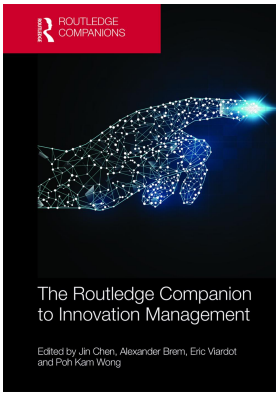

The Routledge Companion to Innovation Management

Jin Chen, Alexander Brem, Eric Viardot, Poh Kam Wong

Interorganizational relations within innovation systems

Publication details
https://test.routledgehandbooks.com/doi/10.4324/9781315276670-19
Terje Grønning, Parisa Afshin
Published online on: 26 Feb 2019

19

INTERORGANIZATIONAL RELATIONS WITHIN INNOVATION SYSTEMS

Terje Grønning and Parisa Afshin

In this chapter we present and discuss selected works that focus in various ways on the management of interorganizational relations within innovation systems. The insight that corporations innovate more often than not in relation to other organizations draws attention to understanding the need for managing the relations between organizations, in addition to understanding factors enabling or hindering innovation at the corporate level. There are various types of such interorganizational relations, and the chapter is structured into five sections where five predominant types are being presented and discussed in sequence. First, we present research that focuses on modularity-based innovation and innovation through various forms of labor division between client and subsidiary organizations or between collaborating peer organizations. Next we turn to the university as an "engine" for innovation in the case of successful relations between industry and academia. Third, we delve into selected works within the field of strategic alliances for innovation. Whereas in the first three sections we have focused on subfields that discuss interorganizational relations as analyzed at the level of the relations as such (modularity, industry-academia, and alliances), the final two sections look at various relations contextualized within larger systems. Thus we review briefly in the fourth and fifth sections some of the works theorizing the importance of multiple relations between organizations in the context of regional innovation ecosystems and some of the works applying the concept of national innovation systems while theorizing the importance of such systems to corporate innovation within such systems. Each of the sections identifies key perspectives within the subfield, as well as works within the subfield that focus on specific aspects relevant to research on the management of interorganizational relations

Modularity innovation and labor division of innovation

Baldwin and Clark (1997) have drawn attention to the central aspect of modularity being "a strategy for organizing complex products and processes efficiently" (Baldwin and Clark, 1997). Modules compose together a *modular* system, where each module can be designed independently at the same time as the system functions as a whole. It may thus be one solution towards solving the classic dilemma of organizations regarding achieving scale and scope objectives simultaneously.

The literature usually treats modular systems as designed, rather than emergent. This means that organizations consciously strive to both conceive of the purpose and workings of the modules and how these modules are integrated. Baldwin and Clark (1997) refer to this process a design: "Designers achieve modularity by partitioning information into *visible design rules* and *hidden design parameters*" (Baldwin and Clark, 1997 their italics). The partitioning must be both precise and unambiguous, as well as complete, since modularity otherwise will turn out to be unbeneficial. The rules are decisions that have consequences also for later design decisions. There are three types of such rules, where the first is called an architecture. An architecture-type rule determines which modules to include in the system and what their roles should be. The second type is referred to as interfaces and concerns how modules are supposed to interact, fit, connect and communicate with each other. Third, the standards-type of rule concerns measuring whether a module conforms to the design rules presented earlier, as well as each module's performance (Baldwin and Clark, 1997).

Some of the literature on modularity is preoccupied with the relationship between innovativeness on the one hand and the possibility that imitation may occur due to modularity on the other hand. Pil and Cohen (2006) are especially interested in "the dilemma firms face regarding modularity" (Pil and Cohen, 2006, p. 996). They define "modular capability" in terms of two elements, where the first concerns the problem-solving processes which are used in order improve the design of a product. The second element is constituted by the performance criteria that result from these processes. With architectures where there are successful interconnected modules, the possibility of imitation arises. Or, as they state: "The links between product design parameters and performance outcomes are more transparent in modular architectures; this facilitates imitation" (Pil and Cohen, 2006, p. 996). They subsequently propose a series of measures in order to counteract the risk of imitation, including paying attention to product heterogeneity, the nature of innovation within the modular design environment, and implementing decisions at the firm level which are augmenting innovation advantages achievable within the modular environment. Thus, "under certain conditions, the innovation advantages of modularity substantially outweigh the imitation impact on sustained performance" (Pil and Cohen, 2006, p. 996). In a similar vein, Ethiraj, Levinthal, and Roy (2008) examine the relationship between imitation and innovation in the context of modularity and identify at least three different "imitation strategies" it may be worthwhile being aware of, where the first is imitation of the module decisions. Then, the second strategy is imitation of linkages, whereas the third is imitation of both the modules themselves as well as of the linkages (Ethiraj, Levinthal, and Roy, 2008, p. 940).

The advance of modularity has been especially associated with the computer industry. Baldwin and Clark (1997) point to numerous examples where there within this industry were constructed complex products or processes with smaller subsystems which were designed on an independent basis at the same time as these subsystems functioned together with other subsystems. They furthermore claim that such a way of organizing modularity has contributed greatly to the rate of innovation within the industry: "Indeed, it is modularity, more than speedy processing and communication or any other technology, that is responsible for the heightened pace of change that managers in the computer industry now face" (Baldwin and Clark, 1997).

The first modular computer is said to have been the IBM System/360 announced in 1964. Until then, each of the models that IBM produced had been unique, with specific software and parts for each model. This incidentally created a disincentive for consumers to switch machines and systems, since all information had to been rewritten. With the new modular approach, different units within IBM as well as collaborating external companies worked independently on modules. This boosted the rate of innovation in a significant way. One prerequisite for being able to organize in such a way was that there were, after all, "design rules" as explained earlier,

which everybody adhered to. However, as long as work and development occurred within the framework of such rules, the participating parties could concentrate on and try out a wide series of different options and hence increase the probability of arriving at workable and ingenious solutions. According to Baldwin and Clarke, "this freedom to experiment with product design is what distinguishes modular suppliers from ordinary subcontractors" (Baldwin and Clark, 1997).

Another industry where modularity has become widespread is the automobile industry. Obviously, decentralized production of components for final assembly at one specific location is a procedure that has got a long history within both the automobile industry and other manufacturing industries. Subsequently, this type of organization should not be referred to as modularity as long as this type of organization is based on subcontracted manufacture of predesigned parts and components, with arm's-length relations between client and suppliers. Whenever suppliers are involved in the design process with a certain amount of "freedom" much in the vein of the citation by Baldwin and Clark (1997) earlier, however, we find a case of modularity.

