings between the licensor and licensee have been taken as indicia of open communication and trust.[108] Likewise, a history of in-licensing by the licensee can establish a reputation for fair dealing in an industry.[109] Finally, the "name-brand" recognition of the inventor or assignee often signals technical strength.[110]

These measures are most relevant for evaluating comparable transactions. It is assumed that the assignee of rights conducting this valuation would likely be a venture capitalist or other individual with the necessary network to successfully market the technology.

X. APPLICATION OF A DISCOUNTED CASH FLOW ANALYSIS

This section develops an integrated analysis utilizing all of the factors discussed in the article. The analysis begins with identifying the potential licenses which can be sold for a patent. It then prices each license as a pre-litigation settlement, considering the royalty base and a reasonable royalty rate. The reasonable royalty is calculated by comparison to similar transactions. Next, the potential risks of the transaction with regard to technical and market failure are evaluated, and the risk level is used to compute a discount rate.[111] Finally, the present value of each potential royalty stream is calculated.

Step 1: Identifying the Income Stream

The first step is to calculate the potential income stream. This is done by estimating the number of potential licensees, and estimating the license payment. First, the royalty base must be identified, as discussed in Section Five. The sales volume of the market must then be estimated.

After potential markets are identified, a royalty rate is identified in each market through evaluating comparable transactions using the metrics developed above:

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[107] Gans & Stern, *supra* note 87, at 344-45.

[108] *See* Anand, Bharat N. & Khanna, Tarun, *The Structure of Licensing Contracts*, 48 J. IND. ECON. 103, at 131 (2000).

[109] *Id.*

[110] *See, e.g.,* Wesley David Sine, Scott A. Shane & Dante DiGregorio, *The Halo Effect and Technology Licensing: The Influence of Institutional Prestige on the Licensing of University Inventions*, 49 MGMT. SCI. 478 (2003) (demonstrating the role of prestige effects in the university license context).

[111] *See generally* RICHARD A. BREALEY & STEWART C. MYERS, PRINCIPLES OF CORPORATE FINANCE 33-40 (7th ed. 2003).

Factor	Metric
Litigation Risk	o Prior Patent Litigation
Patent Scope	o Number of Claims o "Originality" Measure
Technical Quality	o Technology Stage o Weighted Backward Citation Count o "Generality" Measure o Scientific Citation Percentage
Technology Market	o Technology Appropriability o Industry Complimentary Asset Distribution and Specialization
Technology Pull	o Presence of Disruptive Factors o Technology Autonomy
Technology Liquidity	o Association with VC o Prior Dealings Between Firms o Licensee Reputation o Inventor Reputation

After considering comparable transactions, an estimated royalty rate should be determined. With this in hand, the annual income from the license can easily be computed, taking into account the effect of uncertainty and litigation costs:

$$AnnualIncome = \sum_{AllLicenses} \left(LitigationRisk \bullet RoyaltyRate \bullet RoyaltyBase \right) + LitigationCosts$$

Step 2: Risk Calculation

Next, the effect of risks must be captured. This analysis has so far utilized a very qualitative measure of risk. One potential area for growth is the use of more formalized risk estimation, perhaps with Monte Carlo analysis.[112] The key risks discussed were the risk of technical failure and technology market risks, including the existence of potential buyers, lack of demand for external technology, and potential illiquidity. A discount factor can be estimated based upon a qualitative assessment of these risks.

Razgaitis[113] has computed the discount rate used in IP licensing negotiations, based on technical and market risk. These values are somewhat lower than the approximations of discount rates used by VC's, but it is assumed that profit generation through out-licensing is less risky than through startup commercialization.[114]

Description	k
Proven Technology with Reliable Customer	15-20%
Well-Understood Technology with Existing Market with Evidence of Demand	20-30%
New Application of Understood Technology with Existing Market	25-30%
Novel Technology or Unknown Market	35-45%
Unproven Novel Technology with Unknown Market	50-70%

Step 3: Computation

Finally, the value of the license can be taken as the present value of the future earnings. To do so, the royalty stream will be summed and discounted over the life of the patent. Patents have a maximum life of twenty years, and antitrust laws dictate that royalty payments stop when the patent expires.[115] Consequentially, there is no need to consider a terminal value:

[112] *Supra* note 35.

[113] *Supra* note 19, at 192-95.

[114] *See* John C. Ruhnka & John E. Young, *Some Hypotheses About Risk in Venture Capital Investing*, 6 J. BUS. VENTURING 115, 124 (1991).

[115] Consequently, the present value of patent royalties decreases with the age of the patent, because the license will expire sooner. Note, however, that as a startup develops a patent, it becomes more valuable as technical risk is reduced. Therefore, there exists the potential for timing a licensing transaction to optimize value.

$$Value = \sum_{n}^{N} \frac{AnnualIncome}{(1+k)^{n}}$$

XI. CONCLUSION

This article has described an analysis of the value of patents held by startup firms by analyzing the out-licensing of startup technology to established firms. It considers six factors that determine patent value. These reflect risks of legal unenforceability, technical risk, and technology transaction risks. These factors are then incorporated into an analysis that uses market comparables to find royalty rates, and a discounted cash flow calculation to find the present value. This analysis will prove valuable to venture capital firms in evaluating the use of patent-based transactions using the intellectual property of their portfolio companies. Current trends in R&D and innovation suggest that such transactions will become more prevalent in the near future.