



Paper to be presented at  
DRUID15, Rome, June 15-17, 2015  
(Coorganized with LUISS)

## **Network-centered and institution-centered strategies to benefit from the diffusing knowledge of innovation systems: The case of the Triple Helix**

**Georg Reischauer**

Vienna University of Technology  
Department of Labor Science and Organization  
georg.reischauer@tuwien.ac.at

### **Abstract**

This article focuses on activities with which an organization can benefit from the knowledge that diffuses in an innovation system. The innovation system model Triple Helix, which emphasizes how university, industry, and government co-generate innovation, is used as a case in point. I argue that to benefit from the diffusing knowledge of a Triple Helix, an organization can use strategies that target networks (relationships between organizations) and institutions (expectations that legitimize organizational activities). Network-centered strategies aim to change the circulation of diffusing knowledge in accordance with the organization's innovation capability. Institution-centered strategies strive for a legitimacy of the organizational activities to circulate diffusing knowledge. I detail and illustrate these strategies focusing on industry-university interaction and present a flow chart for strategy selection. This synthesis of concepts from social network theory and sociological institutional theory contributes to a better understanding of how organizations of an innovation system utilize external knowledge as well as interact. Moreover, it enables decision makers to intervene into organizational activities that are related to knowledge diffusion.

# **Network-centered and institution-centered strategies to benefit from the diffusing knowledge of innovation systems: The case of the Triple Helix**

## **Abstract**

This article focuses on activities with which an organization can benefit from the knowledge that diffuses in an innovation system. The innovation system model Triple Helix, which emphasizes how university, industry, and government co-generate innovation, is used as a case in point. I argue that to benefit from the diffusing knowledge of a Triple Helix, an organization can use strategies that target networks (relationships between organizations) and institutions (expectations that legitimize organizational activities). Network-centered strategies aim to change the circulation of diffusing knowledge in accordance with the organization's innovation capability. Institution-centered strategies strive for a legitimacy of the organizational activities to circulate diffusing knowledge. I detail and illustrate these strategies focusing on industry-university interaction and present a flow chart for strategy selection. This synthesis of concepts from social network theory and sociological institutional theory contributes to a better understanding of how organizations of an innovation system utilize external knowledge as well as interact. Moreover, it enables decision makers to intervene into organizational activities that are related to knowledge diffusion.

## **Keywords**

innovation system; strategy; organizational activities; network; institution; legitimacy; knowledge; university; industry

## **1. Introduction**

An innovation system stimulates the production, diffusion, and application of knowledge (Cooke, et al., 1997; Freeman, 1995; Malerba, 2002; Nelson, 1993; Ranga & Etzkowitz, 2013). Organizations benefit from the production, diffusion, and application of knowledge on different levels. As concepts such as absorptive capacity (Cohen & Levinthal, 1990; Lane, et al., 2006) demonstrate, the production and application of knowledge mostly takes place at the level of the overall organization. The diffusion of knowledge, however, mainly occurs between organizations and thus at the interorganizational level. To benefit from this diffusing knowledge, especially two sets of organizational activities have been emphasized.

First, organizations should start and maintain external relationships. In other words, they should explicitly engage with each other (Bodas Freitas et al, 2013; Chesbrough, 2003; Dhanasai & Parkhe, 2006; Powell & Grodal, 2006) and manage these interactions (Johnson, 2009; Levén, Holmström, & Mathiassen, 2014; Van de Ven et al, 1999). Second, organizations should take into account the social logics to which other organizations orientate towards. Differences in social logics are likely for organizations in different spheres of society (Bekkers & Bodas Freitas, 2008; Park & Leydesdorff, 2010; Welsh et al., 2008). For example, while universities aim to extend certified knowledge (Merton, 1973 [1942]), firms strive to generate profits.

External relationships and consideration of different social logics present crucial organizational activities to benefit from the diffusing knowledge of an innovation system. However, in innovation system studies, little attention has been devoted to the 'how'. Put differently, we know little about the activities with which organizations establish and maintain relationships as well as take different social logics into account in order to benefit from the diffusing knowledge of an innovation system. My conceptual paper addresses this question by suggesting the use of strategies. More precisely, and borrowing from Nag et al. (2007), I propose intended organizational activities that aim to enhance the innovation

performance of an organization. I suggest two sets of strategies: network-centered strategies and institution-centered strategies. Each strategy set focuses on addressing one of the crucial factors stressed by the literature: external relationships and consideration of different social logics.

*Network-centered strategies* aim to change the circulation of the diffusing knowledge in an innovation system in accordance with the innovation capability of the organization that uses them. To achieve this goal, network-centered strategies intervene in the network structure of an innovation system. A network and its structure thus concretize the proposed solution to focus on external relationships. *Institution-centered strategies* strive for a legitimacy of the organizational activities to circulate diffusing knowledge. As I will discuss below, legitimacy is a crucial status conferred by other organizations that supports – or prohibits – organizational activities such as those involved in benefiting from diffusing knowledge. To attain legitimacy, institution-centered strategies aim at institutions, i.e., expectations about which organizational activities are considered ‘right’ and ‘wrong’. Institutions in this sense therefore present the concrete gestalt of different social logics that should be taken into account. Both strategy sets include different strategies of varying complexity each of which encompasses several tactics. To inform the use of these strategies in both sets, I propose a flow chart for strategy selection.

Due to network-centered strategies and institution-centered strategies focusing on the diffusing knowledge in an innovation system, they analytically target the interorganizational level. Both strategy sets are also complementary to each other. While network-centered strategies target the ‘pipes’ through which diffusing knowledge flows, i.e. relationships, institution-centered strategies aim to legitimize the organizational activities that are linked to these ‘pipes’. This interdependence reflects the recursive nature of the social structures networks and institutions (Owen-Smith & Powell, 2008). These social structures are the concrete and analyzable gestalt of the crucial organizations activities proposed by the

literature, external relationships and consideration of social logics. Networks and institutions have been repeatedly identified as major factors that shape how organizations behave (Beckert, 2010; Fligstein & McAdam, 2012; Fourcade, 2007). To concretize them and to develop the outlined two sets of strategies, I draw upon social network theory and sociological institutional theory. Neither theory is entirely new to innovation system studies. But while scholars have frequently drawn upon social network theory (Levén et al., 2014; Zheng, 2010), they have paid relatively little attention to sociological institutional theory (for exceptions see Bjerregaard, 2010; Cai, 2014; Fuenfschilling & Truffer, 2014).

I illustrate the efficacy of network-centered strategies and institution-centered strategies oriented towards the innovation systems model of the Triple Helix (Etzkowitz, 2008; Etzkowitz & Leydesdorff, 2000; Leydesdorff & Etzkowitz, 1996; Ranga & Etzkowitz, 2013). The Triple Helix model emphasizes how the interaction between university, industry, and government generates innovation. The model thus encompasses both social structures the strategy sets underpin, external relationships and different social logics. Moreover, it considers the interorganizational level as a key level (Ranga & Etzkowitz, 2013). These properties make the Triple Helix the ideal model of an innovation system to illustrate the two strategy sets focusing on university-industry interaction.

My conceptual article on strategies with which an organization that is part of an innovation system can benefit from diffusing knowledge extends our understanding of organizational activities in innovation systems in several ways. First, I contribute towards to a better understanding of how organizations utilize external knowledge. By focusing on university-industry interaction, I especially add to innovation systems research that studies this intersection. Second, I contribute to a more comprehensive understanding of how organizations in the setting of a complex innovation system strategically act. Third, I answer to the call to consider the recursive nature of networks and institutions when studying organizational activities (Owen-Smith & Powell, 2008). To the best knowledge of the author,

a similar attempt to study organizational activities in the setting of an innovation system has so far not been undertaken.

The remainder of the paper is organized as follows. First, I briefly elaborate on the Triple Helix model and – to further detail why external relationships and consideration of different social logics are important when attempting to benefit from diffusing knowledge – present evidence for the challenges these suggested solutions aim to overcome. I then subsequently discuss and illustrate network-centered strategies and institution-centered strategies. This is followed by a flow chart that supports the selection of strategies. In closing, contributions and limitations as well as implications will be discussed.

## **2. The Triple Helix and the challenges of diffusing knowledge**

### *2.1. The Triple Helix as knowledge-based innovation system*

Several innovation system models address the question of how to promote innovation at levels beyond that of the single organization. Among the proposed levels are nations (Nelson, 1993), technological sectors (Malerba, 2002), and regions (Cooke et al., 1997). The Triple Helix differs from these models in that it highlights the multidisciplinary foundation of innovation. The Triple Helix as a “model for analyzing innovation in a knowledge-based economy” (Leydesdorff & Etzkowitz, 1998: 198) emphasizes how universities, industry, and government co-generate innovation. Triple Helix III, the latest variant of the model that also underpins this paper, further points towards the many and constantly changing ways in which university, industry, and government are connected. This dynamic interrelation “generates a reflexive subdynamics of intentions, strategies, and projects that adds surplus value by reorganizing and harmonizing continuously the underlying infrastructure” (Etzkowitz & Leydesdorff, 2000: 112-113) of the Triple Helix. This fluid university-industry-government entanglement enhances the capability to innovate at levels beyond the single organization (Etzkowitz, 2003; Etzkowitz & Leydesdorff, 2000; Leydesdorff & Etzkowitz, 1996, 1998).

