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The Dynamics of Open Strategy: From Adoption to Reversion

Melissa M. Appleyard, Henry W. Chesbrough

Innovation has become more open in recent years. Yet the decision to become more open and the challenge of sustaining that openness are not well understood. This is the concern of the “content” branch of Open Strategy, defined as the branch that addresses an organization’s open innovation strategy. We examine the initial motivations to adopt an open strategy, and then consider when organizations choose to maintain that open strategy or revert to a more proprietary approach. Similarly, we examine motivations to open up a previously proprietary strategy. We find that these dynamics depend on the organization’s desire to either foster greater growth (which favors a more open strategy) or secure greater control and profit directly from the innovation (which favors a more proprietary strategy). Crucially, these choices can shift over the life cycle of a market and are dependent on the competencies amassed by the organization. In early phases, when there are relatively few legacy customers and many new arrivals, open strategies attract customers at a faster rate. In later phases, as the market matures and new arrivals have slowed, there are few new customers to attract with an open strategy and reversion to a more proprietary strategy becomes quite attractive. This suggests that the longevity of open initiatives might be curtailed as organizations opt for value capture over cooperative value creation.

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Introduction

If we are to make strategic sense of innovation communities, ecosystems, networks, and their implications for competitive advantage, we propose that a new approach to strategy — open strategy — is needed.

— Chesbrough and Appleyard, 2007: 58

Since the publication of Chesbrough and Appleyard (2007) nearly a decade ago, there has been significant interest in Open Strategy but limited attention has been paid to the dynamics that characterize a firm’s pursuit of this new approach to strategy. Two branches of Open Strategy have emerged: a “content” branch that examines the ability of organizations to sustain themselves economically with an open approach to innovation (Chesbrough and Appleyard, 2007); and a “process” branch that explores the systems that can enhance strategy formulation by furthering participation of both internal and external actors and improving transparency inside and outside of the firm (Whittington et al., 2011). While other papers in this special issue address this latter branch, this research provides a framework for examining the content branch of Open Strategy from adoption to — under certain circumstances — its abandonment. In our context, we define abandonment as reversion to a proprietary strategy. We have witnessed these dynamics in industries ranging from life sciences to consumer packaged goods, and in this paper, we particularly focus on examples from the information and communications technology (ICT) and software industries, such as the evolution of the Android operating system. The analysis draws on existing literature pertaining to the role of knowledge accumulation, network effects, and ecosystem development in fueling cross-firm cooperation when a new market is emerging, complemented by interviews from leading firms that contribute extensively to open innovation initiatives including IBM and Intel. We find that the decision to either open up a previously closed project (i.e., abandon property rights protection) or close off a previously open project (i.e., revert to a proprietary strategy) hinges on the evolving realities of the market including rate of product adoption and the emergence of a supporting ecosystem, as well as changes in the competencies accumulated by the cooperating firms.

Prior research has observed that open innovation is leading to new empirical phenomena that do not fit well with Porterian theories of business strategy (Chesbrough and Appleyard, 2007; Lerner and Tirole, 2002; West and Gallagher, 2006). The primary tension between Open Strategy and traditional business-level strategy rests with the need to secure an economic return in the face of relinquishing control over critical strategic assets and capabilities (Barney, 1991; Dvoskin, 2016; Peteraf, 1993; Wernerfelt, 1984). The reconciliation of this tension is how we define Open Strategy: a firm’s justification for participating in an open initiative, including its ability to capture value from the initiative. In our application of Open Strategy,

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an open initiative is characterized by: a) the reliance on assets outside of the firm’s boundaries (inclusion), and b) the (free) access to project results by outsiders (transparency). By way of example, in the setting of an open source software (OSS) project, contributions to the code base might span hundreds of software developers who are freelancers, affiliated with non-profit organizations, or employed by companies. The compilation of their individual contributions leads to a new software product, e.g., the well-known example of Linux, which is published in the public domain. This pooling of assets externally leads to a high-quality, freely accessible product, and because of this open access, the participating firms then have to construct business models to capture value elsewhere in the value chain (Chesbrough and Appleyard, 2007; Perr et al., 2010). The participating firms also need to decide their level of commitment to openness over the life of the project, and the drivers behind this decision are the focus of this paper.

The remainder of the paper is organized as follows. In the next section, we introduce a conceptual framework for considering the range of strategic possibilities between open and closed innovation initiatives and provide examples. We then analyze the foundations of value creation during open innovation through a producer and consumer surplus lens. The subsequent section details the basis for collaboration and the factors that might lead to a shift in strategic choice, including the possibility of reversion. The following section goes more deeply into internal competencies that traditional firms have grappled with to effectively support open initiatives. Included is a consideration of how successful cultivation of competencies, the technology prowess competency in particular, might actually hasten reversion back to a closed strategy. The triggers of reversion have not received extensive treatment in the literature, and they help to inform the limits of open innovation. In the final sections, we discuss the findings and conclude with possible paths for future research.

A dynamic view of open strategy

The primary research contributions of this paper are: 1) to demonstrate how a firm’s commitment to Open Strategy may be far from static; and 2) to identify the underlying forces driving the migration of strategic choice. In this section, we introduce an intertemporal framework for understanding the range of strategic choices with illustrative examples. Typically, past researchers have emphasized the strategic decision to own and control intellectual property in order to earn a revenue stream to pay for research and development (Grossman and Helpman, 1994; Nordhaus, 1969; Romer, 1990). Or they have emphasized a perpetual commitment to open, user-led innovation (Baldwin and von Hippel, 2011; Shah and Tripsas, 2007; Swann, 2014; von Hippel, 2005), where one’s ability to benefit directly from the use of an innovation obviates any need to appropriate economic value from that innovation. However, these otherwise highly contrasting approaches share a common characteristic: once the strategic choice is made to be open or to be proprietary, that decision is implicitly treated as fixed thereafter. Recent examples reveal that this is an incomplete reflection of reality, where some projects that began as proprietary have moved to become open, while other projects that began as open have subsequently become proprietary. The choice of openness thus is not static, but dynamic. An examination of firms that have moved along the Open–Closed strategy continuum can help illustrate the dynamics. Figure 1 shows how companies and open projects might start with an Open

Ex Post	Open	Cisco: OpenDaylight IBM: PC Sun: Java Mozilla	Linux Apache Drupal
	Closed	IBM: Mainframe Microsoft: Windows Oracle	Google: Apps Google: Android OS Amazon: Kindle Fire
		Closed	Open
		Ex Ante	

Figure 1. Dynamics behind the Open–Closed Strategic Choice

or Closed strategy (“Ex Ante”) and remain in that initial state over time (“Ex Post”). These two strategic choices constitute the main diagonal of [Figure 1](#).

