Evaluating Patent Licensing Agreements for Technology Diffusion at the U.S. National Labs

Gabriel Chan, Harvard Kennedy School of Government, gabe_chan@hksphd.harvard.edu

The U.S. Department of Energy oversees 17 National Laboratories (Labs) with a combined $11 billion R&D budget (FY 2011) – equivalent to approximately 20% of aggregate U.S. university R&D spending. Under the 1980 Stevenson-Wydler Act (and subsequent reforms), the National Labs are legislatively required to transfer inventions to the private sector. As part of this mission, all Labs have technology transfer offices which facilitate several mechanisms for technology commercialization (e.g. cooperative R&D, leasing user facilities like bio-refineries and cyclotrons, spin-out company formation, and patent licensing). This paper evaluates one of these mechanisms, patent licensing, by (1) identifying the technology application areas that the Labs are most successful in licensing patents to the private sector, and (2) quantifying the public benefits of licensing agreements, as measured by the difference in citations to licensed patents relative to a carefully selected group of control patents.

Innovation is stimulated by both supply-push and demand-pull forces and there are public policies that affect one or both "forces." While substantial research has been done to evaluate the effectiveness of public policy to directly stimulate supply-push drivers of innovation (with a particular emphasis on university innovation), there is a gap in the literature of studies on the commercialization of technologies developed by the government. I characterize these types of activities as public institutions that specialize in supply-push operations engaging with demand-pull forces. This paper fills this gap by quantitatively studying the commercialization of U.S. National Laboratory inventions.

By making knowledge appropriable, the patent system makes technology licensing feasible. In 2008, the Labs disclosed 1,460 new inventions, filed 904 patent applications, were granted 370 new patents, and executed 177 new patent licensing agreements. These new licensing agreements added to the stock of 1,448 previously executed licensing agreements that remained active. Royalty payments are an individual and institutional incentive to license patent, and in 2008, the Labs generated $43.1 mil through these 1,448 active royalty-bearing patent licenses, equivalent to 0.5% of their budget. Of the total royalty revenue, $8.4 mil was distributed directly to the Lab inventors.

Technology transfer between two private actors has been well-studied, but the first-order incentives in these types of transactions are fundamentally different than licensing between a government licensor and a private licensee. I identify three ways in which the governing incentives in public-private licensing agreements differ from private-private agreements:

1) Intellectual property rules provide incentives for invention by facilitating surplus profits if the technology is commercialized, but public R&D institutions are rarely engaged directly in commercialization, severely weakening the incentive effect for directing R&D towards profitable technology areas.

2) Conditional on invention, intellectual property slows diffusion relative to other policy mechanisms; however, codified intellectual property serves as the foundation of technology

transfer agreements. Without such agreements, it is likely that the rate of diffusion would be significantly slowed and the returns to public R&D lower.

3) Between private actors, a licensing agreement induces gains to trade, but public agencies do not necessarily have well defined objective functions. By allocating contracts to the highest bidder, the benefits of R&D may be allocated equitably. Further, public agencies may be less likely to pursue patent enforcement through litigation, weakening the de facto strength of public patents.

In this study, I have collected data on 16,807 utility patents developed at (or in partnership with) the National Labs since 1976 though the U.S. Energy Innovation Portal. For each patent, I have information on the Lab involved, the contract number of the R&D agreement the patent was developed under, the name of the inventors and initial assignee, the application and grant dates, the US and international technology classification, and the text of the patent abstract. For more than 100 licensing agreements for at least two of the Labs, I have detailed information on the execution date and exclusivity of patent licensing agreements, including the patent number licensed. For a subset of these licensed patents, I also have the name of the private sector partner.

My analysis relies on comparing patents within and across technology application areas. U.S. and international classification schemes are not well suited to this task because (1) technologies are not classified by their potential areas of application in the U.S. system, (2) the level of granularity in patent classifications is inconsistent across technology areas, (3) exploratory analysis reveals that very similar technologies (even pairs of patents that are co-licensed by the same specialized company) are not consistently classified. Because of these issues, I implement a more sophisticated statistical classification algorithm. I classify the patents in my dataset using a machine learning algorithm based on the textual content of the patent abstracts. I use the Latent Dirichlet Allocation algorithm, which uses a Bayesian model of word co-occurrence, to classify documents into endogenously-defined technology topic areas. Exploratory analysis reveals classifications in my sample that are consistent with human checks.

The first half of this project assesses the technology application areas in which the Labs are most successful at developing inventions for commercialization. My identification strategy utilizes the lag between when a patent was filed and when a licensing agreement was announced. I estimate a proportional hazard model for the patent being licensed, using the estimated topic structure from the Bayesian topic model as covariates. I find that at one Lab, the National Energy Technology Laboratory, patents in sulfur control technologies for coal combustion, advanced power plant mechanical components, and fluid separation technologies are significantly more likely to be licensed than other classes of technology.

The second half of this project assess the public returns to patent licensing, as measured by the differential citation rates of licensed patents relative to non-licensed patents. To reduce selection bias, I carefully match patents based on their pre-license citation trajectory and their estimated topic structure from the Bayesian topic model. I then compare citation rates after one of the matched patents is licensed, and estimate a preliminary effect of approximately one additional citation per year after a patent is licensed relative to patents developed by the Labs but never licensed.