Using Prediction Markets to Motivate Public Participation in Patent Examination

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Abstract

The United States Patent and Trademark Office (USPTO) is overburdened with a large volume of patent applications while having limited resources to conduct patent examinations. The patent examination process is too long and the quality of issued patents is questioned by the public. We propose to alleviate these problems by setting up prediction markets for each pending patent. In these prediction markets, traders buy and sell bets for the outcomes of patent examinations. Our proposed prediction markets can create social value in two ways. First, they generate forecasts about the likelihood of the pending patents being granted. Before the USPTO completes the examination, decision makers in need of information about the outcome of the patent examination can use these forecasts to make strategic decisions about research and development plans, or investments in the technologies being patented. Second, our proposal creates explicit incentives for public participation in the patent examination process. The proposed prediction markets reward traders with insights into the pending patent, potentially motivating traders to independently perform prior art search — a central task in evaluating patentability. The USPTO can then collect these prior art for reference by giving small rewards to traders who submit relevant prior art.

1 Introduction

The patent system was set up to foster innovation by granting the inventors exclusive rights to extract monopolistic profits from their own inventions for a limited length of time (Article 1, Section 8 of the United States Constitution). Fundamentally, the patent system was based on the premise that patents were truly “inventions” that deserve such privilege. By the United States Patent and Trademark Office’s (USPTO) definition, a patent is considered a true invention if it satisfies two criteria: novelty and non-obviousness. A patent is novel if the same idea has not been previously published. The non-obviousness test is about making a judgment on whether “the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.”1

If a patent which was not truly innovative was granted by the USPTO, the system would impose a dead weight loss of efficiency on society due to the unjustified monopoly. For over 200 years, American industry has flourished under its patent system. However, over the recent decade, the USPTO’s performance in patent examination has come under sharp criticism, especially the long delay in the examination process and the low quality of the patents granted.

1.1 Patent pendency

Patent examination takes a long time, and the time it takes has increased in recent years. In the last fourteen years, the average pendency — the time in months from filing to either issuance or abandonment — has been above 18 months. Figure 1 shows that this number has been increasing since 1995 when it was 19.5 months. In 2008, the average pendency across all technological fields reached 32.2 months. In the field of Computer Architecture, Software & Information Security, it has reached 42.4 months — more than three years.

The long pendency of patent examination hurts social welfare in at least two ways. First, it exacerbates the patent hold-up problem, which occurs when a firm has invested in developing a technology before it discovers it infringes on another firm’s patent. As patent examination has been largely a secret process in which only the examiners and

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Average pendency of patent applications in the USPTO

Figure 1. The average pendency (in the number of months) of patent applications at the USPTO (data published by the USPTO).

the applications are involved, the longer the pendency, the more likely that a hold-up problem will occur. Increased pendency also leads to high damages to the firm being held-up. Second, the long dependency hurts entrepreneurs with pending patents who seek investments. For investors, having an issued patent is a good indicator of the quality of their technology and hence profitability [13]. A panel assembled by the Federal Trade Commission in 2003 expressed their concern of the long pendency and suggested “improving ‘information [available] at an earlier stage about patents likely to issue’ could help ameliorate hold-up” [9].

1.2 Patent quality

There have been a few controversies over the validity of some high-profile patents. A well-known one was Amazon’s one-click shopping cart patent (US Patent 5,960,411), which was granted by the USPTO in 1999. In 2006, a disgruntled customer of Amazon, Peter Calveley, filed for re-examination of this patent. Based on the prior art submitted by Calveley, the USPTO invalidated 21 out of the 26 claims in the patent, leaving only five as actually “patentable” [19]. Cases like this have led to public concerns over bad patents [29, 21]. Although some court rulings have raised the novelty bar of patent applications, e.g., KSR International Co. v. Teleflex Inc. et al. 2, it is still a social loss if a patent has to be invalidated through expensive litigations, rather than the cheaper initial examinations.

