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R&D Alliances and Open Innovation: Review and Opportunities

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14. R&D Alliances and Open Innovation: Review and Opportunities

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Abstract and Keywords

Abstract: This chapter takes stock of the empirical literature on research and development (R&D) alliances, one among other open-innovation (OI) practices, and identifies opportunities to bring the traditions of research on R&D alliances and OI into closer alignment. Through a structured literature review, it finds a wealth of research on the antecedents and consequences of R&D alliances and their characteristics, and almost half the sampled articles study R&D alliances alongside other OI practices. The chapter establishes that the core of the R&D alliance literature is rich and fairly balanced. Yet, it also argues that productive opportunities exist for more comprehensively examining the interdependencies between R&D alliances and other OI practices in their effects on performance.

Keywords: R&D alliance, open innovation, interdependence, performance, structured literature review

Introduction

One among other open-innovation (OI) practices, research and development (R&D) alliances have become progressively more prevalent over time, and the phenomenon of R&D alliances has spawned an impressive body of empirical research (Frankort & Hagedoorn, 2019). Yet while several thorough reviews exist of OI research broadly (e.g., Dahlander & Gann, 2010; Randhawa, Wilden, & Hohberger, 2016; West & Bogers, 2014), integrative insight is lacking regarding core themes and subthemes in the literature on the specific OI practice of R&D alliances, and how scholars have divided their attention across those themes. Also, little is known about the extent to which, and how, studies of R&D alliances have considered other OI practices. Answering these questions is vital to establish the state of the R&D alliance literature, and to identify ways to bring the traditions of research on R&D alliances and OI into closer alignment.

We first position R&D alliances as an OI practice and then take stock of existing empirical research on R&D alliances. Through a structured literature review, we discuss as two core themes the antecedents and consequences of R&D alliances and their characteristics. A third

theme, which fully intersects with the two core themes, concerns studies of R&D alliances alongside other OI practices. The review serves as a springboard for outlining some opportunities for more comprehensively examining the interdependencies between R&D alliances and other OI practices in their effects on performance.

R&D Alliances as an OI Practice

Consistent with prevailing literature (e.g., Ahuja, 2000a; Hagedoorn, 1993; Oxley & Sampson, 2004; Schilling, 2015; Stuart, 1998), by R&D alliances we mean formal agreements between firms that contain arrangements for (joint) R&D. Thus, R&D alliances at once imply a specific legal basis (a contract), objective (R&D), and type of partner (firms).

R&D alliances represent a practice subsumed by accepted definitions of OI. Consider Chesbrough (2006: 1): “Open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively.” More recently, he noted that OI “basically means that innovation is generated by accessing, harnessing, and absorbing flows of knowledge across the boundary of the firm, either flowing in or going out” (Chesbrough, 2020: 30). Knowledge flows are central objectives in R&D alliances, and much evidence links such alliances to knowledge flows and partners’ innovative performance (see Frankort, 2016). Elsewhere, West (2014: 2-3) discusses how “innovation alliances,” of which R&D alliances are a proper subset, also meet the OI definition by Chesbrough and Bogers (2014: 27). In short, R&D alliances unequivocally meet received definitions of OI.

OI through R&D alliances is a ‘coupled’ mode of OI that combines ‘inbound’ and ‘outbound’ modes (West, 2014). Knowledge inflows and outflows can occur that connect the innovation efforts of the partner firms, and partners can also co-create innovations. Knowledge

flows in R&D alliances may or may not be restricted (e.g., by contract), and they can be pecuniary (e.g., through licensing) or nonpecuniary (Dahlander & Gann, 2010). Clearly, not all OI involves R&D alliances. R&D alliances constitute just one among other possible practices through which firms can engage in OI (e.g., Chesbrough & Brunswicker, 2014).

Methodology and Sample

To examine available empirical research on R&D alliances, we began with twelve leading journals spanning management (*Academy of Management Journal*, *Administrative Science Quarterly*, *Journal of Management*, *Journal of Management Studies*, *Management Science*, *Organization Science*, *Strategic Management Journal*), innovation (*Industrial and Corporate Change*, *Journal of Product Innovation Management*, *Research Policy*), and entrepreneurship (*Journal of Business Venturing*, *Strategic Entrepreneurship Journal*). In the spirit of Ryan-Charleton, Gnyawali, and Oliveira (2022), we used Scopus to identify articles in these journals until 2021 inclusive that contained at least one alliance-related word (alliance, collaborat*, contractual agreement, cooperat*, joint venture, partner*) and one innovation-related word (innovat*, inventi*, knowledge transfer, knowledge flow, new product, R&D, technolog*) in their title, abstract, and/or keywords.

After removing duplicates and one retracted article, our search generated 1,472 articles. We read all abstracts, examined a subset of 441 full articles, and retained the 240 articles offering empirical studies of R&D alliances. We excluded articles in which the meaning of collaboration was ambiguous, and ones exclusively focusing on informal ties, collaborations with other actors (e.g., universities), joint patenting, licensing, and/or supply-chain agreements. Finally, we cross-checked our selection against a list of roughly 40 scholars we expected to be represented. This

supplied 13 other relevant articles. The final sample contains 253 articles published in the twelve journals from 1990 to 2021.²

For each article, we coded dependent and independent variables, and whether and how it covers other OI practices, meaning other kinds of externally focused activities (e.g., acquisitions, licensing, propinquity/informal networking), or collaborations with organizations other than alliance partners (e.g., laboratories, public research organizations, universities). We also coded mentions of the words “open innovation.”

By four-year period, Figure 14.1 shows the total number of articles, the number of articles covering multiple OI practices, and the number of articles mentioning “open innovation.” First, scholarly interest in R&D alliances increased over time and the number of articles has averaged around 11 annually since 2006. About half the articles were published in just two of the twelve journals: *Research Policy* (N = 71) and the *Strategic Management Journal* (N = 52). Second, almost half the articles cover at least one OI practice beyond R&D alliances, and such broader coverage occurred since 1990. Third, “open innovation” first appears in Laursen and Salter (2006), soon following Chesbrough (2003). Since 2014, the term has appeared in over 35% of the articles. Almost 65% of the 44 articles referencing “open innovation” appeared in *Research Policy* (N = 17) and the *Journal of Product Innovation Management* (N = 11). Interestingly, four in five articles mentioning “open innovation” cover multiple OI practices, versus two in five among the others.

<Insert Figure 14.1 near here>

Review: Three Major Themes

Figure 14.2 shows the organizing framework that structures our review, with at its basis the two core themes of antecedents and consequences of R&D alliances and their characteristics. A

third theme concerns the study of R&D alliances alongside other OI practices. Figure 14.3 shows a Venn diagram counting numbers of articles across themes. Similar proportions of articles in Themes (1) and (2) intersect with Theme (3), and Theme (3) fully intersects with Themes (1) and (2). Some articles overlap between Themes (1) and (2) (e.g., Hagedoorn & Schakenraad, 1994) or across all themes (e.g., Powell, Koput, & Smith-Doerr, 1996). In the three subsections that follow, we consider each major theme in turn. While we aim for the review to be exhaustive in capturing the literature, we inevitably can only draw selected examples from the 253 articles.

