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Profiting from innovation in the digital economy: Enabling technologies, standards, and licensing models in the wireless world

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ABSTRACT

The value-capture problem for innovators in the digital economy involves some different challenges from those in the industrial economy. It inevitably requires understanding the dynamics of platforms and ecosystems. These challenges are amplified for enabling technologies, which are the central focus of this article. The innovator of an enabling technology has a special business model challenge because the applicability to many downstream verticals forecloses, as a practical matter, ownership of all the relevant complements. Complementary assets (vertical and lateral) in the digital context are no longer just potential value-capture mechanisms (through asset price appreciation or through preventing exposure to monopolistic bottleneck pricing by others); they may well be needed simply for the technology to function. Technological and innovational complementors present both coordination and market design challenges to the innovator that generally lead to market failure in the form of an excess of social over private returns. The low private return leads to socially sub-optimal underinvestment in future R&D that can be addressed to some extent by better strategic decision-making by the innovator and/or by far-sighted policies from government and the judiciary.

The default value-capture mechanism for many enabling technologies is the licensing of trade secrets and/or patents. Licensing is shown to be a difficult business model to implement from a value-capture perspective. When injunctions for intellectual property infringement are hard to win, or even to be considered, the incentives for free riding by potential licensees are considerable. Licensing is further complicated if it involves standard essential patents, as both courts and policy makers may fail to understand that development of a standard involves components of both interoperability and technology development. If a technology standard is not treated as the embodiment of significant R&D efforts enabling substantial new downstream economic activity, then rewards are likely to be calibrated too low to support appropriate levels of future innovation.

1. Introduction

In this paper, I look anew at the Profiting from Innovation (PFI) framework laid out in Teece (1986, 1988a, 2006). The questions addressed in the earlier treatments—what determines which firms profit from an innovation, and which firms earn only meager (and possibly negative) returns—have enduring relevance for both management and public policy.[1] If anything, the importance of the issues is amplified as "digital convergence" and "digital disruption" gain pace. In particular, the mega-convergence of certain industries that is being driven by the merging of wireless and Internet technologies requires that one open the aperture of business and economic inquiry from the innovation of individual products and processes to innovation within ecosystems and across the upstream and downstream levels of competition in an industrial system.

This paper considers the impact of digital convergence, the growing importance of platforms and ecosystems, and the amplified problems associated with enabling technologies. While adding some complexity, this wider aperture of inquiry turns out to reinforce the key elements of PFI. Intellectual property, the nature of knowledge, complementary assets, standards, and timing all remain center stage. What is brought into sharper focus and requires additional granularity are the different types of complementary assets and the ways they impact the capture of value from innovation when digital platforms are at issue. Attention is also provided to how general-purpose technologies and a collaborative standards development process enable downstream innovation.

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[1] Before PFI, capturing value was often considered just a matter of new-product pricing strategy. Setting prices for innovative products and services remains important, but value capture depends on more fundamental considerations. Empirical support for the PFI framework is well-established. Cohen et al. (2000) cite survey evidence showing that, while trade secrets and patents help support appropriability, complementary assets and capabilities are of comparable importance (See their figures 1–4). The framework is also frequently used in applied research (e.g., Desyllas and Sako, 2013) and continues to be taught in business schools (e.g., Tietz and Parker, 2010).

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Business model issues with respect to value capture via licensing are explored. The particular challenges of capturing value from enabling technology are recognized, and policy implications are highlighted.

In short, this essay considers the value capture impacts of changes wrought by the digital revolution, the activity of standards organizations, the presence of enabling technologies, and the growing importance of complementary assets and technologies in the information and communication technology (ICT) sectors and beyond. These phenomena have enhanced salience in the wake of the digital revolution and the associated convergence of industries that is described in Appendix A.

2. PFI revisited

The Profiting from Innovation (PFI) framework (Teece, 1986) was launched thirty years ago in a very different technological and business environment than most companies face today. It is worth revisiting periodically in order to see if improvements are possible. I first did so twelve years ago (Teece, 2006), when I sketched a number of elaborations and extensions in response to shifts in the environment since 1986. These included further development of the multi-invention context for innovation, the incorporation of a richer understanding of network effects, and the consideration of business models engendered by the launch of the Internet. I also discussed the growing importance of complementary technologies, network effects, and supporting infrastructure. Others have extended the framework in various ways, including how to take into account industry architecture (Jacobides et al., 2006).

In the intervening decade, as elaborated in Appendix A, the techno-business environment has shifted still further. The Internet is no longer a utility consulted just from user desktops. It is increasingly pervasive, accessed interactively by users on the go and extended to sensor-equipped terminals anywhere and everywhere. Means of communication have also evolved, from phone and email toward messaging apps that also serve as portals for shopping and a host of other services.