The literature provides extensive treatment of the Closed–Closed strategy ([Porter, 1980](#)), where the organizations pursuing this strategy wall off their innovation initiatives from external contributors, both at the outset and over time. Following this strategy, companies like IBM, Microsoft, and Oracle have enjoyed lucrative profit streams from their proprietary products and services.

Similarly, the literature is replete with examples of the phenomenon of Open–Open initiatives ([Allen, 1983](#); [Baldwin and von Hippel, 2011](#); [von Hippel, 2005](#); [von Hippel and von Krogh, 2003](#)). Three enduring open source software (OSS) projects represent the Open–Open approach in [Figure 1](#): Linux, Apache and Drupal. They also constitute a breed of innovation where (advanced) users are themselves the innovators ([Franke and Shah, 2003](#); [Lakhani and von Hippel, 2003](#); [Lerner and Tirole, 2002](#); [O’Mahony and Bechky, 2008](#); [Raymond, 2001](#)). They have managed to sustain their commitment to openness over time, something we worried greatly about in previous work ([Chesbrough and Appleyard, 2007](#)).

A novel contribution of this paper is to focus on the “off-diagonals” of [Figure 1](#), for the main diagonal in the figure does not represent all of the possible options firms face. In the off-diagonal quadrants, projects can migrate from Closed to Open or from Open to Closed. As an example of the former, in 2013, Cisco coordinated the launch of the OpenDaylight initiative. This open source software project is in effect taking some of the intelligence out of Cisco’s proprietary network hardware and putting it into an openly available software layer. IBM’s PC business similarly started out as initially closed, but rapidly developed into a *de facto* open standard, driven in large part by the actions of Intel and Microsoft supporting “IBM compatible” PC systems ([Chesbrough and Teece, 1996](#)). The history of Java also followed this pattern, where the shepherds of Java at Sun switched Java’s license to a more open one in 2006 ([Fisher, 2006](#)). Mozilla, the free web browser, resulted from the aftermath of Netscape’s battle with Microsoft in the mid-1990s in the so-called Browser Wars.

The reverse flow also arises. Two examples of the Open to Closed migration are Amazon’s build-out of the Kindle Fire ecosystem and Google’s management of the Android operating system and related apps. To launch its Kindle tablet, Amazon adapted, or “forked,” a version of Android to create its Fire operating system and developed its own application programming interfaces (APIs) that would dictate how applications would connect to the operating system ([Pon et al., 2014](#)). This allowed Amazon to control the specifications of the apps that the Kindle and other Amazon devices could use. This control ensured that Amazon would be able to integrate its range of services into apps sold in its Appstore, allowing customers to access not only the digital content that they purchased through Amazon but the expanding range of services like cloud storage and streaming media ([Pon et al., 2014](#)). Because of the very small marketshare of Amazon Fire devices relative to the whole Android universe, only one-tenth the number of apps have been developed for Fire relative to Google’s app store ([Pon et al., 2014](#)).¹

While Amazon pursued a closed Fire ecosystem after adapting an open operating system, the closing off of Android under Google’s leadership has been more oblique. After Google acquired Android in 2005, it opened up the source code to draw in a broad developer base to propel adoption ([Open Handset Alliance, 2007](#)), consistent with the positive feedback effects of [Shapiro and Varian \(1999\)](#). Initially, the open approach succeeded in attracting a large and vibrant ecosystem to Android to catch up to Apple’s iOS operating system, as it was intended to do. That is not the end of the Android story, however. Over time, as Android has surpassed Apple’s operating system in unit market share in the smartphone arena ([Business Wire, 2014](#)), Google has progressively closed off Android through a variety of means. Google has inserted two layers of proprietary control ([Amadeo, 2013](#)). The first is Google’s migration of open source-derived apps to closed source versions provided and maintained exclusively by Google, in the form of Google apps, such as the Calendar and Camera. Google will continue its now-proprietary apps into the future, without any further sharing back to the initial open source versions.

The second way Google is closing off the Android platform is by extracting functionality out of the operating system and placing it in a new proprietary “app” called Play Services ([Amadeo, 2013](#); [Pon et al., 2014](#)). This is a classic envelopment strategy, in the language of [Eisenmann et al. \(2011\)](#). Play Services provides systems-level capabilities like account syncing and Google+ connectivity required for the smooth functioning of Google’s now-proprietary apps found in the Play Store. This means that Google can update Play Services frequently without having to rely on infrequent, major Android operating system updates. It also means that companies like Samsung, who has tried to mimic the functionality of Google’s proprietary apps via its own suite of apps, may have difficulty “inventing around” this new systems-level app, thereby becoming even more beholden to Google. It further means that individual volunteer contributors have no future role to play in this integration of services.

While Android is indeed licensed through the Apache Software License ([Android, 2014](#)), which is an open source license, Google has in effect closed off Android without much public notice or outcry. While these methods are most likely perfectly legal, in our view they violate the spirit of open source development, turning Android into “more of a ‘look but don’t touch’ kind of open” ([Amadeo, 2013](#)). They also qualify some of the more extravagant claims of open source proponents of “democratizing innovation” (e.g., [von Hippel, 2005](#)). The reversion to a proprietary strategy suggests that the initial open

¹ As [Pon et al. \(2014\)](#) analyze, their very different strategies around welcoming apps into their respective stores reflects the different business models pursued by Amazon (retail sales) and Google (advertising). What remains to be seen is whether Google’s strategy of shifting functionality out of Android and into Play Services as described below will hobble Amazon in the long-run when Amazon wants to upgrade Fire, or whether “OS-agnostic” apps like those based on HTML5 might lessen the importance of the operating system.

approach was a strategy to gain rapid adoption, subject to later revision if circumstances warranted it. Open need not imply a commitment to remain open in perpetuity.

The underlying value created by open and closed strategies

The question becomes, why does such migration away from the main diagonal pattern occur? Why do initially Closed strategies shift to Open, and why do initially Open strategies shift to Closed? This section presents the underlying gains that accrue to producer surplus or consumer surplus...or both from the Open or Closed strategic choice. As these underlying gains shift, so too can the optimal choice of strategy.

In the Closed–Closed cell of [Figure 1](#), firms enjoy the (temporary) monopoly profits afforded by intellectual property rights, along with the high barriers to competition that drive the Five Forces analysis of Michael Porter ([Porter, 1980](#)). The producer surplus is increased by having control over price and quantity. In the Open–Open cell, the user-innovators capture a share of the returns from both increased producer *and* consumer surplus because they are not only the creators but also typically the consumers of the output ([Baldwin and von Hippel, 2011](#); [Baldwin et al., 2006](#); [Swann, 2014](#)). They can also benefit from providing complementary goods and services which need not be open, a topic we discussed extensively in our earlier paper ([Chesbrough and Appleyard, 2007](#)). In the Close–Open and Open–Closed cells, producer and consumer surplus evolve with the growth of the market and drive the inter-temporal migration of strategy in ways we discuss below.

