Governance of open innovation networks with national vs. international scope

Thomas Clauss*
University of Marburg, Management and Innovative Value Creation, Universitätsstraße 25a, 35037 Marburg, Germany.
E-mail: thomas.clauss@wiwi.uni-marburg.de

Patrick Spieth
University of Kassel, Technology and Innovation Management, Noraplatz 4, 34109 Kassel, Germany.
E-mail: spieth@uni-kassel.de

* Corresponding author

Abstract:
As firms need to create new products or services continuously, particularly small and midsized enterprises are required to collaborate with different stakeholders in networks in order to share relevant knowledge, distribute risks and improve frequency and performance of new product developments. Extant research is very inconsistent regarding an optimal governance configuration. Based on a sample of 100 mechanical engineering firms involved in open innovation networks we investigate the combined effects of plural governance mechanisms (transactional, relational institutionalized) on joint innovation generation. Our study reveal a positive influence of all three governance mechanisms on joint innovation generation. However, we find different results between open innovation networks with national and those with international scope. While relational governance has only a positive significant effect on joint innovation generation in national networks, both transactional governance and institutionalized governance only become significant in networks with an international scope.

Keywords: open innovation networks, joint innovation generation, transactional governance, relational governance, institutionalized governance, open innovation

1 Introduction
In order to stay competitive, firms must continuously create new products or services. Especially small and midsized enterprises often struggle to achieve this challenge due to limited financial and knowledge resources (Huizingh, 2011). Companies are required to
collaborate with different stakeholders (key suppliers, customers and other strategic partners) in networks in order to share relevant knowledge, distribute risks and large-scale projects (Dooley and O'sullivan, 2007). Several studies show that firms which collaborate in inter-organisational networks can improve the frequency, novelty and performance of new product developments (Brass et al., 2004).

However, as networks are complex systems of interlinked firms, not all networks are successful or provide equal profits to its members (Enkel, 2010). The realization of joint innovation outcomes is closely related to an efficient coordination of network activities. Biemans (1990) states that while the existence of networks offers great opportunities the practice of networking involves some serious potential pitfalls and problems. Hence, network members are required to initiate effective governance mechanisms (Huizingh, 2011) which coordinate joint processes (e.g. knowledge sharing) and eliminate undesired behaviours (e.g. opportunism). As the complex effects of multiple governance approaches on outcomes of open innovation networks are not yet fully understood, the analysis of plural governance strategies for innovation networks provides fruitful insights for innovation management researchers and practitioners.

Previous research primarily focuses on two different types of inter-organisational governance mechanisms: transactional governance based on contracts, rules and procedures, and relational governance based on trust and social identification between individuals (Poppo and Zenger, 2002, Hoetker and Mellewigt, 2009, Cao and Lumineau, 2015). Transactional governance mechanisms define a mutually agreed upon range of acceptable behaviours. By defining procedures and actions of each party and monitoring of these, formal governance mechanisms help to mitigate potential opportunism and coordinate joint activities in a predefined way. Relational governance mechanisms mitigate opportunism and coordinate joint activities by building trust through repeated interactions and the development of a mutual understanding and common goals (Hoetker and Mellewigt, 2009). Besides the type of relational governance, a third type of network governance was recently introduced, namely the institutional governance by a separate functional unit responsible for an active network management (Heidenreich et al., 2014, Landsperger et al., 2012, Lee et al., 2010). This organizational entity can mitigate opportunism and orchestrate joint activities by the execution of hierarchical power and direct situational intervention.

Empirical studies reveal different types of interactions among formal and informal governance: substitutive (Li et al., 2010), complementary (Poppo and Zenger, 2002), and contextually dependent (Hoetker and Mellewigt, 2009, Cao and Lumineau, 2015). As the inconsistency of results regarding an optimal governance configuration is closely related to different contents and objectives of the particular innovation network (Hoetker and Mellewigt, 2009, Cao and Lumineau, 2015), no clear managerial implication can be given for the design of plural governance strategies. As this constitutes a relevant research gap, we intent to investigate the combined effects of plural governance mechanisms (transactional, relational institutionalized) on joint innovation generation. To capture contextual differences, we compare these effects between national and international open innovation networks.

To address the research gap and to provide implications for the design of plural governance mechanisms, our study addresses the following research question: Which governance mechanisms are best suited to foster the effectiveness of national and international open innovation networks? To address our research question, we draw on a large-scale survey based study of 100 mechanical engineering firms involved in open
innovation networks. We apply PLS structural equation modelling to test our hypotheses, as it provides robust results for the estimation of rather complex models with a sample size below 250.

The remainder of this article is organized as follows. The following section focuses on a literature review on open innovation in networks. Consequently, we derive our hypotheses on the three governance types (relational governance, formal governance, and institutional governance), joint innovation generation and moderating effects of international scope. We then explain our methodology, present our results, and discuss our results, concluding with implications of our study.