<Insert Figures 14.2 and 14.3 near here>

(1) Antecedents → R&D Alliances

The first major theme in the literature (N = 116 articles) centers on why R&D alliances are formed (N = 71), and why the formed alliances—individually or collectively—have the characteristics that they do (N = 52). Antecedents are typically one or multiple factors at or across the macro, firm, and dyad levels.

Articles in a first subtheme ask, *why are R&D alliances formed?* Using different antecedents, such articles mostly imply that alliances form through greater awareness of potential partners, and where information asymmetries are smaller and anticipated learning benefits greater. At the macro level, articles trace alliance formation to factors like an industry's R&D intensity (Hagedoorn, 1993) or the stage of the industry life cycle (Hipp, 2021). At the firm level, scholars connect alliance formations to antecedents like a firm's absorptive capacity (Estrada, De La Fuente, & Martín-Cruz, 2010); the scale and characteristics of its resource base (Ahuja, 2000b; Stuart, 1998); the connections, experience, reputation, and status of the firm's founders (Stern, Dukerich, & Zajac, 2014), scientists (Luo, Koput, & Powell, 2009), and top management team (Li, 2013); its product development stage (Banerjee & Siebert, 2017); or recent

performance (Tyler & Caner, 2016). At the dyad level, alliance formation has been attributed to antecedents like geographic proximity (Reuer & Lahiri, 2014), similarity of knowledge bases (Rothaermel & Boeker, 2008), or embeddedness in ties to common third parties (Reuer & Devarakonda, 2017).

Articles in a second subtheme ask, *why do formed R&D alliances—individually or collectively—have the characteristics that they do?* Substantively, most articles focus on understanding what the alliance activities are, who the partners are, and how alliances are organized. For example, articles commonly predict the governance choice, scope of activities, task interdependence, or contractual clauses in an alliance (Lioukas & Reuer, 2020; Oxley & Sampson, 2004; Ryall & Sampson, 2009; Ryu, McCann, & Reuer, 2018); or the kinds of partners and resources involved in a firm's (portfolio of) alliances (Asgari, Singh, & Mitchell, 2017; Kavusan & Frankort, 2019; Palomeras & Wehrheim, 2021). Collectively, such articles suggest that the need for cooperation and coordination, and/or the search for synergies, frequently determine R&D alliance characteristics. Tangential to the firm- and dyad-level foci in the OI literature, some others ask how characteristics of whole alliance networks differ across industries (Rosenkopf & Schilling, 2007) and over time (Gilsing, Cloudt, & Roijakkers, 2016), on the idea that macrostructure can shape innovation (Schilling & Phelps, 2007).

Several articles under either subtheme treat R&D alliances as antecedent *and* consequence, either because prior alliances and their characteristics influence the formation and characteristics of new alliances (Belderbos, Gilsing, & Lokshin, 2012; Lee, Hoetker, & Qualls, 2015), or because focal alliance characteristics condition one another (Li et al., 2008; Oxley & Sampson, 2004). Overall, Theme (1) is critical to understand how alliances and their characteristics emerge, yet it remains silent on their consequences, a question addressed under Theme (2).

(2) R&D Alliances → Consequences

The second major theme, and the largest body of work (N = 149, or 59%), focuses on the consequences of R&D alliances at the dyad or firm levels. Some such articles study attitudinal or behavioral consequences (N = 13), yet most study performance consequences (N = 136). As noted, however, the formation and characteristics of new R&D alliances may depend on prior alliances. Thus, behavioral consequences have received some broader attention.

A first subtheme, on *attitudinal and behavioral consequences*, uncovers some possible transmission channels through which R&D alliances influence performance. It focuses on such dyadic outcomes as whether partners cospecialize their technological activities (Kavusan, Noorderhaven, & Duysters, 2016), levels of trust and conflict in an alliance (Davis, 2016), or competitive aggressiveness towards a partner (Cui, Yang, & Vertinsky, 2018). At the firm level, it examines outcomes such as R&D intensity (Colombo & Garrone, 1996), the establishment of internal collaborations among a firm's scientists (Howard et al., 2016), or the speed with which corporate projects transfer results to business units (Du et al., 2014).

A second subtheme focuses directly on *performance consequences*. Some articles connect R&D alliances and their characteristics to outcomes like project progression, malfunctioning, completion, or termination (Choi, 2020; Hoang & Rothaermel, 2005, 2010; Lokshin, Hagedoorn, & Letterie, 2011). More frequently, and central to prevailing OI research, articles link R&D alliances to interfirm knowledge flows (Devarakonda & Reuer, 2018; Frankort, Hagedoorn, & Letterie, 2012; Lane & Lubatkin, 1998; Mowery, Oxley, & Silverman, 1996; Oxley & Wada, 2009); to the number, diversity, and radicalness of technological innovations (Ahuja, 2000a; Balachandran & Hernandez, 2018; Hohberger, Kruger, & Almeida, 2020; Nooteboom et al., 2007; Phelps, 2010; Schilling, 2015); to the development, approval, launch, or success of new

products (Deeds & Hill, 1996; Laursen & Salter, 2006; Soh, 2003; Talay, Seggie, & Cavusgil, 2009; Wuyts & Dutta, 2014); and to the degree to which knowledge inflows enable new product development (Frankort, 2016). Collectively, this large evidence base implies that R&D alliances predict knowledge flows and innovation, and more so when alliance characteristics enable requisite cooperation, coordination, and/or resource synergies.

Various articles link R&D alliances to financial performance, sometimes as a second-order consequence of knowledge flows and/or innovation (Belderbos, Carree, & Lokshin, 2004; Hagedoorn & Schakenraad, 1994; Powell et al., 1996). Yet many other such studies are less central to the domain of OI research, for example, when the proposed primary role of R&D alliances is not to stimulate knowledge flows and innovation so much as to resolve information asymmetries (Stuart, Hoang, & Hybels, 1999) or manage competitive intensity (Oxley, Sampson, & Silverman, 2009; Silverman & Baum, 2002).

(3) R&D Alliances and Other OI Practices

The third major theme, which is reflected in some form in almost half the articles (N = 119), concerns the analysis of R&D alliances alongside at least one other OI practice. A first subtheme, covering the overwhelming majority among these articles (N = 91, or 76%), explicitly or implicitly treats R&D alliances and other OI practices *as separate choices with independent effects* on performance. In the margin, such effects may be different or, by assumption, identical. Indeed, one typical such kind of study models performance as an additive function of numbers of R&D alliances and one or multiple other OI practices, so that marginal effects can differ across practices (Al-Laham, Tzabbar, & Amburgey, 2011; Baum, Calabrese, & Silverman, 2000; Haeussler, Patzelt, & Zahra, 2012; Hohberger, Almeida, & Parada, 2015). For example, Baum et

al. (2000) show how R&D alliances can have performance effects distinct from alliances with universities, government labs, or research institutes, among others.