Producer surplus in open initiatives

Specifically considering open initiatives, the contributions to producer surplus can be characterized in terms of *cost, quality, speed, and coordination*. The momentum surrounding an open project can draw in vast numbers of contributors as seen in many of the successful open source software projects.² This can drive down costs of production while enhancing quality because of the sheer volume of contributors and their diversity. The often reduced and shared cost of development can lead to a greater number of experiments running in parallel, which can shorten development cycles ([Baldwin and Clark, 2000](#)), and because transparency is a hallmark of open projects ([Whittington et al., 2011](#)), results can be disseminated in a more timely and broader fashion. As Google has demonstrated through the initial open build-out of the Android ecosystem, a further benefit of openness is, in quick order, to coordinate a critical mass of players to launch a new platform. This allowed Google to overcome a late start even in a setting with strong network effects at a time when first Microsoft's and then Apple's ecosystem had threatened to dominate the smartphone market ([Pon et al., 2014](#); [West and Gallagher, 2006](#)).³

Consumer surplus in open initiatives

From the perspective of consumer surplus, openness generates value for consumers through *price, features, and self-determination*. Price generally is lower than proprietary alternatives when the output is freely available, like freely downloadable open source software, and when value can be captured elsewhere in the value chain. Android can be viewed as an example of where this latter downward force on price has occurred. Google does not need to charge for use of its Android operating system, because the company can rely on downstream revenues from a complementary good, paid search.⁴ Regarding features, user-developers can make contributions to the open project to address their specific needs. As [Shapiro and Varian \(1999\)](#) and [Swann \(2014\)](#) demonstrate, a boost to consumer surplus can be realized when users are freed from the lock-in of proprietary systems in favor of open regimes of self-determination. Open projects thus maximize consumer surplus by allowing customers to enjoy desired (or even tailored) features at a lower price while avoiding lock-in to a particular company's ecosystem.

In sum, when deciding in which cell to be, companies need to weigh the monopoly rents from Closed–Closed versus the “double-agent” returns of the Open–Open cell (where the innovator also is the user) ([David, 2001](#)), which are influenced by the value created through producer and consumer surplus. But as the value shifts over time due to the factors analyzed below, firms can find their strategies drifting across the diagonals of [Figure 1](#).

The factors driving strategic choice

The payoffs to consumer and producer surplus can precipitate the migration of strategy, and this section examines how this occurs through user-driven, firm-driven, and market-driven forces. The analysis also introduces the notion that firms

² Crowdsourced innovation projects in a variety of sectors also have attracted a considerable number and variety of contributors ([Hautz et al., 2010](#)).

³ This desire to fuel adoption of a new technology standard lays at the heart of Tesla's announcement about opening up its patent portfolio ([Musk, 2014](#)). This is another setting with strong network effects, and Tesla, as a late entrant, is partnering with established firms Nissan and Toyota to build out a joint charging network in the United States.

⁴ As some observers in Silicon Valley put it: “If you are not paying for the product, you ARE the product.” See [Chesbrough and Appleyard \(2007\)](#) for more examples of how firms can profit from open approaches.

might actually pursue a hybrid strategy that exhibits features of both a Closed and Open strategy reflecting the interaction between user and firm preferences.

Our first consideration is the rationale behind moving from a Closed to Open strategy and how the benefits accruing to users can help spur such movement. Firms following Closed strategies based on competitive barriers such as intellectual property rights, by and large do a good job of capturing value via higher prices and a larger producer surplus (Shapiro and Varian, 1999), which explains why many firms choose a closed strategy initially. However, closed strategies need to generate enough consumer surplus to entice customers to buy their offering. Knowing that the offering is closed and thus must be purchased “off-the-shelf,” customers must derive considerable value to motivate them to buy. The obvious rationale to open up an initially closed strategy is that the offering failed to generate enough value to attract enough customers to sustain the closed strategy. This was the case with Mozilla, for example. Microsoft’s bundling of its Explorer browser with the Windows operating system created an insuperable barrier for Netscape Navigator. The latter had to be downloaded and installed in order to be used, while Microsoft’s offering was already installed, and offered for free.

In response, Netscape eventually decided to release an open-source version of its Navigator browser, called Mozilla. While it could no longer sustain the further development of this browser on its own in competition with Microsoft, it reasoned that an open community might want an extensible browser that users and developers could modify as they wished. Mozilla remains a viable browser option to this day, twenty years after it was put into open source. So Netscape’s calculation proved to be prescient.

This example of Closed to Open migration reflects how the payoffs captured by “user-innovators” can lead to strategic change. The increased payoffs to users derive from improved features, self-determination, and a reduced price can accrue as follows:

- (1) The benefits attributable to “**self-service**,” *i.e.*, allowing users to tailor the product to their needs (Chesbrough and Appleyard, 2007), can offset relative costs penalties – a higher cost of installation in the case of Mozilla.
- (2) An additional benefit of an open source alternative is the **elimination of software licensing fees**. The pressure by lead users for an open source alternative to bring down such fees helped persuade Cisco to initiate the OpenDaylight project (Duffy, 2013), another Closed-to-Open example in Figure 1. Many of these lead users subsequently contributed code to the project.

The less-studied case is the movement from Open to Closed in Figure 1. The factors influencing such movement can be grouped into firm-driven and market-driven categories.

The firm-driven factors depend on the strategic calculus of the firm. A firm contemplating abandonment of an open initiative might weigh the following, which reflect the dynamics of producer surplus related to achieving product quality, coordination across the ecosystem, speed of deployment, and threats to profitability:

- (1) Has the firm accumulated enough **internal technology prowess** to guarantee quality and carry the initiative forward without the help of the community? This factor will be considered in greater detail below.
- (2) A major part of making most open initiatives successful is the emergence of a **supporting ecosystem**. Has the firm’s ability to manage all of the associated touch-points with the open initiative, *i.e.*, its “Architectural Management,” been honed enough? For example, in the Android case above, as Google reverts to a proprietary approach, it needs to manage not only the Android operating system, but also the relationships across the ecosystem spanning the independent apps developers, the handset makers, and the telephony and Wi-Fi service providers. Have the ecosystem partners continued to invest in and support the offering? If not, maybe they are not adding much value anymore. Or if they have, might there be the risk that they actually take control of the offering (as occurred with Intel and Microsoft with the IBM PC)?
- (3) Another critical player in the ecosystem is the customer. If a firm were to close off a project, has its Architectural Management team forged a **strong and credible relationship with the user base**, such that there will not be mass defection if they fully take over the project, close it off, and move it in-house? When considering the customer response, the customer base can be usefully separated into legacy customers (who have already invested substantial time and money into the offering) and newly arriving customers (who have not).
- (4) Has there been a **dissipation of interest** within the sponsoring firms, because the results from the open project have fulfilled their goals or have fallen short of the goals (Schweik and English, 2012)?
- (5) Has the success of an open initiative prompted a firm to **acquire it and close it down**? This can occur if the open initiative threatens the profitability of a main line of business of the potential acquirer, as in the example of Oracle’s acquisition of Sleepycat, after which Oracle changed the Sleepycat software license to make adoption of the open version much less attractive (Phipps, 2013).

