Patenting and Licensing Decisions: A Tested Method for Practical Decisions

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Early stage technologies have been particularly challenging to manage for university technology offices and professional inventors. Two critical decisions that they have to make are patenting and licensing for future streams of financial returns. Most of the current research focused on such decisions for mature or later stage technologies, but studies on early stage technologies have been rather scarce. In this research, we attempted to identify influencing factors of these decisions and established a practical yet swift decision procedure. Our findings generated a set of major decision factors, implementable decision processes and straight-forward decision thresholds of key parameters. This research offered fresh perspectives which further completed our extant knowledge.

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I. INTRODUCTION

We are living in an era of technology explosions, where new technologies and inventions filled today's market with inspiring products (Park and Zhou, 2015). A seemingly incremental invention or a simple twist of perspectives could completely revolutionize the market. Many of such budding technologies come from university labs. Universities manage their research lab technologies by providing facilities for the development of research, contracting with scientists on ownership, protecting contracted property rights, and actively commercializing these technologies to the market. Through the entire process from invention to commercialization, two critical decisions, namely, filing patents and licensing out for market usage, often challenge university technology offices.

These decisions are challenging yet worthy of careful studies. First, most research results directly out of a research lab tend to be at their early, if not infant, stage. A long uncertain commercialization process awaits these lab results. Most of such lab technologies go nowhere and never get commercialized due to various reasons; any efforts or financial resources invested into these technologies become fruitless. Research is an expensive endeavor and universities are no exceptions. High initial stake naturally calls for better results, which make patenting and licensing decisions harder to make. Second, filing patent and licensing requires professional services. For instance, a conversation we had with a patent attorney revealed a price tag of somewhere between $20,000 to $40,000 per patent case in the current market. A good and well protected patent goes a long way for future deals such as licensing, but licensing itself presents other myriads of considerations. The major concerns are fee schedules since licensing fees can be fixed or variable depending on actual arrangements. Fixed fees take the form of pre-purchase, minimum commitment or a hybrid of the two. Variable fees hinge on units and sales volume with fixed or variable royalty rates (Green 2012). Inherent complexity levels of these considerations challenge even the best professionals in the industry. Third, a Brookings Institute report (Valdivia 2013) recently showed that most of the university technology offices were not worth their costs with the report raising serious questions surrounding their operations efficiency. Valdivia (2013) strongly recommended university start-ups as an ultimate solution for universities. More specifically, the report finds that improving efficiency of technology offices or resorting to directly launching start-ups will allow the decision process of patenting and licensing to be well understood and streamlined, which will result in a sustainable while profitable future.

This research was supported and inspired by an Asian government agency who approached us for the best practices of patenting and licensing decisions. The agency was bothered by the same issues as we faced here in the US. After our initial interviews of practitioners, it turns out that these decisions are essentially about valuating a patent and its future licensing potentials. The higher the value or future potential, the easier are the decisions to file patents and price licenses. Our preliminary research showed that there was not a simple yet productive procedure for such valuations. Most of the studies now have been theoretical and overly comprehensive where practical suggestions were non-existent. Hence, we attempted to develop a simple and highly implementable procedure for efficient and scalable valuation. More specifically, we developed patent and license valuation indexes. University technology offices and future investors will both benefit from our discussions and bootstrap their own versions of decision processes based on our results.

The next section presented literature review. Our research method, data and findings were in section three. Section four concluded this paper with managerial implications.

II. LITERATURE REVIEW

2.1 Patent Decision and Valuation Literature

The reality is that most patents do not earn any money. Amram (2005) claimed that more than 95% of patents failed to earn any revenues. His conclusion was that comparable technologies should be critical reference information for evaluating the value of a patent. Reitzig (2002) reviewed 23 studies of patent valuations. His analysis focused on 13 best known indicators: (1) Age of the patent; (2) Market value of the corporation applying for the patent; (3) Backward citations to the patent; (4) Forward citations to the patent; (5) Family size; (6) Scope (of applications using the patent); (7)

Ownership; (8) Number of claims; (9) Strategy used for patenting; (10) Number of applicants; (11) Number of trans-boarder research co-operations involved; (12) Key inventors; and (13) Legal disputes in regards to the patent (opposition in particular). His work served as a good start for enumerating relevant factors for basic patent studies.