On the assumption that the number of OI practices matters more than their distinctions, another typical such kind of study instead models performance as a function of *composite* measures of OI practices (Laursen & Salter, 2006; Powell et al., 1996; Tsinopoulos, Yan, & Sousa, 2019; van de Vrande, 2013). This approach is distinct by essentially constraining to identity the marginal performance contributions of different practices. For example, Laursen and Salter (2006) show how a firm's number of formal external knowledge links can influence innovation performance, irrespective of which specific types of organizations (e.g., firms, consultants, labs, universities) the firm's collaboration portfolio comprises.³

A smaller number of articles (N = 28) instead treat R&D alliances and other OI practices as related, though in two distinct ways. On the one hand, a second subtheme (N = 10) treats the practices *as alternative choices*—i.e., as mutually exclusive ways to govern an R&D transaction, so that choosing one precludes choosing another. For example, such articles pit the choice of an alliance against an acquisition (Vanhaverbeke, Duysters, & Noorderhaven, 2002), or a non-equity alliance against CVC investment, a minority holding, a joint venture, or an M&A (van de Vrande, Vanhaverbeke, & Duysters, 2009). All such articles portray OI practices as alternatives—similar to the choice between non-equity and equity-based R&D alliances (e.g., Oxley & Sampson, 2004). Though none examine performance implications, rich theory and an empirical base exist on the implications of governance choice within the domain of R&D alliances (e.g., Devarakonda & Reuer, 2018; Sampson, 2007).

On the other hand, however, a third and final subtheme (N = 20) conceptualizes and models R&D alliances and other OI practices *as interdependent choices*, on the idea that different

practices can interact to complement or substitute one another. Complementarities may exist where engagement in one OI practice, contemporaneously or subsequently, enhances the marginal value of the outputs of another OI practice. For example, Stuart, Ozdemir, and Ding (2007) argue that the larger and better stock of intellectual property of biotech firms maintaining more upstream agreements with universities leads such firms to enter more downstream R&D alliances with pharma firms. Complementarities may also exist where one OI practice helps a firm identify and pursue productive opportunities for engaging in another OI practice. For example, Wagner and Goossen (2018) show that hiring R&D scientists from a competitor may increase the likelihood that a firm subsequently forms an R&D alliance with that competitor. In contrast, substitution may occur when one OI practice draws away resources elsewhere, or when different practices are equifinal, so that the existence of one eliminates the need for another (e.g., Belderbos, Jacob, & Lokshin, 2018).

Empirically, most articles under this final subtheme examine whether the existence of one OI practice is associated with a greater or lesser likelihood that another will also exist or come into being (Hsu, 2006; Ozmel, Reuer, & Gulati, 2013; Stuart et al., 2007; Wagner & Goossen, 2018). In such studies, scholars assume that firms tend towards choices that are in the interest of performance. Thus, they infer the nature of interdependencies among practices from revealed preferences—specifically, from a positive or negative correlation between practices. Only a handful of articles directly examine interactions between R&D alliances and other OI practices in their effects on performance (Belderbos et al., 2018; Schmiedeberg, 2008; Whittington, Owen-Smith, & Powell, 2009). Yet only such studies of performance consequences permit direct inferences regarding the nature of the interdependencies among OI practices.

Synthesis and Opportunities

Table 14.1 synthesizes our review. The core of the R&D alliance literature—Themes (1) and (2)—is rich and fairly balanced, by dividing its attention between the two themes. Theme (3)—on R&D alliances and other OI practices—also features in almost half the sample, though it largely treats R&D alliances and other OI practices as separate choices with independent effects. That most studies do not consider relations across practices does not mean such relations do not exist, or that knowledge of their presence or absence is superfluous. Moreover, where the literature does treat R&D alliances and other OI practices as related, the focus has overwhelmingly been on firms’ decisions rather than the performance consequences of such decisions.

<Insert Table 14.1 near here>

Overall, our structured review implies that the R&D alliance literature has yet to convincingly translate its longstanding focus on other OI practices (Figure 14.1) into *practical* and *systematic* insights regarding interdependencies with such various practices. We believe herein lie the greatest opportunities for bringing the traditions of research on R&D alliances and OI further into alignment. Specifically, we propose the need for a greater focus on the productive and counterproductive interdependencies between R&D alliances and other OI practices. Consider a few examples: Are firms with ties to universities and research institutes (e.g., through an innovation center), or ones that engage in crowdsourcing or outsourcing to contract R&D providers, more effective at leveraging the fruits of their R&D alliances? Do professional communities or industry events permit firms to find more suitable R&D alliance partners? Or would such forums stand in the way of a more objective appraisal of potential partnering alternatives? Are spinoffs particularly (in)effective in firms with or without prior R&D alliances

in the spawn's knowledge domain? And when would R&D alliances with spawns be more or less effective than such alliances with other firms? Given available data and the econometric methods in use among R&D alliance and OI scholars, we believe pursuing an agenda along questions such as these is eminently doable.

What are the necessary ingredients for the pursuit of this agenda? First, if the research is to *inform practice*, then it must treat interactions between R&D alliances and other OI practices as independent variables, and performance consequences as the dependent variables, as in articles like Belderbos et al. (2018) and Whittington et al. (2009). Of course, studies of the choices that firms make remain critical and are fundamental for establishing how (coalitions of) decision makers think. Yet only studies of subsequent outcomes can help establish normative rules and generate practical advice regarding how they *should* think.

Second, if the research is to be *systematic*, then it should examine all plausible interactions between (kinds of) R&D alliances and other OI practices. The above examples of questions merely scratch the surface. A systematic approach requires a clear definition of OI, and of particular importance would be a taxonomy of the kinds of external relations and kinds of external sources and/or targets that would constitute an OI practice. Much as we began by defining what is an R&D alliance, the OI literature can benefit from clear and shared definitions, and we are encouraged to witness ongoing initiatives to this end (AUTHOR/S, CHAPTER#/s). Even at the intersection of closely related literatures, building a cumulative evidence base is possible only with sharp conceptual distinctions, and clear boundaries between the relevant and irrelevant.

What will be the value of pursuing a more systematic research agenda focused on productive and counterproductive interdependencies between R&D alliances and other OI practices? First, it

will enrich the R&D alliance literature by helping demarcate precise, and possibly novel, boundary conditions on the productive contributions and optimal design of R&D alliances in the innovation process. Establishing such boundary conditions is necessary to inform practice regarding when R&D alliances would add value and, critically, when they might not. Moreover, some OI practices may not (always) interact with R&D alliances and any such instances are themselves worth documenting.

Second, pursuit of such an agenda will contribute to the OI literature by clarifying the specific role of R&D alliances as one among multiple OI activities in the firm's business model. The latter is an area of longstanding interest in the OI literature (e.g., Chesbrough, 2003; West & Bogers, 2017). Specifically, it will expand insight into when and how R&D alliances are interdependent with which other OI practices, and when these interactions imply complementarity or substitution. Through the lens of business models as systems of interdependent activities (e.g., Zott & Amit, 2010), a greater understanding of interdependencies among OI practices can help firms design better business models. It can guide their decisions regarding in which practices to engage, and which ones to connect or separate.