The major driver of the dynamic linkage between university, industry, and government is knowledge. Surpassing the ‘Mode 2’ production of knowledge that centers on transdisciplinarity (Gibbons et al., 1994), a Triple Helix rests upon what Etzkowitz and Viale (2010) have labeled polyvalent knowledge. This knowledge is characterized by “common distinction theoretical, practical and interdisciplinary implications forming a common center of gravity” (Etzkowitz & Viale, 2010: 596). The polyvalent knowledge of a Triple Helix and the different ways it is used by each sphere presents the major stimuli for innovation. It is at the heart of a Triple Helix that has been modeled as a knowledge-based system the main function of which is the production, diffusion, and application of knowledge (Ranga & Etzkowitz, 2013).

Although polyvalent knowledge drives innovation, its production, diffusion, and application come with challenges. As theoretic concepts such as absorptive capacity (Cohen & Levinthal, 1990; Lane et al., 2006) illustrate, the challenges of the production and application of knowledge at the level are generally coped at the level of the overall organization. However, the diffusion of knowledge presents primarily an interorganizational challenge. Especially two hurdles have been highlighted for diffusing knowledge: the circulation of diffusing knowledge and the recognition of such.

## *2.2. Circulation of diffusing knowledge as a challenge*

Circulation of diffusing knowledge refers to the challenge that organizations face when receiving knowledge from a Triple Helix and sending knowledge to it. In innovation studies, diffusion is often modeled as a one-way diffusion: After an innovation is introduced to the market, it spreads over time (Rogers, 1962). However, organizations that are part of a Triple Helix do not just receive knowledge but also generate new information that they let diffuse. In other words, their absorptive capacity (Cohen & Levinthal, 1990) does not only produce commercial outputs but also knowledge outputs (Lane et al., 2006). The organizational capability to receive and send knowledge results in a circulation of knowledge, both between

one sphere of society and among university, industry, and government (Etzkowitz, 2008). To the knowledge of the author, no studies have drawn upon the Triple Helix model to investigate knowledge circulation between these three spheres of society. But, as discussed in the following, research on the circulation between two spheres of society already well illustrates the hurdles of the circulation of diffusing knowledge.

In their review of research on university-industry interactions, Perkmann et al. (2013) highlight that the effect of individual characteristics, organizational properties as well as scientific discipline and public policy on knowledge flow is relatively well explored. Studies on the organizational activities that aim to make the relations between university and industry work are less frequent and have generated varying results. To investigate how collaboration barriers can be mitigated, Bruneel, D'Este, and Salter (2010) focused on the effects of interorganizational trust, experience of collaboration, and breadth of interaction channels. They found that a positive history of relationships contributes to an enhanced knowledge flow between universities and industry. This basic insight is shared by Thune (2007) and others (Broström, 2010; Petruzzelli, 2011) who studied how geographically proximate links affect knowledge diffusion.

Investigations of knowledge flows between university and government have yielded similar insights on the challenge of knowledge circulation. Larédo (2003) emphasizes that public intervention should aim at providing an infrastructure enabling both a global and local circulation of knowledge. In a similar vein, Laranja (2009) demonstrates the importance of government in establishing a far-reaching technology infrastructure. On a more concrete level, Autant-Bernard, Fadairo, and Massard (2013) urge policy makers to consider the multiple paths knowledge flows can take (e.g. intra-organizational vs. interorganizational; intra-industry vs. cross-industry).

### *2.3. Recognition of diffusing knowledge as a challenge*

The previous section illustrated the challenges linked to the circulation of diffusing knowledge. The other significant hurdle is linked to the spheres of society across which diffusing knowledge spans. Organizations that embrace the Triple Helix idea cross the traditional borders of the sphere of society towards which they trend. Universities, for example, become more entrepreneurial and thus make their boundaries more permeable to industry (Etzkowitz, 2008; Etzkowitz & Viale, 2010). Firms that engage in more professional training and in sharing knowledge become more like universities (Etzkowitz, 2003). This illustrates that knowledge from very different sources circulates within a Triple Helix. However, the mere flow of knowledge between spheres of society has been found not to be sufficient to generate innovation. As shown in the remainder of this section, one domain of society also needs to recognize the diffusing knowledge from other spheres as useful for innovation. This presents the heart of the challenge that I label recognizing diffusing knowledge: An organization needs to recognize the diffusing knowledge as beneficial for innovation.

In science, the challenge of recognizing knowledge between different scholarly communities has been addressed by highlighting different 'epistemic cultures' (Knorr Cetina, 1999). Investigations of how different types of knowledge in an industry impact on innovation point to a similar direction (Asheim & Gertler, 2006; Jensen, et al., 2007; Tether, Li, & Mina, 2012). The complexity of recognizing diffusing knowledge increases when considering the intersection of multiple spheres of society. Due to such knowledge originating from another sphere, it might be considered a priori less useful for the own sphere. While several indicators for converging social logics between different spheres of society have been identified (Ankrah, Burgess, Grimshaw, & Shaw, 2013; Bjerregaard, 2010; Vallas & Kleinman, 2008), the boundaries between them still have not been completely lifted. This especially holds true for a Triple Helix in which three main logics meet: "scholars wish to publish; industries wish to gain financially from collaboration; and policy-makers represent the public interest, but

also want to win elections” (Park & Leydesdorff, 2010: 647). These different orientations have noticeable implications.

Gilsing et al. (2013) have shown that the risk of information leakage, scientific knowledge being too general, and the risk of conflict of interests inhibit knowledge transfer between university and industry. In a similar vein, Bruneel et al. (2010) pointed towards differences in terms of incentives and orientation as a major hurdle. Also Bekkers and Bodas Freitas (2008) demonstrated that, next to underlying knowledge types and individual characteristics, scientific disciplines and the different spheres of society impact the transfer of knowledge between academia and industry. Finally, Welsh et al. (2008) found that scientists believed that working with industry partner can restrict communication among peers.

#### *2.4. Tackling the challenges of diffusing knowledge with strategies*

The previous discussion highlights organizations facing two major challenges when trying to benefit from the diffusing knowledge of a Triple Helix. First, as discussed in the section on the circulation of diffusing knowledge, they have difficulties in receiving the ‘right’ knowledge from other organizations and to send the ‘right’ knowledge of their own to other organizations. This lead to the advice to establish and maintain external relationships with other organizations (Bodas Freitas et al, 2013; Chesbrough, 2003; Dhanasai & Parkhe, 2006; Powell & Grodal, 2006) and to manage these relationships (Johnson, 2009; Levén et al., 2014; Van de Ven et al, 1999). Second, as discussed in the section on the recognition of diffusing knowledge, organizations face challenges in recognizing diffusing knowledge from different spheres of society. This brought forward the call to explicitly consider the different social logics that shape the overall scope of organizations (Bekkers & Bodas Freitas, 2008; Fontana et al., 2006; Park & Leydesdorff, 2010; Welsh et al., 2008).

As indicated, this paper adopts the advice to focus on external relationships and consideration of different social logics and asks which concrete activities organizations can benefit from the diffusing knowledge of in innovation system. I propose two strategy sets:

Network-centered strategies aim to change the circulation of the diffusing knowledge in accordance with the innovation capability of the organization using them. To achieve this goal, network-centered strategies intervene in the structure of the network of the innovation system. Institution-centered strategies strive for the legitimacy of the organizational activities to circulate diffusing knowledge. To attain legitimacy, institution-centered strategies aim at institutions, i.e., expectations about which organizational activities are considered ‘right’ and ‘wrong’. Institutions in this sense thus present the concrete gestalt of the different orientations.

Table 1 summarizes the main properties of both strategy sets. What follows in the next two sections are illustrations showing how each strategy and its tactics work. In the subsequent section, their usage is elaborated by presenting a flow chart for strategy selection. Throughout the discussion, I constantly refer to ‘the’ organization. Note that especially within the Triple Helix encompassing university, industry, and government, this phrase could refer to a university, a firm, or an organization from public services. Hence, the strategies are in principle applicable to all types of organizations. However, for the purpose of a consistent illustration, I will assume the perspective of a firm when illustrating concepts and strategies.

--- TABLE 1 ABOUT HERE ---

### **3. Network-centered strategies**

In this chapter, I introduce core concepts of social network theory and, based on that, how network-centered strategies work.

#### *3.1. Conceptual background: Brokerage and centrality*

Social network theory is an integral part of innovation research (Hemphälä & Magnusson, 2012; Zheng, 2010) and has frequently been used to study the effects of interorganizational relationships on innovation (Dhanasai & Parkhe, 2006; Padula, 2008; Powell & Grodal, 2006). Networks, the unit of analysis, are conceptualized as links – or *ties* – between social entities – or *nodes*. The common representation of a network – ties as lines, nodes as dots – is

depicted in Figure 1. This network level consisting of ties and nodes is referred to as the network structure (Scott, 2000). While a network can also be analyzed on other levels, the structural dimension is considered crucial for innovation (Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 1998).