The market-driven factors address the evolution of the customer base and the preservation of the customer experience. They blend the payoffs to consumer and producer surplus:

- (1) Firms involved in an open initiative must develop business models that balance value creation with value capture. The **arrival rate of new customers** into the market addressed by the open initiative drives value creation. Therefore

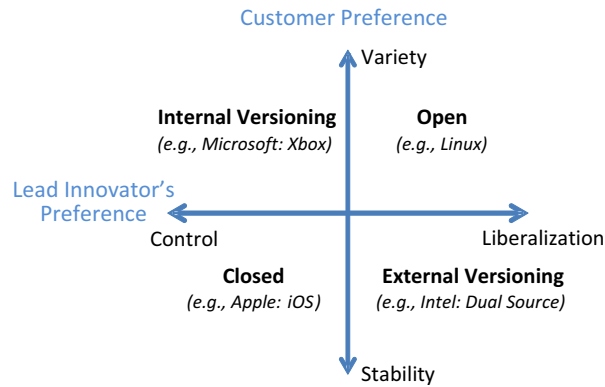


Figure 2. The Interaction between Innovator and Customer in Strategy Creation

when markets are small and arrivals are high, there are benefits to an open approach from the customers' perspective, because they value not having to "lock-in" to a proprietary architecture (Shapiro and Varian, 1999) and appreciate expanded product choice. Open accelerates adoption faster than Closed, because consumers are benefiting from self-determination while producers are benefiting from coordination and speed of adoption.

However, when markets become large and the arrival of new customers slows, this reduces the further benefits of remaining open. The strategic emphasis shifts from value creation to value capture. The motivations behind such a shift parallel those behind the migration from exploration to exploitation in high-risk environments (March, 1991; Raisch et al., 2009; Rothaermel and Deeds, 2004; Smith et al., 2010; Volberda et al., 2001).

- (2) As markets mature, customers also care about the **stability of the product platform**, when either there is a steep learning curve to use the product or the need for interoperability with complementary goods and services. The consumer desires feature stability and the producer wants the ecosystem to achieve a seamless customer experience. These desires are particularly salient when a large proportion of the customer's employees need to be trained to use the product or related integrated system (Shapiro and Varian, 1999). The customer's desire for stability is a conceivable argument behind Google's decision to close off the Android operating system. Closing off Android means that Google decreases the likelihood of the source code being "forked" into multiple versions for which they could not guarantee quality or compatibility. The argument is that excessive fragmentation could complicate the customer experience to the point that customers defect for a more stable platform such as Apple's.

These effects can be synthesized along two dimensions: the "Liberalization–Control" continuum, which reflects the firm's assessment of the firm-driven factors; and the "Variety–Stability" continuum, which reflects the market-driven factors influenced by customer behavior (Figure 2). The interactions of the two dimensions can add subtleties to the firm's strategic choice. The "Closed" quadrant in Figure 2 reflects the situation described in the market-driven factor (2) above when customers would be willing to lock into a stable, closed system like Apple's iOS to ensure the customer experience does not appreciably change over time. In contrast, customers might favor feature variety – and even the ability to create their own features – so a project with these characteristics like Linux would be in the "Open" quadrant.

To understand the off-diagonal quadrants, we consider strategic choices that are composites of open and closed characteristics. These quadrants demonstrate the possibility that firms may choose a more nuanced strategy by relaxing the binary choice between Open and Closed. An example of a strategy that ensures stability but loosens intellectual property rights ownership occurs when a firm guarantees a second source for its product (Shapiro and Varian, 1999), which again reflects a customer demanding stability. The requirement of a second source is common in critical applications, e.g., technologies used in the national defense arena. Companies that supply such technologies, like IBM, can require that their parts suppliers, like Intel, license their chip technologies to a second source of supply, like AMD.⁵ Unlike the example of stability leading to a Closed strategy, this quest for stability would instead require Intel to relax, or "liberalize," its control over its product by licensing its chip design to AMD. This customer requirement would force Intel to open up and move into the hybrid "External Versioning" quadrant of Figure 2.

The dynamics behind the movement from the Closed quadrant to "Internal Versioning" could be driven by pressure from the customers for new features, or greater variety, rather than greater stability. Internal Versioning allows a firm to maintain control over much of its intellectual property portfolio but open up enough to allow others to develop complements that would work with a firm's core technology. An example can be drawn from the video gaming industry. In this industry, new generations of consoles allow for enhanced graphics capabilities and engagement with game play. To enter

⁵ IBM also obtained a manufacturing license to Intel's microprocessor design, so that it could act as its own second source.

this industry, superior technology prowess is required to make a new console so compelling that the barriers to entry from network effects are broken and gamers are willing to switch to the new system. But over subsequent generations of the console, the customers would want to be able to use their library of games, so the console maker would need to balance backward compatibility with new features. This balance is also affected by the number of newly arriving customers relative to legacy customers.

Internal Versioning is defined as this ability of incumbents to release multiple generations of propriety systems to satisfy customers' desire for variety and feature improvement. Microsoft demonstrated this ability to marshal internal technology prowess to enter the console industry with the Xbox (Takahashi, 2011), and exhibited sensitivity to backward compatibility in subsequent generations. Microsoft also understood the need to relax control to attract complementors namely independent game developers, thus embracing some horizontal movement in Figure 2 toward Liberalization. As an example of this commitment to foster complements, at the time of launch, one of Xbox's marquee game titles, Halo, had originated outside of the company.

This analysis suggests the broad and nuanced presence of these kinds of Open–Closed dynamics across industries, and while a lead innovator may lean towards preferring a Closed strategy based on proprietary technology, customers may force migration to a more Open strategy to reduce their lock-in, while benefitting from positive network effects, technological advancement, and engaged complementors.

Enabling competencies

A firm's ability to capture the gains to its strategic choice ultimately dictates its willingness to sustain participation in open initiatives, but which competencies inside the firm most effectively enable value capture? Two critical competencies that contribute to a firm's inter-temporal ability to pursue Open Strategy are its technology prowess and organizational processes that support openness.

The technology prowess competency

To further understand the firm-level assets that push companies either toward or away from open innovation initiatives, we draw lessons from an analytical model developed by Appleyard et al. (2008). As developed in the model, the pivotal competency that sways the firm's strategic decision between open and closed innovation is its technology prowess relative to its potential collaborators. Technology prowess is defined as the firm's ability to apply its knowledge stock to the innovation initiative at hand. But because of the "ecosystem effect" explained below, even firms with superior technology prowess might wish to collaborate to expand the market and lessen the uncertainty of sustained market adoption, because a supporting ecosystem is more likely to rally around a larger user base.