In modern societies the issue of competitiveness and innovativeness of services is very much in vogue. Baldwin and Clark (1997) tend to apply their framework on modularity in a rather general sense and appear to find few obstacles towards modular organization also within services. They do have some caveats, like the fact that services are intangible; however, like in the case of finances they find the principle applicable. Since "the science of finance is sophisticated and highly developed" (Baldwin and Clark, 1997, p. 3), it is relatively easy to modularize by way of defining, analyzing, and splitting apart these services. This notion has, however, been met with critique (Miozzo and Grimshaw, 2005). Miozzo and Grimshaw (2005) acknowledge that modularity has relevance for services; however, they contend that modularity has its limits, especially in the case of knowledge-intensive business services (KIBS). Based on their own research data, they state that the involvement of external KIBS is "not just a simple substitution of internal services but instead a rather more complex process of knowledge transfer that required reciprocal learning and interaction" (Miozzo and Grimshaw, 2005, p. 1434).

In sum, modularity may be one promising approach towards achieving scale and scope in a simultaneous way, but the principle poses a series of challenges to interorganizational relations. In addition to the dilemma of innovation versus imitation mentioned earlier, the close relationships between organizations involved in a modular system place demands on coordination as well as a high level of trust. In addition, the approach may in some cases turn out to be incongruent with aspirations towards achieving "systemic innovation", since "modularity as a means of coordination involves partitioning activities into those that can take place independent of one another, which does not apply to systemic innovation" (Helfat and Campo-Rembado, 2016, p. 253).

The university as an engine for innovation

Universities have always played a central role in society through education and training of skilled labor as well as conducting basic research. Recently, universities have got an increasingly important additional role in contributing towards innovativeness and economic development, as there is shift in their function from only conducting research and educating skilled labor into a more entrepreneurial role – the third mission of the university. Hence, it has been stated that universities can also improve the economic performance of regional or national innovation systems (Barra and Zotti, 2018; Cooke, Gomez Uranga, and Etxebarria, 1997). As an example of how universities contribute to innovation systems, Motohashi (2005) identified with reference to the case of Japan that this new role of universities can reduce the dependence of the country's innovation system on in-house R&D within large enterprises. It has also been identified that based

on their academic research universities create a seed bed for new firms through the formation of firms that can be important in the development of innovation systems (Etzkowitz, Webster, Gebhardt, and Terra, 2000).

Subsequently, university and industry collaboration and relations have been emphasized as an important element for innovativeness and growth in today's knowledge-intensive economy, with the main emphasis on the role of universities as a provider of knowledge to firms, which in turn innovate by bringing science to the market (OECD, 2000). The creation of new knowledge-intensive industries such as nanotechnology and biotechnology underline the significance of this relation that can be in different forms such as joint research and R&D, licensing and intellectual property rights (IPR) transactions, financing, student internships or consultancy.

Therefore, a vastly growing number of studies have been dedicated to understanding the ways that firms in specific sectors benefit from such collaboration, as well as how such collaborations can be encouraged (Liew, Shahdan, and Lim, 2012; Powell, 1998). In this regard, universities are identified as crucial for creating and disseminating knowledge, building skilled human capital, increasing firms' sales and as providing other financial benefits such as cost savings and having a reputation-related benefit (Agrawal, 2001). Another stream of research has focused on the other side of this relationship, looking at how such a relationship can affect and benefit universities (Balconi and Laboranti, 2006; Chapple, Lockett, Siegel, and Wright, 2005; Shattock, 2005) This stream has been gaining popularity, as there is a growing need for understanding the pressure on universities through new policies for creating new knowledge and alternative means for funding (Ankrah and Al-Tabbaa, 2015; Geuna and Muscio, 2009).

In investigating the ways to promote such collaborations, many challenges and issues in managing and increasing the effectiveness of such interorganizational collaboration have been identified that vary depending on the type of the relationships and cooperation, types of science, and the type of industry. For instance, Lin (2017) indicated that excessive collaboration with industry can affect the university's academic innovation negatively, and special attention must thus be paid to collaboration breadth and knowledge capacity strategies of the university when deciding the number and types of such collaborations.

In this section, we will reflect on some selected aspects of university–industry collaboration (UIC) these relations. First, we look at the role of the university in promoting innovativeness in UIC, and second we look at the management of UIC.

One important contribution of universities to innovation is through generating new knowledge that is important for firms, especially within the knowledge-intensive sectors. Firms cannot merely rely on internal knowledge for their progress and innovation – they need to acquire outside knowledge, as innovation is an open mechanism with inflows and outflows of knowledge across boundaries (Chesbrough, 2006). The interaction with science gives firms access to the diversified range of knowledge sources that are important for innovativeness (Kaufmann and Tödtling, 2001). In this regard, it is important to note that the role of the university as a creator and transfer agent of knowledge and technology to the industry is not a new one; nevertheless, the ways that it has been achieved and the institutionalizations collaboration linkages are quite new (Geuna and Muscio, 2009). This new role is fulfilled through various formal and informal models such as research collaborations, recruitment of educated personnel, IPR, spin-offs, licensing and informal or formal networks. Channels for transferring the knowledge can vary depending on the types and stages of the inventions. For instance, early-stage inventions' knowledge transfer can be through scientist and firm interaction, while other transfers will be through patent licensing (Agrawal, 2001).

One of the means of transferring knowledge is through the impact that universities may have on the industry R&D. The impact can be through main channels such as published papers and

reports, public conferences and meetings, informal information exchange and consulting (W. M. Cohen, Nelson, and Walsh, 2002). In addition, "degree programmes, in fields useful for local firms, act as a channel for R&D collaborations with universities, public research labs and private firms" (Maietta, 2015, p. 1356).

Universities' joint R&D projects with industries and firms benefit both large enterprises and start-up firms, although it has been stated that large firms benefit more in general from public research (Cohen, Nelson, and Walsh, 2002). These R&D collaborations not only enable firms in the creation of new ideas but also in the completion of ongoing projects (Cohen, Nelson, and Walsh, 2002). Such R&D collaborations can be funded internally by the parties or can be funded through public funding. However, it has been emphasized that when the funding is from a third party – public funding – the result of collaboration is more positive. According to Scandura (2016), having joint R&D efforts with universities through public funding has the benefit of not only obtaining knowledge from the universities research and facilities but also getting access to the pool of employees that are skilled and knowledgeable in that field.

The other key reasons for industry to enter collaboration with the university is to seek opportunities to commercialize university-based technologies for financial gain (Siegel, Waldman, Atwater, and Link, 2003). Such transfer of technology from research to the industry can be through IPR transfers and licensing. It has been claimed that university patents are mostly essential as a source of generic knowledge, as they influence a wide range of technologies rather than creating specific knowledge spillovers (Otsuka, 2011). Universities also have a significant role through the contribution of human capital (Etzkowitz, Webster, Gebhardt, and Terra, 2000; Fukugawa, 2016). In addition to the creation of skilled labor at bachelor, master and even PhD levels, attachment of the researchers and students to the industry by different trainee and internship programs may result in a higher level of engagement and facilitate transfer of knowledge and technology (Liew, Shahdan, and Lim, 2012).

