Long-lasting appropriation success of an innovation? A comparative case study of Bayer's Aspirin and Roundup

Pia Hurmelinna-Laukkanen*

Oulu Business School, University of Oulu, P.O. Box 8000, FI-90014 Oulu, Finland.
E-mail: pia.hurmelinna-laukkanen@oulu.fi

Jialei Yang*

Oulu Business School, University of Oulu, P.O. Box 8000, FI-90014 Oulu, Finland.
E-mail: jialei.yang@oulu.fi

* The authors have contributed equally

Abstract: Changes such as expiring patents and shifting environments challenge a firm trying to reach long-lasting appropriation success of an innovation. To understand how appropriation can be continued over time, this study investigates and compares Bayer's two innovations, Aspirin medicine and Roundup herbicide. Whereas for the first, appropriation success has been continued through decades, for the latter, such a continuum has not realized. Our findings suggest that long-lasting appropriation success lies in adjusting the appropriation strategy by identifying the most substantial appropriability premises for innovation (appropriability mechanisms and complementary assets) and the ways to use them in different situations, paying specific attention to the shifting appropriability conditions. For long-term success, it is critical for firms to recognize that isolating appropriability mechanisms and complementary assets can have varied and distinctive implications depending on the pertinent contextual factors at innovation level and to strategize accordingly.

Keywords: Appropriability; appropriation; innovation; interactive; dynamic; Bayer; Aspirin; Roundup.

1 Introduction

Bayer AG, a life science company and one of the largest pharmaceutical companies in the world, is a company that has illustrated long term innovative success in the fields of health and nutrition. As a relevant example, Aspirin (Acetylsalicylic acid, ASA, synthesized by Felix Hoffman in 1897) became the world's best-known pain killer soon after its emergence, and it has continued to attract interest, innovation, and excitement in the following 120 years, thereby allowing value appropriation from this innovation even through some tough times (Jennewein *et al.*, 2010; Walker *et al.*, 2018). However, Bayer also has had different experiences. In June 2018, Bayer completed its $63 billion

acquisition of Monsanto, an agrochemical and agricultural biotechnology corporation based in Missouri, United States. It was one of the largest Merger and acquisition deals in the past decade (Ritsos-Kokkinis, 2020), and it was expected to yield new value appropriation possibilities for Bayer. Yet, the expected outcomes did not realize. Instead, Bayer faced notable problems especially due to Roundup, a glyphosate-based herbicide developed by Monsanto. While Roundup was one of the world's top-selling weed killers and valuable innovation for Monsanto (Mendelson, 1998; Bunge, 2020), it became an object of litigation and posed challenges for Bayer; about one year after the acquisition, Bayer was worth less than the $63 billion it paid for Monsanto (Bender, 2019).

This failure to appropriate value from innovation is interesting, especially given that in the past, Bayer has been successful in both internal research and development (R&D) and opening its innovation (Vanhaverbeke *et al.*, 2019), and that it has managed to get past notable hardships with Aspirin, enjoying continued appropriation success with this innovation. This success has also lasted long after the expiration of the related patents, which is an appropriability mechanism typically used to keep excessive competition at bay and to secure returns from innovation (Jennewein *et al.*, 2010; Kim *et al.*, 2018). Although appropriation (as the realization of appropriability potential built on mechanisms such as patents) becomes typically challenged by these kinds of changes, Bayer seems to have found a way to prolong appropriation for Aspirin. However, the same did not happen in the Roundup case. These differences raise questions of, first, how the appropriation strategies and the relevant elements such as appropriability conditions may be different, accounting for differing outcomes, and second, how a firm could repeatedly continue the appropriation success of an innovation. Inspired by these questions, our research asks: *how can a firm promote long-lasting appropriation of individual innovations?*

Contrasting and analysing the two innovation cases within the same company draws attention to the distinction between innovation appropriability as the potential to capture value from innovation, and appropriation as the realization of that potential (Hurmelinna-Laukkanen and Yang, 2022). While both innovations have the potential to generate value, there are notable differences in realized appropriation. These similarities and differences indicate that rather than simply looking at appropriability regime (Teece, 1986) and selecting appropriability mechanisms to build the appropriability potential, a wider view is needed. We suggest that the notion of *interactive appropriability* in existing research is useful in terms of understanding the differences between innovations' appropriation success. Interactive appropriability is defined as "context-specific, dynamic aligning of appropriability premises (constituted with appropriability mechanisms and complementary assets), and interacting with other agents by relying on exclusion of others, leveraging the appropriability premises, and abandoning of protection, to benefit from innovation and appropriate value" (Yang and Hurmelinna-Laukkanen, 2022). It shifts the focus from relatively static proprietary approaches and private returns toward a wider and more dynamic model. The model entails that adjusting to appropriability conditions is constant, and that benefiting from innovation can be seen more widely than just as profiting from innovation. Returns on innovation may accumulate over time directly and indirectly.

The comparative case study of Bayer's two innovations (Aspirin and Roundup) suggests that the appropriation success of innovation lies in diligently adjusting the appropriation strategy with attention paid to the shifting appropriability conditions. More specifically, our cases demonstrate that this adjustment requires a firm to identify the

most pertinent appropriability premises (i.e., isolating appropriability mechanisms such as patents, and complementary assets, such as marketing capabilities) in different situations. The findings also bring forward the interplay between complementary assets and the nature of the innovation elements (and the need to change these through incremental innovation). Our study indicates that aligning the complementary assets with the appropriability conditions is as important as aligning the isolating appropriability mechanisms and their uses.

By directing attention to these aspects, this study addresses earlier blind spots in the literature on innovation appropriability and appropriation. It makes contributions in several aspects. First, we suggest an (interactive) process model of innovation appropriation strategies. Second, Our study extends the discussion on complementary assets and their nature and control (see Jacobides *et al.*, 2006; Teece, 1986). We argue that not just isolating appropriability mechanisms, but also complementary assets need to be considered in light of the changes in appropriability conditions. Third, we advance discussion on the interactive appropriability generally, and especially at the level of innovation and innovation projects, demonstrating how discrete alignment of the different elements is a key issue. These advancements are valuable for practitioners to innovate on their business models.