Later research turned their attentions to intangible parts of a technology. The popularity of computer software, nanotechnology, stem cell research and other computer programmed technologies sharply contrasted our tangible technology world. Newly emerged technologies bore little relevance to historical data, which rendered conventional wisdom out of touch. Patents in these categories were more challenging thanks to their short history and lack of empirical references (Merges 1999). Uncertainty is simply an inherent nature of patent valuation and filing decisions. Chiu and Chen (2007) best defined such nature by: "A patent is an exclusive right of limited duration over a new, non-obvious invention capable of industrial application, where the right to sue others for infringement is granted in return for publication of the invention."

Long and tedious steps/methods were abundant in existing research. Cromley (2004) provided a twenty step procedure to value a patent from an accounting perspective: (1) Checking if the patent is in force currently; (2) Context identification; (3) Collecting information; (4) Putting together a team; (5) Reading the patent (actual patent documentation and allied documentation); (6) Evaluating the scope of the patent; (7) Consulting with a patent attorney; (8) Checking the patent's validity; (9) Checking the blocking patents; (10) Considering synergies among various patents; (11) Checking foreign patents for any blocks; (12) Understanding the remaining duration of the patent under consideration; (13) Analyzing any prior royalties paid for the patent; (14) Analyzing any current or potential litigations against the patent in question; (15) identification of the next best available technologies; (16) estimating demand; (17) identifying patent's point of profit maximization; (18) applying traditional valuation approaches; (19) applying an income approach valuation; and (20) writing the patent valuation report.

Chiu and Chen (2007) developed the following patent valuation structure (Figure 1).

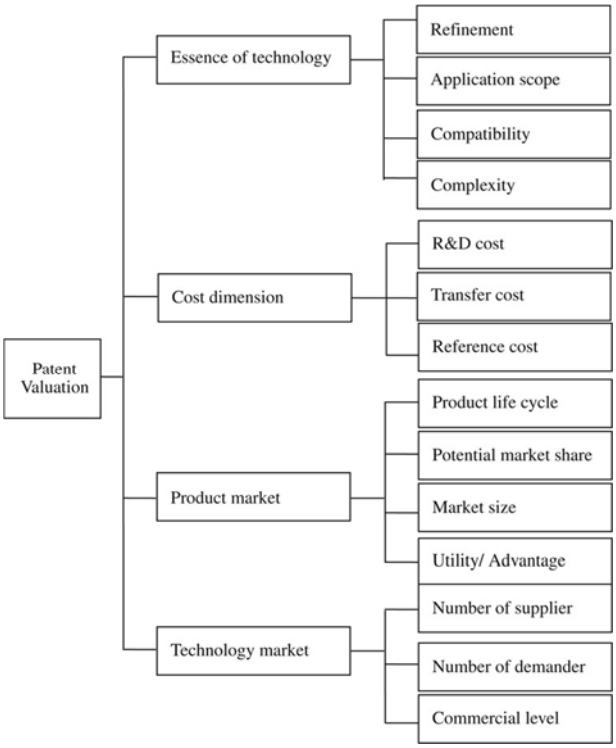

FIGURE 1. PATENT VALUATION STRUCTURE.

As these step methods got hierarchical and multi-dimensional, analytical hierarchy process (AHP) naturally had its advantages (Razgaitis 1999; Chiu and Chang 2007).

Other research touched more on valuation perspectives than on valuation methods. Narin et al. (1997) researched the value of patents based on backward citations to the patent. Similarly, Trajtenberg (1990) introduced forward citation as an indicator of patent valuation. Griliches (1981) and Conolly and Hirschey (1988) both examined the relation

between the market value and the patent valuation. Burke and Reitzig (2007) argued that judging a patent's validity based on the underlying technological quality could be important. Apparently, patent valuation and decision to file have been both art and science. Plenty of facets have been considered, yet practicality is lacking. As any valuation method would be just the preclude for a long and tedious process (Pitkethly 1997), making the starting process economical and efficient shall be desirable for all parties involved.