In terms of a firm's ability to capture value from its open initiatives, the model considers profit levels in different scenarios: cooperative, duopolistic, and monopolistic. It assumes there is a technology leader that initiates the innovation project. In instances where the technology prowess of the leader's staff overlaps with that of close competitors, the firms will produce a similar product such that they will split the end-product market. The value to the user who consumes their end products is determined by the firms' respective technology prowess and by users' specific needs, because users will have to incur a cost to adapt the product if it is not perfectly aligned with their needs.

Depending on a firm's level of technology prowess, it can be shown that a firm could become a natural monopolist even if a competitor's product were free, in the setting where the former firm's product is so technologically advanced and fits the user's needs so precisely. However, for other levels of the focal firm's technology prowess, where their innovation capabilities are so similar to those of the other firm, there is a willingness to cooperate in an open initiative. Although still positive, the profit level for the focal firm falls, as multiple firms share the profits, but a supporting ecosystem emerges because of the larger, joint market created by the focal firm and its collaborators.

The ecosystem effect of the Appleyard et al. (2008) model captures the willingness of an ecosystem to form in order to support deployment of the new product. In the software sector, crucial members of a supporting ecosystem are the systems integrators, like Accenture or IBM, who combine software and hardware into a functional system. If the lead innovator in an open source software project were to close off the project too quickly, the market might be too small for systems integrators to be willing service the market. Similarly, if the closed project does not open up enough it might be preempted by an open alternative that siphons off support from systems integrators. This "mutualism" experienced by competing innovators reflects a shared need for ecosystem support and provides a countervailing force to abandoning an open strategy.

Applying this intuition to the Google Android example from above, the switch from Open to Closed can be triggered by a change in Google's technology prowess. As Google's technology prowess in software development has grown, not only through experience working on Android but by hiring leading Android software developers into Google (Dahlander and Wallin, 2006), Google's payoffs approach the natural monopoly situation. This result is similar to a learning race where one strategic alliance partner learns more from the other partner than vice versa and then abandons the relationship (Kale et al., 2000; Khanna et al., 1998).

The Closed to Open example of Cisco's OpenDaylight project reflects the reverse dynamic, where a company with a large lead in its technology prowess is actively inviting other companies to collaborate, which effectively erodes its relative prowess over time. In this case, Cisco is willing to share (cede) its technology prowess to avoid being disrupted in a Christensen (1997)

sense, while ensuring a say in the direction of the emerging *de facto* standard in software-defined networking (Shapiro and Varian, 1999). The willingness of Cisco to share control of the project and become more inclusive over time can be verified by monitoring the code contributions to important modules in the project. This monitoring is possible because of the transparency of the source code.⁶

The organizational support competency

Another critical competency required to effectively execute Open Strategy is a firm's ability to provide organizational support for the open initiative (Herzog, 2011). Utilizing Open Strategy requires substantial attention to how a firm will support the initiative across all levels of the organization (Chesbrough and Crowther, 2006; Dodgson et al., 2006; Jarzabkowski et al., 2007; Sieg et al., 2010; Whittington, 2006). Developing internal organizational processes that facilitate participation is paramount, particularly for firms that are shifting their strategy from Closed to Open.

To understand the necessary changes in organization processes, we interviewed leaders from a cross-section of organizations within the open source software sector. These interviews reflect the evolution of open innovation projects, where people no longer question *whether* openly sourced initiatives will survive, but instead are asking *how* their internal and external processes need to evolve to fully deploy Open Strategy.

The process question becomes how to set the level of commitment to Open Strategy beyond merely opening up parts of one's product portfolio. Mike Woster, COO of the Linux Foundation, proposes four organizational strategies depending on the firm's level of commitment to the open initiative: *consumer*; *participant*; *influencer*; and *initiator* (Woster, 2014). The *consumer* model expressly targets cost savings by adopting free and open source software, similar to consuming third party off-the-shelf software. *Participants* typically pursue limited interactions with specific OSS communities, such as finding and proposing solutions to software bugs. Companies exerting an *influencer* strategy can sway the direction of the software project with software contributions that extend or modify functionality (Dahlander and Wallin, 2006). Finally, *initiators* are contributing software and building communities around it so as to make it a market standard, which often leads to the commoditization of competitors in particular application areas (West and Gallagher, 2006).

This progression requires a conversion of organizational practices. One of the most extensive commitments to the *initiator*-end of the strategy spectrum by an established (proprietary) company has been by IBM. Not only has IBM contributed over \$2 billion to the development of Linux (IBM, 2013; Wilcox, 2000), but the company reengineered its internal processes to sustain Open Strategy. According to Dan Frye, the head of Open Systems Development at IBM for over a decade, they had to alter their internal processes at both an organizational-level and individual developer-level to work with OSS communities (Frye, 2014).

Because of its crisis years in the late 1980s and early 1990s (Mills and Friesen, 1996) and the company's experimentation with business models (Chesbrough, 2010), IBM's senior leadership was responsive to understanding OSS and how to change its processes to support a leadership role in the emerging ecosystems. While IBM's OSS business model has increasingly focused on the services it wraps around OSS, the company initially captured value by selling the hardware underneath, so on balance, OSS was not seen as a threat (even though IBM had a sizable proprietary software business) but as an opportunity. This garnered top leadership support and allowed Frye and his team to alter the processes necessary to establish IBM's role as an *influencer* in various OSS ecosystems, with the most noteworthy being the Linux ecosystem.

Another technology leader, Intel, similarly progressed through the *participant*, *influencer*, and *initiator* stages, once open source initiatives were identified as a strategic imperative in the early 2000s. Like IBM, Intel had a large, in-house, proprietary software group, and so organizational buy-in was critical. Imad Sousou, General Manager of Intel's Open Source Technology Center, observed that senior leadership gave two overarching reasons why it was vital for Intel to aggressively pursue OSS: 1) A traditional business strategy argument around complements where better, more widely available software would support mainline businesses (chip and server sales); and 2) If OSS could help accelerate the overall pace of innovation, then Intel would grow with it (Sousou, 2014). For example, if OSS fueled burgeoning sectors like the Internet of Things (IoT), then Intel would benefit through the sale of more Intel chips. Furthermore, in the late 1990s, Intel faced instances of being constrained by proprietary software vendors in the IT infrastructure sector that refused to support Intel systems, and so OSS allowed Intel to circumvent those barriers. A few early and decisive wins of opening up software to promote the growth of other business units within Intel induced organizational support of OSS (Sousou, 2014).

With strategic clarity came the need to define internal processes. Similar to IBM, Intel's OSS vetting committee comprises legal, business, and technical leaders from each major time zone. Hundreds of projects have gone through their review process. Such a process allows Intel to analyze the growth potential associated with each OSS project, while mitigating the risks and potential costs of infringing someone's intellectual property or unintentionally disclosing a trade secret (Sousou, 2014). Sousou noted that pursuing OSS cannot be a distraction with a limited level of commitment, but rather part of a sound business strategy, technically feasible, and without any licensing issues. And like IBM, Intel has had to modify its internal processes to work effectively as a member of OSS projects.