2 Literature Review: Open innovation in networks

Open Innovation has been defined as “the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation respectively” (Chesbrough et al., 2006: 1). From this perspective, open Innovation has long been primarily recognized as a paradigm comprised of two dimensions. (1) Inbound Open Innovation, the practice of establishing relationships with external knowledge sources with the purpose of accessing their technical/scientific competences for improving internal innovation performance; (2) Outbound Open Innovation, the practice of establishing relationships with external organizations with the purpose of commercially exploiting technological knowledge (Chiaroni et al., 2010).

This separated conceptualization however omits that the real potential of joint innovation activities among partners with complementary but different knowledge stores stems from the joint utilization, combination and creation of knowledge as a source of joint value creation (Johnson and Johnston, 2004, Dyer and Singh, 1998, Kale et al., 2000). Therefore a modern view of open innovation treats R&D as an open system (Chesbrough, 2006) and stresses the relevance of coupled processes, linking outside-in and inside-out flows of ideas by working within innovation networks of complementary companies (Gassmann and Enkel, 2006). This concept requires simultaneous internal and external knowledge management processes (Chesbrough, 2003c) to overcome prior research emphasizing a need to make “either-or” decisions about whether to perform specific knowledge management internally or externally (Lichtenthaler, 2011).

Firms are embedded in networks of partners (suppliers, competitors, customers, universities, etc.) that are connected by information and knowledge flows. Bargaining these sources can be regarded as a major source of competitive advantage (Dyer and Nobeoka, 2000). In line with this idea, open innovation research has to shift the focus from the management of a unidirectional transfer of knowledge to the effects of multidirectional knowledge flows among partners in open innovation networks (Gassmann and Enkel, 2004, Gassmann and Enkel, 2006).

Recent research has provided empirical evidence for the positive effects of networks on innovation generation of companies in terms of patent filing, product development, and time to market or entrance into new markets (Powell et al., 1996, Baum et al., 2003). Westergren (2011) shows that joint open innovation success cannot be comprehensively measured in terms of fulfilment of set targets (quality, time, costs), but also has to take the creation of mutual value and the development of trust and strong inter-organizational relationships into account. By co-creating value with other network actors, the innovating
A firm may open up the innovation process and insource ideas from the network and thus benefit from external knowledge while developing internally (Vanhaverbeke et al., 2008).

If firms want to develop innovations in tight connection to partners, innovation processes from idea generation to marketing have to be aligned with networks. The changing boundaries and the process of creating and maintaining partnership relations over time thus have to be strategically managed in order to maximize potential value and decrease potential risks (Vanhaverbeke and Cloodt, 2006, Maula et al., 2006, Lee et al., 2010). An open innovation network management has to select appropriate partners and networks (Simard and West 2006), (re)organize the process of knowledge transfer (Vanhaverbeke and Cloodt, 2006, Kale et al., 2000) and allocate and coordinate internal and external resources. Furthermore, coupled processes require simultaneous internal and external knowledge management processes (Chesbrough, 2003a). Not only structures’ openness, but also the individual’s openness correlates strongly with the degree to which a firm can profit from networking. An open environment that enables every member to contribute is important to profit from open innovation networks (Enkel, 2010). Continuous regulation and evaluation of the open innovation network members and outcomes are needed because empirical findings indicate that interactions of individuals in open innovation networks have significant influence on their firm’s innovation outcome (Enkel, 2010).

In order to align activities and contributions of members of open innovation networks, adequate governance mechanisms need to be developed. The role of governance is mainly twofold: control and coordination (Mellewigt et al., 2007, Lumineau and Malhotra, 2011). While control aims to minimize the risks of opportunism, coordination enables orchestrated activities and the deployment of complementary competences (Mesquita and Brush, 2008).

3 Hypotheses Development: The role of governance for joint innovation generation in open innovation networks

Governance mechanisms

Relational, transactional as well as institutionalized approaches to governance are usually analysed separately. Transactional governance studies have focused on the deployment of rules and contracts to safeguard transactions from opportunistic behaviour (Puranam and Vanneste, 2009, Williamson, 1999). These are specified in order to formalize processes, activities and roles, define responsibilities and justify consequences in case of disputes (Lumineau and Malhotra, 2011, Mayer and Teece, 2008). On the other hand, studies concerned with relational governance have taken the implicit functions of relationships into account. “Relational mechanisms emphasize inherent and moral control, governing exchanges through consistent goals and cooperative atmospheres” (Liu et al., 2009). Trust has been emphasized as a fundamental element of relational governance (Das and Teng, 1998). It has an even greater effect if relational norms between partners establish consistent role behaviours that are in line with partners’ joint interests (Dwyer et al., 1987, Tangpong et al., 2010). Institutionalized governance covers a separate functional unit responsible for an active network management (Heidenreich et al., 2014, Landsperger et al., 2012). Along with Heidenreich et al. 2014, a dedicated network manager represents such a single entity in an innovation network, entrusted with
orchestrating and controlling network relationships. Here, orchestration mentions activities that enable and facilitate the coordination of the network and the realization of the innovation outputs (Dhanaraj and Parkhe, 2006, Ritala et al., 2012, Ritala et al., 2009). The orchestrator is responsible for discretely influencing other firms and to support the appropriate conditions for knowledge exchange and innovation (Ritala et al., 2012).