One possible reason for the decline of patent quality is that the USPTO is inundated with patent applications and has limited resources. The USPTO receives about 300,000 patent applications each year, which means about 1,000 applications every working day [9, Ch. 5]. The USPTO is staffed with about 3,000 examiners, and it has been estimated that each patent application receives about 20 hours of attention on average from its examiners [18, 3], sometimes as little as 8 hours [9, Ch. 5]. During this time, the officer must read and understand the application, search for prior art, evaluate patentability, communicate with the applicant, work out necessary revisions, and research and write up conclusions [9, Ch. 5]. In addition, the patent examiners may not have the expertise or be competent to review the patent applications. The USPTO recruits examiners from law graduates, who are not necessarily trained for specific technological fields. Further, top graduates may prefer law firms where the starting salaries are about $140,000 to the USPTO where the starting pay is around $40,000 [11].

In this paper, we propose to build a prediction market for each pending patent application, to alleviate both the pendency and the quality problem of the patent examination process. Prediction markets are markets in which traders buy and sell bets for the outcomes of future events. In our case, these future events are the issuance or abandonment of the patent application. Such markets will create social benefits in two ways. First, they generate an aggregated prediction for the likelihood of each pending patent being granted, before the USPTO makes a decision. As mentioned in Section 1.1, it reduces the occurrence of hold-up problems and it also helps venture capitalists to assess the value of pending patents. Second, prediction markets give traders incentives to discover prior art, since they can profit from such private information. The USPTO only needs to create an extra incentive, e.g., pay a lump sum of money, for people to share the prior art they have discovered. Such a market can help in incentivizing the public to participate in the prior art search, thereby increasing the quality of issued patents.

2 The prior art search

Searching for prior art — prior publication of the same idea — is a crucial task in the patent examination process. Only patents cleared of prior art are deemed novel and worthy of protection by the USPTO. An examination of the way prior art searches are conducted by the patent examiners shows that the USPTO needs help from the public.

Patent examiners rely on two sources of prior art to assess novelty: applicants’ submitted prior art and the examiner’s own prior art search. Neither source is perfect. In theory, patent applicants have the “duty of candor” to disclose any prior art for which there is “a substantial likelihood that a reasonable examiner would consider it important in deciding whether to allow the application to issue as a patent” (USPTO 1998, Section 2242). Breach of this duty constitutes “inequitable conduct”. If an applicant knowingly leaves out relevant prior art at the point of submission, and if the patent is granted, the validity of the patent can be challenged on the grounds of inequitable conduct.
Nevertheless, various court rulings have shown that proving inequitable conduct is hard, effectively making the “duty of candor” unbinding [17].

While conducting prior art searches, patent examiners typically search an internal Patent Office database containing all U.S. and foreign patents as well as some journals. It is illegal for the examiners to consult the public for prior art [23]. Theoretically the patent examiners are scientifically well informed such that they can identify all prior art on their own. In practice, this may not be true. [25] find that patent examiners are much better at identifying prior art in patents than identifying non-patent prior art, such as academic journals, conference publications etc. In emerging technology fields, such as nano-technology, patent examiners face particular challenges due to their lack of participation in the scientific community, thereby not being up-to-date on the venue (e.g., workshops, conferences, or personal websites) where the latest inventions are published. Arguably, bad patents in the scientific frontier may pose the highest social cost by hindering technological progress.

3 Public participation in the patent examination process

To enable the USPTO to perform thorough reviews on the applications, it requires drastic increases in USPTO’s funding and perhaps an overhaul of its examination process [31]. Various types of reforms of the patent examination rules have been suggested [30, 28, 9]. Most of these suggestions require legislative changes to the rules on patent protection, which might take a long time to take effect.

Another solution to the limited-resource problem at the USPTO is to draw on the expertise in the public to review patent applications. In fact, the USPTO itself provides a channel for public involvement. With a fee any third party may submit prior art relevant to a pending published patent application within a certain period of time of the publication. Unfortunately, this provision has been little utilized.4

Entities other than the USPTO have initiated projects to bring the public into the patent examination process. BountyQuest (2000 ~ 2003) 5 was a platform that brought interested parties to offer rewards to whoever submits relevant prior art to their targeted patents. However the public was not enthusiastic about participating in BountyQuest, and the project did not last long. There are a few other projects achieving various degrees of success, including Wikipatents (wikipatents.com) and Article One Partners [22].