The structural level of networks influences innovation through knowledge. The affiliation of an organization to a network leads to iterative knowledge exchanges with other organizations. Metaphorically speaking, ties present ‘pipes’ through which knowledge flows. Basically, there are two different approaches to analyzing this knowledge flow: the overall structure of the network on the one hand and the quality of the ties on the other hand (Inkpen & Tsang, 2005; Johnson, 2009). Given this paper’s emphasis on innovation systems and the interorganizational level as well as the fact that the quality of the ties is often analyzed at the individual level (Perry-Smith & Shalley, 2003; Zheng, 2010), I in the following discuss two concepts that are used for the analysis of the overall network structure: brokerage and centrality.

--- FIGURE 1 ABOUT HERE ---

*Brokerage*, the first important concept on the effects of the overall network structure on innovation, is based on the structural hole concept developed by Burt (1992). Similar to “an insulator in an electric circuit” (Burt, 1992: 18), a structural hole refers to a tie that links groups of nodes that otherwise would not be connected. The existence of a structural hole is linked to a redundancy of ties: If there are several ties between groups, a redundancy of ties and thus no structural hole is at hand. The node that bridges a structural hole is considered a broker. The capability to link otherwise non-linked groups grants a broker control over the information that flows between the groups it bridges (Burt, 1992). In Figure 1, the tie between D and C presents a structural role, which is absent in the lower part of the network due to redundancy. D assumes the position of a broker.

For innovation, “brokerage across the structural holes between groups provides a vision of options otherwise unseen” (Burt, 2004: 354). Bridging structural holes thus enables access to new knowledge that positively impacts on innovation (Burt, 2004; Powell & Grodal, 2006; Zheng, 2010). This effect of brokerage also holds true for spanning various spheres of society or several industries. As Hargadon (2003) illustrates, highly innovative organizations come up with new concepts by brokering technology from different domains. The mechanism crucial to generating knowledge consists therefore of reaching out to contacts beyond one’s ‘natural habitat’.

The second concept important for innovation linked to the overall network structure is *centrality*. In a similar vein to the structural holes concept, centrality emphasizes a nodes’ capability to connect nodes with each other. Here however, the focus is placed on the number of ties. Basically, centrality measures the number of nodes to which a node is adjacent. Centrality, which is operationalized in various forms, thus corresponds to the everyday notion of ‘being well connected’ (Scott, 2000). In Figure 1, H occupies the most central position. C and D follow with both having the same centrality.

Two main hypotheses on how centrality impacts on innovation have been proposed. On the one hand, being at the center – or *core* – of a network allows access to a large knowledge source. This relates positively to innovation up to a moderate level of ties. On the other hand, innovation may also flourish at a non-central position or at the *periphery*. These peripheral nodes, which are only loosely connected to the overall network, are likely to have access to knowledge that is not part of the observed network. This argument rests upon the idea that occupying a peripheral position pushes a node to reach out to others that are not part of the analyzed network (Perry-Smith & Shalley, 2003; Zheng, 2010).

### 3.2. *Strategies and tactics*

The outlined concepts of social network theory provide us with three main insights. First, networks can be considered the concrete structure that underpins the flow of knowledge

between organizations. Knowledge is both received by and sent through – thus circulating in – networks. To infer how diffusing knowledge circulates, the structure of the network should be targeted. Second, a major means of attaining the knowledge needed to innovate is to engage in brokering. This enables access to new knowledge and control over the knowledge flow between the bridged parties. Third, both a high and low centrality can positively affect innovation. While a high centrality (core) increases the amount of knowledge received, a low centrality (periphery) is promising for receiving new knowledge. These insights are the point of departure for strategies that focus on the circulation of diffusing knowledge.

Network-centered strategies aim at a changed circulation of diffusing knowledge by intervening in the structure of the network of the innovation system. Valente (2010, 2012), who outlines basic strategies and tactics to intervene in networks to change activities, presents the main source to develop this strategy set. I complement his work with the discussed effects of networks on innovation.<sup>1</sup> Table 2 summarizes the network-centered strategies and tactics that I discuss in the following.

--- TABLE 2 ABOUT HERE ---

### 3.2.1. Identification

The tactics of the strategy identification aim at finding organizations in the network that are important for the overall circulation of diffusing knowledge. These tactics that identify organizations which stand out in different respects shape the view of the network.

The tactic *leader* brings those organizations to the fore that others consider important for knowledge circulation. For example, a firm categorizes selected firms from other industries or universities as important because they tend to circulate new knowledge or a great amount of knowledge that is relevant for the focal firm. These leading organizations are identified using nominations or by applying the centrality concept. In Figure 1, H is identified as leader based on the centrality concept.

---

<sup>1</sup> Because of the conceptualization of diffusion as one-way diffusion, in the strategy identification one tactic – finding low-threshold change agents to intervene in diffusion – was excluded.

The tactic *bridge* identifies organizations that act as brokers. Organizations categorized this way link organizations that otherwise would not be connected. For example, a firm has ties to universities that others in the same industry do not have. To find bridges, again the concept of structural holes is used. In Figure 1, D functions as bridge.

*Peripheral* represents a tactic to identify those organizations that assume peripheral positions. Although they are part of the network, they have only few ties to other organizations. This location at the periphery leads to an exclusion of the main flow of diffusing knowledge. However, it increases the chance of receiving new knowledge through ties that are not considered to be part of the network of the innovation system. For example, a peripheral firm is the only one linked to a government agency and is the first to know about the launch of a new research program. Peripherals are also identified by applying the centrality concept. But instead of the nodes with the most ties, those with the least ties are centered. In Figure 1, the nodes A, B, F, and I represent peripherals.

### 3.2.2. Segmentation

The tactics clustered in this strategy aim at identifying groups of organizations. This reflects the fact that organizations often consider themselves to be part of a group that is also categorized as differing from other groups of organizations.

The tactic *groups* identifies clusters of organizations that are at the core and periphery of the circulation of diffusing knowledge. This tactic thus differentiates between organizations that are more closely connected with each other (core) and organizations which are not (periphery). Networks structured this way may be mobilized “by focusing resources on the core members or by ensuring that the core members have sufficient resources or diversity” (Valente, 2012: 50). For example, a core of a Triple Helix consists of few firms and a university. To identify groups, several algorithms are used. The network in Figure 1 may consist of two mutually exclusive groups with a different core-periphery structure each: the nodes A, B, C, and D on the one hand, E, F, G, H, and I on the other hand.

The tactic *roles* identifies those organizations that occupy the same roles with regard to the circulation of diffusing knowledge. It allows organizations to be addressed not according to their position in the network – as with the previous tactic –, but according to the overall scope of their activities. For the setting of the Triple Helix, the five activities proposed by Ranga and Etzkowitz (2013) can be used to categorize roles: (1) technology transfer or acquisition; (2) conflict moderation; (3) collaborative leadership (i.e. coordination of multiple organizations to jointly innovate); (4) substitution (i.e. filling functional gaps, such as providing venture capital, both in the same and other spheres of society); (5) networking (i.e. linking the innovation system with other innovation systems). Using these roles helps to distinguish groups of organizations in a Triple Helix based on their activities. For example, it is found that some firms are actively engaging in technology transfer and networking as well as that a research agency is engaging in collaborative leadership.

### 3.2.3. Induction

The tactics of the network-centered strategy *induction* aim at encouraging interactions among close organizations to trigger cascades in knowledge. They therefore represent an active approach towards changing the overall circulation of diffusing knowledge. They also partly rely on insights gained from using tactics from the previously described strategies.

An organization that uses *word-of-mouth* aims at stimulating the interorganizational communication to persuade other organization to also engage in the circulation of diffusing knowledge. Hence, the focal organization does not target receiving or sending new or more knowledge but to change how other organizations partake in this activity. For example, a firm spreads the word among its suppliers about the benefits of collaborating with certain other firms or a university.

An organization that uses the tactic *outreach* seeks to actively promote the circulation of knowledge together with selected other organizations. In contrast to the previous tactic, a

more specific approach is taken here. For example, a firm reaches out to universities with a concrete idea for a joint research project.

*Matching* intends to facilitate circulation of diffusing knowledge by bringing together the organizations that were identified as leading (using the tactic leader of the identification strategy) with those organizations that were clustered into groups (based on the tactic groups of the segmentation strategy). A group contains organizations that are more closely connected with each other (core) and those that are not (periphery). The organization identified as leader often occupies a core. Hence, the actions of the leader, which is also at the core, can promote a change of the circulation of diffusing knowledge for the periphery of this group. For example, a firm hosts a forum at which scientists from a university give presentations on how science and industry can successfully collaborate. The university these scientists are part of was identified as being at the core of a certain group of organizations. The peripheral organizations of this group are thus exclusive participants.

#### 3.2.4. Alternation

The tactics of the network-centered strategy alternation intend to “deliberately alter the network to improve efficiency” (Valente, 2012: 51) of the circulation of diffusing knowledge. These tactics represent to some degree drastic interventions in the structure of the network of an innovation system. They also rely on insights from the tactics of the strategy identification.

