Patent Examination and Innovation

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The process through which patent offices grant patents has recently been subject to intense scrutiny. Experts have alleged that the examination process at the US Patent and Trademark Office (USPTO) is both slow and sloppy, and results in questionable patents that hinder rather than promote innovation (see National Academy of Sciences 2001, Jaffe and Lerner 2004, Bessen and Meurer 2008). Writing with economist Gary Becker, Judge Posner opined that "the problem of patent trolls is a function in part of the promiscuity with which the patent office has issued patents..." (Posner 2013).

How does the patent examination process affect the rate and quality of inventions that seek patent protection? Our proposal seeks to formally model and test how two key operational parameters associated with patent examination—speed and quality—affect the quantity and quality of inventions that seek patent protection.

Model and Testable Implications

Our model draws on the economics and operations management literatures and endogenously derives the relationship between patent examination characteristics and patent application (innovation) characteristics. In particular, our project builds on the framework introduced by Hassin and Aviv (2002) who argued that operational decisions made by a service provider have an effect on the arrival rate into the system and the types of agents choosing to enter the system. The operational inputs of our model are: (a) the speed of patent examination (characterized by the average and standard deviation of speed at a given time t), (b) the quality of examination (characterized by the average and standard deviation of quality at a given time t), and (c) the dependency of speed and quality on technology type.

Inventors choose whether or not to file a patent given their invention's quality and expected value from the patent (which depends on the speed and quality of patent examination). Effectively, for any speed and quality of examination chosen by the patent office, this determines the equilibrium rate and quality range of patent submissions. A preliminary version of the model has yielded the following testable implications.

- Improving the average speed of processing leads to higher submission rates, as patents approved earlier are more valuable to inventors. Similarly, increasing average examination quality leads to higher quality applications.
- Increasing the average examination quality may require a longer review processes (and higher fees to cover higher operational costs), and thus leads to fewer submissions due to lower speed. Conversely, higher average speed may lead to lower quality control, and thus lower quality applications.
- The variance of examination speed and quality plays an important role: if the speed/quality are more unpredictable, inventors will submit more lower quality applications rather than fewer high quality submissions. Through the same mechanism, unpredictability (from the patentee's point-of-view) may lead to lower average speeds and quality of submissions in equilibrium.

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- Making the operational decisions contingent on technology-specific characteristics (in particular, rate of obsolescence) will lead to better outputs. Making patents in areas with high obsolescence rates (*e.g.*, semiconductors and electronics) easier to obtain than in areas with low obsolescence rate (*e.g.*, pharmaceuticals) will lead to lower delays and higher quality overall.

Empirical Analysis

The empirical analysis will estimate the relationship between examination quality and speed at time *t* on the quality and arrival rate of inventions (patent applications) at the patent office. Although the first two implications of the model are quite intuitive, empirically testing them poses two main challenges. The first challenge is to separately measure the quality of examination and the quality of the invention underlying the patent. For the former, we propose to use measures of examination quality available through the internal databases at the USPTO. These include an indicator revealing whether the decision of the patent examiner was subject to the PTO's internal appeals process (and the outcome of appeals), an indicator revealing whether the patent application was sampled for the office's quality review (and the outcome), and the number of hours spent by the examiner on prosecuting applications. Invention quality is measured using conventional proxies such as the number of claims, forward citations, and indicators for the payment of patent maintenance fees.

To deal with the second empirical challenge, the endogenous relationship between examination quality and innovation quality, we propose to exploit exogenous shocks to the funding available at the patent office to prosecute patent applications (since the funds available to examine applications are appropriated by the Congress, there are years during which the Congress appropriated fewer funds to the PTO than requested by the Office to tackle the backlog of pending applications) as well as data on the timing of initiatives introduced at the patent office that allocated additional resources to enhance the quality of patent examination.

Finally, we measure the rate of obsolescence associated with different technology sectors both by calculating the average vintage of backward patent citations in different technologies, as well as by using the reported importance of lead time by inventors belonging to different technological industries as reported in Cohen, Nelson and Walsh (2000).

Implications for Innovation Policy

The model uniquely endogenizes the operations of the patent office and the arrival rate and quality of innovations that seek patent protection. The key insight of the model is that low quality patents are both a cause and consequence of an examination system that encourages dubious quality inventions to seek patent protection in the first place. The specific testable implications of our model are applicable to many other processes with queues such as the refereeing process at peer-reviewed journals, call centers, hospital management systems, and so on. Very few studies, other than those by Cockburn, Kortum and Stern (2003) and Lemley and Sampat (2012) have investigated the patent examination system, much less study how it affects the rate and quality of innovations that seek patent protection. When complete, we expect our research to address this gap, by proposing and exploiting unique measures that tease apart the quality of patent examination from the quality of the invention underlying patents. Our analysis will also provide insights into how policy makers can allocate scarce resources to adjust the speed and quality of examination, taking into account the idiosyncratic nature of innovation across different technology fields, so as to maximize the overall welfare of patenting innovators.

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