UIC entails a complex interplay between different determinants in different levels, including system, institutional and individual (Muscio and Pozzali, 2013). Promoting this collaboration from the perspective of the university as well as from the firm thus requires considering such interplay and the different system levels, as well as the environmental issues and the nature of different industries that can influence and facilitate or hinder UIC.

The management of the knowledge transfer processes within UICs, including different transfer methods such as IPR, spin-offs and research collaborations, has traditionally been administered through personal relations between people within university, industry and government, whereas recently the processes have been achieved mostly through instruments such as knowledge transfer offices (KTOs), technology transfer offices (TTOs) (Geuna and Muscio, 2009) and research and innovation offices (RIOs) of universities (Liew, Shahdan, and Lim, 2012). These intermediaries can bridge the universities and industries as well as identify the business and focus on the exploitation of IPRs while considering the issues regarding the share of profits, ownership and distribution of responsibilities, whether through licensing or spin-offs, and facilitate UIC (Franco and Haase, 2015; Geuna and Muscio, 2009; Liew, Shahdan, and Lim, 2012). However, the existence of bureaucracy, legal frameworks and weak organizational support may affect the UIC negatively (Franco and Haase, 2015).

At the more micro level, it has been suggested that for bridging offices like TTOs and KTOs to operate optimally, they must have management experienced in knowledge transfer, the ability to hire qualified and expensive staff and be regional rather than for each individual university (Geuna and Muscio, 2009). The university's management is also important in managing the interorganizational relationship by way of improving the interactions, since university leadership

can be important in identifying the joint interest between external organizations and their academic counterparts (Etzkowitz, Webster, Gebhardt, and Terra, 2000).

However, the different orientations and procedures of industry and university, respectively, may create TTO-related conflicts that are not easy to alleviate, but can be overcome by way of building strong interorganizational trust through informal reciprocity and exchange based on incentives, procedures and goals (Bruneel, d'Este, and Salter, 2010). The importance of the role of TTOs in facilitating the knowledge transfer of UIC requires more specialized TTOs possessing staff with strong technology backgrounds (Barra and Zotti, 2018).

Another facilitating factor is the role of the individual researcher. It is important that the scientist are involved from the early phases in the case of joint R&D spin-offs or licensing UICs, (Geuna and Muscio, 2009). The network of industry and academic researchers may enhance the productivity of endeavors between firms and universities (Balconi and Laboranti, 2006) (Balconi and Laboranti, 2006). Also, UICs are facilitated when industry hires former academia researchers or when universities hire industry experts in order to seek potential partners (Huang and Chen, 2017). In addition to formal ties, maintaining strong informal ties with industry through scientists in the universities is an important factor in the success of UICs (Liew, Shahdan, and Lim, 2012), as such ties increase the level of trust and mutual understanding (Bruneel,¸ d'Este, and Salter, 2010). Having informal communication and networking in UICs will increase not only tacit knowledge transfer but also the level of trust in their relationship (Bruneel, d'Este, and Salter, 2010; Liew, Shahdan, and Lim, 2012). Additionally, the presence of highly qualified academics facilitates UICs, since such academics are more engaged in interaction with industries (Franco and Haase, 2015).

At the project level, the research on such collaborations is vast, and different suggestions have been made as a means of improving UICs. For instance, based on their 17-year collaboration in a project between university, industry and government Jones, Scrimgeour, and Tonn (2017) state that several issues must be considered in maintaining a smooth UIC. First, both sides must have engagement early on, as it improves the teams' environment as well as scientific content. Second, defining the roles and responsibilities and expectations prevents conflicts and creates trust, as well as increased financial efficiencies. Third, agreeing on data sharing and standardization leads to cost efficiencies and better management of the collaboration, subsequently treating the project as an experiment that helps understanding the uncertainties as well expecting and resolving setbacks and surprises that in turn leads to faster reactions to unexpected outcomes. Last but not least, defining program success is essential so that all collaborators are aware of what they can expect (Jones, Scrimgeour, and Tonn, 2017).

In addition, Edmondson et al. (2012) list nine main factors in managing the UIC, including the university's leadership abilities, creating selective long-term partnership, having shared visions through assessing the core competences of both sides, putting people that cross boundaries easily in charge of managing the relationship, creating opportunities for people from both sides with the same interests to come together and develop dialogue, developing a "broad overarching framework agreement" (Edmondson et al., 2012, p. 10) for collaboration that does not overemphasize the role of IPR, creating multidisciplinary institutes especially in the university campus and redefining the role of the university research. They state that university leadership can enhance such relations through prioritizing UIC strategies, creating a joint steering group of academics and industry executives and providing resources for keeping basic research while focusing on industry-relevant research. In the case of a long-term relationship, this will ensure that industry knows what is going on in terms of science development in universities and bring the innovations to market (Edmondson et al., 2012).

Strategic alliances for innovation

The literature on strategic alliances encompasses a wide range of diverse issues, for example, who the alliance partners are, as well as the purpose of the alliances (Gulati, 1998). One encompassing definition is that strategic alliances are "trading partnerships and new business forms that enable participating firms to achieve strategic objectives beyond their existing capabilities by providing for mutual resource exchanges (technologies, skills, or products)" (Todeva, 2007). Such alliances thus involve two or more partner firms which, per definition, remain legally independent at the same time, as they in theory share both the benefits and the control of the partnership (Todeva, 2007;Yoshino and Rangan, 1995). Furthermore, partners should continuously contribute to the alliance in order to ensure its survival and success (Todeva, 2007;Yoshino and Rangan, 1995).

Strategic alliances come in various forms, where some may be short term and project based and others may be more long term and involve equity relations (Todeva, 2007). One typology as for why firms attempt to enter into alliances distinguishes between four different types of needs, namely cash needs, the need for increased scale, access to specific markets and the need for specific skills which they assume are available from the partner (Bleeke and Ernst, 1994). It is obviously the fourth type of need which may be most closely associated with issues pertaining to innovation. A similar framework adjusts the perspective from perceived needs to firm motives (Todeva, 2007). Three types of motives correspond overall to the first three types of perceived needs, namely economic motives (e.g. reduction or sharing costs), strategic motives (e.g. cooperating with potential rivals in order to reduce uncertainty) and political motives (e.g. overcoming regulatory barriers). The fourth type of motive, labeled somewhat broadly as "organizational motives" (Todeva, 2007), corresponds roughly to the perceived need for skills and how to possibly satisfy this need by way of one or more strategic alliances aimed at learning, competence building and organizational restructuring (Todeva, 2007).

Related to the theorizing about this latter type of organizational motive, one proposition has been formulated as a "resource-based theory of strategic alliances" (Das and Teng, 2000). In addition to theorizing the individual firm as a set of resources and processes applied in order to acquire these resources, the cases where firms enter into strategic alliances, must according to this view, be analyzed according to resource-based assumptions and concepts. Das and Teng (2000) put forward rationale, formation, structural preferences and performance as four major aspects of strategic alliance, and subsequently propose an analysis of interpartner resource alignments where "resource similarity" and "resource utilization" constitute the two dimensions of the analysis. This results in a typology with four types of alignment: "supplementary", "surplus", "complementary", and "wasteful" (Das and Teng, 2000). They also discuss how particular types of alignment may affect collective strengths and conflicts between allied firms as well as the performance of the alliance.