2 Towards continued appropriation success through interactive appropriability

The prevalent appropriability literature mainly predicts that if a firm has a strong appropriability regime and has secured access to complementary assets such as distribution channels and strong marketing and sales, it would successfully appropriate value (profits) from an innovation (Teece, 1986, 2018; Winter 2006). However, there are practical examples showing how firms might suffer from the appropriability problem—i.e., the inability of innovators to benefit from their innovations (Arrow, 1962; Chaudhary *et al.*, 2022)—despite these factors being in place (see, e.g., Marullo *et al.*, 2020; Yang *et al.*, 2021, Hurmelinna-Laukkanen and Yang, 2022).

Some part of the perceived 'appropriation failures' can be explained by the changes in the innovation environment and possible challenges in meeting the related requirements (Marullo *et al.*, 2020; Hurmelinna-Laukkanen and Yang, 2022). Current innovation context involves notable interaction between and within different organizations and entails increasing focus on the need to address grand societal challenges, which shifts the focus from private to societal returns (e.g., Bekkers and Tummers, 2018). In such settings, the persisting emphasis on protection and risks of imitation maintains a relatively one-sided view and likely hampers understanding of the appropriability problem (Fisher and Oberholzer-Gee, 2013; Yang *et al.*, 2021). For example, as Jacobides *et al.* (2006) noted, imitation by competitors might challenge profitability, but it might also increase the value of the underlying assets from which the innovator can benefit. Recently, it has become better acknowledged that the question is not about protecting the innovation *per se* but about connecting it to the wider contexts where it makes an impact (Hurmelinna-Laukkanen, 2009; Di Minin and Faems, 2013; Marullo *et al.*, 2020; Hurmelinna-Laukkanen and Yang, 2022).

Relatedly, the examination of appropriability conditions increases its relevance. Notions in the existing literature on issues such as changes of local regulations that

possibly cut short the appropriation of value from a specific innovation (Kao, 2013) deserve attention. The conditions and their influences are varied. For instance, in international markets, the widening competitor base increases risks of uncontrolled knowledge flows (Di Minin and Bianchi, 2011), but the international context also has the potential to strengthen certain isolating appropriability mechanisms (e.g., tacitness and secrecy); distance influences communication frequency and quality, and cultural and language differences limit excessive knowledge exchange (Hurmelinna-Laukkanen and Ritala, 2012). However, as individual studies often focus on specific situations and contexts (see literature review by James *et al.*, 2013), a holistic view of the role of appropriability conditions awaits development.

Another limitation of existing literature on appropriability and appropriation is that it typically seems to assume innovation to be inherently valuable, and appropriable in that sense. The discussion starts from the expectation that innovation is attractive to varied stakeholders, and the insight that weaknesses in innovative offerings have critical effects on appropriation is often overlooked. Yet, for example, Teece (1988) has brought up the fact that product flaws may cause irreversible loss of reputation. Likewise, the extent to which an innovation draws attention and holds potential value may be dependent on the innovation being discrete *versus* enabling or general-purpose technology (Gambardella *et al.*, 2021). Moreover, the features of innovations influence the feasibility of different appropriability premises (isolating appropriability mechanisms and complementary assets), and the ways they should be approached (Cohen *et al.*, 2000; James *et al.*, 2013).

Summarising the above insights, we suggest that the innovation appropriability problem, as it emerges today, could be better addressed by considering *interactive appropriability* (Yang and Hurmelinna-Laukkanen, 2022). Basically, interactive appropriability connects to business model innovation; how the appropriability mechanisms are used in different contexts to support the ways of a firm to conduct business is relevant (see Teece, 2018). Leveraging the appropriability premises (e.g., using patents as bargaining chips or focusing on developing complementary assets to enable the distribution of the innovation), abandoning protection to promote wide adoption of innovation and its further development, and (selectively) excluding others from exploiting the innovation and the underlying assets as relevant appropriation processes can be effective in innovation appropriation, but they need to be aligned with the appropriability premises of the innovators, and with the contextual and situational factors (i.e., appropriability conditions) (Hurmelinna-Laukkanen and Yang, 2022). However, integrated knowledge and empirical studies are limited on these issues, especially in terms of firms (not) being able to repeat their successes in appropriation. This study examines two innovations in the same organization to narrow this gap.

3 Case study – Bayer’s Aspirin and Roundup

3.1 Research context – A brief introduction to Bayer’s Aspirin and Roundup

In this study, a comparative, longitudinal case study of two innovations within a single company—Bayer's Aspirin and Roundup—was conducted. Bayer, headquartered in Germany, is a well-known life science business. It was first founded as a dyestuffs factory in 1863, but shifted its business and gained a reputation in the chemical and

pharmaceutical fields (Bayer, 2022). Today, Bayer's strategy builds on addressing the major social challenges in health and nutrition through continuous innovation in three main business areas: consumer health (e.g., over-the-counter medicines, dietary supplements, and dermatology products), pharmaceuticals (prescription drugs), and crop science (e.g., seeds and crop protection) (Vanhaverbeke *et al.*, 2019). Within these fields, the company has experienced varying success in terms of appropriating value from its innovations.

Aspirin is one of the central innovations of Bayer in the field of pharmaceuticals. It was named and branded by Bayer in 1899 (Mann and Plummer, 1991). Even though Aspirin's patent has already expired, and despite that Bayer even lost Aspirin for some time to another firm (Sterling). Bayer has continued the appropriation success of Aspirin for over 100 years (Jennewein *et al.*, 2010; Mehta, 2005). Aspirin products have been improved over time via incremental innovation (see Ahuja et al., 2013, on generative appropriability), with Bayer's corporate innovation, and collaboration and acquisition activities (e.g., Alka-Selzer) (Jennewein, 2005).

As a relevant example of innovation that was acquired in line with Bayer's search for continuous innovation through acquiring complementary external technology (Vanhaverbeke *et al.*, 2019), *Roundup*, the most widely used pesticide in the US, came to the firm from outside. In June of 2018, after convincing authorities to accept the deal, Bayer completed the acquisition of American Monsanto, a giant in genetically modified organisms (GMO) and genetic-modification technologies (Rebière and Mavoori, 2020). Through this $66-billion acquisition, Bayer aimed to become a leading agricultural company and put crop science on an equal footing with its traditional strengths, i.e., pharmaceutical research (Waltz, 2016).