Conclusion

We documented a rich literature on the OI practice of R&D alliances. It is fairly balanced between the antecedents and consequences of alliances and their characteristics. Yet though almost half the articles also consider other OI practices, important questions remain regarding possible interdependencies between R&D alliances and such other practices in their effects on performance. Various productive opportunities to examine such interdependencies deserve scholarly attention.

Notes

¹ We thank Jean-Pascal Gond for advice on our review methodology. We also thank Joel West, an anonymous reviewer, and participants in the Berkeley Open Innovation Seminar for critical questions and suggestions.

² A complete list of all 253 articles is available from the authors.

³ Under this subtheme, studies of relationship *formation* (rather than performance) can also be categorized by whether they use separate (e.g., Kapoor & McGrath, 2014) or composite (e.g., Laursen & Salter, 2014) indicators to measure multiple OI practices.

References

- Ahuja, Gautam (2000a). Collaboration networks, structural holes, and innovation: A longitudinal study. *Administrative Science Quarterly*, 45(3), 425-455. <http://doi.org/10.2307/2667105>
- Ahuja, Gautam (2000b). The duality of collaboration: Inducements and opportunities in the formation of interfirm linkages. *Strategic Management Journal*, 21(3), 317-343. [http://doi.org/10.1002/\(SICI\)1097-0266\(200003\)21:3<317::AID-SMJ90>3.0.CO;2-B](http://doi.org/10.1002/(SICI)1097-0266(200003)21:3<317::AID-SMJ90>3.0.CO;2-B)
- Al-Laham, Andreas, Tzabbar, Daniel, & Amburgey, Terry L. (2011). The dynamics of knowledge stocks and knowledge flows: Innovation consequences of recruitment and collaboration in biotech. *Industrial and Corporate Change*, 20(2), 555-583. <http://doi.org/10.1093/icc/dtr001>
- Asgari, Navid, Singh, Kulwant, & Mitchell, Will (2017). Alliance portfolio reconfiguration following a technological discontinuity. *Strategic Management Journal*, 38(5), 1062-1081. <http://doi.org/10.1002/smj.2554>
- Balachandran, Sarath, & Hernandez, Exequiel (2018). Networks and innovation: Accounting for structural and institutional sources of recombination in brokerage triads. *Organization Science*, 29(1), 80-99. <http://doi.org/10.1287/orsc.2017.1165>
- Banerjee, Tannista, & Siebert, Ralph (2017). Dynamic impact of uncertainty on R&D cooperation formation and research performance: Evidence from the bio-pharmaceutical industry. *Research Policy*, 46(7), 1255-1271. <http://doi.org/10.1016/j.respol.2017.05.009>
- Baum, Joel A. C., Calabrese, Tony, & Silverman, Brian S. (2000). Don't go it alone: Alliance network composition and startups' performance in Canadian biotechnology. *Strategic Management Journal*, 21(3), 267-294. [http://doi.org/10.1002/\(SICI\)1097-0266\(200003\)21:3<267::AID-SMJ89>3.0.CO;2-8](http://doi.org/10.1002/(SICI)1097-0266(200003)21:3<267::AID-SMJ89>3.0.CO;2-8)
- Belderbos, René, Carree, Martin, & Lokshin, Boris (2004). Cooperative R&D and firm performance. *Research Policy*, 33(10), 1477-1492. <http://doi.org/10.1016/j.respol.2004.07.003>
- Belderbos, René, Gilsing, Victor, & Lokshin, Boris (2012). Persistence of, and interrelation between, horizontal and vertical technology alliances. *Journal of Management*, 38(6), 1812-1834. <http://doi.org/10.1177/0149206310386962>
- Belderbos, René, Jacob, Jojo, & Lokshin, Boris (2018). Corporate venture capital (CVC) investments and technological performance: Geographic diversity and the interplay with technology alliances. *Journal of Business Venturing*, 33(1), 20-34. <http://doi.org/10.1016/j.jbusvent.2017.10.003>
- Chesbrough, Henry (2003). *Open innovation: The new imperative for creating and profiting from technology*. Harvard Business School Press.
- Chesbrough, Henry (2020). *Open innovation results: Going beyond the hype and getting down to business*. Oxford University Press.
- Chesbrough, Henry, & Bogers, Marcel (2014). Explicating open innovation: Clarifying an emerging paradigm for understanding innovation. *New Frontiers in Open Innovation*. Oxford University Press, 3-28. <https://doi.org/10.1093/acprof:oso/9780199682461.003.0001>
- Chesbrough, Henry, & Brunswicker, Sabine (2014). A fad or a phenomenon? The adoption of open innovation practices in large firms. *Research-Technology Management*, 57(2), 16-25. <http://doi.org/10.5437/08956308X5702196>
- Choi, Jeonghoo (2020). Mitigating the challenges of partner knowledge diversity while enhancing research & development (R&D) alliance performance: The role of alliance governance mechanisms. *Journal of Product Innovation Management*, 37(1), 26-47. <http://doi.org/10.1111/jpim.12505>

- Colombo, Massimo G., & Garrone, Paola (1996). Technological cooperative agreements and firm's R&D intensity. A note on causality relations. *Research Policy*, 25(6), 923-932. [http://doi.org/10.1016/0048-7333\(96\)00883-9](http://doi.org/10.1016/0048-7333(96)00883-9)
- Cui, Victor, Yang, Haibin, & Vertinsky, Ilan (2018). Attacking your partners: Strategic alliances and competition between partners in product markets. *Strategic Management Journal*, 39(12), 3116-3139. <http://doi.org/10.1002/smj.2746>
- Dahlander, Linus, & Gann, David M. (2010). How open is innovation? *Research Policy*, 39(6), 699-709. <https://doi.org/10.1016/j.respol.2010.01.013>
- Davis, Jason P. (2016). The group dynamics of interorganizational relationships: Collaborating with multiple partners in innovation ecosystems. *Administrative Science Quarterly*, 61(4), 621-661. <http://doi.org/10.1177/0001839216649350>
- Deeds, David L., & Hill, Charles W. L. (1996). Strategic alliances and the rate of new product development: An empirical study of entrepreneurial biotechnology firms. *Journal of Business Venturing*, 11(1), 41-55. [http://doi.org/10.1016/0883-9026\(95\)00087-9](http://doi.org/10.1016/0883-9026(95)00087-9)
- Devarakonda, Shivaram V., & Reuer, Jeffrey J. (2018). Knowledge sharing and safeguarding in R&D collaborations: The role of steering committees in biotechnology alliances. *Strategic Management Journal*, 39(7), 1912-1934. <http://doi.org/10.1002/smj.2898>
- Du, Jingshu, Leten, Bart, Vanhaverbeke, Wim, & Lopez-Vega, Henry (2014). When research meets development: Antecedents and implications of transfer speed. *Journal of Product Innovation Management*, 31(6), 1181-1198. <http://doi.org/10.1111/jpim.12249>
- Estrada, Isabel, De La Fuente, Gabriel, & Martín-Cruz, Natalia (2010). Technological joint venture formation under the real options approach. *Research Policy*, 39(9), 1185-1197. <http://doi.org/10.1016/j.respol.2010.05.015>
- Frankort, Hans T. W. (2016). When does knowledge acquisition in R&D alliances increase new product development? The moderating roles of technological relatedness and product-market competition. *Research Policy*, 45(1), 291-302. <http://doi.org/10.1016/j.respol.2015.10.007>
- Frankort, Hans T. W., & Hagedoorn, John (2019). Characteristics of innovation-driven interfirm alliances, 1957–2006: Analysis and research directions. *Frontiers of Strategic Alliance Research: Negotiating, Structuring and Governing Partnerships*. Cambridge University Press, 370-389. <http://doi.org/10.1017/9781108236188.023>
- Frankort, Hans T. W., Hagedoorn, John, & Letterie, Wilko (2012). R&D partnership portfolios and the inflow of technological knowledge. *Industrial and Corporate Change*, 21(2), 507-537. <http://doi.org/10.1093/icc/dtr045>
- Gilsing, Victor, Cloudt, Myriam, & Roijakkers, Nadine (2016). From birth through transition to maturation: The evolution of technology-based alliance networks. *Journal of Product Innovation Management*, 33(2), 181-200. <http://doi.org/10.1111/jpim.12289>
- Haeussler, Carolin, Patzelt, Holger, & Zahra, Shaker A. (2012). Strategic alliances and product development in high technology new firms: The moderating effect of technological capabilities. *Journal of Business Venturing*, 27(2), 217-233. <http://doi.org/10.1016/j.jbusvent.2010.10.002>
- Hagedoorn, John (1993). Understanding the rationale of strategic technology partnering: Interorganizational modes of cooperation and sectoral differences. *Strategic Management Journal*, 14(5), 371-385. <http://doi.org/10.1002/smj.4250140505>
- Hagedoorn, John, & Schakenraad, Jos (1994). The effect of strategic technology alliances on company performance. *Strategic Management Journal*, 15(4), 291-309. <http://doi.org/10.1002/smj.4250150404>