Research within this tradition thus extends the notion of resource-based firms and the origin of firm innovativeness from the individual firm to its strategic alliance partners (Hagedoorn and Duysters, 2002; Narula and Hagedoorn, 1999). In a similar vein, albeit with an even stronger emphasis on management aspects, there has been a focus recently on the relations between the firms within alliances applying the concept of (dynamic) capabilities, transferring the locus of capabilities management from the individual firm (Teece, 1992;Teece, Pisano, and Shuen, 1997) to the capabilities necessary for the management of strategic alliance-based relations between firms (i.e. "alliance capabilities") (Wang and Rajagopalan, 2015). These capabilities-related issues have, albeit with a different terminology, been the focus also of earlier and ongoing research by Doz (1996) and Oliver and Liebeskind (Oliver, 2009; Oliver and Liebeskind, 1997), focusing on the role of alliance formation on the firm's learning processes. Doz (1996) conducted

analyses of learning as occurring along several dimensions (i.e. environment, task, process, skills and goals) and found that successful alliances were evolutionary in the sense that they evolved through a sequence of "interactive cycles of learning, reevaluation and readjustment" (Doz, 1996, p. 55). In contrast, failed projects were inertial. Oliver and Liebeskind (1997) view formalized strategic alliances as but one type of possible relation between firms (i.e. "relationships that operate at the organizational level") and develop a typology which includes two additional types of more informal relations: individual or interpersonal level and interorganizational network relationships that operate at the individual or interpersonal level (Oliver and Liebeskind, 1997). Although strategic alliances are, as introduced earlier, per definition a concept reserved for formalized types of relations, the inclusion of a focus on informal types of relations may be useful, especially in connection with a discussion on interorganizational ties aimed at innovation or learning. Moreover, Oliver (2009) highlights that formal strategic alliances aimed at R&D outputs may in some cases entail delimited transactions in the form of licenses in return for advance investments in successful results of R&D conducted by the other party and are thus not "learning" alliances in the pure sense (Oliver, 2009), whereas other alliances entail various forms of scientific and technological collaboration and warrant the label of learning alliances.

Management of innovation in the context of strategic alliances is thus a field that has taken into consideration a great number of elements, ranging from the original need and subsequent motive for an alliance as perceived from both parties to the question of what type of strategic alliance it is. A special set of challenges may be attached to the type of alliances most conducive to innovation, namely the cases where there is a mutual perception regarding the need for specific skills and hence organizational motives behind alliance formation. Entering into such skills-related alliances may pose particular management challenges, since the alliance must take into consideration issues related to intellectual property rights. In the case of learning alliances the alliance must take into consideration issues such as how to organize collaborative R&D efforts.

Innovation ecosystems

Innovation ecosystem (IE) is a relatively new buzzword in government, industry and academia environments as means of looking at promoting dynamics and affecting innovation (Oh, Phillips, Park, and Lee, 2014). The concept is founded partly on notions such as "business ecosystems" (Moore, 1993) and partly on innovation system conceptualizations. The goal of researchers applying the concept of an ecosystem is to explain the interplay of factors, environment and institutions at different levels that affect and promote innovation in the region, state and organization (Mercan and Götkas, 2011)

Since research in this area is still very limited and very new, there is not a clear cohesive definition of what an IE is. In different definitions that have been offered, the innovation ecosystem concept has encompassed different – yet not that distant – elements (Oh, Phillips, Park, and Lee, 2014). The concept of an ecosystem also has been coupled with other modifiers, such as city-based ecosystem (Cohen and Desarrollo, 2014), industry ecosystem (Tsvetkova and Gustafsson, 2012) and national innovation ecosystem. For instance, while emphasizing the boundary-spanning and networking elements of businesses, Tsvetkova and Gustafsson (2012) highlight in reference to the industry ecosystem that it entails the environment of the industry that the firm is in, including different stakeholders such as customers, partners and suppliers, that affects the firm's business model and business process. Other studies offering a similar definition refer to the ecosystem as the network that firms are connected to providing the required resources, alliance partners and information and are the result of an evolutionary process (Zahra and Nambisan, 2012). While pointing to the importance of an external environment in addition to the internal

one in understanding the successful dynamics of innovation, Adner and Kapoor (2010) in their definition of an ecosystem include the external partners of the focal firm that cooperate and compete at the same time in the exchange networks, namely upstream suppliers and downstream customers, as important elements.

Zahra and Nambisan (2012) introduced four models of ecosystems based on the differences and nature of innovation in terms of space and governance: orchestra, creative bazaar, jam central and modification (MOD) station model where communities of innovators can collaborate. An 'orchestra ecosystem model' is a system in which firms are gathered around a key player firm which creates a strong leadership network around itself in order to utilize a market opportunity. In a creative bazaar ecosystem, the key firm obtains innovation through searching the global bazaar and using its infrastructure to realize the values. A 'jam central' ecosystem involves a set of independent entities which collaborate in order to create and develop innovations. And a 'MOD station' ecosystem includes large established firms that smaller newer firms use to enhance their existing and proprietary innovation architecture and products. This perspective mostly looks at the ecosystem in terms of a collection of firms and their relations and networks.

Jackson (2011) defined IE as the complex economic dynamics "between actors or entities whose functional goal is to enable technology development and innovation", in which actors can be material resources, human capital and participating institutions. In this perspective, innovation ecosystem includes two major economies, namely the research economy and the commercial economy (Jackson, 2011). The research economy is driven by basic research, and the latter by the marketplace, and it generates resources, which go back to the research economy in the ecosystem cycle. The spatial element is then an important part of the innovation ecosystem, since entities are geographically localized or strategically linked for implementing a technology and/or business system (Jackson, 2011). Jackson (2011) offers Silicon Valley as an example of such a geographically localized ecosystem, and the European Innovation Initiative as an example of a strategically linked one.

Nevertheless, there have been disagreements as to whether the model is sufficiently defined and constructed and whether there are indeed benefits with adapting this perspective. Oh, Phillips, Park, and Lee (2014) state that the ecosystem phrasing that is mostly used in governmental initiations and industrial papers without peer review is unnecessary and incomplete, and the term "system" would be sufficient in explaining and understanding the developments they actually try to portray. In their paper reviewing the literature on innovation ecosystems, they state that researchers use the term differently; many have used the term loosely and did not have the biological ecosystem as an analogy. One can thus conclude that an "'innovation ecosystem' is identical to 'innovation system,' at present" (Oh, Phillips, Park, and Lee, 2014, p. 2) and although the approach encourages system thinking, which is valuable in itself, the concept itself is not yet a rigorous construct. They further suggest that in order to make the concept into a practical and rigorous construct, there is still a need to define the concept and its precise level and to identify its difference from that of NISs and RISs. Furthermore, there is a need to find ways to measure the system's performance (Oh, Phillips, Park, and Lee, 2014).

