



**THE IMPLICATIONS OF INCUMBENT INTELLECTUAL  
PROPERTY STRATEGIES FOR OPEN SOURCE SOFTWARE  
SUCCESS AND COMMERCIALIZATION**

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by

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## **Dissertation Abstract**

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This dissertation investigates how IPR enforcement by proprietary incumbents influences open source software (OSS) adoption and production. It suggests user interest and developer activity on OSS are negatively affected by IPR enforcement particularly for OSS projects technologically overlap with litigated OSS and business projects specific to a litigated OSS platform. Second, it examines how royalty-free patent pools contributed by incumbents affect OSS product entry. It finds the pools related to a software segment will facilitate OSS start-up entry into the same segment; this marginal effect is especially large in segments with high cumulativeness of innovation or high patent ownership concentration.

## Executive Summary

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Open source software (OSS) has emerged as a new model of software innovation that draws upon public knowledge contributed by many individuals and commercial firms. The success of OSS has been evidenced by the rapid growth of the Linux ecosystem that was worth \$25 billion as of 2008, the widespread adoption of Apache HTTP Server by 2.6 million newly established websites as of 2009, and the surge of the Android platform which hit a 60 percent market share for smartphone mobile operating system as of early 2012. Correspondingly, it is interesting to identify the determinants of OSS success within the communities of developers and users as well as how commercial firms appropriate value from open source innovation. It has also been emphasized that the driving force for the growth of OSS is its open access to the source code and the resulting freedom in modifying and advancing the software.

Despite the increasing popularity of OSS, one important issue that has not been fully addressed is how the existence and exercise of formal intellectual property rights (IPR) such as patents play a role in influencing the direction of OSS innovation. Since the first major IP enforcement action against OSS (*SCO v. IBM*) in 2003, proprietary software firms have initiated a series of IP enforcement actions against OSS-based firms. Their targets include firms providing OSS-related service (e.g. *FireStar/DataTern v. Red Hat*), firms embedding OSS into hardware products (e.g. *Microsoft v. TomTom*), and even firms adopting OSS for their own use (e.g. *SCO v. DaimlerChrysler*). More broadly, a large body of anecdotal evidence suggests that software patents and their enforcement against OSS projects have had an impact on the diffusion of OSS. For instance, when the first major intellectual property (IP) enforcement action (*SCO v. IBM*) against Linux was filed, many observers voiced concerns that open source may confront an

increasing number of IP threats. One such concern was expressed by Gordon Haff, an analyst at Illuminata in Nashua, N.H. who said that “some issues around patents, copyrights, and licenses will, to some degree, perhaps make Linux a victim of its own success”. More recently, the smartphone industry has also seen a flood of stories about the legal battles between Apple and Samsung and HTC related to the Android open source platform.

The highly cumulative innovation process within the open source community, along with the difficulty in identifying source code ownership, makes OSS easily targeted by proprietary holders of IPR. This problem becomes even more acute when proprietary IPR holders face fierce competition from OSS and thus have incentives to dampen its diffusion, and when formal IPR have become increasingly valid and enforceable because of recent changes to US law. Therefore, it is important to take a first step to investigate the quantitative impact of such lawsuits (and their risks) on OSS innovation. Empirical evidence in this area will help inform firms about the IP-related risks in adopting OSS and developing OSS, because firms provide more inviting targets than individuals for IP rights holder and the litigation costs are high for both large firms and small start-ups in the sense that the penalties claimed by the plaintiff are usually proportionate to defendant’s revenue. In fact, this is especially important for start-up firms, since they are in fact the primary users of enterprise OSS applications and also the major force to commercialize OSS projects. Lastly, evidence on this question will inform the debate about the social costs of software and business method patents.

While no systematic research has quantified the effects of formal IPR on OSS, prior study suggests that the existence of overlapping IPR, particularly patents (denoted as patent thickets), can create substantial costs for firms to commercialize software products in general. In OSS regime, to confront the strategic patenting by proprietary firms, large OSS firms can expand

their own portfolios of patents to either strength negotiation positions or achieve cross-licensing agreements. For instance, after Microsoft claimed that OSS violates 235 of its patents, a number of large companies such as Novell and Linpire signed deals with Microsoft for protecting their Linux-based products from the threat of patent infringement lawsuits. However, this strategy may not be viable for start-ups, since they usually lack enough internal R&D capabilities and financial resources to obtain a portfolio of patents. Therefore, it remains to explore what mechanisms could be effective in reducing the costs associated with strategic patenting by proprietary incumbents for start-ups within the OSS communities and how.