⁶ An earlier example of an erosion of a leader's technology prowess comes from the opening up of Mozilla. Originally intended to act as a proprietary web browser, this technology lost its early lead to Microsoft's Internet Explorer. As noted above, once IE became more pervasive, the Mozilla project was put into the open domain.

Discussion and extensions

In this paper, we have shown that the choice of how open to be in one's innovation strategy is not a once-and-for-all decision. Instead, we have presented evidence that while some projects remain open or remain proprietary over time, other projects switch modes or even exhibit hybrid modes that blur the binary choice between Open and Closed. Understudied in the literature is the transition from Open to Closed, which we call reversion. Evidence of reversion, such as in the Android operating system, might reflect the customer's desire for platform stability after a network has grown large enough to attract a supporting ecosystem, and the lead innovator, Google in this case, has amassed enough technology prowess to be able to shift to value capture from market expansion. These dynamics have important implications for both the content branch of Open Strategy as well as the process branch.

This paper proceeds through three layers of analysis. First, we consider the underlying payoffs to openness. The payoffs can be categorized as consumer surplus, producer surplus, or even both when the innovator is the user. The allocation of gains can shift over time which can trigger a shift in strategy.

Second, we analyze the user-, firm-, and market-level drivers derived from consumer and producer surplus that may cause a firm to switch strategies. A synthesis of a subset of these drivers shows how customer preferences for product stability versus feature variety can interact with the willingness of the lead innovator to relinquish some control over proprietary assets. As the product market matures, legacy customers who likely prefer stability may prove more influential if fewer new customers are entering the market, and this dynamic could ultimately lead to reversion.

But a strategic shift can only occur if the third layer of analysis supports it, where the third layer represents organizational competencies. To be in a position to capture the value created in an open initiative, our analysis finds that competencies spanning technology prowess and open-supporting organizational processes emerge as vital.

Ironically, a firm's commitment to an open project might precipitate reversion over time. In the specific setting of open initiatives that focus on innovation, the growth of associated knowledge assets leads to the deepening of the technology prowess competency reflecting the accumulation of experience as well as the movement of top talent across company boundaries. The ability of firms to grow their knowledge assets through these means during an open innovation project can, over time, reduce their need to collaborate with outsiders. Therefore, multiple forces might precipitate reversion and additional research is needed to assess their strength relative to the countervailing payoffs to openness.

Conclusions and directions for future research

Open Strategy has evolved to encompass two primary dimensions: a process dimension that examines the effects of substantially greater participation in the strategy determination process (Whittington et al., 2011); and a content dimension that considers the sustainability of open innovation approaches (Chesbrough and Appleyard, 2007). More recent proponents of open innovation have celebrated the value of opening up (Chesbrough, 2003; von Hippel, 2005), but issues of whether and how this openness can be sustained have not received adequate attention (Chesbrough and Appleyard, 2007).

The possibility of switching strategy of being Closed or Open over time has been neglected by both the process side and the content side of Open Strategy. From the process branch of Open Strategy, it is likely that at least some adherents of a much more participatory strategy formulation process at a later time revert to a more restricted process. Understanding when this reversion occurs will help to clarify the boundary conditions that enable Open Strategy formulation processes to thrive over time. Within the content branch of Open Strategy, the underlying dynamics that a lead innovator might face with regards to its technology prowess relative to a collaborator, coupled with customer preferences for stability or variety, might alter the anticipated payoffs to a particular innovation strategy and cause the pendulum to swing back.⁷ The possibility of switching content strategies also calls attention to the internal organizational practices of firms, and the range of payoffs that figure into the calculus of whether to switch or not. Only future systematic analysis across industries will be able to assess the limits to Open Strategy and open innovation more generally.

While our primary examples have been within the ICT and software sectors, we strongly suspect that these dynamics are in play in other parts of the economy, meriting future research. Wherever there are extensive value chains, supported by surrounding ecosystems of complementary suppliers and third parties that require coordinating actions and investments, the dynamics of the lead innovator's motivations and the market's characteristics are likely to apply. For example, in many standards-setting battles, seemingly small initial differences can tip in the favor of a more open standard over a more restricted one — or vice versa. The classic Beta vs. VHS example has been analyzed this way by Cusumano et al. (1992). Empirical research into standards organizations reveals a wide range of rules and a substantial role for discretion for the lead innovator as documented by Lemley (2002), including the initiator proposing the standard.

The pursuit of Open Strategy necessitates the construction of business models that will lead to economic viability by allowing participating firms to not only create but capture value. How value is created and captured can change over the life of an open initiative, and in some cases, can lead the firm away from openness. Viable Open Strategy business models have been demonstrated in the realm of open source software (Chesbrough and Appleyard, 2007; Perr et al., 2010; West

⁷ In software, open projects worried about being closed off can thwart such moves. The code can be forked into another version governed by an open license, as happened to MySQL as it was being acquired by Oracle as part of Oracle's acquisition of Sun (Pearce, 2013).

and Gallagher, 2006), but parallel (or alternative) business models in other industries have received less attention. Software firms that value time-to-market often opt for open source, but wrap proprietary add-ons (or services) around it. To help formulate a strategy for portfolio balancing between Open and Closed products, companies like Red Hat are consulting with system integrators like Accenture. These relationships deepen the software sector's ability to determine when companies should pursue (traditional) open source projects and when they should instead apply open source philosophies to internal, proprietary development projects (so-called inner sourcing). Future studies can survey firms that participate in open initiatives to detail where in the value chain they are capturing value and how Open and Closed products and services are co-existing in their portfolios.

Not only have business models that sustain Open Strategy received limited attention outside of software, but few studies detail the internal competencies a traditional, proprietary-oriented firm must develop to achieve openness. Two prevailing competencies that we consider in this paper are technology prowess and organizational processes that will support the non-traditional strategic choice of Open Strategy (Barney, 1991; Chesbrough, 2003). As Chesbrough (2003) establishes, without a supportive organizational structure, other competencies that are valuable, rare, and costly to imitate will not lead to sustained competitive advantage. Delving into the organization processes including reward systems, promotion paths, and norms governing interactions with others in open initiatives could help with the understanding of how firms are able to migrate along the Open Strategy spectrum.

This research implies testable hypotheses that warrant further research. Future empirical research could specifically analyze how technology prowess influences participation. As noted, we anticipate that accumulated technology prowess would be expected to increase the likelihood of withdrawal from an open initiative and even possibly trigger reversion. One can go about testing this hypothesis through a longitudinal examination of contributions to open projects, like the code contributions made over time in open source software projects.