Another issue with the current model is that while some use the innovation ecosystem for describing a system at the national level and thus with a macro-perspective (Adner and Kapoor, 2010; Jucevicius, Juceviciene, Gaidelys, and Kalman, 2016; Zahra and Nambisan, 2012), others suggest a micro-perspective of the ecosystem focusing on firm-level strategies of innovation ecosystems (Pellikka and Ali-Vehmas, 2016).

Arguments in favor of the concept and the benefits of using it include, for instance, that unlike in the previous innovation system approaches, the innovation ecosystem approach explains the difference between the innovation events and innovative structure. This is because it includes a

focus on the evolutionary and evolving nature of the system, in that it describes both interactions of individual firms and the way the relationships between innovative efforts of firms and the environment can be influenced by institutions through policy (Mercan and Götkas, 2011). In addition, the IE model explains the element of internationalization in a way many of the other innovation system approaches cannot (Mercan and Götkas, 2011).

In attempt to define a more clear IE concept as separate from those of NIS and RIS, Jucevicius, Juceviciene, Gaidelys, and Kalman (2016) define IE, based on the Jackson (2011a) definition, as "a complex network of interactions between the actors from industry, government and academia that underlies the innovative activities and performance in the area" (Jucevicius, Juceviciene, Gaidelys, and Kalman, 2016, p. 430), and although there are some similar key elements in all the well-functioning innovation ecosystems, each IE has its own unique characteristics. This perspective nonetheless seems to be close to that of the triple helix model (Leydesdorff and Etzkowitz, 1998), in which the concept of innovation has been seen as an interplay of the industry, government and academia spheres (Etzkowitz and Leydesdorff, 2000). However, it is claimed that the difference from previous models arises from the "eco" perspective of the new system approach, meaning that the innovation processes are self-organizing and evolutionary, similar to that of the biological ecosystem, and also include the continuous pursuit of balancing the opposite elements of openness and ownership, public and private, short term and long term and supply and demand (Jucevicius, Juceviciene, Gaidelys, and Kalman, 2016). When constructing the model, they emphasize the entrepreneurial value creation role regarding innovation neglected in institutional perspectives such as the triple helix model. The entrepreneurial value creation role is an important factor since it analytically complements the existing regional strengths (Jucevicius, Juceviciene, Gaidelys, and Kalman, 2016). On the whole, the concept aims to address the shortcomings of previous models by way of emphasizing the evolving nature of systems. However, since it is very much in its infancy, it has a long way to go before it can offer a well-constructed and well-distinguished model that can separate itself from the previous institution-focused constructs of NIS and RIS.

However, if, as stated by Jackson (2011a), an IE is a comprise of the two economies (research economy and commercial economy), the important issue in managing within an innovation ecosystem is to address the existing gap between the research economy and commercial economy. This is the gap between the ideas within publicly funded basic research and the commercialization of viable products and services into a marketplace associated with high investments, high risk and high uncertainty (Jackson, 2011a; Jucevicius, Juceviciene, Gaidelys, and Kalman, 2016). This transition of resources from the research economy to the commercial economy is sometimes called the "valley of death" (Butler, 2008, p. 840) and requires the reassessment and reconsideration of the policy at the regional and organizational levels. This means that the regional innovation policy needs to include and consider the specific needs of the emerging innovation ecosystems, while other factors such as entrepreneurial mind-sets, motivation, capabilities and strength are considered at the more organizational levels (Jucevicius, Juceviciene, Gaidelys, and Kalman, 2016).

Additionally, it is important to have a clear and unified vision between the members of an innovation ecosystem, since such unification can result in a more aligned environment and its goals and enhance the collaborations' effectiveness within the system (Pellikka and Ali-Vehmas, 2016). In this respect, Pellikka and Ali-Vehmas (2016) suggest that in an "orchestra innovation ecosystem" (Zahra and Nambisan, 2012), such a vision can be promoted through the core firm in the system. However, this view indicates the role of firms as the main actors in such a system, while it seems to undermine the role of other organizations such as public research institutes and government agencies in the system that can be just as – if not more – influential in how the

system functions (Pellikka and Ali-Vehmas, 2016). Thus, in their study of innovation ecosystem "components", Mercan and Götkas (2011) state three components as important elements of the innovation ecosystem, including cluster, university–industry relations and culture. They indicate that strengthening the university and industry relations is the most important aspect of the IE, while culture and clustering, although important, do not affect the innovation output of the system. When considering the university–industry relations in IE, it is important as well to note the role of anchoring entities such as TTOs and PROs (Clarysse, Wright, Bruneel, and Mahajan, 2014). Last but not least, when looking at creating, developing and managing the IE, it is essential to consider that supporting policies must be tailored for each type of ecosystem (Clarysse, Wright, Bruneel, and Mahajan, 2014).

National innovation systems and their importance to corporate innovation

The national innovation systems (NIS) research field has traditionally mostly been preoccupied with a macro level of analysis. In other words, rather than taking corporate innovation as the point of departure for analysis, it is the national system where corporations and their innovative activities are embedded which is being theorized as a context for the innovative activities. The systems are perceived to be composed of actors as well as institutions, and it is the character of the interplay between organizations on the one hand and between these organizations and the systemic institutions on the other hand which are perceived as being conducive towards innovation or functioning as barriers against innovation.

The origins of this approach and its associated concept of NISs are in the works of Freeman (1987) and subsequent theoretical developments by Lundvall (1992) and Nelson (1993). These authors took inspiration from the classical works of List (1789–1846) and his notion of national and systemic contexts for economic activity (Carayannis, Samara, and Bakouros, 2015). Subsequently, the nature and set-up of particular national systems have been theorized while suggesting the kinds of organizations, institutions and policies that are perceived as relevant within the systems based on assumptions that "countries exhibit systematic *differences in terms of economic performance*", that "economic performance depends in large [part] not only on different technological and innovation capabilities but also the *development of institutions*" and "that *innovation and technology policies* are an effective tool for fostering and shaping the performance of countries" (Filippetti and Archibugi, 2011, as cited in Ács, Audretsch, Lehmann, and Licht, 2016. Our italics).