Our proposal builds on Peer-to-Patent (P2P), a pilot project launched by the USPTO in 2007, to harness the “wisdom of the crowd” to identify prior art for pending patent applications. For each patent application published on P2P, anybody can post prior art or vote for the most relevant prior art already posted. Four months after the listing of a pending patent on P2P, the USPTO collects the submitted prior art and considers them in their examination process.

P2P achieved moderate success during its first year [2]. It had over 2,000 registered users and 173 items of prior art were submitted on 40 applications. The first 27 patent examination decisions issued during the pilot phase showed use of P2P submitted prior art in nine rejections. Also, non-patent prior art was submitted to the patent office through the P2P site, compensating for the lack of expertise on the patent examiners’ part on non-patent prior art search, as mentioned in Section 2.

P2P has not gone without criticism [6, 7], particularly about the incentives to participate in this community. Currently P2P relies on three measures to motivate participation [23]: 1) Reliance on people’s sense of responsibility to ensure quality patents in their own fields; 2) Publishing software-related patents to attract participation from software developers who have a “strong spirit of volunteerism”; and 3) Appeal to vanity and status in professional networks to attract participation.

These incentives are not robust. Prior art is a public good: each piece of relevant prior art benefits the society, but not usually the contributor herself, unless she has a stake in the outcome of the patent examination. Contributing prior art costs time and effort. Especially for experts in specific technological fields, the opportunity cost of time can be high. Economics theory has proved that public goods are likely under-provided if provided voluntarily [26]. Certainly, altruistic people who care enough about the quality of the patents in their fields may spend the time and effort to contribute prior art [12], but relying on altruistic users to sustain efficient levels of contribution of public goods has its own drawbacks. In particular, there may not be enough altruistic users. For example, [1] have shown that in a popular peer-to-peer file sharing network, Gnutella, the vast majority of users are free-riders. [23] also posited that software developers may carry their volunteerism from open-source software projects to P2P. This may not happen. In fact, the major motivations for many software developers to participate in open-source projects are private use and learning [24], not volunteerism. Vanity and status are important for some people. But such type of motivation works best after a community that recognizes one’s status in a network such as P2P is formed.

37 CFR § 1.99 Third-party submission in published application.
4See [9], footnote 51 and 141, for discussions about third parties’ reluctance to submit prior art about pending patents.
4 The use of prediction markets for patent applications

We propose to implement a prediction market for each pending patent application. Such markets will reduce the long pendency problem by providing early assessment of the likelihood of issuance of the patents. More importantly, they will improve on the P2P project by creating explicit incentives to participate in the prior art search.

In a prediction market traders buy and sell securities whose values depend on the outcome of future events, e.g. oil prices or presidential elections. A prediction market for a patent facilitates trades on the security based on the USPTO’s action on that patent. Each trader buys or sells a share that is worth $1 if the patent is granted, and $0 if it is not. Prices in such markets fully aggregates all individual traders’ private prediction [20]. That is, the market price reflects what the market as a whole “thinks” the probability of the patent being issued will be. For example, if a seller believes the probability of issuance is 0.3, she will sell the security at any price higher than $0.3. A buyer who believes the probability of the patent being granted is 0.9 will buy it at any price lower than $0.9. These two traders can settle at any price between $0.3 and $0.9. In the end, the realized price reflects the aggregated belief of the probability of the patent being issued, i.e., somewhere between 0.3 and 0.9.

Prediction markets’ advantages in aggregating multiple individuals’ private predictions have been empirically demonstrated in a large number of markets. The Iowa Electronic Markets (IEM) consistently outperforms opinion polls in predicting the two-party vote shares of U.S. presidential elections [5]. In corporate settings in particular, prediction markets outperform traditional forecasting methods such as face-to-face meetings [8] and surveys [10]. The success of these markets has led a few leading scientists to advocate for favorable policies by the U.S. Congress to clear such markets of these markets has led a few leading scientists to advocate for favorable policies by the U.S. Congress to clear of these markets.