The tactic *node alternation* adds and removes nodes, i.e. organizations, at crucial locations of the network. New organizations are added to enhance the knowledge circulation to nearly detached organizations and to nurture the random creation of ties. For example, a consultancy is brought in to bring together peripheral organizations. The links that are forged due to these efforts may persist after the consulting projects ends. If organizations are removed, this often takes place at the core of a group. This step presents a drastic attempt since without a core, a group of organizations becomes more fragile. However, in case the remaining organizations link to each other or create a new core-periphery structure, these dynamics may well lead to a

better knowledge circulation. For example, a firm starts cooperating with firms that are competitors of its former collaborators.

The tactic *tie alternation* proceeds in a similar way to the previous one. However, instead of adding and removing organizations, it adds and removes ties. Adding new ties leads to enhanced redundancy and makes structural holes disappear. This step increases the knowledge circulation between the newly linked organizations, but also decreases the chance of acquiring new knowledge. For example, a firm at peripheral positions decides to form ties with other peripheral organizations. In contrast, the removal of ties causes redundancy to decrease and hence lets structural holes emerge. This leads to a decrease of the overall flow of diffusing knowledge. At the same time, it increases the possibility of new knowledge. For example, a firm engaging in several small research projects with universities decides to concentrate on fewer but larger projects and thus to end a number of the existing collaborations that were forged to support the smaller projects.

*Rewiring* presents the most complex and radical intervention in the network structure. The overall ensemble of organizations and ties is changed, and new organizations may be included. A reason for such an overhaul can be the goal of immediately improving the overall circulation of diffusing knowledge. It may also be aimed at creating a greater number of groups with fewer organizations in each or a smaller number of groups that each encompasses a great number of organizations.

#### **4. Institution-centered strategies**

In the previous section, I illustrated how network-centered strategies work. In this section, I discuss strategies that address institutions.

##### *4.1. Conceptual background: Institutions and legitimacy*

For innovation systems studies, an emphasis on institutions at first glance seems misplaced. Institutions are an integral part of various concepts of this research field including the Triple Helix (Etzkowitz & Leydesdorff, 2000; Ranga & Etzkowitz, 2013). However, as

Edquist (2006) notes, scholars use the term institution in many ways, among others to refer to organizations or the law. These understandings of institutions differ from those of the framework of sociological institutional theory utilized here. Due to its common use to study organizations, this theory is also known as organizational institutionalism (Greenwood, Oliver, Sahlin, & Suddaby, 2008; Meyer & Rowan, 1977; Scott, 2001).

*Institution* refers to a set of interpretation frames and behavior patterns that both control and support organizational activities. In other words, institutions present expectations about which organizational activities are considered ‘right’ and ‘wrong’. Organizations follow these “classifications built into society as reciprocated typifications or interpretations” (Meyer & Rowan, 1977: 341) because of legal sanctions, moral governance, and/or because they are considered to be custom (Scott, 2001). For example, a university changes its budgeting system to become more attractive for a leading funding agency (Moll & Hoque, 2011). An example for firms is the institution that Research & Development (R&D) represents a highly appropriate functional area for generating innovation. Moreover, there are several institutions in place that prescribe the ‘normal’ way R&D department are organized (e.g. research groups, principal investigators). These and many other institutions play a major role in how organizations legitimize their activities.

To acquire resources – among them knowledge –, organizations are dependent on *legitimacy*. They, more precisely, rely on the “generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate” (Suchman, 1995: 574). If an organizational activity is considered legitimate, the environment of an organization does not question it. Legitimacy is a status conferred by others. Hence, it presents no specific resource that co-exists with others. Legitimacy presents a prerequisite enabling organizations to attain resources (Suchman, 1995). Several sources of legitimacy have been identified. Next to society-at-large and the media, organizations and their linkages play a crucial role. An organization is able to legitimize its activities by engaging with other organization that are

considered legitimate. Due to “many common sources of legitimacy are themselves organizations” (Deephouse & Suchman, 2008: 57), interorganizational relations are thus crucial for legitimacy (Deephouse & Suchman, 2008).

To gain and maintain legitimacy for organizational activities by appealing to other organizations, institutions are decisive. Those organizations “that incorporate societally legitimated rationalized elements in their formal structures maximize their legitimacy” (Meyer & Rowan, 1977: 352). In other words, if an organization follows institutions and adapts them formally, legitimacy becomes more likely. In practice, adhering to institutions mainly takes the form of adopting ideas and expectations of already legitimized organizations (Suchman, 1995). For example, a firm starts an accelerator program because a number of leading universities and firms have had similar programs in place.

Early sociological institutional theory gave organizations little room to maneuver and thus conceptualized them as passive reactors to institutional pressures. But more recent work demonstrates that organizations have means available to manage institutional pressures (Alexy, et al, 2013; Lawrence, 1999; Oliver, 1991; Pache & Santos, 2010). An organization aims at managing institutional demands if they cause problems. Basically, two general problems can arise (Meyer & Rowan, 1977). First, institutional demands are at odds with the efficiency of organizational activities. For example, the demand to closely observe environmental safety concerns in research leads to high additional costs. Second, organizations tend to not fully follow institutional demands if different institutional expectations conflict with each other. For example, the demand by science to open up a firm’s knowledge base is not fully compatible with the expectations of shareholders to have a strong protection of intellectual property rights. To address these tensions, strategies can be used.

#### *4.2. Strategies and tactics*

The previous discussion provides us with three main insights. First, legitimacy functions indirectly. It does not represent a resource to be directly obtained but is a prerequisite so that

organizational activities such as circulating knowledge can work. Second, legitimacy enables addressing the issue how to increase the chance that knowledge of other organizations is considered useful: This different knowledge has to be considered as legitimate knowledge. One means to achieve this is to legitimize the organizational activity that is linked to how the knowledge is diffused. Third, attaining legitimacy for an organizational activity that deviates from institutional expectations leads to tensions. Addressing these tensions is the focus of the following strategies that target institutions.

Institution-centered strategies aim at creating legitimacy for the organizational activities to circulate diffusing knowledge. They rest upon the strategies and tactics that Oliver (1991) developed to understand how organizations strategically respond to institutional pressures. I modify these insights, which are still a major source of inspiration for contemporary institutional theory (Pache & Santos, 2010), to fit the setting of a Triple Helix. Similar to the network-centered strategies, institution-centered strategies vary in terms of complexity. What follows is a description and illustration of each strategy and its tactics as summarized in Table 3.

--- TABLE 3 ABOUT HERE ---

#### 4.2.1. Acquiescence

The tactics of this strategy lead to a passive adherence of institutional demands and thus do not challenge institutions. *Habit* refers to unconscious adaption of organizational activities. Hence, an organization has activities of circulating diffusing knowledge in place which are taken for granted. For example, a firm has an R&D department in place responsible for all knowledge-related activities in that firm.

The tactic *imitate* denotes the way an organization mimics common organizational activities for the circulation of diffusing knowledge. For example, a firm has setup positions such as head of R&D, principal investigator, or chief science officer.

*Comply* refers to the “conscious obedience to or incorporation of values, norms, or institutional requirements” (Oliver, 1991: 152). For the setting of a Triple Helix, an organization accepts common rules and norms of how to circulate diffusing knowledge. For example, a firm puts a special emphasis on a fit in terms of scientific disciplines and the status of the university of graduation when recruiting knowledge workers since this presents a ‘gold standard’ for highly qualitative scholarly output.

#### 4.2.2. Compromise

The tactics of the strategy *compromise* “represent the thin edge of the wedge in organizational resistance to institutional pressures” (Oliver, 1991: 153). Contrary to the tactics of the strategy acquiescence, the organization reacts to institutional expectations by not fully conforming. The tactic *balance* intends “to achieve parity among or between multiple stakeholders and internal interests” (Oliver, 1991: 153). In a Triple Helix, an organization balances the expectations with regard to its involvement in the circulation of diffusing knowledge. For example, a firm engages only in scientific projects that do not require disclosing information about its core technology.

The objective of *pacify* is to correspond to institutional expectation by fulfilling only minimal requirements. Hence, the nonconforming activity is adapted only to a necessary degree. For example, a firm engages in a research project together with a university that is thematically close to its core technology but discloses knowledge only to few faculty members and upon request.

The tactic *bargain* refers to a rather active form of how organizations compromise. An organization negotiates the activity in question, in the Triple Helix context its involvement in the circulation of diffusing knowledge. For example, a firm negotiates with a university the intellectual property rights of a collaborative project.

#### 4.2.3. Avoidance

The essence of avoidance tactics is to “preclude the necessity of conformity” (Oliver, 1991: 155) with institutional expectations. The tactic *conceal* disguises nonconforming organizational activities. For the Triple Helix, this describes how the circulation of diffusing knowledge actually happens. For example, a firm shields its actual involvement in knowledge circulation by publishing generic descriptions of these activities in reports and on websites.