Carayannis, Wright, Bruneel, and Mahajan (2015) provide an overview of these and other central aspects pertaining to the debate on innovations systems as follows. Organizations include businesses, private research facilities, public research centers and universities. It follows that the interaction between various types of organizations is at the center of attention within the approach, be it business-business organization or interaction between business and public research centers. However, one distinguishing feature of the approach is that these interactions are interpreted in view of the constraints and possibilities offered by the institutional framework in which the organizations operate. Institutions relevant for understanding the set-up of a particular innovations systems include, for example, laws, regulations, contracts, rules of market exchange, shared values and codes of conduct (Carayannis, Wright, Bruneel, and Mahajan, 2015, p. 119). More important than organizations as such and their inter-collaboration, as well as the question of institutions as such, is the focus on these two different types of "components" (Carayannis, Wright, Bruneel, and Mahajan, 2015, p. 119) within a system and the interrelationship which exists between organizations on the one hand and institutions on the other

hand. Organizations within the NIS approach are the "players or actors", whereas "institutions may develop simultaneously and are not always characterized by a specific purpose" (Edquist and Johnson, 1997, p. 47).

In addition to the more individually based phenomenon of potential "staff mobility" between organizations Carayannis, Wright, Bruneel, and Mahajan (2015) include in their reflections on the various conceivable types of interactions within NISs the following three types of interorganizational relations. First, *interactions between firms* are potentially crucial. These may be in the form of formal partnerships much in the same vein as the relations reviewed in the sections on modularity and strategic allinaces earlier (i.e. technical cooperation or R&D-related collaboration). More informal relations may also exist between producers and users, for example. The significance of both formal and informal relations between firms may be that it can be a joint usage of technical resources or mutually improved access to human and technical resources (Carayannis, Wright, Bruneel, and Mahajan, 2015, p. 120). Second, *research interactions between the public and private sectors* may be crucial, since such interactions may alleviate improved translational processes between (basic) science and (applied) technology within a system. Such interactions may be divided into different subtypes, with collaboration between industry, universities and reseach centers as the more comprehensive types and cooperation regarding patents or publication activities as more delimited types. In addition, streams of information exchanges, which are a less defined type of relations between the actors, may be conducive towards innovative activities within the NISs (Carayannis, Wright, Bruneel, and Mahajan, 2015, p. 121). Third, interaction may occur through *technology diffusion* by way of the "use of technologies coming from industry and the diffusion of embedded technologies" (Carayannis, Wright, Bruneel, and Mahajan, 2015, p. 122). More speciifically, such diffusion may occur through the transfer of intermediate and capital goods; through embedded technology and the tacit knowledge of people; through access to technology which is codified in the form of documents, databases and patents; and through access to knowledge residing with customers, supplliers, competitors and public agencies (Carayannis, Wright, Bruneel, and Mahajan, 2015, p. 122). It may be noted that, as with the other forms of conceivable interactions, these porcceses may occur both within the national system and partners outside, and the relevance of specifying these processes in a context of national innovation systems analysis will subsequently be to reveal and discuss whether there are in particular many or close kinds of such interactions within the national borders.

In recent years, the approach has been supplemented with attempts at theorizing innovation systems at other levels than the national level. The concept of regional innovation systems (RIS) was launched in the early 1990s (Cooke, 1992), partly based on previous research on "the learning region" (Florida, 1995; Morgan, 1997) which had produced empirical results that showed the importance of both interorganizational relations based on an exchange of tacit knowledge and the occasional heavy influence of facilitating agencies at the local level. Also in the early 1990s, the concept and framework of technological systems was introduced in order to highlight the way interactions occur within the processes related to the emergence and further development of specific technologies (Carlsson and Stankiewicz, 1991). The sectoral system of innovation and production concept and framework, defined as "a set of new and established products for specific uses and the set of agents carrying out market and non-market interactions for the creation, production and sale of those products" (Malerba, 2002, p. 248), attempted to highlight the way there may be relations within particular sectors conducive to innovation within such sectors. And the triple helix perspective of innovation systems (Leydesdorff and Etzkowitz, 1998) focuses on the selection environments (i.e., markets, organizations and technological opportunities) and the three networked relations among universities, industries and governments relevant to these environments (i.e. the "carriers" of the system), while assuming that the three selection

environments fulfill social functions such as organized knowledge production, wealth creation and control of organizations (Leydesdorff and Zawdie, 2010, p. 789). These additional theoretical developments may at one level be viewed as a critique of the strong emphasis of the national level of analysis within the NIS framework. Taking the recent increased impact of globalizations forces into account, one may argue that the importance of national-level institutions is debilitated and that intercorporate relations at technological and sector levels gain in importance. However, one may also, as in the RIS approach, argue for the continued importance of local processes and relations which are either subnational or may even be supranational in cases where clusters of firms are co-located in regions that geographically span country borders. On the other hand, one may also interpret these additional systems of innovation frameworks as supplementary frameworks rather than fundamental critiques. They take into consideration other sets of indicators and empirical material for use within analysis and highlight additional aspects of the NIS key points without necessarily constituting a fundamental critique or substitute.

One somewhat peculiar feature of the NIS concept and framework is that it has in a much stronger degree than the other four frameworks presented in this chapter been associated with and incorporated within policies at the national and supranational levels. As examples of the former, policies related to innovation and entrepreneurship have been embedded within an NIS framework in Finland (Miettinen, 2002) and Sweden (Bitard, Edquist, Hommen, and Rickne, 2008), and as an example of the latter, the Organisation for Economic Co-operation and Development (OECD) has for a number of years operated with policy formulations heavily inspired by the framework (Lundvall and Borrás, 2005). There are thus several versions of the NIS framework, where some operate within the academic domain striving for theory formulations and empirical analyses, whereas the applications within the policy sphere may be interpreted as more loosely applied guidelines.

Types of critiques that have, however, been posted against both the NIS framework and its supplements include the observation that there may be an overly suppressed role of corporate and individual agency within the frameworks. Perhaps the most vocal proponent of such a critique in recent years is the group suggesting the alternative concept "national systems of entrepreneurship" (Ács, Autio, and Szerb, 2014; cf. also Surie and Groen, 2017) and attempts to align the approach to the "broader ecosystems literature" (Ács, Audretsch, Lehmann, and Licht, 2016, p. 3). They assert that the national innovation systems concept is "mostly about context, how institutions drive knowledge production and application and how countries differ according to their '. . . set of institutions . . . ' but totally overlooks the individual agency" (Ács, Autio, and Szerb, 2014, p. 477). Perhaps there will in coming years be increased efforts at cross-over research where researchers form disciplines focusing on the role of individual and organizational agency, such as management and organization theory, and merge with the economics-oriented researchers hitherto dominating the national systems of the innovation approach.

References

Ács, Z. J., Audretsch, D. B., Lehmann, E. E. and Licht, G. (2016). National systems of innovation. *Journal of Technology Transfer*, 1–12. doi:10.1007/s10961-016-9481-8.

Ács, Z. J., Autio, E. and Szerb, L. (2014). National systems of entrepreneurship: measurement issues and policy implications. *Research Policy*, 43(3), 476–494.

Adner, R. and Kapoor, R. (2010). Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations. *Strategic Management Journal*, 31, 306–333. doi:10.1002/smj.

Agrawal, A. (2001). Common property institutions and sustainable governance of resources. *World Development*, 29(10), 1649–1672.