Relational governance and joint innovation generation in open innovation networks

If members of organizational networks establish relational governance mechanisms, coordination and control of individual contributions relies on self-enforcing mechanisms that establish in the course of repeated interactions (Das and Teng, 1998, Puranam and Vanneste, 2009). Relational governance copes with opportunism through the establishment of trust and social bonds (Das and Teng, 1998, Mellewigt et al., 2007). When partners gain experiences about the behaviours of the other network members, confidence in the stability and future reliability of the network increases (Poppo et al., 2008). Coordination is ensured as partners develop consistent role behaviors capturing the members’ joint interests (Tangpong et al., 2010, Poppo and Zenger, 2002). Expectations of continuity of the network and mutual returns combined with low opportunism can stimulate knowledge transfers and a better understanding for each and the requirements of joint processes (Liu et al., 2009, Poppo and Zenger, 2002, Enkel, 2010). This facilitates an open sharing of ideas, joint problem solving and increased flexibility of joint activities. Especially regarding tasks with an increased complexity (e.g. innovation generation), the better understanding and flexibility help to coordinate partners in regard to joint effectiveness outcomes (Park and Ungson, 2001).

Relational attributes like trust were previously linked to network success (Brass et al., 2004) and more specifically open innovation in small and midsized firm (SME) networks (Lee et al., 2010). Rampersad et al. (2010) show that trust can positively influence harmony within company networks, leading to increased openness for knowledge sharing (Landsperger et al., 2012). Additionally, the individual’s openness correlates strongly with the degree to which a firm can profit from networking (Enkel 2010). We hypothesize:

Hypothesis 1: Relational governance positively affects innovation generation.

Transactional governance and joint innovation generation in open innovation networks

Transactional governance mechanisms rely on the precise specification and control of performance requirements, procedures and roles (Hoetker and Mellewigt, 2009). Opportunism is mitigated by limiting the individual scope of the partner to deviate from predefined procedures (Williamson, 1991). Concordance with these specifications is ensured by monitoring of results and concrete arrangements when disputes arise (Mellewigt et al., 2007, Lumineau and Malhotra, 2011). Coordination of network activities is ensured by precise definition of processes and interfaces. Network members
can specify clauses about delivery dates and reporting mechanisms in order to establish regular knowledge flows (Mayer and Argyres, 2004) or meetings (Landsperger et al., 2012). As contracts codify mutual expectations transactional governance, they allow network members to define specific performance criteria (Hoetker and Mellewigt, 2009). Certain activities can be outlined in detailed process blueprints, including measurable process indicators and process ownership (Mayer and Argyres, 2004).

Formalized transactional governance mechanisms were previously linked to network success (Landsperger et al., 2012), as they provide formal certainty about sharing of outcomes, behaviours and duration of the open innovation network. This certainty increase the likelihood that individual contributions are compensated adequately in terms of value appropriation in the future (Vanhaverbeke et al., 2008). Furthermore, formal conditions for intellectual property handling increase members’ willingness to share sensitive information and ideas (Enkel, 2010).

**Hypothesis 2: Transactional governance positively impacts on innovation generation.**

**Institutionalized governance and joint innovation generation in open innovation networks**

Institutionalized governance relies on the exertion of governance by a dedicated network management unit that can exert hierarchical power for coordination and control of the network (Lee et al., 2010, Heidenreich et al., 2014). As the reason for joint participation in open innovation networks is the aim to develop new products, services or processes together, having a person or organizational entity in place keeping track of network activities and interfering in case of imbalances, opportunistic behavior or misleading activities was identified as key advantage to company networks (Heidenreich et al., 2014, Landsperger et al., 2012). In order to achieve joint innovation, the context in networks has to satisfy all the participants (Huizingh, 2011). If a dedicated person or entity provides relevant information and orchestrates activities, certainty for all members of the open innovation network increases. The orchestrator is responsible for discretely influencing other firms and to support the appropriate conditions for knowledge exchange and innovation (Ritala et al., 2012). Ramersad et al. (2010) have shown that different key factors, such as coordination or communication, have a significant impact on network effectiveness in different industries. Hence, it is likely that effective network management, which includes factors such as communication and coordination, will improve the members’ commitment, which, in turn, will increase innovation generation (Malewicki, 2005).

**Hypothesis 3: Institutionalized governance influences innovation generation in open innovation networks positively.**

**Moderating effect of (inter-)national scope**

Meanwhile early research on open innovation primarily addressed the R&D process, internationalization receives an increasing attention (Gassmann et al., 2010). The focus on globalisation of innovation as open innovation becomes easier in terms of accessibility. New information and communication technologies enable virtual R&D
teams and decentralized innovation processes (Boutellier et al., 1998). In sum, many open innovation networks cross international boarders (De Meyer, 1993).