- Hipp, Ann (2021). R&D collaborations along the industry life cycle: The case of German photovoltaics manufacturer. *Industrial and Corporate Change*, 30(3), 564-586. <http://doi.org/10.1093/icc/dtaa054>
- Hoang, Ha, & Rothaermel, Frank T. (2005). The effect of general and partner-specific alliance experience on joint R&D project performance. *Academy of Management Journal*, 48(2), 332-345. <http://doi.org/10.5465/AMJ.2005.16928417>
- Hoang, Ha, & Rothaermel, Frank T. (2010). Leveraging internal and external experience: Exploration, exploitation, and R&D project performance. *Strategic Management Journal*, 31(7), 734-758. <http://doi.org/10.1002/smj.834>
- Hohberger, Jan, Almeida, Paul, & Parada, Pedro (2015). The direction of firm innovation: The contrasting roles of strategic alliances and individual scientific collaborations. *Research Policy*, 44(8), 1473-1487. <http://doi.org/10.1016/j.respol.2015.04.009>
- Hohberger, Jan, Kruger, Heidi, & Almeida, Paul (2020). Does separation hurt? The impact of premature termination of R&D alliances on knowledge acquisition and innovation. *Research Policy*, 49(6), 103944. <http://doi.org/10.1016/j.respol.2020.103944>
- Howard, Michael, Steensma, H. Kevin, Lyles, Marjorie, & Dhanaraj, Charles (2016). Learning to collaborate through collaboration: How allying with expert firms influences collaborative innovation within novice firms. *Strategic Management Journal*, 37(10), 2092-2103. <http://doi.org/10.1002/smj.2424>
- Hsu, David H. (2006). Venture capitalists and cooperative start-up commercialization strategy. *Management Science*, 52(2), 204-219. <http://doi.org/10.1287/mnsc.1050.0480>
- Kapoor, Rahul, & McGrath, Patia J. (2014). Unmasking the interplay between technology evolution and R&D collaboration: Evidence from the global semiconductor manufacturing industry, 1990-2010. *Research Policy*, 43(3), 555-569. <http://doi.org/10.1016/j.respol.2013.08.002>
- Kavusan, Korcan, & Frankort, Hans T. W. (2019). A behavioral theory of alliance portfolio reconfiguration: Evidence from pharmaceutical biotechnology. *Strategic Management Journal*, 40(10), 1668-1702. <http://doi.org/10.1002/smj.3041>
- Kavusan, Korcan, Noorderhaven, Niels G., & Duysters, Geert M. (2016). Knowledge acquisition and complementary specialization in alliances: The impact of technological overlap and alliance experience. *Research Policy*, 45(10), 2153-2165. <http://doi.org/10.1016/j.respol.2016.09.013>
- Lane, Peter J., & Lubatkin, Michael (1998). Relative absorptive capacity and interorganizational learning. *Strategic Management Journal*, 19(5), 461-477. [http://doi.org/10.1002/\(sici\)1097-0266\(199805\)19:5<461::aid-smj953>3.3.co;2-c](http://doi.org/10.1002/(sici)1097-0266(199805)19:5<461::aid-smj953>3.3.co;2-c)
- Laursen, Keld, & Salter, Ammon (2006). Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal*, 27(2), 131-150. <http://doi.org/10.1002/smj.507>
- Laursen, Keld, & Salter, Ammon J. (2014). The paradox of openness: Appropriability, external search and collaboration. *Research Policy*, 43(5), 867-878. <http://doi.org/10.1016/j.respol.2013.10.004>
- Lee, Jongkuk, Hoetker, Glenn, & Qualls, William (2015). Alliance experience and governance flexibility. *Organization Science*, 26(5), 1536-1551. <http://doi.org/10.1287/orsc.2015.0989>
- Li, Dan (2013). Multilateral R&D alliances by new ventures. *Journal of Business Venturing*, 28(2), 241-260. <http://doi.org/10.1016/j.jbusvent.2012.02.004>