More generally, future research could test whether Open Strategy leads to heightened competitive payoffs. As noted, open projects are anticipated to enjoy time-to-market, cost, and quality advantages, and these advantages would be expected to translate into improved margins in the short-run and greater market capture and profitability in the long-run. Open projects that embrace transparency like open source software publish who is contributing to which modules of the project. Such information aligns the varied interests of developers, users, complementors and third parties within the ecosystem, improving performance while reducing cost and accelerating time-to-market. The projects that switch their modes over time face the possibility of misalignment with one or more external parties as a result of the switch. The presence of alignment or the potential for misalignment may affect the performance of these projects and hence the firms supporting these projects. Parties who are no longer properly aligned with the new mode may suffer diminished performance, when compared to others who have aligned themselves. Comparisons of product market performance, profitability, and stock performance between member firms of an open initiative and matched non-member firms offer metrics by which to judge the advantages of openness. For example, stock price performance might be assessed following a switch in mode from Open to Closed or Closed to Open.

Another interesting research question is the apparent lack of concern exhibited by participants in open projects that are reverting to a more proprietary approach. One might expect volunteer contributors to these projects to have strong, negative reactions to this reversion, and this anticipated effect could be tested, for example, by analyzing patterns in code contributions in open source software projects that are starting to close off. Countering the expectation that volunteer contributors might curtail their contributions, we have found only modest evidence of defection in response to reversion in our interviews with leaders in the OSS arena.

It is clear that open innovation is an inherently dynamic process. Strategies to support open innovation must similarly incorporate dynamic elements if they are to reflect the reality of today's technological world. For both reasons of rigor and of relevance, we hope others will pursue these dynamics in future work on both the content and the process of Open Strategy.

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References

- Allen, R.C., 1983. Collective invention. *Journal of Economic Behavior and Organization* 4 (1), 1–24.
- Amadeo, R., 2013. Google's iron grip on Android: controlling open source by any means necessary. *Ars Technica*, October 20, 2013. <<http://arstechnica.com/gadgets/2013/10/googles-iron-grip-on-android-controlling-open-source-by-any-means-necessary/1/>> (accessed 23.06.14).
- Android, 2014. Why Apache Software license? <<http://source.android.com/source/licenses.html#why-apache-software-license>> (accessed 23.06.14).
- Appleyard, M.M., Wang, C.Y., Liddle, J.A., Carruthers, J., 2008. The innovator's non-dilemma: the case of next-generation lithography. *Managerial and Decision Economics* : MDE 29 (5), 407–423.
- Baldwin, C., von Hippel, E., 2011. Modeling a paradigm shift: from producer innovation to user and open collaborative innovation. *Organization Science* 22 (6), 1399–1417.
- Baldwin, C., Hienrth, C., von Hippel, E., 2006. How user innovations become commercial products: a theoretical investigation and case study. *Research Policy* 35 (9), 1291–1313.