*Buffer* refers to the tactic that aims at reducing how externals can inspect or evaluate organizational activities. Such can be achieved by detaching an actual activity such as circulating diffusing knowledge from the formal structure of the organization. For example, a firm defines the business development department, which is rather detached from the knowledge-producing departments, as main contact for externals interested in a collaborative research project.

The use of the tactic *escape* leads the organization to exit the coverage of the institutional pressure that it currently faces. For an innovation system, this strategy alters the organizational activity of how knowledge is circulated. For example, a firm starts to engage with contract research organizations instead of continuing collaborations with universities.

#### 4.2.4. Defiance

The tactics of the strategy defiance present an even more active form of resisting institutional expectations. *Dismiss* is about deliberately ignoring institutional rules and values. In the setting of a Triple Helix, organizations use nonconforming activities to circulate diffusing knowledge without concealing them. For example, to nurture the innovative potential of their projects, a firm advertises vacancies that explicitly do not require a close fit in scientific disciplines.

The tactic *challenge* takes the resistance one step further. Not only does it not conceal the nonconforming activity, but also articulates it as superior to existing ones. For example, a firm claims that its policy of recruiting from distant scientific disciplines yields better innovation than collaborating with academics from the same discipline.

*Attack* refers to the most aggressive form of defiance. An organization targets the sources of the organizational activity in question. In the setting of a Triple helix, it targets the source that defines what the activity of circulating diffusing knowledge should look like. For example, a firm appeals to government agencies to favor grant applications with applicants with interdisciplinary background.

#### 4.2.5. Manipulation

The tactics of the manipulation strategy represent the most active approach towards institutions and intend “to actively change or exert power over the content of the expectations themselves or the sources that seek to express or enforce them” (Oliver, 1991: 157). The tactic *co-opt* targets the source of the institutional expectation that is coopted. An organization allies with influential actors that are important for how the overall circulation of diffusing knowledge in the Triple Helix takes place. For example, a firm invites former government officials to join their board or management.

*Influence* refers to a broader attempt to manipulate institutional expectations. For an innovation system, the organization attempts to shape what is considered a standard activity for the circulation of diffusing knowledge. A major means of this tactic is lobbying. For example, a firm leads a group of firms that strive to convince universities to also adapt their advocated policy of recruiting from distant scientific disciplines.

*Control* describes the “specific efforts to establish power and dominance over the external constituents that are applying pressure on the organization” (Oliver, 1991: 158). Within an innovation system, an organization that uses this tactic seeks to become the source that defines the activities to circulate diffusing knowledge. For example, a firm arranges for a familiar law firm to be consulted by the government when changing the guidelines for research grants.

## **5. Selection of network-centered and institution-centered strategies**

The previous sections aimed to provide an overview of the strategies that an organization can use to benefit from the diffusing knowledge of a Triple Helix focusing on industry-university interaction. However, as Valente (2012) and Oliver (1991) emphasize, not every organization is able to use any strategy. To address this issue, I suggest a flow chart supporting the selection of strategies in each set. It incorporates three main factors that impact the use of both strategy sets: data availability, organization-system fit, and impact of misfit. These factors consider suggestions from the major sources of each strategy set (Oliver, 1991; Valente, 2012) and reflect the specifics of an innovation system. Note however that, given the breadth of each strategy set, these three factors do not represent determinants that allow predictions for strategy selection. These factors and deriving suggestions for strategies in the flow chart depicted in Figure 2 inform about basic forces that shape the selection of strategies. In the remainder of the section, I discuss the factors, specifically how to empirically analyze them, and how they are linked to the strategies.

--- FIGURE 2 ABOUT HERE ---

At first glance, the factor *data availability* seems to point to a merely academic issue. However, sufficient data is vital to using both strategy sets. In particular the efficacy of network-centered theories rests upon the availability of sufficient network data. The first step to acquiring such data is to specify the boundaries of an innovation system (Laumann, Marsden, & Prensky, 1983). In the next step, data on the structure of the network of the Triple Helix can be collected. While surveys are an important method (Marsden, 2011), sources for secondary data are also available. For industry, annual reports, media reports, websites, or industry reports can provide the grounds on which to construct a network based on secondary data. For the intersection of universities and government, information on publicly funded research projects is increasingly becoming available through the websites of the funding agencies. However, as Valente (2012) notes, both primary and secondary sources face the problem that organizations may not want to disclose information on interorganizational

relationships because of fears that their status would be jeopardized. This fact needs to be borne in mind when analyzing networks. A recent discussion of software available for analyzing networks and using the outlined concepts of social network theory is offered by Huisman and van Duijn (2011).

Some of the data underpinning the analysis of networks can also be used to analyze institutions. Drawing upon Schneiberg and Clemens (2006), four groups of effects can be focused on to approximate the effects of institutions. First, direct ties to core positions provide hints for which organizations define the ‘normal’ organizational activity to diffuse knowledge. Second, indirect ties to – or conduits for – organizations that spread institutional pressures can provide information. Third, aspects such as visibility – i.e. how ‘well known’ organizations are – to institutional pressures can be analyzed. This highlights the likelihood of how organizations are influenced by institutions. Finally, an analysis can focus on the degree of certifications and accreditations that are relevant for innovation. These four sources can be tapped in order to develop a broader picture of which institutions are currently effective in an innovation system.

The second factor *organization-system fit* draws upon the notion of a fit between organizational properties and the external environment (Lawrence & Lorsch, 1967). This factor addresses whether there is a gap between the state of diffusing knowledge an organizations aims for and its actual state within the innovation system. To select network-centered strategies, this results in asking if the network position of the organization enables it to circulate the diffusing knowledge it aims for. This judgment is made relative to the organization. For example, while one organization considers a position at the core of a network enabling a high flow of knowledge as highly favorable, another organization might aim for a position at the periphery. To select institution-centered strategies, it needs to be asked if the expectations of the identified institutions are at odds with the organizational activities that are in place to circulate diffusing knowledge.

The third factor, *impact of misfit*, points the attention to how a misfit between organization and system affects the organization. To select network-centered strategies, it needs to be asked whether closing the previously identified gap between the organizational position in the network and its aimed diffusing knowledge is worth closing or not. In other words, the question is whether the aimed diffusing knowledge is essential for the organization. The selection of institution-centered strategies is guided by the question whether the organizational activity to circulate diffusing knowledge that does not fully conform to institutional expectations needs to be legitimized.

The properties of these factors enable us to capture the rationale of the flow chart. It is orientated towards the level of complexity that is involved in using a strategy. As illustrated in the respective sections above, the complexity of strategies in each set ranges from very low to very high. Lowly complex strategies imply little efforts or a passive behavior of organizations, whereas strategies of higher complexity imply high efforts and an active behavior. In the flow chart in Figure 2, the strategies at the upper and lower left represent the least complex strategies of each set. Those on the upper and lower right represent the most complex ones.

The sequence of the three factors is linked to the complexity of the strategies and is based on the consequences and preconditions of each factor. Having a sufficient amount of data available is crucial for the selection in general, which justifies putting the factor data availability in first place. Based on available data, it can then be identified and compared whether an organization-system fit is at hand or not. If there is a fit, the situation by and large is satisfactory for the organization and may need only minor adjustments. If a misfit is identified, a more drastic change is likely. The degree of this change is specified by focusing on the impact of this misfit. If it is essential for the organization to alter the misfit, then the most complex strategies seem appropriate. If not, i.e. if only medium adjustments are

necessary, then less complex strategies also seem suitable. This rationale results in the suggestions to use strategies that are visualized as the endpoint of an arrow in Figure 2.

## **6. Discussion and implications**

This article focused on the activities with which an organization can benefit from the knowledge diffused in a Triple Helix. I suggested two strategy sets – or sets of intended organizational activities – for that purpose. Network-centered strategies aim at changing the circulation of the diffusing knowledge in accordance with an organization’s innovation capability. Institution-centered strategies strive for a legitimacy of the organizational activities to circulate diffusing knowledge. Both strategy sets were illustrated focusing on the industry-university interaction. The selection of strategies in both sets is informed by the impact of the factors data availability, organization-system fit, and impact of misfit.

### *6.1. Contributions and limitations*

The presented theoretical arguments drawing upon social network theory and sociological institutional theory and focusing on the interorganizational level contribute to the study of innovation systems in several ways. First, the interorganizational perspective on organizational activities with regard to the diffusing knowledge in innovation systems complements insights that were gained on the organizational level (Cohen & Levinthal, 1990; Johnson, 2008; Wallin & von Krogh, 2010). This focus allows for a better understanding of how organizations of an innovation system utilize external knowledge and interact with each other.

Second, the work contributes to a more comprehensive understanding of how organizations in the setting of an innovation system strategically act. Given that organizations represent a major driving force of an innovation system (Edquist, 2006; Ranga & Etzkowitz, 2013), such a systematic view on organizational activities considering the specifics of an innovation system is highly relevant.

Third, by simultaneously encompassing social network theory and sociological institutional theory, this paper answers the call to consider the recursive nature of networks and institutions when studying organizational activities (Owen-Smith & Powell, 2008). To the knowledge of the author, a similar combination of these theories to study organizational activities in the setting of an innovation system has so far not been undertaken. Given that networks and institutions represent one of the most powerful social structures that shape how organizations behave (Beckert, 2010; Fligstein & McAdam, 2012), such an overview is of high value for both research and managerial practice.