Since 2005, an increasing number of patent-pledging events have been announced by large OSS-friendly incumbents such as IBM, Sun Microsystems, and Nokia. Moreover, a few royalty-free patent pools such as the Patent Commons and Open Invention Network were established within the OSS communities, representing a special type of institution that offers royalty-free usage of patents to any OSS firm that promises not to sue the pool's beneficiaries. No matter in what format, all these initiatives are trying to give the OSS community a body of patents to freely draw on for cross-licensing arrangements like those commonly reached among large companies. As noted by Matt Asay, the chief operating officer at Canonical (the company behind the Ubuntu Linux operating system), "this (type of patent collectives) may be the only refuge for start-ups and others, like Red Hat, that don't have an aggressive patent-acquisition policy".

Nevertheless, to the best of my knowledge, no systematic study has investigated whether and how these defensive patent pools would affect start-up decisions to commercialize OSS. This is a surprising gap in understanding. Empirical evidence on this can underscore the role of patent pools in shaping market competition by encouraging start-ups to enter the OSS industry. Second,

systematic evidence on this question can help address the controversial views from observers, some of whom are skeptical about the effectiveness of such defensive patent pools. One comment, for instance, was “the perception is that bigger companies only commit their least-effective, least-important patents to a patent pool”. Third, efforts to investigate how patent pools encourage entry may imply that large OSS incumbents are strategically contributing patents to the pools in order to bring greater market competition against proprietary incumbents. That is, it remains intriguing to examine the outcome on market structure of the strategic decisions for large OSS incumbents such as IBM to donate hundreds of their patents to the OSS community.

My dissertation hopes to bridge these gaps in prior work and takes the first step to study the implications of formal IPR for OSS innovation. I particularly investigate the impacts of the following two types of IPR strategies exercised by incumbents: (i) IPR enforcement actions by incumbents, such as these lawsuits against a variety of OSS platforms as mentioned above, and (ii) the creation of royalty-free patent pools by OSS-friendly incumbents, which arguably serve as a counter measure against those litigation attacks. In short, my dissertation asks: how do these incumbent IPR strategies affect the direction of OSS innovation?

More specifically, I first investigate how IPR enforcement actions exercised by proprietary IPR holders affect OSS project success. Two key metrics of OSS success are focused here: user interest and developer activity. I focus on the implications of IPR enforcement through litigation actions rather than the existence of formal IPR like patents or copyrights because the former provides a more proximate signal about the risks to users and developers. I next develop the main hypothesis of this study: I argue that when an IPR enforcement action is filed, user interest and developer activity will be particularly affected in two types of OSS projects—those

that have technology overlap with the litigated project and those that are intended for business and specific to a litigated OSS platform.

I test these hypotheses by examining how the filing of two widely publicized lawsuits—*SCO v. IBM* and *FireStar/DataTern v. Red Hat*—affected user interest and developer activity in these two types of projects. I use data from the largest available repository of OSS projects—SourceForge.net (SourceForge). I first examine the implications for user interest by studying the impact of IPR enforcement actions on the number of project downloads. I find that in the months following the filing of *SCO v. IBM*, monthly downloads of OSS projects that display technology overlap with the focal litigated OSS fell 15%-16% relative to a control group, while those projects that are intended for business and specific to a litigated OSS platform fell 34%-35% more than other projects. I find similar results following the filing of *FireStar/DataTern v. Red Hat*. These results are robust to a large variety of analyses and additional tests.

I next examine the effects of the same IPR enforcement actions for developer activity. In keeping with prior study, I use the number of closed artifacts in a project as a proxy. In the months following the filing of *SCO v. IBM*, the number of closed artifacts per month for projects that exhibit technology overlap with the litigated one fell 60.2%-63.8% more than the control group; business-related projects specific to the litigated platform also had 86%-87% fewer closed artifacts per month following the suit than the control group. I find similar results when I study the number of closed artifacts following the filing of *FireStar/DataTern v. Red Hat*. Once again, I further examine the robustness of these results using a series of additional tests.