However, the success of Aspirin could not be repeated for Roundup. Although merging the two firms held promise, the acquisition turned out as "one of the worst corporate deals" (Bender, 2019). Bayer's market value took a nosedive from then on. As an experienced innovator and operator in the fields of life science and agriculture, Bayer was assumed to be able to continue the appropriation success of Roundup. The unmet expectations inspire the question of how a firm can continue innovation appropriation success.

3.2 Data collection and analysis

This study adopts a process research approach and uses innovation as the unit of analysis (Langley, 1999; Langley *et al.*, 2013; Yin, 2014) to study the topic of interest. Using this approach and looking into two separate innovations in one company enables examining the variety and adjustments of appropriation strategies of firms for different innovations. It also allows examining how the chosen approaches account for differing outcomes. While the examined two innovations come from different sources—one from inhouse development (with borrowing from external sources; Jennewein *et al.*, 2010) and the other acquired from outside—and while they come from neighbouring (see Vanhaverbeke *et al.*, 2019) rather than exactly the same field, the two cases share similarities in terms of important patents expiring, intellectual property protection being questioned over the years, and changing operational environment of the firm (e.g.,

Srinivas, 2006; Jennewein *et al.*, 2010; Rebière and Mavoori, 2020). These are valuable for generating insight into appropriability and appropriation.[1]

To study the changes in the innovation landscape of the two innovations and the related appropriation strategies, longitudinal archival data on Bayer, Aspirin, and Roundup, as well as the acquisition of Monsanto, were collected. Extensive data include annual reports, press releases, websites, videos, blogs, white papers, presentations, and articles from journals, newspapers, and the Internet (see Glaser *et al.*, 2016). When collecting the publications, we conducted a systematic literature review to enhance methodological rigor and transparency and to ensure the inclusion of essential articles on Bayer (Aguinis *et al.*, 2018).[2] In total, 485 documents were collected.

In analysing the data, timelines (Figure 1) were first drafted for each innovation to provide an overview of the important events marking the changes in appropriability and appropriation for both Aspirin and Roundup. The appropriability conditions and each innovation were then reflected against these timelines. Auto-coding powered by machine learning in Nvivo (Release 1.6.1) was used to assist the manual coding results to capture possibly hidden patterns or themes (see Nowell *et al.*, 2017). Through within and between case analysis (Eisenhardt, 1989), we reached a view of central factors explicating the long-lasting and discontinuing innovation appropriation. These findings are discussed in the following chapter.

[1] Accordingly, in the Roundup case, the focus is not on Bayer's acquisition of Monsanto as such, but on appropriability and appropriation of the innovation. The Aspirin case was similarly scrutinized for the shifts in appropriation strategies.

[2] The initial search using the keyword "Bayer" produced 10,494 records in Scopus—a comprehensive and multidisciplinary database. We conducted three rounds of selection and filtered the publications against inclusion and exclusion criteria (see Moher *et al.*, 2009). In the 1st round, an article was excluded if it is not written in English, OR is a book, OR is not in the fields of Business, Management and Accounting, Social Sciences, Economics, Econometrics and Finance, Multidisciplinary, Decision Sciences, or undefined. 608 records were identified after the 1st round of selection. In the 2nd round, an article was included if it is related to Bayer's innovation appropriability and appropriation. An article was excluded if it is studying Bayer's other individual innovations or specific deals. Records after the 2nd round selection were 41. In the 3rd round, if an article is relevant to the topic of this research AND its full text is available, it was included. The records after the 3rd round of selection were 35. After the third round, we employed a backward snowballing technique to use the references of the 35 articles to find more relevant studies (Wohlin, 2014). Finally, 37 articles were obtained. We paid special attention to these 37 articles when analysing the data.