Networks that incorporate only members that are collaborating in one region or country have greater proximity in terms of physical distance, language and culture (De Meyer, 1993). Huggins and Johnston (2010) show that firms collaborating in the same region are more likely to build strong relationships. This can be linked to the way proximate firms work together. First, if firms are located close by, trust can be built through face-to-face interactions (Watts et al., 2003). Since the cooperating parties’ representatives get to know one another in person, they develop a deeper understanding of one another’s behaviour and reliability. In the course of reoccurring personal interactions, the partners can also assess one another’s trustworthiness precisely (Westlund and Bolton, 2003, Lorenzen, 2007). Huggins and Johnston (2010) show that firms collaborating in the same region are more likely to build strong relationships. This can be linked to the way proximate firms work together. First, if firms are located close by, trust can be built through face-to-face interactions (Watts et al., 2003). Since the cooperating parties’ representatives get to know one another in person, they develop a deeper understanding of one another’s behaviour and reliability. In the course of reoccurring personal interactions, the partners can also assess one another’s trustworthiness precisely (Westlund and Bolton, 2003, Lorenzen, 2007). Proximity is assumed to foster the transfer of knowledge between the partners (Lagendijk and Lorentzen, 2007). This is enabled through opportunities for personal interaction, but also because a congruent understanding among network partners can be established more efficiently if members speak the same language and interpret each other’s behaviours in the same cultural context. Whilst the transfer of codified knowledge is a straightforward process that can be utilized automatically via mail or telephone, personal interactions are crucial for the transfer of tacit knowledge (Asheim and Gertler, 2005). Transferring tacit knowledge requires special transmission channels and becomes increasingly costly with geographical distance (von Hippel, 1994). Gellner (1994) postulates that the dissemination of knowledge requires a social framework in which an open discourse about new ideas, as well as a joint investigation of problems can take place. Tacit knowledge incorporates not only process related know-how, but also the emergence of a shared meaning among the partners. In the course of an intense interaction-oriented relationship, partners learn to understand one another and how to interpret one another’s behaviour correctly. Firms in the same region or country develop implicit social norms and behavioural rules embedded in the social environment and specific to the community (Lorenzen, 2007). This leads to relationships in regional proximity having self-enforcing effects, since close interaction enables knowledge transfer, as well as the development of close ties (Iyer et al., 2005).

In sum, open innovation networks with a national scope provide a proper breeding ground for the development and effectiveness of relational governance mechanisms. Since proximity supports the development of common norms (Chesbrough, 2003a, Enkel, 2010, Vanhaverbeke and Cloodt, 2006), we assume that relational governance can fully govern open innovation networks with national scope:

\textbf{Hypothesis 4: The effect of relational governance on innovation generation increases (decreases) if the scope of the open innovation network is national (international).}

On the opposite, if a network internationalizes, members need to overcome barriers in terms of distance, culture and language in order to transfer relevant knowledge. As diversity increases, the credibility of knowledge is lower and the mutual understanding among network members is much more difficult to establish (De Meyer, 1993). This reduces the social stability and increases the complexity of the network. It becomes more difficult for members to establish self-enforcing relational mechanisms and norms to ensure coordination and control (Iyer et al., 2005). Especially in early stages of international network cooperation, degrees of social interaction are naturally low (Li et
Cao and Lumineau (2015) find significant differences in the effects of different governance mechanisms for different countries. Previous studies have shown that the lower the network’s stability is, the lower the network’s value creation capabilities are (Lorenzoni and Lipparini, 1999).

Considering this, international open innovation networks predominantly require mechanisms that are robust against complexity and culturally different interpretation but ensure coordination and control across boarders. As argued before, transactional governance mechanisms can a priori define the objectives of collaboration, time, quantity and costs of specific contributions, can assign roles and responsibilities (Mayer and Teece, 2008, Williamson, 1991, Liu et al., 2009) and therefore provides a reliable and clear structure to the interaction of dispersed members in international networks. Therefore, we hypothesise:

**Hypothesis 5:** The effect of transactional governance on innovation generation increases (decreases) if the scope of the open innovation network is international (national).

In line with the above argument, control of compliant behaviour within the network gains an increased importance in open innovation networks with an international scope. Single firms will find it difficult to control other members in international networks because of lower inter-organizational understanding and transparency. Especially as open innovation activities require a certain degree of flexibility as well as a transfer of tacit knowledge (Cavusgil et al., 2003, Enkel, 2010), institutionalized governance can complement limitations of static transactional mechanisms in international networks.

**Hypothesis 6:** The effect of institutionalized governance on innovation generation increases (decreases) if the scope of the open innovation network is international (national).

### 4 Methodology

#### Sample

To test our model, we collected survey-based data in the sensor technology industry. This industry is particularly appropriate to investigate open innovation networks. Most of the associated firms provide highly specialized products (i.e. sensors, measuring and testing technology) to large original equipment manufacturers in engineering and in particularly in the automobile industry. Therefore, many of them need organize in open innovation networks in order to bundle their competences and to cope with frequently changing demands of their buyers (Dodourova and Bevis, 2014, Narula, 2004). This is particularly relevant as partners in open innovation networks are necessary to exploit technology based business opportunities (Vanhaverbeke and Cloodt, 2006).