As noted above, this study advances recent understanding on the implications of formal IPR for the generation and use of new public good knowledge. Further, my study has important implications for the study of IPR in software particularly. The validity and enforceability of



software patents has become more certain in US law since 1980, and individual and firm behavior has changed accordingly. The increasing use of software patents has contributed to a concern about their detrimental effect on the development and adoption of new software. Empirical work in this area has usually focused on the implications of IPR for the behavior of firms producing software under the proprietary model. My study adds to this stream of literature by providing empirical evidence about the implications of IPR protection for software development activity under the open source model.

The negative effects of IPR enforcement on OSS use and production as identified in the above study provides some evidence that the “tragedy of the anti-commons” exists in the setting of OSS innovations. I further investigate whether and how the creation and the size of a royalty-free OSS patent pool may positively encourage OSS innovation by mitigating the anti-commons problem. While OSS innovation can be examined from many different perspectives, my research strategy is to look at the impact of an OSS patent pool along a margin of innovation where it is likely to have the strongest impact. Therefore, this research focuses on the software product entry behavior by start-ups using an OSS license (denoted as OSS entry). My focus on this margin of innovation is motivated by several considerations. First, the formation of OSS patent pools may have a particularly strong impact on start-up innovation. As mentioned above, unlike large firms, start-ups usually lack enough resources required to expand their own patent portfolios, so it is difficult for them to navigate patent thickets using other approaches such as cross-licensing agreements. This is particularly likely to be the case for start-ups that produce OSS and who, for a variety of reasons, may be unlikely to patent their innovations. Further, as has been highlighted elsewhere, the knowledge of the implications of formal IP rights for OSS innovation is still quite limited. My focus on entry is motivated by the context: since many firms producing under an

OSS license do not patent, traditional patent-based measures of innovation are inappropriate for my setting. In short, due to the uncertainty about the effectiveness of OSS patent pools, my research strategy is to examine their impact along a margin of innovation where they are more likely to matter.

Based on prior work, I hypothesize that (i) changes in the size of the OSS patent pool related to a software segment facilitates OSS entry by start-up firms into the same segment; and (ii) the marginal effect of the pool on OSS entry will be especially large in software segments where the cumulateness of innovation is high or where patent ownership in a segment is concentrated. Focusing on one major OSS patent pool—the Patent Commons, I examine the empirical salience of these predictions using a unique data set. I assemble data on OSS entry using data on product releases from 2,054 start-up software firms contained in the Gale database “PROMT”. Following prior work that has examined the extent to which patents deter entry into the software industry, I allocate patents to software product market segments by (i) identifying the main technological classes of patents acquired and cited by single software product producers and (ii) comparing a set of keywords from a software segment classification with the keywords from the patent’s technological classes. I use this mapping to identify the number of pool patents related to each market segment, as well as the cumulateness of innovation and patent ownership concentration in the segment.

My empirical results suggest that a 10% increase in the pool’s patent claims in a software segment is associated with a 1.5%-2.9% increase in the rate of OSS entry by start-ups into that segment. The marginal impact of the OSS patent pool is significantly greater in segments where the cumulateness of innovation is high: a 10% increase in the pool’s patent claims is associated with a 3.8%-5.6% increase in the rate of OSS entry when the cumulateness of innovation is

high, compared to no significant increase when cumulateness is low. The effect of OSS patents pools is also greater when the concentration of patent ownership is high. A 10% increase in the pool's patent claims is associated with a 1.3%-1.7% increase when patent concentration is high and no increase when patent concentration is low, however the statistical significance of these results vary somewhat across specifications.

My study provides the first large sample evidence on how the provision of a royalty-free patent pool shapes OSS entry by start-ups. As such, my research advances our understanding on how IPR licensing and enforcement influences OSS innovation as well as recent work that studies firm decisions to commercialize innovations using an OSS license. My research also provides implications for the economic impact of patent pools. While previous studies on patent pools have focused mainly on their design, a few recent empirical studies have begun to look at the impact of patent pools on the direction of innovative activities. However, to the best of my knowledge, there has been no empirical research on how patent pools shape start-up entry.

Finally, this work also adds to our knowledge about the potential anti-commons problems from strategic patenting and the impact of patent thickets on entry into the software industry. While the patent thickets problem can be examined from different perspectives, I highlight the roles of cumulateness of innovation and patent ownership concentration as two different and important dimensions of patent thickets. I propose mechanisms under which these characteristics may interact with the OSS patent pool to determine start-up entry costs. Thus, my research also provides empirical evidence on the effectiveness of mechanisms meant to mitigate the anti-commons problem, such as the establishment of patent pools or standard-setting organizations.