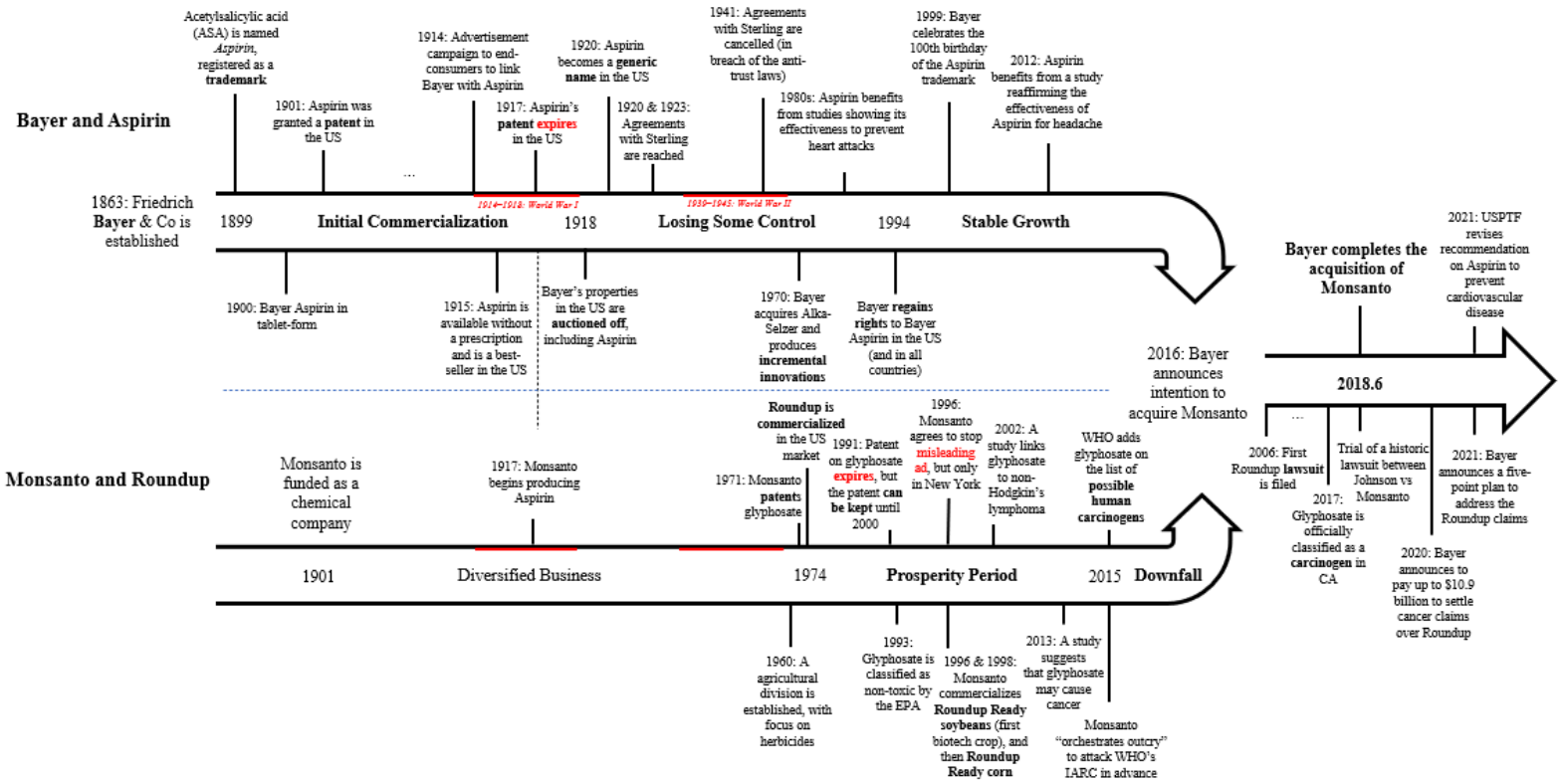

Figure 1 Key events in Aspirin and Roundup cases.

4 Findings

4.1 Bayer's Aspirin: From initial commercialization to challenges and reaching stable growth

There are many aspects of the Aspirin case that bring it forward as a successful case. Aspirin has become one of the rare medicines that have thrived for more than a century, with the 20th century even reputed as the 'The Aspirin Age' (Mehta, 2005). Since its commercialization, Aspirin has been accepted widely, and it has received great interest (Walker *et al.*, 2018). Aspirin has brought Bayer a great fortune until today, and its trademark is retained in more than 70 nations (Mehta, 2005). This path has not been always easy, and controversy and doubt have been present (Rooney and Campbell, 2017), sometimes for the innovation itself, sometimes about the brand of the product and the firm (Mann and Plummer, 1991; Page, 1992; Jennewein *et al.*, 2010).

The events leading to long-lasting appropriation success are manifold. The first synthesis of acetylsalicylic acid (ASA), the active ingredient of Aspirin, was done as early as 1853 (Lichterman, 2004), but researchers of Bayer first foresaw the medical value of ASA. Building appropriability potential required effort. At first, the German Bayer could not find a way to patent ASA (except in the US) due to the regulatory environment (a relevant appropriability condition). However, it did manage to acquire a trademark for Aspirin, which provided a de facto monopoly to the firm (Mann and Plummer, 1991). Moreover, our case materials indicate that Bayer has been motivating internal and external R&D in the field of ASA, thereby building the premises to improve the Aspirin products in a way that allowed the firm to keep its leading position (Ahuja et al., 2013; Jennewein, 2005). Importantly, the continuous development work on the same innovation, which is considered a relevant isolating appropriability mechanism in prior research (see Saviotti, 1998; Hurmelinna-Laukkanen and Ritala, 2012, on lead-time), and utilizing relevant complementary assets help to secure value appropriation for Bayer. For example, using manufacturing capabilities ingeniously to modify the core innovation led to advances such as introducing the tablet form of Aspirin, and maintaining association with a strong brand constantly and consistently has upheld commercial opportunities (Jennewein, 2005).

The initially established control over Aspirin also allowed the firm to get passed some challenging points. During World War I (in 1918), Bayer's physical property in the US—and the name Bayer and the Bayer cross symbol, were seized and auctioned to another company, Sterling (Page, 1992). However, Sterling faced many challenges. With the U.S. patent on Aspirin expiring in 1915, another firm brought an identical product to the markets under the name *Aspirin.* Sterling's trademark infringement suit did not succeed either, as the trademark was found diluted (see Beebe, 2019); *Aspirin* had become a generic term for all acetylsalicylic acid painkillers (Page, 1992). Moreover, production problems emerged. Sterling needed Bayer's help to produce and sell the compound, not being able to fully comprehend the patent documents. The resulting contractual arrangement (Jennewein *et al.*, 2010) was an opportunity for Bayer to regain some of the

control and appropriation opportunities.[3] In the wake of the Second World War, Bayer lost the contracts and its appropriability premises again in some countries.[4] Changing ownership arrangements also connected Bayer to Nazis, thereby causing reputational issues (Page, 1992). Besides these issues, the experts in the field and the public have not always responded favourably to the advertising activities of Bayer (for Aspirin and other products), which has caused challenges over time (Jennewein *et al.*, 2010).

However, Bayer managed to tackle the reputation issues through appropriate responses, and it also retrieved its intellectual property; Bayer regained rights to Aspirin in 1994 (Jennewein *et al.*, 2010). Such recovery allowed Bayer to continue its value appropriation from Aspirin. Every year, more than 50 billion tablets of Aspirin are consumed worldwide (Surrell, 2017). Aspirin products have been developed further (e.g., Toleraid Micro-Coating was added to make the tablets easier to swallow), and the usage of Aspirin has expanded to the prevention of blood clots, stroke (Bayer, 2022), and certain cancers (Cuzick *et al.*, 2015), far beyond its original purpose of treating pain and inflammation (Montinari *et al.*, 2019). Overall, both primary and generative appropriability (i.e., appropriability of the future inventions spawned by the existing invention; see Ahuja *et al.*, 2013; Olander *et al.*, 2014; Choi *et al.*, 2021) have been achieved for Aspirin.