We personally surveyed exhibitors of the most relevant industry specific trade fair for this industry, the Sensor & Test, which was held in Germany in June 2014. We asked representatives at each stand if their company is currently a member of a company network. If yes, we further asked if a person is available and willing to take part in our survey that is knowledgeable about this network. Only if these criteria applied, companies were surveyed. Together, we collected a sample of 100 network members.
The sample is representative for the industry structure and covers mainly small and midsized firms. 47% employ up to 50, 31% between 51 and 500 and 12% more than 500 employees. These companies reported on networks with a median number of 10 network members, of which 33% had a national scope and 67% had an international scope.

We took relevant precautions in order to rule out potential bias effects and to ensure the validity of our data. First, we ensured that all respondents held a responsible position: 28% were from general management, 29% divisional leaders and 19% group or team leaders. As managers are generally more reliable in smaller companies (Homburg et al., 2012), key informant bias was not a serious issue. Second, we assessed potential non-response bias by comparing the companies in our sample to those who declined to participate in terms of size and product portfolio without finding significant differences. Third, we followed the recommendations of Podsakoff et al. (2012) in order to cope with common method bias: guaranteeing anonymity, selecting only experts in relevant positions and changing the order of dependent and independent variables in the survey. The Harman single factor test further substantiated that common method bias is not a serious issue in our data. A restricted principal component analysis of all indicators only explains 35.5% of the total variance, a non-restricted analysis with Kaiser criterion revealed seven factors.

Measures

We operationalized our model constructs based on validated multi-item scales whenever available. All items were measured based on five-point Likert scales ranging from 1=do not agree to 5= fully agree.

Since relational governance manifests in the behaviours of the networks actors (Hoetker and Mellewigt, 2009), it was operationalized as a higher-order construct consisting of two first-order constructs: Quality of interaction and informal rules. Repeated interactions are necessary for partners to proof their trustworthiness and reliability and develop a mutual understanding of the other partners (Puranam and Vanneste, 2009). Informal rules complement repeated interactions and enable governance by moral control through consistent goals and norms that guide the behaviour. (Liu et al., 2009, Tangpong et al., 2010). Quality of interaction is measured using five items from Hult et al. (2004) and Mohr and Puck (2005). We relied on four items of Lavie et al. (2012) to measure informal rules. Transactional governance was also operationalized as a higher order reflective construct. As transactional governance governs networks through clearly defined contracts (Williamson, 1991) and the formal control of activities, procedures and roles (Hoetker and Mellewigt, 2009). Contractual details are measured using five items taken from Liu et al. (2010) and Jap and Ganesan (2000). Boyle and Dwyer (1995) provide a four-item scale to measure formal rules. Institutionalized governance exerted by network managers was not operationalized in a differentiated way before. Recently, Heidenreich et al., (2014) measured the involvement of network managers only in dichotomous way. Rampersad et al. (2010) provide two items for network coordination by a coordination body. These were adapted. Furthermore, we self-developed five additional items based on conceptual insights Ritala et al. (2012) who provide valuable thoughts about the specific functions of a “network orchestrator”. We specified joint innovation generation as a higher order reflective construct. As innovation outcomes regularly capture more exploitative as well as more exploratory outcomes, we measure explorative innovation and exploratory innovation based on eight respectively
five items from Jansen et al. (2006). Finally, to measure internationalization of the network, we asked each responding firm if the network had (1) a regional scope, (2) a national scope, (3) a European scope or (4) a global scope. Because of the relatively small sample, this nominal values were aggregated to a dichotomous scale differentiating between national (1 and 2) and international (3 and 4) networks.

Method

We test our hypotheses as a variance based structural equation model (SEM) with SmartPLS3 (Ringle et al., 2015). PLS in comparison to covariance based SEM is particularly suited for our purposes because of several reasons: First, it leads to robust results for complex models even for smaller sample sizes and if variables are not normally distributed (Chin and Newsted, 1999, Reinartz et al., 2009). Second, PLS is appropriate when measures are new or not well established (Fornell and Bookstein, 1982). Third, PLS is advantageous as higher-order constructs can be modelled (Chin, 2010). To obtain the standard errors for all outer and inner model parameters, nonparametric bootstrapping with 5000 replications (Hair et al., 2011), construct-level changes and mean replacement of missing values was used.

As we rely on first-order constructs for each of the three second-order constructs that distinguish from each other but are highly correlated, we specify higher-order constructs as reflective-reflective type 1 measurement models (Becker et al., 2012) or hierarchical common factor models (Lohmöller, 1989). Following the recommendations of Wetzels et al. (2009), we model these by applying the repeated indicator approach (Wold, 1982, Lohmöller, 1989). For this approach, the higher-order construct is reflected by lower-order latent variables and again by all manifest indicators of its underlying lower-order constructs.