2.2 Licensing Literature

Licensing decision was frequently tied to the effectives of patent protection (Arora and Ceccagnoli. 2006). They found that "increases in the effectives of patent protection increase licensing propensity, but only when the firm lacks specialized complementary assets required to commercialize new technologies." Some of the complementary assets were manufacturing and marketing capabilities. When the firm had the assets to commercialize, then the opposite would be true. For example, large multinationals did not find an impact of patent effectiveness on licensing (Fosfuri, 2004). Patent effectiveness or strength of patent protection increased the licensing payoffs: "technology start-ups lacking manufacturing or market assets should license their innovations when patent protection is effective."

Rahal and Rabelo (2006) identified 43 important factors for licensing and commercializing university technologies. They developed a survey of Licensing Executive Society's professional members to evaluate relative importance of these factors. The survey returned twelve most important factors (Table 1) based on a five point Likert scale.

TABLE 1. RAHAL AND RABELO RESULTS.

Strength of the Intellectual Property	4.50
Significant identifiable benefits	4.45
Uniqueness and superiority	4.31
Probability of market success	4.30
Significant quantifiable benefits	4.30
Sustainable competitive advantages	4.23
Exclusivity of the intellectual property	4.20
Current and immediate market needs	4.16
Size of the potential market	4.16
Patent clear and clean	4.16
Technical feasibility	4.11
Development time to market	4.05

A regression model was then developed to predict the probability for a technology or IP to be licensed. Their survey rating method was instrumental and greatly reduced dimensionality of such decisions.

GIP Research & Consultancy Services (2012) addressed the licensing decision by introducing the following factors: legality, safety, impact on society, performance, profitability, market demand, market size, manufacturing feasibility, analysis of competition and related products, quality/quantity of competition and related products, competitive advantages and disadvantages, consumer appeal, and major barriers toward market or manufacturer acceptance.

Licensing decisions have been closely related to success and soundness of patenting. We studied both decisions together due to their inherent relevance.

III. RESEARCH METHOD AND ANALYSIS

We interviewed and studied the current practices of patenting and licensing at some universities in Silicon Valley. A team was established to review current literature review and public-domain data. The first two steps built

solid foundations for our survey of university technology offices around the US. These offices are in charge of intellectual properties and technology licensing. Using SJSU as an example, the office in charge of technology and intellectual property serves as "the campus agency to assist in bringing inventions to the public marketplace and to promote their greatest public benefit." Directors and other key members of an office received our survey and we followed up by phone calls to encourage their responses and discuss any questions they may have. Most of the respondents had five to ten years of experiences in the field and they were all knowledgeable of the subject matter. In the survey, we compiled as complete a list of factors as possible for our respondents to rate using a 1-7 scale with 7 being the most important. Similar methods were used in previous research, such as Rahal and Rabelo (2006). Please see appendix 1 for the full list of factors. Fourteen universities responded. Average ratings of the factors were as below in Table 2.

TABLE 2. FACTOR AVERAGE RATINGS.

No.	Question	Rating
1	Potential Market Value	5.357
2	Potential Market Size	5.643
3	Scope or Application	4.500
4	Utility Value	4.857
5	Legal or Regulatory Demands	4.286
6	Creativity or Uniqueness	5.500
7	Ease of developing around the patent	5.286
8	Time needed to commercialize	4.357
9	Uncertainly or Risk	4.214
10	R&D Cost	4.500

We took a marginal effect perspective in order to make the cut of most important factors. In the table below, Gap refers to the first order difference between a rating and its immediate higher rating. For instance, in the case of 0.143, it was produced by subtracting 5.5 from 5.643.

TABLE 3. MARGINAL EFFECT CALCULATION.

No.	Question	Rating	Gap
2	Potential Market Size	5.643	
6	Creativity or Uniqueness	5.500	0.143
1	Potential Market Value	5.357	0.143
7	Ease of developing around the patent	5.286	0.071
4	Utility Value	4.857	0.429
3	Scope of Application	4.500	0.357
10	R & D Cost	4.500	0.000
8	Time needed to commercialize	4.357	0.143
5	Legal or Regulatory Demands	4.286	0.071
9	Uncertainty or Risk	4.214	0.072

We then discussed all factors with our experts, such as technology office and patenting professionals, and team members. The largest gap of 0.429 showed up between question number 7 and question number 4. The second largest gap of 0.357 was between question number 4 and question number 3. Our expert panel discussions assisted us and led to our final decision of making the cut at question number 4. Hence, the top five factors for patenting valuation and decision were:

- Potential Market Size
- Creativity or Uniqueness
- Potential Market Value
- Ease of developing around the patent
- Utility Value

These turned out to be the most valuable factors agreed upon by our expert panel and team members. We then calculated their individual weights as a percentage of total ratings.

