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8 Conclusions

In my dissertation, the research questions defined in chapter 1.2 were answered. The main research question 'how suitable innovation partners can be identified' is approached by three sub-questions. In the following chapters, each research question is answered and linked to the findings in the previous chapters.

RQ: How can a suitable innovation partner be identified?

The main research question is answered by the three sub-questions RQ1-3. A suitable innovation partner may be identified through the following setting and mechanisms:

RQ1: A multi-sided market, where interactions substitute a transaction-based logic, as it is shown in part II and III. The intermediary coordinates the interactions on a multi-sided market which lead to positive or negative network effects.

RQ2: A matching process which is coordinated by an innovation intermediary as active agent on the market, as it is shown in part III (and II). Asymmetries are reduced by dynamic interaction patterns between the market agents. Such dynamic interaction patterns are in line with network effects on multi-sided markets, as it is shown in part III.

RQ3: A distinct matching capability for profiling, search and selection, a project and portfolio management capability and an innovation process management capability are distinct mechanisms, as it is shown in part II and IV.

The following table summarises my research findings:
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Table 13: Answers to the research questions.

<table>
<thead>
<tr>
<th>No.</th>
<th>Research question</th>
<th>Finding</th>
<th>In this thesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ</td>
<td>How can a suitable innovation partner be identified?</td>
<td>Innovation partners are identified on a multi-sided market with a structured matching process operated by an intermediary with distinct capabilities.</td>
<td>Part II, III and IV (main RQ)</td>
</tr>
<tr>
<td>RQ₁</td>
<td>How can the failure on innovation markets for collaboration be resolved?</td>
<td>Innovation markets are cleared with a multi-sided market model based on interactions leading to a shared vision, rather than a classical market transaction perspective.</td>
<td>Part II and III</td>
</tr>
<tr>
<td>RQ₂</td>
<td>How can asymmetries between innovation partners be reduced?</td>
<td>Asymmetries are reduced by dynamic interactions between market agents, facilitated by the intermediary.</td>
<td>Part (II), III</td>
</tr>
<tr>
<td>RQ₃</td>
<td>What are matching mechanisms as patterns for managerial action?</td>
<td>Mechanisms are a structured matching processes based on distinct managerial capabilities.</td>
<td>Part II and IV</td>
</tr>
</tbody>
</table>

8.1 The failure on innovation markets

RQ₁: How can the failure on innovation markets for collaboration be resolved?

The failure of technology and innovation markets (e.g. Arora et al., 2001) is rather seen as a market with search and matching frictions. Those frictions can be reduced as shown in this thesis that open innovation emerges between partners. Innovation intermediaries contribute to reduce information asymmetries (see chapter 4.1) and enable trustful interactions among potential open innovation partners on a multi-sided market (see chapter 4.2). I do not claim having solved the failure of technology and innovation markets with my study. I rather contribute to a better understanding of the matching mechanisms and how
interactions in innovation networks lead to successful tie building over time. My results show that successful matchmaking is possible under the described conditions. First, an external intermediary helps to solve the market failure in creating a common understanding within an organisation (profiling). Second, the intermediary searches partners in external networks and builds a portfolio for potential partners. Third, a temporary matching market is created by the intermediary where agents can interact individually, but through a structured matching process. Matchmaking is not a classical single market transaction; it is an interactive process over time. As shown in part II in this thesis, matchmaking is possible under economic conditions and leads to successful innovation.

As already defined in two-sided market theory, network effects play also an important role on a multi-sided market for open innovation. Such network effects emerge through dynamic interaction among the market agents. Positive network effects lead to successful matches based on a shared vision. Thus I hypothesize that positive network effects as (social) interactions, as described in chapter III, are a necessary condition for successful matching.

8.2 Matching dynamics for reducing asymmetries

RQ2: How can asymmetries between innovation partners be reduced?

As shown in chapter 8.1, multi-sided market logic may resolve the market failure on innovation markets. Matching dynamics as network effects or also called network externalities are central on such networked two- or multi-sided markets. In part III of this thesis, concrete interaction patterns are presented between the hierarchical organisations of potential partner firms and their agents. They have to be differentiated from market transactions, as no property rights are transferred. Interactions lead to a commitment of market agents within an organisation and to a common understanding between all agents on a multi-sided market. The innovation intermediary is the central agent who coordinates the interactions and creates the matching market.
Thus, the intermediary is modelled with its own right, as economic value is generated through a higher matching probability and the coordination efforts.

The two concepts of a “virtuous” and a “vicious” circle of matchmaking are linked to a dynamic process logic and support an evolutionary perspective on matchmaking. The identified interactions along the process circles reduce asymmetries towards a common understanding and a shared vision. Such process dynamics or positive network effects are necessary for successful matchmaking and may even have self-amplifying effects. The innovation intermediary facilitates the interaction between the market-agents within the organisation, that first a common understanding between the agents in a hierarchy emerges and second a shared vision among the all relevant agents on the market.