- Li, Dan, Eden, Lorraine, Hitt, Michael A., & Ireland, R. Duane (2008). Friends, acquaintances, or strangers? partner selection in R&D alliances. *Academy of Management Journal*, 51(2), 315-334. <http://doi.org/10.5465/AMJ.2008.31767271>
- Lioukas, Constantinos S., & Reuer, Jeffrey J. (2020). Choosing between safeguards: Scope and governance decisions in R&D alliances. *Journal of Management*, 46(3), 359-384. <http://doi.org/10.1177/0149206318795240>
- Lokshin, Boris, Hagedoorn, John, & Letterie, Wilko (2011). The bumpy road of technology partnerships: Understanding causes and consequences of partnership mal-functioning. *Research Policy*, 40(2), 297-308. <http://doi.org/10.1016/j.respol.2010.10.008>
- Luo, Xiaowei Rose, Koput, Kenneth W., & Powell, Walter W. (2009). Intellectual capital or signal? the effects of scientists on alliance formation in knowledge-intensive industries. *Research Policy*, 38(8), 1313-1325. <http://doi.org/10.1016/j.respol.2009.06.001>
- Mowery, David C., Oxley, Joanne E., & Silverman, Brian S. (1996). Strategic alliances and interfirm knowledge transfer. *Strategic Management Journal*, 17(SUPPL. WINTER), 77-91. <http://doi.org/10.1002/smj.4250171108>
- Nooteboom, Bart, Vanhaverbeke, Wim, Duysters, Geert, Gilsing, Victor, & van den Oord, Ad (2007). Optimal cognitive distance and absorptive capacity. *Research Policy*, 36(7), 1016-1034. <http://doi.org/10.1016/j.respol.2007.04.003>
- Oxley, Joanne E., & Sampson, Rachelle C. (2004). The scope and governance of international R&D alliances. *Strategic Management Journal*, 25(8-9), 723-749. <http://doi.org/10.1002/smj.391>
- Oxley, Joanne E., Sampson, Rachelle C., & Silverman, Brian S. (2009). Arms race or détente? How interfirm alliance announcements change the stock market valuation of rivals. *Management Science*, 55(8), 1321-1337. <http://doi.org/10.1287/mnsc.1090.1022>
- Oxley, Joanne, & Wada, Tetsuo (2009). Alliance structure and the scope of knowledge transfer: Evidence from U.S.-Japan agreements. *Management Science*, 55(4), 635-649. <http://doi.org/10.1287/mnsc.1080.0968>
- Ozmel, Umit, Reuer, Jeffrey J., & Gulati, Ranjay (2013). Signals across multiple networks: How venture capital and alliance networks affect interorganizational collaboration. *Academy of Management Journal*, 56(3), 852-866. <http://doi.org/10.5465/amj.2009.0549>
- Palomeras, Neus, & Wehrheim, David (2021). The strategic allocation of inventors to R&D collaborations. *Strategic Management Journal*, 42(1), 144-169. <http://doi.org/10.1002/smj.3233>
- Phelps, Corey (2010). A longitudinal study of the influence of alliance network structure and composition on firm exploratory innovation. *Academy of Management Journal*, 53(4), 890-913. <http://doi.org/10.5465/amj.2010.52814627>
- Powell, Walter W., Koput, Kenneth W., & Smith-Doerr, Laurel (1996). Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. *Administrative Science Quarterly*, 41(1), 116-145. <http://doi.org/10.2307/2393988>
- Randhawa, Krithika, Wilden, Ralf, & Hohberger, Jan (2016). A bibliometric review of open innovation: Setting a research agenda. *Journal of Product Innovation Management*, 33(6), 750-772. <http://doi.org/10.1111/jpim.12312>
- Reuer, Jeffrey J., & Devarakonda, Ramakrishna (2017). Partner selection in R & D collaborations: Effects of affiliations with venture capitalists. *Organization Science*, 28(3), 574-595. <http://doi.org/10.1287/orsc.2017.1124>

- Reuer, Jeffrey J., & Lahiri, Nandini (2014). Searching for alliance partners: Effects of geographic distance on the formation of R&D collaborations. *Organization Science*, 25(1), 283-298. <http://doi.org/10.1287/orsc.1120.0805>
- Rosenkopf, Lori, & Schilling, Melissa A. (2007). Comparing alliance network structure across industries: Observations and explanations. *Strategic Entrepreneurship Journal*, 1(3-4), 191-209. <https://doi.org/10.1002/sej.33>
- Rothaermel, Frank T., & Boeker, Warren (2008). Old technology meets new technology: Complementarities, similarities, and alliance formation. *Strategic Management Journal*, 29(1), 47-77. <http://doi.org/10.1002/smj.634>
- Ryall, Michael D., & Sampson, Rachelle C. (2009). Formal contracts in the presence of relational enforcement mechanisms: Evidence from technology development projects. *Management Science*, 55(6), 906-925. <http://doi.org/10.1287/mnsc.1090.0995>
- Ryan-Charleton, Tadhg, Gnyawali, Devi R., & Oliveira, Nuno (2022). Strategic alliance outcomes: Consolidation and new directions. *Academy of Management Annals*, 16(2), 719-758. <https://doi.org/10.5465/annals.2020.0346>
- Ryu, Wonsang, McCann, Brian T., & Reuer, Jeffrey J. (2018). Geographic co-location of partners and rivals: Implications for the design of R&D alliances. *Academy of Management Journal*, 61(3), 945-965. <http://doi.org/10.5465/amj.2016.0416>
- Sampson, Rachelle C. (2007). R&D alliances and firm performance: The impact of technological diversity and alliance organization on innovation. *Academy of Management Journal*, 50(2), 364-386. <http://doi.org/10.5465/AMJ.2007.24634443>
- Schilling, Melissa A. (2015). Technology shocks, technological collaboration, and innovation outcomes. *Organization Science*, 26(3), 668-686. <http://doi.org/10.1287/orsc.2015.0970>
- Schilling, Melissa A., & Phelps, Corey C. (2007). Interfirm collaboration networks: The impact of large-scale network structure on firm innovation. *Management Science*, 53(7), 1113-1126. <http://doi.org/10.1287/mnsc.1060.0624>
- Schmiedeberg, Claudia (2008). Complementarities of innovation activities: An empirical analysis of the German manufacturing sector. *Research Policy*, 37(9), 1492-1503. <http://doi.org/10.1016/j.respol.2008.07.008>
- Silverman, Brian S., & Baum, Joel A. C. (2002). Alliance-based competitive dynamics. *Academy of Management Journal*, 45(4), 791-806. <https://doi.org/10.5465/3069312>
- Soh, Pek-Hooi (2003). The role of networking alliances in information acquisition and its implications for new product performance. *Journal of Business Venturing*, 18(6), 727-744. [http://doi.org/10.1016/S0883-9026\(03\)00026-0](http://doi.org/10.1016/S0883-9026(03)00026-0)
- Stern, Ithai, Dukerich, Janet M., & Zajac, Edward (2014). Unmixed signals: How reputation and status affect alliance formation. *Strategic Management Journal*, 35(4), 512-531. <http://doi.org/10.1002/smj.2116>
- Stuart, Toby E. (1998). Network positions and propensities to collaborate: An investigation of strategic alliance formation in a high-technology industry. *Administrative Science Quarterly*, 43(3), 668-698. <http://doi.org/10.2307/2393679>
- Stuart, Toby E., Hoang, Ha, & Hybels, Ralph C. (1999). Interorganizational endorsements and the performance of entrepreneurial ventures. *Administrative Science Quarterly*, 44(2), 315-349. <https://doi.org/10.2307/2666998>
- Stuart, Toby E., Ozdemir, Salih Z., & Ding, Waverly W. (2007). Vertical alliance networks: The case of university-biotechnology-pharmaceutical alliance chains. *Research Policy*, 36(4), 477-498. <http://doi.org/10.1016/j.respol.2007.02.016>