TABLE 4. WEIGHT RESULTS.

Factors	Rating	Importance Weight
Potential Market Size	5.643	0.212
Creativity or Uniqueness	5.500	0.206
Potential Market Value	5.357	0.201
Ease of developing around the patent	5.286	0.198
Utility Value	4.857	0.182
Total	26.643	1.000

These weights were of great practical meanings. A professional could score each of the five factors with a 100-point scale and then weight average the scores. The weighted average would be between 0 and 100. We then asked our expert panels to put the system to their own practices and give us their cut for "go", "hold" and "no" when it came to patent decision. While "go" and "no" are clear instructions for moving forward, "hold" normally means wait or more deliberations needed. Basically, a "hold" decision is put aside for future visits if necessary. In general, our expert panel agreed upon the following cut numbers.

TABLE 5. WEIGHT CUTS.

Score Range	Decision
<= 34	no
35 - 60	hold
61 and above	go

The procedure was welcomed by our expert panel and the sponsoring government agency as they found our method practical, intuitive and fair. The procedure could be summarized as:

1. Score the five factors.
2. Multiple the scores with our weights.
3. Compare the final weighted average with the above cuts.
4. Introduce institutional knowledge and make decisions.

A similar procedure was applied to license decision. Please refer to Appendix 2 for a list of factors. Our findings were as below:

TABLE 6. LICENSING FACTOR RATINGS.

No	Question	Rating
1	Technological Superiority	5.714
2	Ease of Imitation	5.286
3	Time needed to commercialize	5.429
4	Cost of Commercialization	5.143
5	Legal or Regulatory Demands	5.214
6	Potential Market Size	5.571
7	Competition in the market	5.071
8	Contribution of technology to the product value	5.786
9	Scope or Application	4.643
10	Rate of Return on Investment	5.500

Gap differences were calculated for selecting the most important factors. In this case, the largest gap showed up between question 1 and 6 as well as between question 2 and 3. Expert opinions helped greatly in order for us to reach the final result (Table 7).

Again, after expert panel discussions and taking into consideration of gap values, we selected the following five factors:

- Contribution of technology to the product value
- Technological Superiority
- Potential Market Size
- Rate of Return on Investment
- Time needed to commercialize

TABLE 7. MARGINAL EFFECT CALCULATION FOR LICENSING FACTORS.

No.	Question	Rating	Gap
8	Contribution of technology to the product value	5.786	
1	Technological Superiority	5.714	0.072
6	Potential Market Size	5.571	0.143
10	Rate of Return on Investment	5.500	0.071
3	Time needed to commercialize	5.429	0.071
2	Ease of Imitation	5.286	0.143
5	Legal or Regulatory Demands	5.214	0.072
4	Cost to Commercialization	5.143	0.071
7	Competition in the Market	5.071	0.072
9	Scope or Application	4.643	0.428

Weights were calculated as:

TABLE 8. WEIGHT RESULTS FOR LICENSING.

Factors	Rating	Importance Weight
Contribution of technology to the product value	5.786	0.207
Technological Superiority	5.714	0.204
Potential Market Size	5.571	0.199
Rate of Return on Investment	5.500	0.196
Time needed to commercialize	5.429	0.194
Total	28.000	1.000

Similarly, our expert panels and team members were asked to make the cuts again. An agreed upon schedule was:

Table 9: Licensing Weight Cuts

Score Range	Decision
<= 39	no
40 - 63	hold
64 and above	go

The four-step procedure for the patent case would be followed here to reach a license decision.