Our study indicates that, first, in the case of Aspirin, Bayer has been able to align its appropriability mechanisms (patent, trademark, tacitness/complexity of technological knowledge, and lead-time) and complementary assets (manufacturing, marketing, brand, and reputation), as well as the ways of utilizing these (to exclude others or to bargain with them) with the situational and temporal conditions—admittedly sometimes luckily. The successful alignment has allowed Bayer to extend the benefits from this innovation. Second, the above observations bring up one important notion not well recognized in the existing literature: the complementary assets of the firm entail varied implications. While having the technical know-how accessible seems to have preserved the appropriability potential and allowed it to be realized in this case, (consider, e.g., the leverage of Bayer when the patents were with Sterling), the reputational issues are more complex. Although the brand and reputation have mainly enabled the firm to strengthen appropriation, the public acceptance has not been always self-evident. This aspect is even more strongly present in the Roundup case.

4.2 Roundup: From prosperity to downfall, and searching for remedy

Internal and external collaborations for innovation are significant for Bayer's activity (Dorsch *et al.*, 2014; Vanhaverbeke *et al.*, 2019; Wild, Huwe and Lessl, 2013), and

[3] See Alnuaimi and George (2016) on knowledge retrieval. While the situation for Aspirin is somewhat different from the setting that the authors describe, especially with giving out of the innovation being involuntary rather than deliberate, Bayer benefitted from having held tacit knowledge and relevant skills in the organization. This denotes decoupling of the innovation of itself and the isolating appropriability mechanisms, as well as refers to possibilities to see appropriation as derivative; building on innovation that does not necessarily reside in the firm (at all times). We consider this a relevant insight, even if deeper examination is beyond the scope of this study.

[4] Bayer has mostly held its exclusive rights on the trademark Aspirin, e.g., Germany, Spain, Italy, and most of Latin America over time.

reflecting this, Roundup represents an innovation that was acquired by Bayer. The acquisition of Monsanto, and Roundup as a part of that, was meant to stimulate innovation in agriculture toward doubling the world's food supply by 2050. It made Bayer the single biggest supplier of crop and seed protection chemicals (Kumar, 2019).

Within this setting, the signs that Roundup would become an appropriation success were initially good. The innovation was patented (Mendelson, 1998), and the Roundup trademark (including different forms such as Roundup Ready) was well-known among farmers (Kimpel, 1999). This combination of patents and trademarks generated a notable competitive advantage. In fact, Monsanto had initially built efficient premises against any competition. The firm held the patent not only for Roundup herbicide, but also for the invention of glyphosate-resistant plants (e.g., canola) that were safe from being killed by the herbicide. Bayer had also worked in this field to develop herbicide-resistant seeds (Kilman, 2010), but Monsanto had the lead, as it had bound farmers using Roundup-resistant plants by a licensing agreement that required the use of Roundup instead of generic herbicides (Srinivas, 2006). Monsanto's profile and market position naturally attracted Bayer: the two companies were offering similar products in the area where both of them had strong R&D capabilities, and combining them promised notable opportunities (Kumar, 2019).

Bayer could have benefitted from the strong appropriability premises initiated by Monsanto, except that the appropriability conditions changed. Specifically, a phenomenon that started to affect both Monsanto and Bayer, was an increasing concern about the toxicity of pesticides, including glyphosate. Even Monsanto's aggressive public relations campaign was not enough to remove the concern about the problems of genetically engineered crops (Mendelson, 1998). At the time of the acquisition, this concern led to Bayer having to fight reputation loss (Rebière and Mavoori, 2020), and address the loss of appropriability potential (see Hurmelinna-Laukkanen and Yang, 2022).

At first, the appropriability potential was approached with defensive actions. For some time, the discussion suggested that the problem was not in the key ingredient, the glyphosate, but rather in unlabelled "inert" ingredients in Roundup (Mendelson, 1998). Had this been true, it would have allowed Monsanto—and Bayer—to respond by changing the product through incremental innovation. Still, concerns remained. In fall 2017, after strong lobbying, the EU closed the glyphosate disputes, suggesting that toxicity was not confirmed. However, the public did not settle for this (Rebière and Mavoori, 2020). Heidingsfelder *et al.*'s (2015, p. 291) statement, "public acceptance is vital to innovation", also applies in the Bayer's Roundup case: The feasibility of innovative advances depends on synchronising long-term research trajectories with public preferences (Heidingsfelder *et al.*, 2015). In particular, what rubbed the public the wrong way towards the end of 2017 was public suspicion of food security, related to a lack of transparency in the agrochemical sector caused by reliance on trade secrets (Rebière and Mavoori, 2020) and misleading advertising (Mendelson, 1998).

The insights from the above discussion indicate that under these conditions, secrecy as an appropriability mechanism turned harmful. Likewise, marketing capabilities and brand as complementary assets failed. In fact, they turned out to have adverse effects. To address these issues, Bayer responded to stakeholder distrust by launching a transparency initiative and a public-interest innovation initiative, where it revealed toxicity information but kept the production information secret, thereby finding some balance between transparency and trade secret protection. Likewise, the firm declared abandoning the

Monsanto brand, retaining only the product brand Roundup (Rebière and Mavoori, 2020). However, the appropriation problem is still not solved for the innovation.

4.3 (Dis)continuing appropriation success – Insights from adjusting appropriation strategies for Aspirin and Roundup

There are a lot of aspects of the Aspirin and Bayer cases that potentially explain how appropriation success can be continued (or not). Both innovations show a history of praise and controversy, that has affected the appropriability and appropriation of value from these innovations. Some of the debate is at *the firm level*—generating specific *appropriability conditions* for the individual innovations. For example, Bayer's reputation was stained by the early commercialization of the notorious heroin (Moore, 2014) and its connection to Nazis during times of war (Page, 1992). Likewise, Roundup has been exposed to firm reputation issues. In particular, Monsanto became known for misleading advertising, lobbying, and other controversial actions, and the reputation stuck through the acquisition of the firm by Bayer (Mendelson, 1998; Rebière and Mavoori, 2020). Such conditions forced Bayer to consider its approaches regarding marketing and brand as appropriability premises for its specific innovations. In fact, while Bayer had relied on defensive approaches when repairing its reputation issues during wartime, it had turned to more proactive approaches around the time of Monsanto acquisition (Rebière and Mavoori, 2020); once the acquisition was settled, an adjustment could be started.