Ankrah, S. and Al-Tabbaa, O. (2015). Universities-industry collaboration: a systematic review. *Scandinavian Journal of Management*, 31(3), 387–408. doi:10.1016/j.scaman.2015.02.003.

Balconi, M. and Laboranti, A. (2006). University-industry interactions in applied research: the case of microelectronics. *Research Policy*, 35(10), 1616–1630. doi:10.1016/j.respol.2006.09.018.

Baldwin, C.Y. and Clark, K. B. (1997). Managing in an age of modularity. *Harvard Business Review*. September–October. https://hbr.org/1997/09/managing-in-an-age-of-modularity.

Barra, C. and Zotti, R. (2018). The contribution of university, private and public sector resources to Italian regional innovation system (in)efficiency. *The Journal of Technology Transfer*. doi:10.1007/s10961-016-9539-7.

Bitard, P., Edquist, C., Hommen, L. and Rickne, A. (2008). Reconsidering the paradox of high R&D input and low innovation: Sweden. In Edquist, C. and Hommen, H. (Eds.), *Small country innovation systems: globalization, change and policy in Asia and Europe*. Cheltenham: Edward Elgar Publishing, pp. 237–280.

Bleeke, J. and Ernst, D. (1994). *Collaborating to compete: using strategic alliances and acquisitions in the global marketplace*. New York: John Wiley & Sons Ltd.

Bruneel, J., d'Este, P. and Salter, A. (2010). Investigating the factors that diminish the barriers to university – industry collaboration. *Research Policy*, 39(7), 858–868.

Butler, D. (2008). Crossing the valley of death. *Nature*, 453(7197), 840.

Carayannis, E. G., Samara, E. T. and Bakouros, Y. L. (2015). *Innovation and entrepreneurship: theory, policy and practice*. Zurich: Springer International Publishing.

Carlsson, B. and Stankiewicz, R. (1991). On the nature, function and composition of technological systems. *Journal of Evolutionary Economics*, 1(2), 93–118.

Chapple, W., Lockett, A., Siegel, D. and Wright, M. (2005). Assessing the relative performance of U.K. university technology transfer offices: parametric and non-parametric evidence. *Research Policy*, 34(3), 369–384. doi:10.1016/j.respol.2005.01.007.

Chesbrough, H. (2006). *Open innovation: a new paradigm for understanding industrial innovation*. Oxford: Oxford University Press.

Clarysse, B., Wright, M., Bruneel, J. and Mahajan, A. (2014). Creating value in ecosystems: crossing the chasm between knowledge and business ecosystems. *Research Policy*, 43(7), 1164–1176. doi:10.1016/j.respol.2014.04.014.

Cohen, B. and Desarrollo, U. (2014). Call for papers – The city as a lab: open innovation meets the collaborative economy. *California Management Review*, 3–5.

Cohen, W. M., Nelson, R. R. and Walsh, J. P. (2002). Links and impacts: the influence of public research on industrial R&D. *Management Science*, 48(1), 1–23.

Cooke, P. (1992). Regional innovation systems: competitive regulation in the new Europe. *Geoforum*, 23(3), 365–382.

Cooke, P., Gomez Uranga, M. and Etxebarria, G. (1997). Regional innovation systems: institutional and organisational dimensions. *Research Policy*, 26(4–5), 475–491. doi:10.1016/S0048-7333(97)00025-5.

Das, T. K. and Teng, B-S. (2000). A resource-based theory of strategic alliances. *Journal of management*, 26(1), 31–61.

Doz, Y. L. (1996). The evolution of cooperation in strategic alliances: initial conditions or learning processes? *Strategic Management Journal*, 17(S1), 55–83.

Edmondson, G., Valigra, L., Kenward, M., Hudson, R. L. and Belfield, H. (2012). *Making industry-university partnerships work: lessons from successful collaborations*. Brussels: Science | Business Innovation Board AISBL.

Edquist, C. and Johnson, B. (1997). Institutions and organisations in systems of innovation. In Edquist. C. (Ed.) *Systems of innovation: technologies, institutions and organisations* (pp. 41–63). London: Pinter Publishers.

Ethiraj, S. K., Levinthal, D. and Roy, R. R. (2008). The dual role of modularity: innovation and imitation. *Management Science*, 54(5), 939–955.

Etzkowitz, H. and Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and 'Mode 2' to a Triple Helix of university – industry – government relations. *Research Policy*, 29, 109–123.

Etzkowitz, H., Webster, A., Gebhardt, C. and Terra, B. R. C. (2000). The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm. *Research Policy*, 29(2), 313–330.

Filippetti, A., and Archibugi, D. (2011). Innovation in times of crisis: national systems of innovation, structure, and Demand. *Research Policy* 40(2), 179–192. doi: 10.1016/j.respol.2010.09.001

Florida, R. (1995). Toward the learning region. *Futures*, 27(5), 527–536.

Franco, M. and Haase, H. (2015). University-industry cooperation: researchers' motivations and interaction channels. *Journal of Engineering and Technology Management – JET-M*, 36, 41–51. doi:10.1016/j.jengtecman.2015.05.002.

Freeman, C. (1987). *Technology policy and economic performance: lessons from Japan*. London: Pinter.

Fukugawa, N. (2016). Knowledge spillover from university research before the national innovation system reform in Japan: localisation, mechanisms, and intermediaries. *Asian Journal of Technology Innovation*, 24(1), 100–122. doi:10.1080/19761597.2016.1141058.

Geuna, A. and Muscio, A. (2009). The governance of university knowledge transfer: a critical review of the literature. *Minerva*, 47(1), 93–114. doi:10.1007/s11024-009-9118-2.

Gulati, R. (1998). Alliances and networks. *Strategic Management Journal*, 19(4), 293–317.

Hagedoorn, J. and Duysters, G. (2002). External sources of innovative capabilities: the preferences for strategic alliances or mergers and acquisitions. *Journal of Management Studies*, 39(2), 167–188.

Helfat, C. E. and Campo-Rembado, M. A. (2016). Integrative capabilities, vertical integration, and innovation over successive technology lifecycles. *Organization Science*, 27(2), 249–264.

Huang, M. H. and Chen, D. Z. (2017). How can academic innovation performance in university-industry collaboration be improved? *Technological Forecasting and Social Change*, 123 (October 2017), 210–215. doi:10.1016/j.techfore.2016.03.024.

Jackson, D. J. (2011a). *What is an innovation ecosystem?* Arlington, VA: National Science Foundation.

Jackson, D. J. (2011b). *What is an innovation ecosystem*. Arlington, VA: National Science Foundation.

Jones, N. E., Scrimgeour, G. J. and Tonn, W. M. (2017). Lessons learned from an industry, government and university collaboration to restore stream habitats and mitigate effects. *Environmental Management*, 59(1), 1–9. doi:10.1007/s00267-016-0792-1.