IV. DISCUSSION

In this research, a patenting index and a licensing index were developed using survey data and expert opinions. We identified the most important factors to be used in patenting and licensing decisions using survey ratings. The rating then assisted us to generate good relative weights for the later scoring and weighted averaging step. More importantly, we validated our procedure by testing it with our practitioner contacts. Their inputs produced a general yet highly practical cut schedule. Such schedule of realistic practices has yet to be witnessed in our current research. Although a technology office may choose to deviate from our cuts, what we offered here at least provided a simple and meaningful starting point. Our contribution is mainly two folds. First, we have identified, from the practitioners' perspective, the top factors which should be considered for patenting and licensing decisions. Our findings are refreshing to existing literature and offer good guidance for future research. Second, our methods, seemingly simple, have been tested by practitioners; the sponsoring agency reported satisfactory results. We showed that the simple methods could still significantly impact and guide real operations problems.

IV. CONCLUSION

We thoroughly reviewed existing research, interviewed practitioners in the Silicon Valley area, and surveyed university technology offices. Instead of presenting another theoretical and exhaustive research, we aimed at developing a practical guideline that a government agency and university office could easily deploy and get things moving to later steps of managing early stage technologies. We provided a procedure to thriftily value and make patenting and licensing decisions. This procedure was welcomed by practitioners in our expert panel and university officers in our interview group. This research contributed to

our current understanding and practices of managing early stage technologies by instating a heuristically simple, yet theoretically solid method for both patenting and licensing decisions. This method to the greatest extent avoided being "mathematically sophisticated but contextually naive" (Dissel et al., 2005).

From our own consulting experiences and interactions with industry practitioners, mathematically advanced methods were often perceived as impractical or overly academic. A sustainable and useful method has to be easy to understand, easy to implement and simple to present and make sense of. Based on the feedback from our expert panel and professional contacts, we believe we have achieved the goal and developed an instrument for the real world.

Our results could be impacted by our sample size and even biased a bit by our focus on the Silicon Valley area. Future research, blessed with bigger data size and more insights, may want to further train and validate our parameter values in order to obtain more consistent results and analyze our decision factors for different industries.

We acknowledge that there is limitation to implementing the results of our study. This paper is more intended to report on a practical case of implementing quantitative, yet comprehensible methods for the practicing agency. Hence, more advanced methods are not explored. Scenarios of a fuller list of factors that could have been incorporated into our calculations is not discussed. As numerical results and implemented methods with five factors already satisfied our sponsoring agency, we believe it is better to retain implementation actuality as adding factors only offered marginal theoretical and computational values. Due to confidentiality agreement, we were verbally briefed of implementation results without disclosing any detail of the results, and we are at no position to discuss or disclose their implementation in this paper. We would also like to caution our readers for generalizing this method to other scenarios as variations in other applications might call for revisions of our procedure, such as the number of factors.

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APPENDIX 1. PATENT SURVEY FACTORS.

1. Potential Market Value
   - Estimates of future returns on the technology development and/or commercialization.

2. Potential Market Size
   - Future user base of the technology

3. Scope of Application
   - The various fields or industries able to use the technology

4. Utility Value
   - Utilitarian contributions to the society/ market

5. Legal or Regulatory Demands
   - Time, financial resource, and legal step requirements in order to proceed with the patent

6. Creativity or Uniqueness
   - How radical is the content of the technology in relativity to comparable technologies

7. Ease of developing around the patent
   - Potential to create new products or to improve upon existing products

8. Time needed to commercialize
   - Time length from R&D to product launching

9. Uncertainty or Risk
   - Market risk, such as product failure, competition, regulation and others

10. R&D Cost
   - Additional R&D investments needed to advance the technology from its current shape

11. Others

APPENDIX 2. LICENSE SURVEY FACTORS.

1. Technological Superiority
   - The construct is measured with multiple dimensions: performance, cost, quality, ease of use etc.

2. Ease of Imitation
   - The degree to which the technological content can be understood and therefore reproduced by others.

3. Time needed to commercialize
   - Time length from R&D to product launching

4. Cost of Commercialization
   - Present value of expected capital investments before the technology's very first commercialization

5. Legal or Regulatory Demands
   - Time, financial resource, and legal step requirements in order to proceed with the patent

6. Potential Market Size
   - Future user base of the technology

7. Competition in the market
   - Existing competitors and expected number of new competitors to enter the markets

8. Contribution of technology to the product value
   - Difference between value of product with & without the new technology

9. Scope or Application
   - The various fields or industries able to use the technology

10. Rate of Return on Investment
   - Present value of cash inflow from investment divided by the investment

11. Other