Another relevant issue is the *influence of external forces* present in the institutional environment in general, and intellectual property regime as part of that environment, in particular, on building appropriability by isolating appropriability mechanisms. In both cases, the acquisition of patents and ownership of trademark rights has been determined by the international regulatory environment and its variations (Kimpel, 1999; Jennewein, 2005; Srinivas, 2006; Rebière and Mavoori, 2020). At one end of a continuum, these allowed a stronger protective approach (de facto monopoly) and market opportunities, and at the other end, they signified the loss of intellectual property rights. While Roundup has not been lost as such at any point in time (on the contrary—quite strong defences have been put up for any kind of imitation), acquiring the innovation was not straightforward. In this case, Bayer effectively needed to create change in the appropriability conditions (by ensuring officials for the benefits of the Monsanto deal) to be able to capture the innovation (Kumar, 2019; Rebière & Mavoori, 2020).

Importantly, the *changing situations* have been critical for innovation appropriation and the possibilities to continue it over time. As one anticipated, inevitable issue, patent expiration called for attention, and for both innovations, the firm managed to rise to the challenge by relying on other isolating appropriability mechanisms and complementary assets. For Aspirin, more unexpected events were also managed in a way that preserved appropriability; crucial knowledge stayed in the company despite confiscation of (intellectual) property, and the firm managed to maintain the connection to the valuable brand over years (Jennewein *et al.*, 2010). This shows the importance of adjustment and alignment of the selection and uses of appropriability mechanisms to the changing contextual factors.

We further find that the *nature of the innovation and the appropriability premises*—isolating appropriability mechanisms and complementary assets—bear importance for the ability to adjust to the changing conditions. First, while the debates around Aspirin have

been more related to its (limited) suitability and effectiveness for different uses, Roundup has been accused of being harmful. Especially because these innovations are positioned in the field where human health and wellbeing are of central concern, the innovation itself needs to meet certain qualities. One relevant remedy for shortcomings of innovation is reaching out to acquire external knowledge for incremental innovation that enables improving the firm offerings, strengthening the positive features, and fixing the shortcomings (Vanhaverbeke *et al*., 2019). This has been done differently in the case of the two innovations, likely contributing to different appropriation outcomes. Second, and relatedly, whereas in the case of Aspirin, lead-time, tacit knowledge embedded in the organization, and complementary assets such as manufacturing skills and technological know-how supported the continuation of appropriation past patent expiration, for Roundup, the strong patent protection, tight contracting, and trade secret protection combined with aggressive (and inaccurate) marketing led to adverse outcomes. With these kinds of appropriability premises emphasizing individual profiting and benefit of the firm, interaction with the environment expecting a different approach was difficult (see Marullo et al., 2020, pointing toward tight appropriability mechanisms having limitations in interacting with other actors).

Based on our case-study findings discussed above, we develop an (interactive) process model of adjusting appropriation strategy (Figure 2).

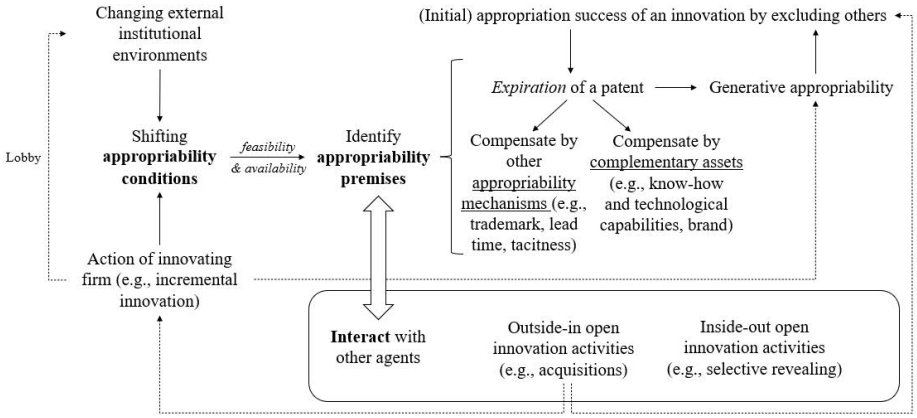

Figure 2 An (interactive) process model of adjusting the appropriation strategy.

This process model introduces a more detailed view of how to continue appropriation success, with attention to shifting appropriability conditions. It suggests how the changes of and in appropriability conditions connect to appropriability premises which are available and useful, and how these are interlinked with other actors in the relevant innovation environment. Importantly, the model suggests that the firm, with its own actions, can affect how it can get past the problematic points, and continue its innovation appropriability through purposeful adjustment and alignment of the varying elements.

5 Conclusions

Our study contributes to existing knowledge by examining appropriability and appropriation through a dynamic lens (e.g., Teece, 1986; Laursen and Salter, 2014; Holgersson *et al.*, 2018; Athreye and Fassio, 2019) and by bringing up the relevance of interactive appropriability (Yang and Hurmelinna-Laukkanen, 2022). We illustrate the role of appropriability conditions in adjusting innovation-specific appropriation strategies as we demonstrate the importance of alignment between the different dimensions that jointly determine appropriability and appropriation of innovation (see Hurmelinna-Laukkanen and Yang, 2022). By addressing these issues, our study contributes to explaining the successes and failures of appropriation strategies across innovations in different contexts and provides preliminary insight into the logic of long-lasting appropriation success.

Our study also provides insight for managers on how to extend and continue appropriation success by adjusting the appropriation approaches according to the changes in the appropriability conditions. While some changes originating from the external environment may be difficult to anticipate or avoid, the focus on the core innovation and building appropriability proactively on that seems to allow for long-lasting appropriation success. In this, it should be noted that the nature of the appropriability premises and their uses often produce beneficial effects but can also lead to adverse outcomes if not matched to the relevant conditions. This capability for focused alignment also seems to be a factor to reckon in successfully transferring the experience and learnings from appropriation approaches within organizations to other innovations.