PFl addressed a puzzle that had not been well explained in the previous literature, namely: why do highly creative, pioneering firms often fail to capture much of the economic returns from innovation? Apple's iPod was not the first standalone MP3 player, but it has dominated the category for more than a decade (Cole, 2013). Merck was a pioneer in cholesterol-lowering drugs (Zocor), but Pfizer, a late entrant, secured a superior market position with Lipitor (Hilzenrath, 1998). At first glance, it is tempting to say that these examples reflect the result of Schumpeterian gales of creative destruction where winners are constantly challenged and overturned by entrants. But the cited cases and countless others involve mostly incremental/imitative entrants rather than the radical breakthroughs associated with enabling and general-purpose technologies.

The focus of the 1986 PFI article was on a single, autonomous innovation that was commercially viable (i.e., technological uncertainty (Rosenberg, 1982) was assumed to be low). The paper thus side-stepped one question—why inventions so often fail to succeed in (or even reach) the market—and focused instead on how the spoils are divided once positive net value is within sight. The paper also focused on product innovations rather than process improvements, creative output, or other valuable intellectual capital. These and other simplifications made the analysis tractable. In this paper, I maintain the focus on value capture rather than value creation, but I now consider how the problems for the innovator differ in the case of enabling technologies and in the presence of multi-level platforms and ecosystems.[2]

The PFI framework provides an explanation as to why some innovators win in the marketplace while others lose out—often to technologically weak imitators. The framework also made it apparent that, even when the innovator "wins" (i.e., takes the largest piece of the available private returns), spillovers are still considerable (Mansfield et al., 1977; Griliches, 1992). Lichtenberg (1992) found that the national rate of return (in terms of productivity) from private R&D investment was about seven times as large as the return from investment in plant and equipment. A survey of previous studies showed that the social rate of return to private R&D was usually found to be about twice that of the private return (Hall et al., 2010). A more recent study determined that, even taking rent capture (what the authors call "negative business stealing effects from product market rivals") into account, social returns to R&D are at least twice as high as private returns (Bloom et al., 2013). A pioneering scholar of R&D spillovers summed it up this way: "there has been a significant number of reasonably well done studies all pointing in the same direction: R&D spillovers are present, their magnitude may be quite large, and social rates of return remain significantly above private rates" (Griliches, 1992, p. S43).

The fundamental imperative for profiting from an innovation is that, unless the inventor/innovator moves down an improvement path and enjoys strong natural protection against imitation and/or has strong intellectual property protection, then potential future streams of income are at risk. The relevant appropriability regime is thus critical to shaping the possible outcomes.

Appropriability regimes, while partly endogenous (Pisano and Teece, 2007), can, theoretically, be "weak" (innovations are difficult to protect because they can be easily codified and legal protection of intellectual property is ineffective) or "strong" (innovations are easy to protect because knowledge about them is tacit and/or they are well protected legally). The fact that empirical studies establish that the social returns to innovation are generally considerably greater than private returns is *prima facie* evidence that appropriability is almost always difficult. The challenge is larger if the innovations in question are basic research results or general-purpose/enabling technologies. While appropriability regimes for some downstream digital businesses (e.g., Facebook) are strong,[3] those for upstream providers of enabling technology are often quite weak. Business models cannot rely heavily on intellectual property (IP) to capture value because IP is generally not self-enforcing; patent infringement and trade secret misappropriation must be identified, then negotiated or litigated, often at great expense. The net result is that free riding is common and patent licenses have to be negotiated under the shadow of continued infringement. Patents rarely, if ever, confer strong appropriability, outside of special cases such as new drugs, chemical products, and rather simple mechanical inventions (Levin et al., 1987). Patents can also, in some cases, be "invented around" at modest costs (Mansfield, 1985; Mansfield et al., 1981).

Often patents provide little protection because the legal and financial requirements for upholding their validity or for proving their infringement are high, or because, in many countries, law enforcement for intellectual property is weak or nonexistent. In terms of preventing imitation or bringing infringers into licensing arrangements, a patent is merely a passport to a journey down the road to enforcement and potential royalty streams. Of course, a large portfolio of patents can prove valuable for cross-licensing deals with rivals that help reduce the likelihood of costly litigation. To help with appropriability, the inventor of a core technology can also seek complementary patents on new features and/or processes, and, in some cases, on designs.

A further complication in recent times is the emergence of cybertheft and other cybersecurity problems. Being secure to market must often take precedence over being first to market. The adoption of secure coding practices can reduce the number of exploitable vulnerabilities in software products and in hardware products with embedded software. The advent

[2] See Michel (2014) for additional discussion of value-capture strategies for innovators.

[3] Facebook sells advertising space on its site, which it offers to personalize to help advertisers target specific groups of users based on their stated and observed characteristics. Its ad revenues grew rapidly after it developed a mobile app. Like most consumer-facing tech firms, its business relies completely on upstream digital and wireless enabling technologies.