- Talay, M. Berk, Seggie, Steven H., & Cavusgil, Erin (2009). Exploring correlates of product launch in collaborative ventures: An empirical investigation of pharmaceutical alliances. *Journal of Product Innovation Management*, 26(4), 360-370. <http://doi.org/10.1111/j.1540-5885.2009.00665.x>
- Tsinopoulos, Christos, Yan, Ji, & Sousa, Carlos M. P. (2019). Abandoning innovation activities and performance: The moderating role of openness. *Research Policy*, 48(6), 1399-1411. <http://doi.org/10.1016/j.respol.2019.02.005>
- Tyler, Beverly B., & Caner, Turanay (2016). New product introductions below aspirations, slack and R&D alliances: A behavioral perspective. *Strategic Management Journal*, 37(5), 896-910. <http://doi.org/10.1002/smj.2367>
- van de Vrande, Vareska (2013). Balancing your technology-sourcing portfolio: How sourcing mode diversity enhances innovative performance. *Strategic Management Journal*, 34(5), 610-621. <http://doi.org/10.1002/smj.2031>
- van de Vrande, Vareska, Vanhaverbeke, Wim, & Duysters, Geert (2009). External technology sourcing: The effect of uncertainty on governance mode choice. *Journal of Business Venturing*, 24(1), 62-80. <http://doi.org/10.1016/j.jbusvent.2007.10.001>
- Vanhaverbeke, Wim, Duysters, Geert, & Noorderhaven, Niels (2002). External technology sourcing through alliances or acquisitions: An analysis of the application-specific integrated circuits industry. *Organization Science*, 13(6), 714-733. <http://doi.org/10.1287/orsc.13.6.714.496>
- Wagner, Stefan, & Goossen, Martin C. (2018). Knowing me, knowing you: Inventor mobility and the formation of technology-oriented alliances. *Academy of Management Journal*, 61(6), 2026-2052. <http://doi.org/10.5465/amj.2016.0818>
- West, Joel (2014). Open innovation: Learning from alliance research. *Open Innovation through Strategic Alliances*. Palgrave Macmillan, 1-15. https://doi.org/10.1057/9781137394507_1
- West, Joel, & Bogers, Marcel (2014). Leveraging external sources of innovation: A review of research on open innovation. *Journal of Product Innovation Management*, 31(4), 814-831. <http://doi.org/10.1111/jpim.12125>
- West, Joel, & Bogers, Marcel (2017). Open innovation: Current status and research opportunities. *Innovation*, 19(1), 43-50. <https://doi.org/10.1080/14479338.2016.1258995>
- Whittington, Kjersten Bunker, Owen-Smith, Jason, & Powell, Walter W. (2009). Networks, propinquity, and innovation in knowledge-intensive industries. *Administrative Science Quarterly*, 54(1), 90-122. <http://doi.org/10.2189/asqu.2009.54.1.90>
- Wuyts, Stefan, & Dutta, Shantanu (2014). Benefiting from alliance portfolio diversity: The role of past internal knowledge creation strategy. *Journal of Management*, 40(6), 1653-1674. <http://doi.org/10.1177/0149206312442339>
- Zott, Christoph, & Amit, Raphael (2010). Business model design: An activity system perspective. *Long Range Planning*, 43(2-3), 216-226. <https://doi.org/10.1016/j.lrp.2009.07.004>