These aspects can also be seen as relevant areas for future research. Other qualitative studies and quantitative research are encouraged to accumulate more information on the relevant patterns and constituents of this phenomenon. We believe that such patterns can be connected, for example, to business models or internationalization strategies. This study adopts a case study methodology and considers changes such as expiring patents and shifting environments that influenced Bayer's chances to continue appropriation success of two separate innovations. It thus has limitations in generalizing the findings outside of the context (see Di Minin and Bianchi, 2011). The cases in this paper should not be considered as means of validating theory or as descriptions of characteristics of the two innovations. Instead, they represent relevant empirical examples communicating the significance of the role of interactive appropriability in constantly changing contexts, and as a step in the theory-building on this topic. Nevertheless, the developed conceptual framework is useful in analysing varying innovations and has more general applicability. It can also be used by firms to strategize and make plans for long-term success at innovation level. Relatedly, our study also has practical implications for conducting research. Importantly, it suggests that rather than looking into patent databases only, taking a wider view is needed to understand appropriability and appropriation. This study offers one example showing how archival data or reanalyses of earlier cases can be useful in detecting relevant aspects. We hope that this research can become a relevant steppingstone for such research endeavours.

References and Notes

Aguinis, H, RS Ramani and N Alabduljader (2018). What you see is what you get?

Enhancing methodological transparency in management research. *Academy of Management Annals*, 12(1), 83–110.

Ahuja, G, CM Lampert and E Novelli (2013). The second face of appropriability: Generative appropriability and its determinants. *Academy of Management Review*, 38(2), 248–269.

Arrow, KJ (1962). Economic welfare and the allocation of resources for invention. *In*: *The Rate and Direction of Inventive Activity: Economic and Social Factors*, pp. 609–626. Princeton: Princeton University Press.

Athreye, S and C Fassio (2019). Why do innovators not apply for trademarks? The role of information asymmetries and collaborative innovation. *Industry and Innovation*, 27(1-2), 134-154.

Bayer, 2022. History of Bayer [online]. Available from: https://www.bayer.com/en/history.

Bekkers, V and L Tummers (2018). Innovation in the public sector: Towards an open and collaborative approach. *International Review of Administrative Sciences*, 84(2), 209–213.

Bender, R (2019). How Bayer-Monsanto became one of the worst corporate deals-in 12 charts. *The Wall Street Journal*, 28 Aug.

Bunge, J (2020). Business news: Bayer touts herbicide research discovery. *Wall Street Journal*, 14 Feb.

Chaudhary, S, P Kaur, S Talwar, N Islam and A Dhir (2022). Way off the mark? Open innovation failures: Decoding what really matters to chart the future course of action. *Journal of Business Research*, 142, 1010–1025.

Choi, Y, J Barden and G Lee (2021). Standing ground? The influences of knowledge diversity and technology opportunity on generative appropriation. *International Journal of Innovation Management*, 25(7), 2150076.

Cohen, WM, RR Nelson and JP Walsh (2000). Protecting their intellectual assets: Appropriability conditions and why U.S. manufacturing firms patent (or not). *National Bureau of Economic Research Inc*, No. Working Paper 7552.

Cuzick, J, MA Thorat, C Bosetti, PH Brown, J Burn, NR Cook, LG Ford, EJ Jacobs, JA Jankowski, C La Vecchia, M Law, F Meyskens, PM Rothwell, HJ Senn and A Umar (2015). Estimates of benefits and harms of prophylactic use of aspirin in the general population. *Annals of Oncology*, 26(1), 47–57.

Dorsch, H, AE Jurock, S Schoepe, M Lessl and K Asadullah (2014). Grants4Targets: an open innovation initiative to foster drug discovery collaborations. *Nature Reviews Drug Discovery*, 14(1), 74–76.

Eisenhardt, KM (1989). Building theories from case study research. *Academy of Management Review*, 14(4), 532–550.

Fisher, WW and F Oberholzer-Gee (2013). Strategic management of intellectual property: an integrated approach. *California Management Review*, 55(4), 157–183.

Gambardella, A, S Heaton, E Novelli and DJ Teece (2021). Profiting from enabling technologies? *Strategy Science*, 6(1), 75–90.

Glaser, VL, PC Fiss and MT Kennedy, (2016). Making snowflakes like stocks: Stretching, bending, and positioning to make financial market analogies work in online advertising. *Organization Science*, 27(4), 1029–1048.

Heidingsfelder, M, K Kimpel, K Best and M Schraudner (2015). Shaping Future — Adapting design know-how to reorient innovation towards public preferences. *Technological Forecasting and Social Change*, 101, 291–298.

Holgersson, M., O Granstrand and M Bogers (2018). The evolution of intellectual property strategy in innovation ecosystems: Uncovering complementary and substitute appropriability regimes. *Long Range Planning*, 51(2), 303–319.