This work is not without limitations. To provide a clear picture of the suggested strategies, this interorganizational analysis was simplified in three ways. First, the focus was placed on diffusing knowledge. This left out the fact that innovation systems also affect how organizations produce and apply knowledge. It can be expected that the use of the suggested strategies will also alter the organizational capability to produce and apply knowledge.

Second, organizational activities were focused on with a special emphasis on the setting of an innovation system. However, the efficacy of the strategies is not only dependent on the factors that underpin the flow chart for strategy selection. Several other external and internal factors come into play as well. Major external factors include, for example, the overall network structure aside from innovation activities and the degree to which organizations are engaging in political struggles (Fligstein & McAdam, 2012). Major internal factors affecting the efficacy of strategies are available resources (Barney, 1991) and the organizational capabilities to reconfigure these resources (Teece, Pisano, & Shuen, 1997).

Third, the strategies centered on the specific setting of a Triple Helix. Given that other variants such as national systems of innovation (Nelson, 1993), sectoral systems of innovation (Malerba, 2002), and regional systems of innovation (Cooke et al., 1997) differ from the Triple Helix model, accordingly, the scope of the strategies may also differ.

## *6.2. Implications for further research*

This conceptual work provides several points of departure for future research. The next logical step is to empirically inquire into the prevalence of the strategies suggested here. The strategies could be operationalized to measure which of them are dominant and which are not. It would also be of interest to search for possible patterns in the selection of strategies and thus to uncover possible configurations of strategies. In a similar vein, comparative studies focusing on differences and similarities with respect to the overall strategy selection could be conducted. They might draw upon variation criteria such as the nation (Nelson, 1993), technological sectors (Malerba, 2002), regions (Cooke et al., 1997), or culture (Cai, 2014) in question. There could also be historical analyses investigating which strategies have been used by organizations which are currently successful. Universities provide a valuable case in point for such inquiries (Etzkowitz, 2008). Moreover, qualitative studies that dig deeper into the subtleties of the strategies to benefit from the knowledge of innovation system could be conducted. Such exploratory research might reveal new strategies.

Another strand of research could aim at enriching the basic ideas presented in this work. Network-centered strategies might be extended by considering the effects of the quality of relationships (Gilsing & Duysters, 2008). Moreover, next to the here centered structural level of networks, the cognitive level, which includes aspects such as shared codes and language, and the relational level, which encompasses aspects such as trust and norms, could be added (Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 1998). Institution-centered strategies may be complemented by asking how organizations appeal to third parties, such as stakeholders (Levén et al., 2014), to indirectly affect the legitimacy of the organizational activities circulating diffusing knowledge. The enrichments could also encompass investigations on how the use of strategies interacts with innovation performance. One could expect that very active organizations, i.e. those that use strategies of higher complexity, outperform very passive organizations in terms of innovation output.

Another interesting direction to pursue is to ask how organizations react to the use of strategies. As Hernandez, et al. (2014) found, organizations group to defend the knowledge of their network from intervention by third parties. This demonstrates that organizations are likely to react to strategic activities such as those proposed here. Furthermore, scholars could study the organizational design needed to effectively execute strategies.

### *6.3. Implications for decision makers*

The tactics of network-centered strategies and institution-centered strategies provide decision makers in firms, universities, and government agencies with a fresh and ‘unusual’ perspective on organizational activities in an innovation system. The proposed perspective allows understanding of the fact that seemingly irrational and contradicting organizational activities may be triggered by conflicts in terms of the underlying network structure or institutional pressure. This enables decision makers to attain a more complete picture on organizational activities in innovation systems beyond the management of concrete projects (Johnson, 2009; Levén et al., 2014). The perspective thus also allows a reflection – or evaluation – of the state of an innovation system that goes beyond metrics and thus can provide a foundation for a visionary development of the innovation system.

But day-to-day operations are also likely to benefit from the presented insights. The two strategy sets can be considered as cognitive instruments that, similar to a business model, enable managers in industry and academia to better understand how elements in the environment are connected to the organizational capability to benefit from the knowledge of an innovation system (Baden-Fuller & Mangematin, 2013). Furthermore, policy makers are provided with the means to better understand – and intervene in – how organizations in an innovation system act.

The study of how organizational activities in an innovation system are related to the production, diffusion, and application of knowledge is a complex terrain that remains to be

explored in multiple ways. This paper and its focus on intended organizational activities linked to diffusing knowledge attempted to shed some light on one path through this terrain.

## References

- Alexy, O., George, G., & Salter, A. J. 2013. Cui bono? The selective revealing of knowledge and its implications for innovative activity. *Academy of Management Review*, 38(2): 270-291.
- Ankrah, S. N., Burgess, T. F., Grimshaw, P., & Shaw, N. E. 2013. Asking both university and industry actors about their engagement in knowledge transfer: What single-group studies of motives omit. *Technovation*, 33(2-3): 50-65.
- Asheim, B. T. & Gertler, M. S. 2006. The geography of innovation: Regional innovation systems. In R. R. Nelson & D. C. Mowery & J. Fagerberg (Eds.), *The Oxford handbook of innovation*: 291-317. Oxford: Oxford University Press.
- Autant-Bernard, C., Fadaïro, M., & Massard, N. 2013. Knowledge diffusion and innovation policies within the European regions: Challenges based on recent empirical evidence. *Research Policy*, 42(1): 196-210.
- Baden-Fuller, C. & Mangematin, V. 2013. Business models: A challenging agenda. *Strategic Organization*, 11(4): 418-427.
- Barney, J. 1991. Firm resources and sustained competitive advantage. *Journal of Management*, 17(1): 99-120.
- Beckert, J. 2010. How do fields change? The interrelations of institutions, networks, and cognition in the dynamics of markets. *Organization Studies*, 31(5): 605-627.
- Bekkers, R. & Bodas Freitas, I. M. 2008. Analysing knowledge transfer channels between universities and industry: To what degree do sectors also matter? *Research Policy*, 37(10): 1837-1853.
- Bjerregaard, T. 2010. Industry and academia in convergence: Micro-institutional dimensions of R&D collaboration. *Technovation*, 30(2): 100-108.
- Bodas Freitas, I. M., Geuna, A., & Rossi, F. 2013. Finding the right partners: Institutional and personal modes of governance of university-industry interactions. *Research Policy*, 42(1): 50-62.
- Broström, A. 2010. Working with distant researchers: Distance and content in university-industry interaction. *Research Policy*, 39(10): 1311-1320.
- Bruneel, J., D'Este, P., & Salter, A. 2010. Investigating the factors that diminish the barriers to university-industry collaboration. *Research Policy*, 39(7): 858-868.
- Burt, R. S. 1992. *Structural holes. The social structure of competition*. Cambridge: Harvard University Press.
- Burt, R. S. 2004. Structural holes and good ideas. *American Journal of Sociology*, 110(2): 349-399.
- Cai, Y. 2014. Implementing the triple helix model in a non-western context: An institutional logics perspective. *Triple Helix*, 1(1): 1-20.
- Chesbrough, H. 2003. *Open innovation: The new imperative for creating and profiting from technology*. Boston: Harvard Business School Press.
- Cohen, W. M. & Levinthal, D. A. 1990. Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35(1): 128-152.
- Cooke, P., Gomez Uranga, M., & Etxebarria, G. 1997. Regional innovation systems: Institutional and organisational dimensions. *Research Policy*, 26(4-5): 475-491.
- Deephouse, D. L. & Suchman, M. C. 2008. Legitimacy in organizational institutionalism. In R. O. Greenwood, Christine; Sahlin, Kerstin; Suddaby, Roy (Eds.), *The Sage handbook of organizational institutionalism*: 49-77. Thousand Oaks: Sage.
- Dhanasai, C. & Parkhe, A. 2006. Orchestrating innovation networks. *Academy of Management Review*, 31(3): 659-669.
- Edquist, C. 2006. Systems of innovation: Perspectives and challenges. In R. R. Nelson & D. C. Mowery & J. Fagerberg (Eds.), *The Oxford handbook of innovation*: 181-208. Oxford: Oxford University Press.
- Etzkowitz, H. & 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(2): 109-123.