5 Results

Measurement model

We conduct a sequential assessment of our first and second-order measures. First, as all first-order constructs are operationalized in a reflective way, we tested indicator reliability, construct reliability, convergent validity and discriminant validity (Hair et al., 2011). Indicator reliability can be assumed if indicator loadings reach at least 0.7 and are significant (Chin, 2010). All loadings were highly significant. Three indicator loadings were slightly below the threshold value. As these positively influenced the constructs composite reliability and are still significantly higher than 0.4, we kept them in the model (Hulland, 1999). Construct reliability (CR) was found for all first-order constructs, as composite reliability values were all above the threshold of 0.7 (between 0.871 and 0.958) (Bagozzi and Yi, 1999). Consistently high average variance extracted (AVE) values (between 0.550 and 0.821) substantiated high convergent validity of the first-order constructs (Hair et al., 2011). Discriminant validity (DV) is given as the differences of the AVE of each first-order construct and its highest squared inter-correlation with all other first-order constructs is positive for all constructs (Fornell and Larcker, 1981). The results of the assessment of the first-order constructs are summarized in Table 1.
### Table 1: First-order measurement model results

<table>
<thead>
<tr>
<th>Second-order construct</th>
<th>First-order construct</th>
<th>Item</th>
<th>Factor loading</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transactional Governance</strong></td>
<td>Contractual Details</td>
<td>Our membership in this network is governed by explicitly described and clearly written contract terms.</td>
<td>0.905</td>
<td>42.128</td>
</tr>
<tr>
<td></td>
<td>Liu et al. (2010), Jap/Ganesan (2000)</td>
<td>In the network we are careful to define in writing what each party's obligations are.</td>
<td>0.880</td>
<td>30.151</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The behaviours of both parties in this network are governed by written contract.</td>
<td>0.919</td>
<td>48.667</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Members in the network resolve disagreements by referring back to the contract.</td>
<td>0.923</td>
<td>52.519</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The activities of the firms within the network are determined by the written contracts.</td>
<td>0.903</td>
<td>36.677</td>
</tr>
<tr>
<td></td>
<td>Formal Rules Boyle/Dwyer (1995)</td>
<td>My firm's dealing in this network are subject to a lot of rules and procedures stating how various aspects are to be done.</td>
<td>0.851</td>
<td>22.698</td>
</tr>
<tr>
<td></td>
<td></td>
<td>There are standard procedures to be followed by the members of the network.</td>
<td>0.922</td>
<td>61.155</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The responsibilities of the network members are clearly specified.</td>
<td>0.872</td>
<td>30.033</td>
</tr>
<tr>
<td></td>
<td></td>
<td>There are precise outlined procedures for guiding the procedures (e.g., ordering, receiving, and merchandising) within the network.</td>
<td>0.897</td>
<td>42.987</td>
</tr>
<tr>
<td><strong>Relational Governance</strong></td>
<td>Quality of Interaction</td>
<td>We meet regularly with our network partners.</td>
<td>0.797</td>
<td>18.535</td>
</tr>
<tr>
<td></td>
<td>Hult et al. (2004), Mohr/Puck (2005)</td>
<td>We are cultivating a close relationship to our network partners.</td>
<td>0.907</td>
<td>65.41</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The communication between us and our network partners is mutual.</td>
<td>0.798</td>
<td>16.349</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A frequent contact between us and our network partners is important.</td>
<td>0.819</td>
<td>20.565</td>
</tr>
<tr>
<td></td>
<td></td>
<td>There are frequently informal conversations between us and our network partners.</td>
<td>0.783</td>
<td>16.082</td>
</tr>
<tr>
<td></td>
<td>Informal Rules Lavie et al. (2012)</td>
<td>The network partners rely on an informal organization (e.g., have few managerial layers, loose control and monitoring; would settle for a handshake instead of sticking to bureaucratic procedures, contracts and legal documentation)</td>
<td>0.85</td>
<td>20.66</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The network partners use consensus seeking rather than authoritarian decision making (e.g., many people are democratically involved in decisions instead of one senior person making all the calls)</td>
<td>0.766</td>
<td>12.311</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The network partners prefer informal over formal communication (e.g., bullet-point presentations or verbal communication instead of lengthy written reports)</td>
<td>0.738</td>
<td>8.997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The network has an apolitical organization (e.g., decisions are guided by concrete considerations and planned processes rather than by personalities and hidden agendas)</td>
<td>0.814</td>
<td>22.572</td>
</tr>
<tr>
<td>Institutional Governance</td>
<td>Exploitative Value Creation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CR = 0.941, AVE = 0.668, DV = 0.340</td>
<td>CR = 0.906, AVE = 0.550, DV = 0.132</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A central network management function/institution ... ensures efficient project management within the network. ... ensures synchronized working among all network members. ... creates possibilities for informal knowledge exchange (workshops, discussions, meetings, etc.). ... builds a common vision among network members. ... generates adequate structures for collaborative interaction. ... ensures that the partner members all know each other well. ... orchestrates the contributions of the individual members. ... ensures that the partners follow joint guidelines.