- Baldwin, C.Y., Clark, K.B., 2000. *Design Rules, Vol. 1: The Power of Modularity*. The MIT Press, Cambridge, MA.
- Barney, J., 1991. Firm Resources and Sustained Competitive Advantage. *Journal of Management* 17 (1), 99–120.
- Business Wire, 2014. Android and iOS continue to dominate the worldwide smartphone market with Android shipments just shy of 800 million in 2013, according to IDC. <<http://www.businesswire.com/news/home/20140212005399/en/Android-iOS-Continue-Dominate-Worldwide-Smartphone-Market#.U16231erHag>> (accessed 23.06.14).
- Chesbrough, H., 2010. Business model innovation: opportunities and barriers. *Long Range Planning* 43 (2), 354–363.
- Chesbrough, H., Crowther, A.K., 2006. Beyond high tech: early adopters of open innovation in other industries. *R&D Management* 36 (3), 229–236.
- Chesbrough, H.W., 2003. *Open Innovation: The New Imperative for Creating and Profiting From Technology*. Harvard Business School Press, Boston, MA.
- Chesbrough, H.W., Appleyard, M.M., 2007. Open innovation and strategy. *California Management Review* 50 (1), 57–76.
- Chesbrough, H.W., Teece, D.J., 1996. When is virtual virtuous. *Harvard Business Review* 74 (1), 65–73.
- Christensen, C.M., 1997. *The Innovator's Dilemma*. Harvard Business School Press, Boston, MA.
- Cusumano, M.A., Mylonadis, Y., Rosenbloom, R.S., 1992. Strategic maneuvering and mass-market dynamics: the triumph of VHS over beta. *Business History Review* 66 (1), 51–94.
- Dahllander, L., Wallin, M.W., 2006. A man on the inside: unlocking communities as complementary assets. *Research Policy* 35 (8), 1243–1259.
- David, P.A., 2001. Notes on 'trading in trade secrets' and the economics of double-agency. NSF/SIEPR Project on Economic Organization and the Viability of Open Source Software, Working Paper Series: 2001-02.
- Dodgson, M., Gann, D., Salter, A., 2006. The role of technology in the shift towards open innovation: the case of Procter & Gamble. *R&D Management* 36 (3), 333.
- Duffy, J., 2013. Cisco, IBM on the defensive with OpenDaylight. *Network World*. <<http://www.networkworld.com/article/2224451/cisco-subnet/cisco-ibm-on-the-defensive-with-opendaylight.html>> (accessed 16.05.16).
- Dvoskin, E., 2016. Tech firms grapple with how to make open source pay. *WSJ.com*, March 3, 2016. <http://www.wsj.com/article_email/tech-firms-grapple-with-how-to-make-open-source-pay-1457031731-1MyQjAxMTI2MjAzNDMwMTQwWjw> (accessed 04.03.16).
- Eisenmann, T., Parker, G., Van Alstyne, M., 2011. Platform envelopment. *Strategic Management Journal* 32 (12), 1270–1285.
- Fisher, K., 2006. Sun opens Java under the GPL. *Ars Technica*, November 13, 2006. <<http://arstechnica.com/business/2006/11/8205/>> (accessed 16.03.16).
- Franke, N., Shah, S., 2003. How communities support innovative activities: an exploration of assistance and sharing among end-users. *Research Policy* 32, 157–178.
- Frye, D., 2014. Interview regarding Open Source Software Strategy at IBM. Personal communication, October 7, 2014.
- Grossman, G.M., Helpman, E., 1994. Endogenous innovation in the theory of growth. *The Journal of Economic Perspectives: A Journal of the American Economic Association* 8 (1), 23–44.
- Hautz, J., Hutter, K., Füller, J., Matzler, K., Rieger, M., 2010. How to establish an online innovation community? The role of users and their innovative content. In: *Proceedings of the 43rd Hawaii International Conference on System Sciences*. IEEE, pp. 1–11.
- Herzog, P., 2011. *Open and Closed Innovation: Different Cultures for Different Strategies*, 2nd ed. Gabler Verlag, Springer Fachmedien, Wiesbaden, Germany.
- IBM, 2013. IBM commits \$1 billion to fuel Linux and open source innovation on power systems. IBM News room. <<http://www-03.ibm.com/press/us/en/pressrelease/41926.wss>> (accessed 05.11.14).
- Jarzabkowski, P., Balogun, J., Seidl, D., 2007. Strategizing: the challenges of a practice perspective. *Human Relations: Studies Towards the Integration of the Social Sciences* 60 (1), 5–27.
- Kale, P., Singh, H., Perlmutter, H., 2000. Learning and protection of proprietary assets in strategic alliances: building relational capital. *Strategic Management Journal* 21 (3), 217–237.
- Khanna, T., Gulati, R., Nohria, N., 1998. The dynamics of learning alliances: competition, cooperation and relative scope. *Strategic Management Journal* 19 (3), 193–210.
- Lakhani, K.R., von Hippel, E., 2003. How open source software works: "free" user-to-user assistance. *Research Policy* 32 (6), 923–943.
- Lemley, M.A., 2002. Intellectual property rights and standard-setting organizations. *California Law Review* 90 (6), 1889–1980.
- Lerner, J., Tirole, J., 2002. Some simple economics of open source. *The Journal of Industrial Economics* L (2), 197–234.
- March, J.G., 1991. Exploration and exploitation in organizational learning. *Organization Science* 2 (1), 71–87.
- Mills, D.Q., Friesen, G.B., 1996. *Broken Promises: An Unconventional View of What Went Wrong at IBM*. Harvard Business School Press, Boston, MA.
- Musk, E., 2014. All our patent are belong to you. <<http://www.teslamotors.com/blog/all-our-patent-are-belong-you>> (accessed 21.06.14).
- Nordhaus, W.D., 1969. An economic theory of technological change. *The American Economic Review* 59 (2), 18–28.
- O'Mahony, S., Bechky, B.A., 2008. Boundary organizations: enabling collaboration among unexpected allies. *Administrative Science Quarterly* 53, 422–459.
- Open Handset Alliance, 2007. What types of companies are in the Open Handset Alliance? November 2007. <http://www.openhandsetalliance.com/oha_faq.html> (accessed 23.06.14).
- Pearce, R., 2013. Dead database walking: MySQL's creator on why the future belongs to MariaDB. *Computerworld*, March 28, 2013. <http://www.computerworld.com.au/article/457551/dead_database_walking_mysql_creator_why_future_belongs_mariadb/?pp=2> (accessed: 16.03.16).
- Perr, J., Appleyard, M.M., Sullivan, P., 2010. Open for business: emerging business models in open source software. *International Journal of Technology Management* 52 (3/4), 432–456.
- Peteraf, M.A., 1993. The cornerstones of competitive advantage: a resource-based view. *Strategic Management Journal* 14 (3), 179–191.
- Phipps, S., 2013. Oracle switches Berkeley DB license. *InfoWorld*, July 5, 2013. <<http://www.infoworld.com/article/2611450/open-source-software/oracle-switches-berkeley-db-license.html>> (accessed 16.03.16).
- Pon, B., Seppälä, T., Kenney, M., 2014. Android and the demise of operating system-based power: firm strategy and platform control in the post-PC world. *Telecommunications Policy* 38, 979–991.
- Porter, M., 1980. *Competitive Strategy*. Free Press, New York.
- Raisch, S., Birkinshaw, J., Probst, G., Tushman, M.L., 2009. Organizational ambidexterity: balancing exploitation and exploration for sustained performance. *Organization Science* 20 (4), 685–695.
- Raymond, E.S., 2001. *The Cathedral and the Bazaar*. O'Reilly Media, Inc., Sebastopol, CA.
- Romer, P.M., 1990. Endogenous technological change. *The Journal of Political Economy* 98 (5), S71–S102.
- Rothaermel, F.T., Deeds, D.L., 2004. Exploration and exploitation alliances in biotechnology: a system of new product development. *Strategic Management Journal* 25 (3), 201–221.
- Schweik, C.M., English, R.C., 2012. *Internet Success: A Study of Open-Source Software Commons*. The MIT Press, Cambridge, MA.
- Shah, S.K., Tripsas, M., 2007. The accidental entrepreneur: the emergent and collective process of user entrepreneurship. *Strategic Entrepreneurship Journal* 1 (1–2), 123–140.
- Shapiro, C., Varian, H.R., 1999. *Information Rules: A Strategic Guide to the Network Economy*. Harvard Business School Press, Boston, MA.
- Sieg, J.H., Wallin, M.W., von Krogh, G., 2010. Managerial challenges in open innovation: a study of innovation intermediation in the chemical industry. *R&D Management* 40 (3), 281–291.
- Smith, W.K., Binns, A., Tushman, M.L., 2010. Complex business models: managing strategic paradoxes simultaneously. *Long Range Planning* 43 (2), 448–461.
- Sousou, I., 2014. Interview regarding open source software strategy at Intel. Personal communication, November 7, 2014.
- Swann, G.M.P., 2014. *Common Innovation: How We Create the Wealth of Nations*. Edward Elgar Publishing, Cheltenham, UK.
- Takahashi, D., 2011. The making of the Xbox: how Microsoft unleashed a video game revolution (part 1). *Venturebeat.com*, November 14, 2011. <<http://venturebeat.com/2011/11/14/making-of-the-xbox-1/view-all/>> (accessed 31.08.15).
- von Hippel, E., 2005. *Democratizing Innovation*. The MIT Press, Cambridge, MA.

- von Hippel, E., von Krogh, G., 2003. Open source software and the “private-collective” innovation model: issues for organization science. *Organization Science* 14 (2), 209–223.
- Volberda, H.W., Baden-Fuller, C., Van Den Bosch, F.A., 2001. Mastering strategic renewal: mobilising renewal journeys in multi-unit firms. *Long Range Planning* 34 (2), 159–178.
- Wernerfelt, B., 1984. A resource-based view of the firm. *Strategic Management Journal* 5 (2), 171–180.
- West, J., Gallagher, S., 2006. Challenges of open innovation: the paradox of firm investment in open-source software. *R&D Management* 36 (3), 319–331.
- Whittington, R., 2006. Completing the practice turn in strategy research. *Organization Studies* 27 (5), 613–634.
- Whittington, R., Caillaud, L., Yakis-Douglas, B., 2011. Opening strategy: evolution of a precarious profession. *British Journal of Management* 22 (3), 531–544.
- Wilcox, J., 2000. IBM to spend \$1 billion on Linux in 2001. CNET, December 12, 2000. <http://news.cnet.com/IBM-to-spend-1-billion-on-Linux-in-2001/2100-1001_3-249750.html> (accessed 13.11.14).
- Woster, M., 2014. Interview regarding Open Source Software Strategy and the Linux Foundation. Personal communication, September 30, 2014.

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