- Etzkowitz, H. 2003. Innovation in innovation: The triple helix of university-industry-government relations. *Social Science Information*, 42(3): 293-337.
- Etzkowitz, H. 2008. *The triple helix. University-industry-government innovation in action*. New York: Routledge.
- Etzkowitz, H. & Viale, R. 2010. Polyvalent knowledge and the entrepreneurial university: A third academic revolution? *Critical Sociology*, 36(4): 595-609.
- Fligstein, N. & McAdam, D. 2012. *A theory of fields*. New York: Oxford University Press.
- Fontana, R., Geuna, A., & Matt, M. 2006. Factors affecting university-industry R&D projects: The importance of searching, screening and signalling. *Research Policy*, 35(2): 309-323.
- Fourcade, M. 2007. Theories of Markets and Theories of Society. *American Behavioral Scientist*, 50(8): 1015-1034.
- Freeman, C. 1995. The 'national system of innovation' in historical perspective. *Cambridge Journal of Economics*, 19(1): 5-24.
- Fuenfschilling, L. & Truffer, B. 2014. The structuration of socio-technical regimes: Conceptual foundations from institutional theory. *Research Policy*, 43(4): 772-791.
- Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M. (Eds.). 1994. *The new production of knowledge*. London: Sage.
- Gilsing, V., Bekkers, R., Bodas Freitas, I. M., & van der Steen, M. 2011. Differences in technology transfer between science-based and development-based industries: Transfer mechanisms and barriers. *Technovation*, 31(12): 638-647.
- Gilsing, V. A. & Duysters, G. M. 2008. Understanding novelty creation in exploration networks: Structural and relational embeddedness jointly considered. *Technovation*, 28(10): 693-708.
- Greenwood, R., Oliver, C., Sahlin, K., & Suddaby, R. (Eds.). 2008. *The Sage handbook of organizational institutionalism*. Los Angeles: Sage.
- Hargadon, A. 2003. *How breakthroughs happen: The surprising truth about how companies innovate*. Boston: Harvard Business School Press.
- Hemphälä, J. & Magnusson, M. 2012. Networks for innovation – but what networks and what innovation? *Creativity and Innovation Management*, 21(1): 3-16.
- Hernandez, E., Sanders, W. G., & Tuschke, A. 2014. Network defense: Pruning, grafting, and closing to prevent leakage of strategic knowledge to rivals. *Academy of Management Journal*.
- Huisman, M. & van Duijn, M. A. J. 2011. A reader's guide to SNA software. In J. Scott & P. J. Carrington (Eds.), *The Sage handbook of social network analysis*: 578-600. London: Sage.
- Inkpen, A. C. & Tsang, E. W. K. 2005. Social capital, networks, and knowledge transfer. *Academy of Management Review*, 30(1): 146-165.
- Jensen, M. B., Johnson, B., Lorenz, E., & Lundvall, B. Å. 2007. Forms of knowledge and modes of innovation. *Research Policy*, 36(5): 680-693.
- Johnson, D. J. 2009. *Managing knowledge networks*. Cambridge: Cambridge University Press.
- Johnson, W. H. A. 2008. Roles, resources and benefits of intermediate organizations supporting triple helix collaborative R&D: The case of precarn. *Technovation*, 28(8): 495-505.
- Knorr Cetina, K. 1999. *Epistemic cultures: How the sciences make knowledge*. Cambridge: Harvard University Press.
- Lane, P. J., Koka, B. R., & Pathak, S. 2006. The reification of absorptive capacity: A critical review and rejuvenation of the construct. *Academy of Management Review*, 31(4): 833-863.
- Laranja, M. 2009. The development of technology infrastructure in Portugal and the need to pull innovation using proactive intermediation policies. *Technovation*, 29(1): 23-34.
- Larédo, P. 2003. Six major challenges facing public intervention in higher education, science, technology and innovation. *Science and Public Policy*, 30(1): 4-12.
- Laumann, E. O., Marsden, P. V., & Prensky, D. 1983. The boundary specification problem in network analysis. In R. S. Burt & M. J. Minor (Eds.), *Applied network analysis. A methodological introduction*: 18-34. Beverly Hills: Sage.
- Lawrence, P. R. & Lorsch, J. W. 1967. *Organization and environment. Managing differentiation and integration*. Boston: Harvard Business School Press.
- Lawrence, T. B. 1999. Institutional strategy. *Journal of Management*, 25(2): 161-187.
- Levén, P., Holmström, J., & Mathiassen, L. 2014. Managing research and innovation networks: Evidence from a government sponsored cross-industry program. *Research Policy*, 43(1): 156-168.

- Leydesdorff, L. & Etzkowitz, H. 1996. Emergence of a triple helix of university-industry-government relations. *Science and Public Policy*, 23(5): 279-286.
- Leydesdorff, L. & Etzkowitz, H. 1998. The triple helix as a model for innovation studies. *Science and Public Policy*, 25(3): 195-203.
- Malerba, F. 2002. Sectoral systems of innovation and production. *Research Policy*, 31(2): 247-264.
- Marsden, D. V. 2011. Survey methods for network data. In J. Scott & P. J. Carrington (Eds.), *The sage handbook for social network analysis*: 370-388. Los Angeles: Sage.
- Merton, R. K. 1973 [1942]. The normative structure of science. In R. K. Merton (Ed.), *The sociology of science. Theoretical and empirical investigations*: 267-278. Chicago: The University of Chicago Press.
- Meyer, J. W. & Rowan, B. 1977. Institutionalized organizations. Formal structure as myth and ceremony. *American Journal of Sociology*, 83(2): 340-363.
- Moll, J. & Hoque, Z. 2011. Budgeting for legitimacy: The case of an Australian university. *Accounting, Organizations and Society*, 36(2): 86-101.
- Nag, R., Hambrick, D. C., & Chen, M.-J. 2007. What is strategic management, really? Inductive derivation of a consensus definition of the field. *Strategic Management Journal*, 28(9): 935-955.
- Nahapiet, J. & Ghoshal, S. 1998. Social capital, intellectual capital, and the organizational advantage. *Academy of Management Review*, 23(2): 242-266.
- Nelson, R. R. (Ed.). 1993. *National systems of innovation: A comparative study*. Oxford: Oxford University Press.
- Oliver, C. 1991. Strategic responses to institutional processes. *Academy of Management Review*, 16(1): 145-179.
- Owen-Smith, J. & Powell, W. W. 2008. Networks & institutions. In R. Greenwood & C. Oliver & K. Sahlin & R. Suddaby (Eds.), *The Sage handbook of organizational institutionalism*: 594-620. Thousand Oaks: Sage.
- Pache, A.-C. & Santos, F. 2010. When worlds collide: The internal dynamics of organizational responses to conflicting institutional demands. *Academy of Management Review*, 35(3): 455-476.
- Padula, G. 2008. Enhancing the innovation performance of firms by balancing cohesiveness and bridging ties. *Long Range Planning*, 41(4): 395-419.
- Park, H. W. & Leydesdorff, L. 2010. Longitudinal trends in networks of university-industry-government relations in south korea: The role of programmatic incentives. *Research Policy*, 39(5): 640-649.
- Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'Este, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A., Krabel, S., Kitson, M., Llerena, P., Lissoni, F., Salter, A., & Sobrero, M. 2013. Academic engagement and commercialisation: A review of the literature on university-industry relations. *Research Policy*, 42(2): 423-442.
- Perry-Smith, J. E. & Shalley, C. E. 2003. The social side of creativity: A static and dynamic social network perspective. *Academy of Management Review*, 28(1): 89-106.
- Petruzzelli, A. M. 2011. The impact of technological relatedness, prior ties, and geographical distance on university-industry collaborations: A joint-patent analysis. *Technovation*, 31(7): 309-319.
- Powell, W. W. & Grodal, S. 2006. Networks of innovators. In R. R. Nelson & D. C. Mowery & J. Fagerberg (Eds.), *The Oxford handbook of innovation*: 56-85. Oxford: Oxford University Press.
- Ranga, M. & Etzkowitz, H. 2013. Triple helix systems: An analytical framework for innovation policy and practice in the knowledge society. *Industry and Higher Education*, 27(4): 237-262.
- Rogers, E. M. 1962. *Diffusion of innovations*. New York: Free Press of Glencoe.
- Schneiberg, M. & Clemens, E. S. 2006. The typical tools for the job: Research strategies in institutional analysis. *Sociological Theory*, 24(3): 195-227.
- Scott, J. 2000. *Social network analysis. A handbook* (2 ed.). Los Angeles: Sage.
- Scott, W. R. 2001. *Institutions and organizations* (2 ed.). Thousand Oaks: Sage.
- Suchman, M. C. 1995. Managing legitimacy: Strategic and institutional approaches. *Academy of Management Review*, 20(3): 571-610.
- Teece, D. J., Pisano, G., & Shuen, A. 1997. Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7): 509-533.
- Tether, B. S., Li, Q. C., & Mina, A. 2012. Knowledge-bases, places, spatial configurations and the performance of knowledge-intensive professional service firms. *Journal of Economic Geography*, 12(5): 969-1001.

- Thune, T. 2007. University-industry collaboration: The network embeddedness approach. *Science and Public Policy*, 34(3): 158-168.
- Van de Ven, A. H., Polley, D. E., Garud, R., & Venkataraman, S. 1999. *The Innovation Journey*. New York: Oxford University Press.
- Valente, T. W. 2010. *Social networks and health: Models, methods, and applications*. New York: Oxford University Press.
- Valente, T. W. 2012. Network interventions. *Science*, 337(6090): 49-53.
- Vallas, S. P. & Kleinman, D. L. 2008. Contradiction, convergence and the knowledge economy: The confluence of academic and commercial biotechnology. *Socio-Economic Review*, 6(2): 283-311.
- Wallin, M. W. & von Krogh, G. 2010. Organizing for open innovation: Focus on the integration of knowledge. *Organizational Dynamics*, 39(2): 145-154.
- Welsh, R., Glenna, L., Lacy, W., & Biscotti, D. 2008. Close enough but not too far: Assessing the effects of university–industry research relationships and the rise of academic capitalism. *Research Policy*, 37(10): 1854-1864.
- Zheng, W. 2010. A social capital perspective of innovation from individuals to nations: Where is empirical literature directing us? *International Journal of Management Reviews*, 12(2): 151-183.