Due to the network, we frequently refine the provision of existing products and services. Due to the co-operation within the network, we regularly implement small adaptations to existing products and services. Our production costs are monitored frequently to the achievable market prices and if necessary, amended. Within the network we were able to launch existing, but improved products to already existing markets. Due to the cooperation in the network, we are able to increase the efficiency of the value offering. Due to the cooperation within the network, we were able to experience economies of scale. Due to the cooperation in the network, we were able to extend service offerings for existing customers. Due to the cooperation in the network, we were able to decrease the internal process costs.

Together with our network partners we were able to invent new products and services. Within the network we experiment with new products and services. Within the network we commercialize products and services that are completely new to our unit. We frequently utilize new opportunities in new markets. Due to our co-operation in the network, we are able to approach new clients in new markets.
As our second-order constructs are also reflective, the same criteria can be applied at a higher level. Indicator reliability was also found for all second-order constructs, as all second-order factor loadings are greater than 0.7 (ranging between 0.850 and 0.945). Composite reliability at the second-order level ranges from 0.917 and 0.957 and exceeds the cut-offs. Regarding convergent validity, one second-order construct only achieved an AVE value of 0.462. However, as this value is only slightly below the threshold of 0.5 and discriminant validity based on the Fornell-Larcker-Criterion was still shown for all second-order constructs, this is not seriously reduce the validity of our second-order measures. The results for the second-order measurement assessment are shown in Table 2.

Table 2: Second-order measurement results

<table>
<thead>
<tr>
<th>Second-order construct</th>
<th>First-order construct</th>
<th>Factor loading</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relational Governance</td>
<td>Quality of Interaction</td>
<td>0.945</td>
<td>83.707</td>
</tr>
<tr>
<td>CR = 0.918</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVE = 0.555</td>
<td>Informal Rules</td>
<td>0.888</td>
<td>29.163</td>
</tr>
<tr>
<td>DV = 0.291</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transactional Governance</td>
<td>Contractual Details</td>
<td>0.952</td>
<td>97.862</td>
</tr>
<tr>
<td>CR = 0.957</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVE = 0.710</td>
<td>Formal Rules</td>
<td>0.923</td>
<td>51.048</td>
</tr>
<tr>
<td>DV = 0.334</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joint Innovation Generation</td>
<td>Exploitative Innovation</td>
<td>0.935</td>
<td>59.664</td>
</tr>
<tr>
<td>CR = 0.917</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVE = 0.462</td>
<td>Exploratory Innovation</td>
<td>0.850</td>
<td>24.534</td>
</tr>
<tr>
<td>DV = 0.171</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hypotheses test

We test our structural model in two steps. First, in order to test the first three hypotheses, we estimated the results for the model based on the entire dataset of 100 open innovation network members. Second, we test the moderating effect of internationalization (hypotheses 4-6) by comparing the results of two separate model estimations based on (a) members of networks with a national scope and (b) members of networks with an international scope. All results are summarized in Figure 1.

The estimation of the overall model shows a high variance explanation (R²) of 42.6% of the joint innovation generation in the open innovation networks under investigation. The predictive validity of the model was calculated by applying the blindfolding approach with an omission distance of 7 (Fornell and Bookstein, 1982). As the cross-validated redundancy (Q²) (Hair et al., 2011) for the endogenous construct is 0.184 and thus significantly exceeded 0, the model has a high predictive power.

Hypotheses 1 which proposed a positive influence of relational governance on joint innovation generation was substantiated by our data, as we find a positive and significant effect (β=0.303, p<0.01). We also find a positive relationship of transactional governance and joint innovation generation (β=0.333, p<0.01), supporting hypotheses 2. Finally, in line with hypothesis 3 institutionalized governance enhances joint innovation generation (β=0.249, p<0.01). All three exogenous constructs also show considerable effect sizes (f²) ranging from 0.09 to 0.16.
Based on the two separate estimations of the model for national (33%) and international (67%) networks, we still reveal a high explanatory relevance for both models. In open innovation networks that are limited to an international scope, 44.3% of the variance of joint innovation generation is explained and a predictive validity of 0.190 achieved. In international open innovation networks, the variance explanation of joint innovation generation slightly decreases to 38.6%. The predictive validity is still on a high level (0.119).

Despite the consistent overall model fit in the two models, we find different effects of the three different types of network governance. In line with hypotheses 4, the positive effect of relational governance on joint innovation generation is only significant in national networks (βn=0.465, p<0.01) but not in networks with an international scope (βi=0.177, p>0.1). On the opposite, both transactional governance (βn=0.266, p>0.1; βi=0.353, p<0.05) and institutionalized governance (βn=0.201, p>0.1; βi=0.291, p<0.05) exert no positive influence on joint innovation generation in national networks but become significant in networks with an international scope. This gives support to the remaining hypotheses 5 and 6.