Hurmelinna-Laukkanen, P (2009). The availability, strength and efficiency of

appropriability mechanisms–protecting investments in knowledge creation. *International Journal of Technology Management*, 45(3–4), 282–290.
Hurmelinna-Laukkanen, P and P Ritala (2012). Appropriability as the driver of internationalization of service-oriented firms. *The Service Industries Journal*, 32(7), 1039–1056.
Hurmelinna-Laukkanen, P. and J Yang (2022). Distinguishing between appropriability and appropriation: A systematic review and a renewed conceptual framing. *Research Policy*, 51(1), 104417.
Jacobides, MG, T Knudsen and M Augier (2006). Benefiting from innovation: Value creation, value appropriation and the role of industry architectures. *Research Policy*, 35(8), 1200–1221.
James, SD, MJ Leiblein and S Lu (2013). How firms capture value from their innovations. *Journal of Management*, 39(5), 1123–1155.
Jennewein, K (2005). *Intellectual Property Management: The Role of Technology-Brands in the appropriation of Technological Innovation*. Mörlenbach: Springer.
Jennewein, K, T Durand and A Gerybadze (2010). When brands complement patents in securing the returns from technological innovation: The case of Bayer Aspirin. *Management International*, 14(3), 73–86.
Kao, PT (2013). *Institutional Change and Foreign Market Entry Behaviour of the Firm: A Longitudinal Study of Three Swedish Firms in China*. Uppsala: Uppsala University.
Kilman, S (2010). Superweed outbreak triggers arms race. *Wall Street Journal*, 4 Jun.
Kim, C, C Lee and J Kang (2018). Determinants of firm's innovation-related external knowledge search strategy: The role of potential absorptive capacity and appropriability regime. *International Journal of Innovation Management*, 22(6), 1850044.
Kimpel, JA (1999). Freedom to operate: Intellectual property protection in plant biology and its implications for the conduct of research. *Annual Review of Phytopathology*, 37, 29–51.
Kumar, BR (2019). Bayer's acquisition of Monsanto. *In*: *Wealth Creation in the World's Largest Mergers and Acquisitions*. pp. 281–287. Cham: Springer.
Langley, A (1999). Strategies for Theorizing from Process Data. *Academy of Management Review*, 24 (4), 691–710.
Langley, A, C Smallman, H Tsoukas and AH Van de Ven (2013). Process studies of change in organization and management: Unveiling temporality, activity, and flow. *Academy of Management Journal*, 56(1), 1–13.
Laursen, K and AJ Salter (2014). The paradox of openness: Appropriability, external search and collaboration. *Research Policy*, 43(5), 867–878.
Lichterman, BL (2004). Aspirin: The story of a wonder drug. *BMJ*, 329(7479), 1408.
Mann, CC and ML Plummer (1991). *The Aspirin Wars: Money, Medicine and 100 Years of Rampant Competition*. New York: Knopp.
Marullo, C, A Di Minin, C De Marco and A Piccaluga (2020). Is open innovation always the best for SMEs? An exploratory analysis at the project level. *Creativity and Innovation Management*, 29(2), 209–223.
Mehta, A., 2005. Aspirin. *Chemical & Engineering News*. Available from: https://pubsapp.acs.org/cen/coverstory/83/8325/8325aspirin.html.
Mendelson, J (1998). Roundup: the world's biggest-selling herbicide. *Ecologist*, 28(5), 254.
Di Minin, A and M Bianchi (2011). Safe nests in global nets: Internationalization and appropriability of R&D in wireless telecom. *Journal of International Business Studies*, 42(7), 910–934.
Di Minin, A and D Faems (2013). Building appropriation advantage: An introduction to

the special issue on intellectual property management. *California Management Review*, 55(4), 7–14.

Moher, D, A Liberati, J Tetzlaff, DG Altman and PRISMA Group (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS medicine*, 6(7), e1000097.

Montinari, MR, S Minelli and R De Caterina (2019). The first 3500 years of aspirin history from its roots - A concise summary. *Vascular pharmacology*, 113, 1–8.

Moore, D (2014). Heroin: A brief history of unintended consequences. *Times Union*, 24 Aug.

Olander, H, P Hurmelinna-Laukkanen and M Vanhala (2014). Mission: Possible but sensitive -Knowledge protection mechanisms serving different purposes. *International Journal of Innovation Management*, 18(6), 1440012.

Page, J (1992). Book review: The Aspirin Wars: Money, Medicine, and 100 Years of Rampant Competition by Charles C. Mann and Mark Plummer. *Food and Drug Law Journal*, 47(4), 459–481.

Rebière, P and H Mavoori (2020). The Bayer–Monsanto fusion: countering brand tarnishing and rebuilding reputation. *Journal of Business Strategy*, 41(1), 27–37.

Ritsos-Kokkinis, G (2020). *Case Study: The Bayer-Monsanto Acquisition Deal*. Tilburg: Tilburg University.

Rooney, SM and JN Campbell (2017). How aspirin entered our medicine cabinet. Cham: Springer.

Saviotti, PP (1998). On the dynamics of appropriability, of tacit and of codified knowledge. *Research Policy*, 26(7–8), 843–856.

Srinivas, KR (2006). Intellectual property rights and bio commons: Open source and beyond. *International Social Science Journal*, 58(188), 319–334.

Surrell, J (2017). Aspirin 101: Drug facts, history. *The Mining Journal*, 17 Oct.

Teece, DJ (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy*, 15(6), 285–305.

Teece, DJ (1988). Capturing value from technological innovation: Integration, strategic partnering, and licensing decisions. *Interfaces*, 18(3), 46–61.

Teece, DJ (2018). Profiting from innovation in the digital economy: Enabling technologies, standards, and licensing models in the wireless world. *Research Policy*, 47(8), 1367–1387.

Vanhaverbeke, W, N Roijakkers, D Cobben and M Lessl (2019). Reinventing Open innovation in large pharmaceutical companies: The case of Bayer AG. *In*: *Proceedings of the 6th Annual World Open Innovation Conference*. Berkeley and Rome: Garwood Center for Corporate Innovation and LUISS University.

Walker, J, P Hutchison, J Ge, D Zhao, Y Wang, PM Rothwell, JM Gaziano, A Chan, J Burn, J Chia, R Langley, V O'Donnell, B Rocca and C Hawkey (2018). Aspirin: 120 years of innovation. A report from the 2017 Scientific Conference of the International Aspirin Foundation, 14 September 2017, Charité, Berlin. *Ecancermedicalscience*, 12.

Waltz, E (2016). Bayer bids $66 billion for Monsanto. *Nature Biotechnology*, 34(10), 1003–1003.

Wild, H, C Huwe and M Lessl (2013). "Collaborative Innovation" – Wie bringt man die Arzneimittelentwicklung zurück auf die Erfolgsspur? *Angewandte Chemie*, 125(10), 2748–2751.

Winter, SG (2006). The logic of appropriability: From Schumpeter to Arrow to Teece. *Research Policy*, 35(8), 1100–1106.

Wohlin, C (2014). Guidelines for Wohlin, C and Claes (2014) 'Guidelines for snowballing in systematic literature studies and a replication in software engineering', in Proceedings of the 18th International Conference on Evaluation

and Assessment in Software Engineering. *In*: *Proceedings of the 18th International Conference on Evaluation and Assessment in Software Engineering - EASE '14*. New York: ACM Press, 1–10.

Yang, J, H Chesbrough and P Hurmelinna-Laukkanen (2021). How to appropriate value from general-purpose technology by applying open innovation. *California Management Review*, 00081256211041787.

Yang, J and P Hurmelinna-Laukkanen (2022). Benefiting from innovation – Playing the appropriability cards. *In*: *Innovation* R. Agarwal, E. Patterson, S. Pugalia, R. Green (Eds). Chapter 15, London: Routledge, 310–331.

Yin, R (2014). *Case study research: Design and methods.* 5th ed. Thousand Oaks, CA: Sage Publications.