Figure 1: Representation of a network (Modified from Powell & Grodal, 2006)

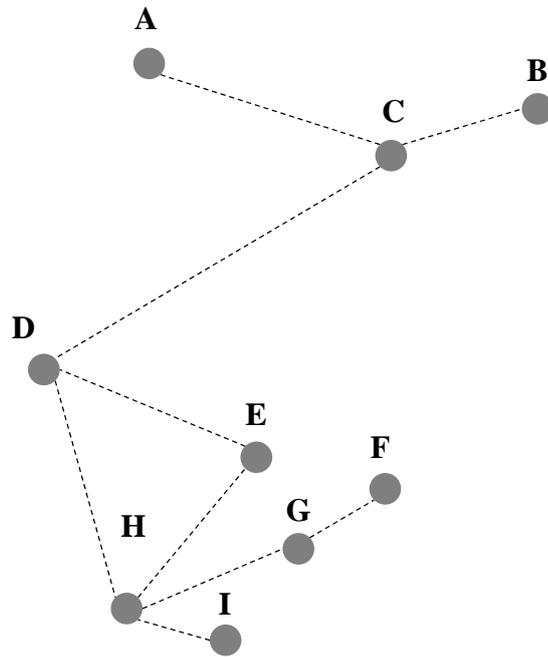


Table 1: Properties of strategy sets

<b>Network-centered strategies</b>	<b>Institution-centered strategies</b>
Concretize the solution “external relationships”	Concretize the solution “consideration of different social logics”
Respond to challenge of the circulation of diffusing knowledge (how to receive and send diffusing knowledge that is beneficial for innovation?)	Respond to challenge of the recognition of diffusing knowledge (how to realize different diffusing knowledge that is beneficial for innovation?)
Aim for changed circulation of diffusing knowledge	Aim for legitimacy of the organizational activity that circulates diffusing knowledge
Target structure of network of innovation system	Target institutions relevant for innovation system

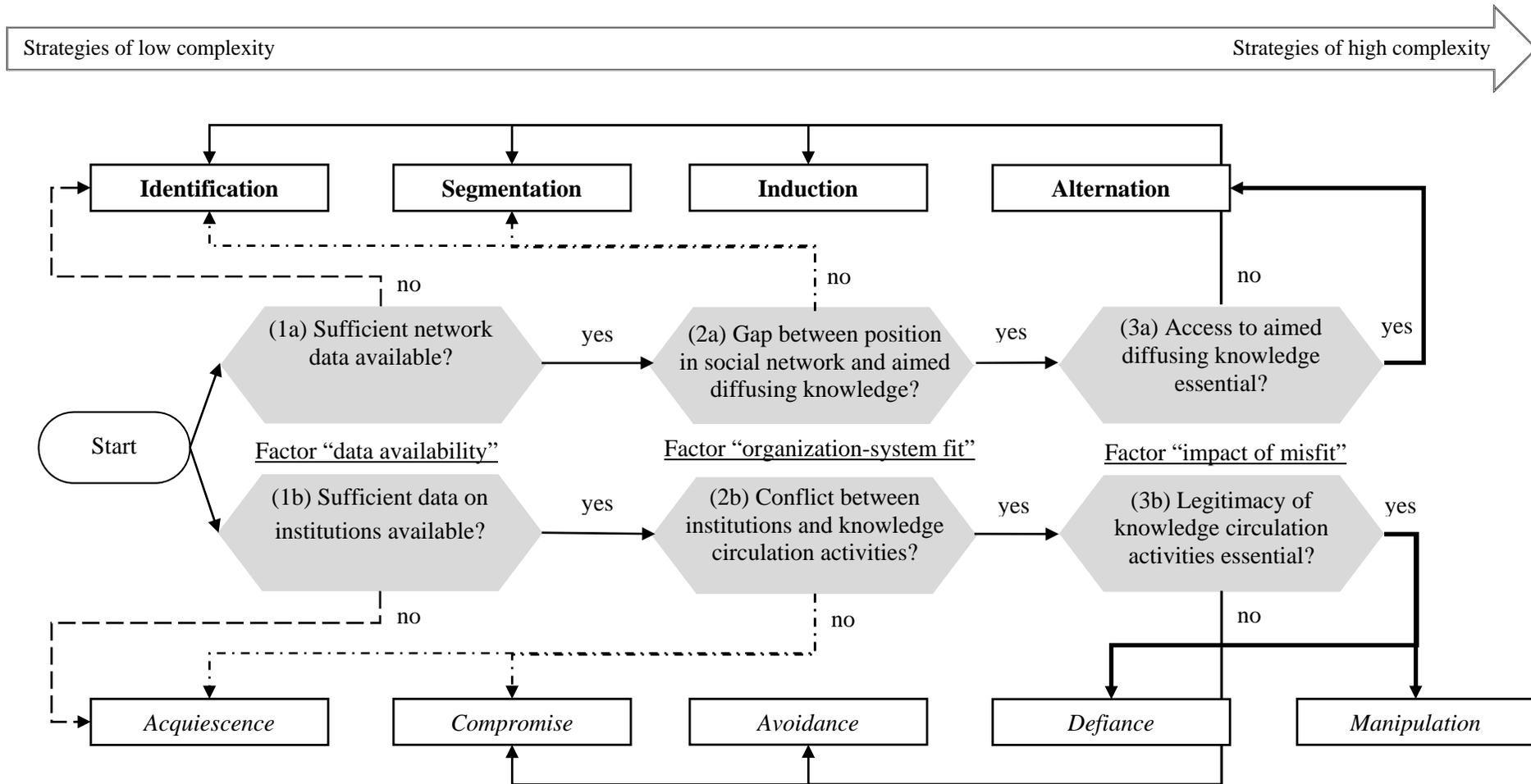
Table 2: Network-centered strategies and tactics (Modified from Valente, 2012)

<b>Strategies</b>	<b>Complexity</b>	<b>Tactics</b>	<b>Illustrations</b>
Identification	Lowest	Leader	Organization(s) that others nominate as important for circulation of diffusing knowledge
		Bridge	Organization(s) that bridge(s) a structural hole with respect to circulation of diffusing knowledge
		Peripheral	Organization(s) nearly detached from circulation of diffusing knowledge but with possible new ideas
Segmentation	Low	Groups	Organizations that are at the core and periphery of circulation of diffusing knowledge of a group
		Roles	Organizations that occupy the same roles with regard to circulation of diffusing knowledge
Induction	Medium	Word-of-mouth	Organization communicates with many others to create buzz about circulation of diffusing knowledge
		Outreach	Organization reaches out for organizations to promote circulation of diffusing knowledge
		Matching	Organizations are matched to organizations identified as leader to enhance circulation of diffusing knowledge
Alternation	High	Node Alternation	New organization that bridges circulation of diffusing knowledge nearly detached organizations is added / organization that occupies core for circulation of diffusing knowledge is removed
	Highest	Tie Alternation	New links between organizations are added / existing links between organizations are cut
		Rewiring	Overall set of organizations and links are changed, possibly new organizations are included

Table 3: Institution-centered strategies and tactics (Modified from Oliver, 1991)

Strategies	Complexity	Tactics	Illustrations
Acquiescence	Lowest	Habit	Organization has in place taken-for-granted activities for circulation of diffusing knowledge
		Imitate	Organization mimics common organizational activities for circulation of diffusing knowledge
		Comply	Organization accepts common criteria for circulation of diffusing knowledge
Compromise	Low	Balance	Organization balances expectations with regard to its circulation of diffusing knowledge
		Pacify	Organization adapts nonconforming activity for circulation of diffusing knowledge at minimum level
		Bargain	Organization negotiates its involvement in the circulation of diffusing knowledge
Avoidance	Medium	Conceal	Organization disguises nonconforming activity for circulation of diffusing knowledge
		Buffer	Organization detaches own circulation of diffusing knowledge from overall knowledge circulation
		Escape	Organization changes its involvement for circulation of diffusing knowledge
Defiance	High	Dismiss	Organization uses nonconforming activity for circulation of diffusing knowledge without concealing
		Challenge	Organization advocates its nonconforming activity for circulation of diffusing knowledge as better than existing ones
		Attack	Organization assaults sources that defines activities for circulation of diffusing knowledge
Manipulation	Highest	Co-opt	Organization allies with influential actors important for circulation of diffusing knowledge
		Influence	Organization attempts to shape overall activities for circulation of diffusing knowledge in a system
		Control	Organization attempts to become the source that defines activities for circulation of diffusing knowledge

Figure 2: Flow chart for strategy selection<sup>a</sup>



<sup>a</sup> Strategies in bold are network-centered strategies, strategies in italic are institution-centered strategies