**Figure 1: Structural Model Results**

6 Discussion and Conclusion

Academic research on strategy, innovation and organizational issues continues to dedicate considerable attention to open innovation networks. This study set out to
investigate the design of plural governance mechanisms. We therefore put particular focus on relational governance, transactional governance and institutional governance examining its ability to foster the effectiveness of national and international open innovation networks. Our study contributes to research in multiple ways.

First, we can show that the governance of open innovation networks is crucial for their joint innovation generation. As the composition of the three mechanisms can explain a significant share of the variance in both settings, governance mechanisms are of a high relevance to ensure the coordination and control of open innovation networks. In particular, our study extends extant research (Li et al., 2010, Poppo and Zenger, 2002, Hoetker and Mellewigt, 2009, Cao and Lumineau, 2015) as we simultaneously test and identify three different governance mechanisms which foster joint innovation generation: (1) transactional governance, (2) relational governance, and (3) institutionalized governance. (1) Transactional governance was identified to significantly enhance joint innovation generation and therefore emphasize the requirement for formalized processes, activities and roles, defined responsibilities and justified consequences in case of disputes (Lumineau and Malhotra, 2011, Mayer and Teece, 2008). (2) Relational governance impacts joint innovation generation which stresses the need for inherent and moral control, governing exchanges through consistent goals and cooperative atmospheres (Liu et al., 2009, Dwyer et al., 1987, Tangpong et al., 2010). (3) Joint innovation generation is supported by institutionalized governance which rely on an active network management (Heidenreich et al., 2014, Landsperger et al., 2012) dealing with orchestrating (Dhanaraj and Parkhe, 2006, Ritala et al., 2012, Ritala et al., 2009) of network relationships.

Second, our results indicate, that the effects of governance mechanisms depend on the geographical scope of the network. This is in line with previous results that show that culture can moderate the effects of specific governance mechanisms (Handley and Angst, 2014). Whereas the interplay of transactional and relational governance seems to be complementary for the aggregated sample, separating national and international networks substantiates a substitutive relationship (Li et al., 2010).

The exclusive positive effects of relational governance mechanisms on joint innovation generation among firms in national open innovation networks calls for trust building activities among network players. This is very much in line with findings from Huggins and Johnston (2010) and Chesbrough (2003). Huggins and Johnston (2010) show that firms collaborating in the same region are more likely to build strong relationships. Chesbrough (2003) states that openness is key to profiting from external influences. It also demonstrated the importance culture as the ninth open innovation perspective by Gassmann et al. (2010). Even more in international open innovation networks, creating a culture that values outside competence and know-how is regarded to be crucial for joint innovation generation. With regard to Enkel (2010) not only structures’ openness, but also the individual’s openness correlates strongly with the degree to which a firm can profit from networking. In this context, the study of value constellations by Vanhaverbeke & Cloodt (2006) shows that openness applies to the commercialisation phase in particular which we did not analyse separately.

As complexity and distance increase in international networks, self-enforcing effects are less effective. In this case, roles and responsibilities need to be documented and monitored to a higher degree. Both transactional governance and institutionalized governance become significant in open innovation networks with an international scope, while these two do not exert positive influence on joint innovation generation in national
networks. In line with others (Heidenreich et al., 2014) institutional governance gains meaning when complexity increases.

Our study enhances the understanding of governance mechanisms and its effects on joint innovation generation. However, our study has some limitations, which in turn provide opportunities for further research. First, the sample size of 100 is appropriate for this study but a larger sample size would strengthen the results and allow the grouping of sub-samples. Here a grouping along the degree of innovation novelty (Freel and De Jong, 2009) or the partners’ diversity (Nieto and Santamaria, 2007) could be of particular interest. Second, we empirically tested the research model in the German mechanical engineering industry, which limits external validity of our results in terms of geographical context and industry setting. Future studies should extent our findings while selecting different industry sectors. Either way, geographical respectively cultural contexts should be extended in future studies. In particular, we did not consider the context as one crucial driver for open innovation networks in detail which would have strengthen the analysis of national/international scope effects. For example, Huizingh (2011) differentiates internal context characteristics (e.g. employee characteristics, size and technological aggressiveness) and external context characteristics (e.g. technology intensity, technology fusion and knowledge leveraging). In future studies, this could potentially allow a detailed analysis of different clusters of open innovation networks and further analyse different context characteristics. Third, although open innovation networks are characterized by high dynamics, it would be useful to collect longitudinal data.

Having knowledge about the impact of different governance mechanisms on the outcomes of innovation networks, has a high practical relevance for network members and policy makers. Network members can decide about adequate governance approaches in order to enhance their individual outcomes form the network membership. Depending on the individual capabilities, scope and power situation, either a negotiation of detailed contracts or the long-term development of informal ties can be efficient. Especially if a firm has a high degree of power and the scope of the network is international, the development of informal mechanisms might be too complex. Practitioners should recognize the meaning of a dedicated network management function for the orchestration and control of network activities.

References