Figure 14.1: Sampled Articles over Time

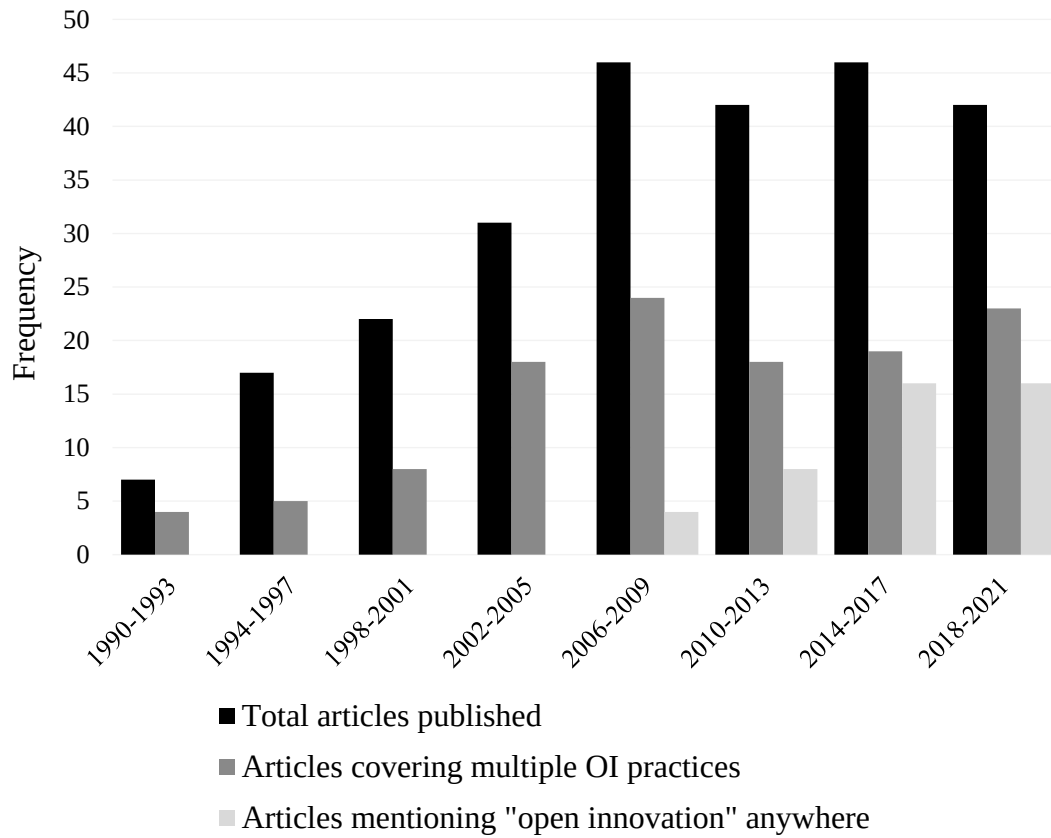


Figure 14.2: Organizing Framework

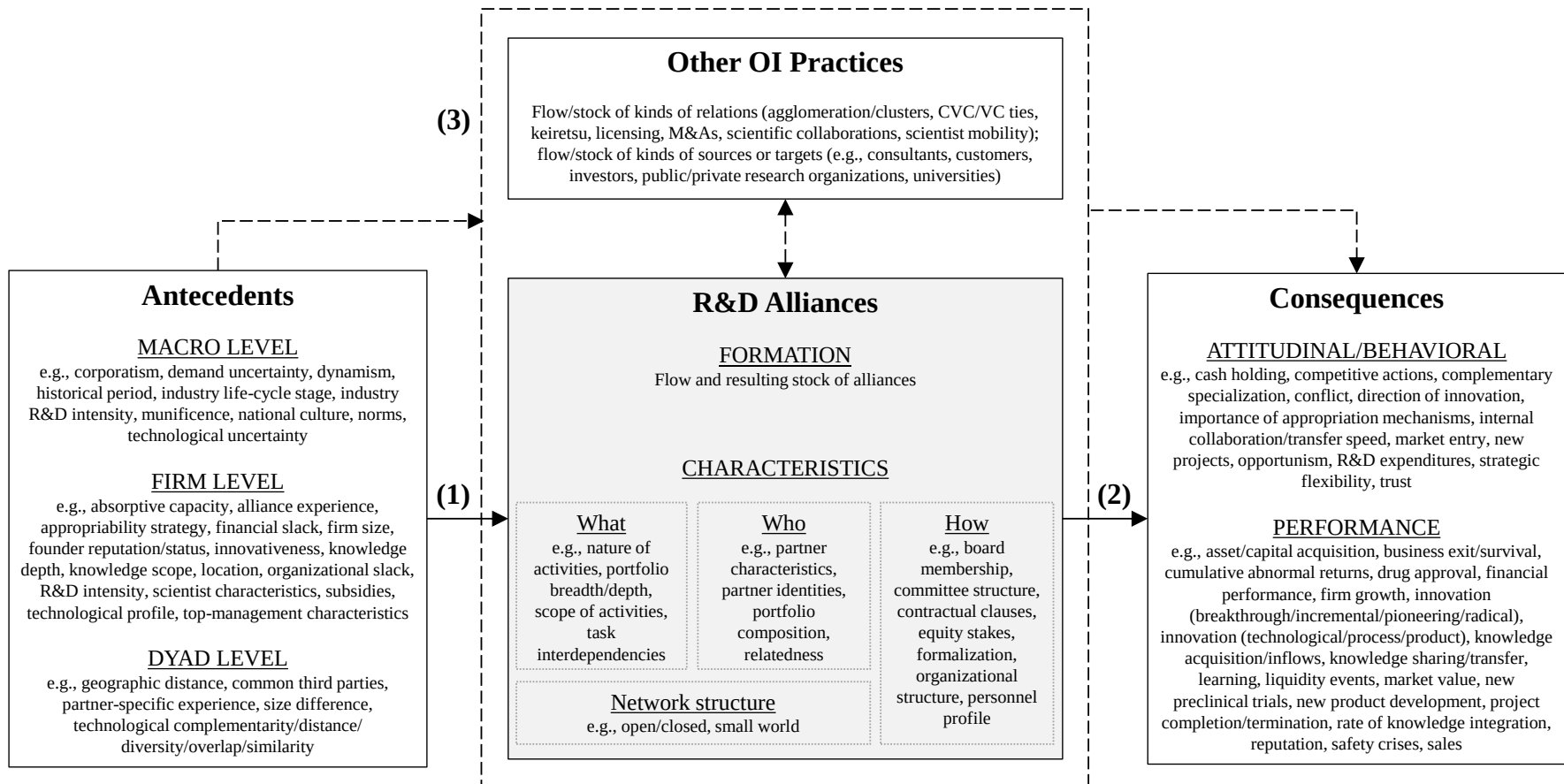


Figure 14.3: Venn Diagram of Themes in the Literature

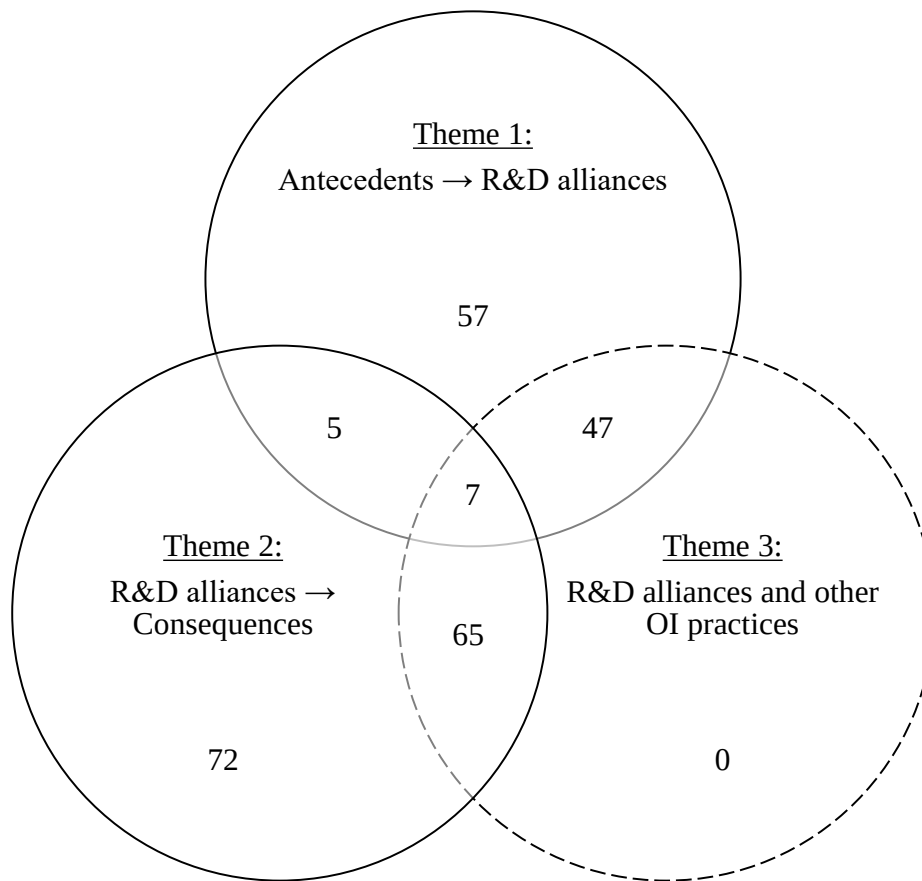


Table 14.1: Review Synthesis

Themes and Subthemes	Number of Articles^a	Summary of Predominant Findings
(1) Antecedents → R&D alliances	116	
Formation	71	R&D alliances tend to form through greater awareness of potential partners, and where information asymmetries are smaller and anticipated learning benefits greater.
Characteristics	52	The need for cooperation and coordination, and/or the search for resource synergies, frequently determine R&D alliance characteristics.
(2) R&D alliances → Consequences	149	
Attitudinal/behavioral consequences	13	R&D alliances have attitudinal and behavioral consequences, which are possible transmission channels towards performance.
Performance consequences	136	R&D alliances predict knowledge flows and innovation, and more so when their characteristics enable requisite cooperation, coordination, and/or resource synergies.
(3) R&D alliances and other OI practices	119	
...as separate choices with independent effects	91	R&D alliances and other OI practices reflect separate choices with independent effects on performance—effects which in the margin may be different or, by assumption, identical.
...as alternative choices	10	At the level of a transaction, R&D alliances and other OI practices can be mutually exclusive ways to govern that transaction.
...as interdependent choices	20	R&D alliances and other OI practices can interact to complement or substitute one another. Complementarities

	may exist where engagement in one OI practice enhances the marginal value of the outputs of another, or where one OI practice helps a firm identify and pursue productive opportunities for engaging in another. Substitution may exist where one OI practice draws resources away elsewhere, or where different practices are equifinal.
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a. N = 253. Totals for themes and subthemes exceed our sample size because various articles are classified under multiple themes or subthemes (see Figure 14.3).