Jucevicius, G., Juceviciene, R., Gaidelys, V. and Kalman, A. (2016). The emerging innovation ecosystems and 'Valley of Death': towards the combination of entrepreneurial and institutional approaches. *Inzinerine Ekonomika-Engineering Economics*, 27(4), 430–438. doi:10.5755/j01.ee.27.4.14403.

Kaufmann, A. and Tödtling, F. (2001). Science-industry interaction in the process of innovation: the importance of boundary-crossing between systems. *Research Policy*, 30(5), 791–804. doi:10.1016/S0048-7333(00)00118-9.

Leydesdorff, L. and Etzkowitz, H. (1998). Triple helix of innovation. *Science and Public Policy*, 25(6), 358–364.

Leydesdorff, L. and Zawdie, G. (2010). The triple helix perspective of innovation systems. *Technology Analysis & Strategic Management*, 22(7), 789–804.

Liew, M. S., Shahdan, T. N. T. and Lim, E. S. (2012). Strategic and tactical approaches on university – industry collaboration. *Procedia – Social and Behavioral Sciences*, 56(Ictlhe), 405–409. doi:10.1016/j.sbspro.2012.09.669.

Lin, J. Y. (2017). Balancing industry collaboration and academic innovation: The contingent role of collaboration-specific attributes. *Technological Forecasting and Social Change*, 123 (October 2017), 216–228. doi:10.1016/j.techfore.2016.03.016.

Lundvall, B. Å. (Ed.) (1992). *National systems of innovation. Towards a theory of innovation and interactive learning*. London: Pinter.

Lundvall, B. Å. and Borrás, S. (2005). Science, technology, and innovation policy. In Fagerberg, J., Mowery, D. C. and Nelson, R. R. (Eds.), *The Oxford handbook of innovation*. Oxford: Oxford University Press.

Maietta, O. W. (2015). Determinants of university – firm R&D collaboration and its impact on innovation: a perspective from a low-tech industry. *Research Policy*, 44(7), 1341–1359.

Malerba, F. (2002). Sectoral systems of innovation and production. *Research Policy*, 31(2), 247–264.

Mercan, B. and Götkas, D. (2011). Components of innovation ecosystems. *International Research Journal of Finance and Economics*, 76(76), 102–112. doi:1450-2887.

Miettinen, R. (2002). *National innovation system: scientific concept or political rhetoric*. Helsinki: Edita.

Miozzo, M. and Grimshaw, D. (2005). Modularity and innovation in knowledge-intensive business services: IT outsourcing in Germany and the UK. *Research Policy*, 34(9), 1419–1439.

Moore, J. F. (1993). Predators and prey: a new ecology of competition. *Harvard Business Review*, 71(3), 75–83.

Morgan, K. (1997). The learning region: institutions, innovation and regional renewal. *Regional Studies*, 31(5), 491–503.

Motohashi, K. (2005). University-industry collaborations in Japan: the role of new technology-based firms in transforming the National Innovation System. *Research Policy*, 34(5), 583–594. doi:10.1016/j.respol.2005.03.001.

Muscio, A. and Pozzali, A. (2013). The effects of cognitive distance in university-industry collaborations: some evidence from Italian universities. *Journal of Technology Transfer*, 38(4), 486–508. doi:10.1007/s10961-012-9262-y.

Narula, R. and Hagedoorn, J. (1999). Innovating through strategic alliances: moving towards international partnerships and contractual agreements. *Technovation*, 19(5), 283–294.

Nelson, R. R. (1993). *National innovation systems: a comparative analysis*. Oxford: Oxford University Press.

OECD (2000). *Benchmarking industry-science relationships*. Paris: OECD.

Oh, D. S., Phillips, F., Park, S. and Lee, E. (2014). Innovation ecosystems: a critical examination. *Technovation*, 54, 3–5. doi:10.1016/j.technovation.2016.02.004.

Oliver, A. L. (2009). *Networks for learning and knowledge creation in biotechnology*. Cambridge: Cambridge University Press.

Oliver, A. L. and Liebeskind, J. P. (1997). Three levels of networking for sourcing intellectual capital in biotechnology: implications for studying interorganizational networks. *International Studies of Management & Organization*, 27(4), 76–103.

Otsuka, K. (2011). University patenting and knowledge spillover in Japan: panel-data analysis with citation data. *Applied Economics Letters*, 19(11), 1045–1049. doi:10.1080/13504851.2011.613743.

Pellikka, J. and Ali-Vehmas, T. (2016). Managing innovation ecosystems to create and capture value in ICT industries. *Technology Innovation Management Review*, 6(10), 17–24.

Pil, F. K. and Cohen, S. K. (2006). Modularity: implications for imitation, innovation, and sustained advantage. *Academy of Management Review*, 31(4), 995–1011.

Powell, W. W. (1998). Learning from collaboration: knowledge and networks in the biotechnology and pharmaceutical industries. *California Management Review*, 40(3), 228–240.

Scandura, A. (2016). University-industry collaboration and firms' R&D effort. *Research Policy*, 45(9), 1907–1922. doi:10.1016/j.respol.2016.06.009.

Shattock, M. (2005). European universities for entrepreneurship: their role in the Europe of knowledge the theoretical context. *Higher Education Management & Policy*, 17(3). doi:10.1111/j.1432-1033.1971.tb01354.x.

Siegel, D. S., Waldman, D. A., Atwater, L. E. and Link, A. N. (2003). Commercial knowledge transfers from universities to firms: improving the effectiveness of university-industry collaboration. *Journal of High Technology Management Research*, 14(1), 111–133. doi:10.1016/S1047-8310(03)00007-5.

Surie, G. and Groen, A. (2017). The importance of social entrepreneurship in national systems of innovation – an introduction. *Technological Forecasting and Social Change*, 121 (August 2017), 181–183. doi:https://doi.org/10.1016/j.techfore.2017.05.010.

Teece, D. J. (1992). Competition, cooperation, and innovation: organizational arrangements for regimes of rapid technological progress. *Journal of Economic Behavior & Organization*, 18(1), 1–25.

Teece, D. J., Pisano, G. and Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 509–533.

Todeva, E. (2007). Strategic alliances. In Clegg, S. and Bailey, J. R. (Eds.), *International encyclopedia of organization studies*. Thousand Oaks, CA: Sage.

Tsvetkova, A. and Gustafsson, M. (2012). Business models for industrial ecosystems: a modular approach. *Journal of Cleaner Production*, 29–30, 246–254. doi:10.1016/j.jclepro.2012.01.017.

Wang, Y. and Rajagopalan, N. (2015). Alliance capabilities: review and research agenda. *Journal of Management*, 41(1), 236–260.

Yoshino, M. Y. and Rangan, S. (1995). *Strategic alliances: an entrepreneurial approach to globalization*. Boston, MA: Harvard Business School Press.

Zahra, S. A. and Nambisan, S. (2012). Entrepreneurship and strategic thinking in business ecosystems. *Business Horizons*, 55(3), 219–229. doi:10.1016/j.bushor.2011.12.004.