8.3 Matching mechanisms for managerial action

RQ3: What are matching mechanisms as pattern for managerial action?

Matching mechanisms outlined in this thesis are divided in three categories. First, a structured matching process as presented in chapter 4.2 offers insights to concrete mechanisms for each process stage (profiling, search, selection, matching and evaluation). Second, distinct managerial capabilities for innovation intermediaries are outlined in chapter 6.2. Concrete mechanisms are structured matching, project and portfolio management and innovation process design. These are necessary capabilities for managerial coordination. The better the capabilities of an innovation intermediary are, the higher the matching probability becomes. Third, a distinction between matching mechanisms as transaction-based e.g. technology or IP auctions (Tietze, 2012) or interaction-based is useful for managerial decision making (see matching matrix in chapter 5.3). The question whether a static database for the search process or an interactive multi-sided market has to be created for a certain innovation request can be answered with the matching matrix. Further mechanisms could be developed with focus on valuation of matching portfolios or matching tools as mechanisms for profil-
ing, search or selection. Based on my findings, I assume that a complete automated matching process is not possible due to the fact that (social) interactions have been identified as necessary conditions for successful matchmaking.

8.4 Implications of the study

For innovation practitioners, my study has four implications for managers, entrepreneurs, innovation intermediaries and policy maker. First, the participatory cases outline the complexity of finding an open innovation partner. Matchmaking is a process which emerges over time and requires active managerial support. My analysis provides a structured matching process with corresponding mechanisms for implementation and testing in further settings. The findings were already transferred to the European level, where colleagues and I adapted the matching process from the presented cases in the German automotive industry to the European Network for Living Labs (ENoLL). In the ENoLL summer schools 2013 and 2014, we matched participants for joint Horizon 2020 initiatives and proposal calls (Pallot, Alishewskikh, Krawczyk, & Holzmann, 2014; Pallot, Holzmann, Krawczyk, & Ruland, 2014).

Second, managerial thinking has to shift from economic short-term valuation in innovation networks based on market transactions. Finding an innovation partner is on the one hand time consuming and costly, but embedded in a multi-sided market with structured matchmaking it might pay off in the long run. The outcome of the matching process is not immediately visible like this is the case in supply chain networks or on IP markets where property rights can be transferred. In one case of my study, it took almost two years since a final successful result could be presented in public. Nevertheless, as shown in my cases, matchmaking requires a multi-sided market which leads to future innovation based on interaction in a networked setting. Interactions are of economic value which might seed the impulse for new products, new technologies or new markets.
Third, innovation intermediaries can derive an own value position in innovation networks as the coordinator on multi-sided markets. This finding provides new fields of application and future research for university incubators or technology transfer centres which are mainly publicly funded, but also existing commercial innovation intermediaries can apply or improve their services.

Fourth, policy maker might consider my findings for their public goal setting. Key performance indicators could be developed for public funded innovation intermediaries, technology transfer offices or public incubators which would have an impact on their funding structure. Interactions on matching events, through matching tools or organised by innovation brokers should be documented. Professional matching services could deliver additional revenue streams in collaboration with industry partners, if properly managed. The public focus of network facilitation or matching support should be reconsidered. Is matchmaking as subsidisation for network formation desired or should the economic value behind matchmaking be generated through an independent business model?

Research on two-sided markets suggests that one market side is charged for getting access to the other market side. In terms of the business model of public funded innovation intermediaries, it means that established companies could pay for the access to the network of university incubators or technology databases, while young start-up firms receive the access and services for free. This reasoning would exonerate public subsidiaries for innovation intermediaries, but on the other hand generating a commercial revenue stream from industry. The legal form of innovation intermediaries has to be considered in this case, whether profit making is possible or not. Future research could build on the pricing structure of such multi-sided markets for open innovation.

Practical impact of my research was generated by matching entrepreneurial start-ups with BMW as project partner and providing an impulse towards the sensibility of this topic within the organisation. Clear results are demonstrated in the United Kingdom, in Berlin and in
Munich. In Berlin the start-up firm ebee smart technologies was matched with BMW in Munich and became member of the hubject consortium, a joint venture for electro-mobility between BMW, Daimler, Siemens, Bosch, EnBW, and RWE. This is a practical example of a multi-sided market for open innovation, with hubject as late stage intermediary between the joint venture partners.\textsuperscript{30}

8.5 Limitations of the study and further research

Each study has certain limitations which opens paths for further research. My research strategy was based on a research agenda on matchmaking for open innovation. I followed an interdisciplinary approach in this thesis, in order to explore the field for further research. Unlike one in-depth study with one deep theoretical focus, I approached matchmaking from a sociological perspective, from a network economical perspective and a managerial perspective. This helped me to explore the field and gain a holistic understanding. Next steps require drilling deeper in the particular theoretical directions. In the following chapter, the limitations of my study are outlined and ways where the field of matchmaking for open innovation could head in future are presented.