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4.1 The thin market problem

Our proposed prediction markets have a thin market problem. In a thin market, only a small number of buyers or sellers are willing to transact at any given time. As a result, the market price may not reflect the true relation between supply and demand, and the accuracy of the market predictions may suffer. Our proposed prediction markets are likely thin markets. First, a large number of patent applications are filed to the USPTO each year [9]. Even if a small portion of them are put up on the prediction markets7, there may still be a large number of markets on the same site. It is likely that each market receives a small number of trades. Second, most patents are on inventions in specialized fields, in which only a small number of experts have sufficient insights to participate in trading. Third, knowing there might be expert traders in the market, non-expert traders may hesitate to participate for fear of loss.

To avoid the thin market problem, we will implement the prediction markets using the market scoring rule (MSR) format. There are two commonly used formats for prediction markets: double auctions and market scoring rules. In a double auction, sellers post their asks — the lowest price at which they are willing to sell — and buyers post their bids — the highest price at which they are willing to buy. If a buyer’s bid is higher than a seller’s ask, then a transaction is realized. Double auctions are appealing to traders due to their simplicity. However, thin markets can severely hamper the performance of double auction-based prediction markets.

Another type of prediction market, proposed by [14], is based on market scoring rules. Scoring rules are tools for eliciting private beliefs. Given a random variable $X$ which has $n$ possible outcomes, to elicit an individual, say Alice’s, belief about the probabilities of each of these outcomes $p = (p_1, \cdots, p_n)$, we can ask her to express her beliefs by $r = (r_1, \cdots, r_n)$ — a vector of reported probabilities for random variable $X$ — and pay her based on the following scoring rule: $S = \{s_1(r), \cdots, s_n(r)\}$. Thus if outcome 1 is realized, she will be paid $s_1(r)$; if 2 is realized, she will be paid $s_2(r)$ and so on. Alice maximizes her expected payment $E(r)$ by choosing an $r$ to report:

$$E(r) = \Sigma_{i=1}^{n} s_i(r)p_i$$

Out of all possible scoring rules, some are proper. Scored under such rules, one’s score-maximizing strategy is to report beliefs honestly. Thus Alice would find $r = p$ maximizes her expected payoffs expressed in Equation (1). Popularly used proper scoring rules include quadratic and logarithmic scoring rules. In a MSR based prediction market traders place their trades sequentially, and earn the difference between their scores and the previous traders scores.

MSR based prediction markets solve the thin market problem. In a MSR market, there is a market maker — an automated trader who is ready to trade with anyone at any time. Even if there is only one interested trader, she can still trade with the market maker, and her private information can thus be elicited. This property is desirable in specialized markets in which only a small number of experts

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7Currently, the patent applications being reviewed on the P2P site were volunteered by their applicants, with the explicit incentive that their examinations would be accelerated.

8See [27] for a discussion of various proper scoring rules.
participate, such as our patent markets.

4.2 Submitting prior art

We propose to augment the prediction market with a secondary channel which allows submission of prior art. For traders who capitalize on their knowledge of the prior art, the USPTO would want them to reveal such knowledge. If someone already has prior art, it costs her very little to share it. The incentive needed to motivate her to overcome this small cost could be a lump sum of money, if their submitted materials are cited by the patent office. For each patent application, a constant amount of money can be shared by all the traders who have submitted useful prior art. This amount can be fairly small. The main incentive for conducting a prior art search comes from the potential to profit in the prediction market: more private information leads to better judgment of outcome and more profits. The lump sum money proposed above is only intended to motivate the traders to submit what they have already found.

This lump sum monetary reward may not even be necessary. Individuals can benefit from submitting the prior art they have discovered. Presumably, if an individual has discovered a useful piece of prior art, she would be trading toward the direction that the patent will be invalidated. If she submits the prior art she discovered, there is a higher chance that the USPTO will invalidate the patent, hence increasing the chance that she will profit in the prediction market.

4.3 System evaluation

We propose the prediction markets for patents to achieve two goals: to predict the outcomes of patent examinations and to incentivize public participation in the prior art search. We will evaluate the performance of our system in these two aspects respectively.

If one needs to know the probability of a patent being granted, absent any assessment of the quality of this specific patent, a starting point is the overall rate of issuance of patents. To assess the accuracy of the market’s predictions on the likelihood of patent issuance, we compare our markets’ forecasts with the baseline probability of patent issuance in the same technological field. Such a baseline probability can be calculated based on the patent examination outcomes during specific time windows, e.g., the previous year. We will use mean square errors as a measure for prediction accuracy. If the error of the market prediction is lower, it would suggest our proposed market makes better forecasts than the overall rate of patent issuance.

We can use a few metrics to assess how well the prediction markets incentivize public participation in the prior art search. The most important one is the number of prior art references cited by the USPTO. We would also consider the number of people submitting prior art, to assess the overall participation level. Lastly, we could survey the patent examiners to gauge the quality of the prior art they receive.

5 Implementation issues

A few issues remain to be considered before our proposed prediction markets can be implemented.

• Manipulation. Attempts to manipulate the prices in our proposed prediction market could come from at least two sources. First, competitors of a patent applicant may have incentives to manipulate the market price to influence the final patent issuance outcome. Such type of manipulations can be discouraged by prohibiting patent examiners from looking at the market price. Second, the patent applicants themselves may want to manipulate the market price to misguide their competitors’ decisions on research and development activities. According to the theory of information markets, attempts to manipulate the market would only hurt the accuracy of the market predictions temporarily, because the presence of manipulators creates opportunity for legitimate traders to profit [15, 16]. Further, to reduce manipulations, we can place a cap on the trading amount by any individual account.

• Budget. If the final market prediction is closer to the final outcome than the initial probability the market was started with, the market maker will lose money. The maximum amount of loss, however, is bounded. Attempts to manipulate the prices in prediction markets, attempts to manipulate the market would only hurt the accuracy of the market predictions temporarily, because the presence of manipulators creates opportunity for legitimate traders to profit [15, 16].

• Disclosure. Some may worry that should a patent fail to be granted, disclosure in a prediction market would have given competitors opportunity to steal the invention. This worry is unfounded [23]. Currently, patent applications are published after 18 months, granted or not. Further, patent protection applies retrospectively to the date of invention. Thus whoever tries to steal the technology in the review process runs the risk of being sued for infringement should the patent be granted. Last, the current patent system already imposes the risk of forgone trade secrets on inventors. Our proposed system merely inherits the same risks.

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9See [14] for a discussion of the market maker’s expected loss.
6 Summary

The USPTO is overburdened with a large number of patent applications and has limited resources, directly resulting in problems such as the long pendency of the patent examination process and the low quality of issued patents. These problems impose dead weight loss on the society. The cost of solving these problems by simply hiring more patent examiners is likely high [31]. Various other proposals have been put forward. Some involve legislative changes in the patent examination, reexamination, and litigation process, which will likely take too long to take effect. Others are aimed to harness the wisdom of the crowd to help the patent examiners do their job. For such type of endeavors, incentivizing the public to participate is essential.

Building on existing projects that bring the public into the patent examination process, we propose a scheme to remedy the two above mentioned problems of the USPTO. We propose to setup a prediction market for each pending patent application. In such a prediction market, participants trade bets on the outcome of the patent examination, and receive rewards depending on the USPTO’s actual decision.

Prediction markets can predict the likelihood of each patent being granted. Given that inevitably there is a long pendency of patent examination, decision makers who need to know the outcomes of patent examinations beforehand can consult the market forecasts. Our proposed markets also help the patent examiners by incentivizing the public to participate in prior art discovery. In the patent prediction markets, the participants will be motivated to search for prior art in order to profit in the market. The USPTO only needs to pay a small additional reward to collect the prior art found by the traders.

References