Limitations of the study

The findings of my qualitative action research study provide in-depth insights of the interactions along the matching process and a conceptual multi-sided market model for innovation networks. Like every research project, my contributions can only be discussed within a limited scope on the matching phenomenon. Although action research can be fundamentally criticised by a positivist world view (see chapter 1.3), I am convinced that my explorative study provides valuable results for innovation academics and practitioners, and enhances our theoretical understanding. The two aims of action research, first leading to practi-
cal change with real impact and second contributing to theory development have been accomplished with my dissertation project.

However, I recognize the following limitations of my study. First, the cases are limited to one single organisation searching for external innovation partners. The small sample of three participatory case studies leading to 18 observed matching events in total and a cross-case analysis only provides a base for limited generalizability. Even if the impact of my work in the greater Munich area, in Berlin and in London is visible, I propose to extend the scope to other regions, networks, and cultures to compare my findings with other cases. First attempts are already presented in Ma, Kaldenbach & Katzy (2014).

Second, the collected data (semi-structured interviews, field notes, meeting minutes, observations, and secondary literature) derived from my personal interaction with the research environment. Even if a constructivist position allows subjective perspectives, a neutral objectivity could be added to my findings with an ex post case study design of my participatory cases. Although, my field data were carefully analysed, reflection meetings with external partners and supervisors were documented, there is more space for generalisation of my results. Especially for a measurable framework towards quantitative matching criteria similar to Mitsuhashi & Greve (2009). This could be addressed in further research projects.

Third, there might also be successful matching cases where no external innovation intermediary was actively involved. Such cases could be of interest in order to compare them with my participatory case results. If other intermediaries like internal promoter of one organisation (Fichter, 2009) matched open innovation partners successfully the question about how they managed the process would be of further interest and which economic or strategic impact they had in addition to my findings.

Directions for further research

Following my limitations, I propose to further test my theoretical findings from different perspectives. The developed multi-sided market
model and the presented interactions along the matching process provide various paths for future research on the intersection between economics, computer science, and sociology. Based on my epistemological position, I excluded the traditional and well researched approaches in game theory and econometrics in my thesis. These fields should be definitely considered in further investigations.

Following a market design and market engineering approach (Roth, 2002; Weinhardt et al., 2003), my work provides a conceptual market model, data and insights about the interactions between the market agents. In the next step, the market model could be evaluated, improved and then implemented. My study provides insights about the market structure, network effects on the market and the behaviour of market agents. The next step would be to build an economic or computational market model. Computer science has not been in the focus of my research. However, the emergence of artificial intelligence, big data analytics, semantic web and data base modelling offer interesting and promising research approaches on the matching phenomenon for open innovation.

A simulation of a multi-sided market could further develop the understanding of mechanism design (e.g. for online platforms). From a system dynamics perspective, the identified interactions could be simulated in order to better understand dynamics along the matching process. Even though, my findings lead to the conclusion that a fully automated matching process like an online platform, similar to dating sites with automated algorithms (Gale & Shapley, 1962), will not work due to the fact of the interactive nature of the matching process, I see a wide field for further research in computer science. Big data is produced daily in the internet, so new mechanisms can be designed for identifying weak innovation signals, similar to Google analytics which can support the matching process. Prediction markets (Servan-Schreiber, Wolfers, Pennock, & Galebach, 2004; Wolfers & Zitzewitz, 2004) for example are one field which could be linked to this work. Furthermore, network analysis could be a valuable methodological approach similar to what (Weng et al., 2014) published in our special issue.
Concerning the valuation problem of innovation on markets, the effect of real option pricing and matching success on a multi-sided market, especially for “deal-flow portfolios” presented in chapter IV could be further developed. In our special issue, Takao Fujiwara (2014) presented a simulation on this topic which could lead to sustainable business models for innovation intermediaries (Agrawal, Hariharan, Kishore, & Rao, 2005). Further research could explicitly show their value to other agents of the multi-sided market.

The legal perspective as completely other field of research is totally neglected in my work. With my background in industrial engineering and management, unfortunately this is out of my scope. Nevertheless, it is important to understand adaptive, incomplete or implicit contracts in the context of matchmaking for open innovation. The treatment of intellectual property and knowledge which is exchanged along the matching process could be direction for research. Further questions arise in terms of electronic law, if matchmaking occurs on online platforms and sensitive information is exchanged online.

I herewith close my thesis with a research agenda and conclude that matchmaking for innovation partnerships offers various interdisciplinary approaches for future research and I am looking forward tackling some of the identified challenges for further development.