Utrecht University
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Analyzing policy-driven innovation network development

- Resource dependencies and expectations in Dutch electric vehicle subsidies -

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Utrecht University, 2010-2011

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Master thesis Science and Innovation Management

MSc Thesis (45 ECTS)

Date:	October 2011
Programme:	SIM
SIM supervisor:	dr. F.J. (Frank) van Rijnsoever
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Abstract

The amount of innovation subsidies for technological development increased vastly over the past decade. However, it still remains unclear for organizations how to increase their chances to access these subsidies. In the current research, the resource dependence view and the sociology of expectations are combined to examine the influence of expectations on the likelihood of receiving innovation subsidies. Three types of expectations are distinguished: scientific expectations, societal expectations, and valorization expectations. Scientific expectations are measured by the amount of scientific publications devoted to a specific technology. Societal expectations measure the amount of newspaper articles in which organizations articulate their expectations towards the specific technology. Valorization expectations measure the amount of patents organizations hold for a specific technology. These expectations indicate the historical achievement of organizations towards a specific technology and will therefore be able to predict their future performances, increasing their likelihood of receiving innovation subsidies. This research examines the Dutch electric vehicle case, which is exemplary for this research since the government supports this technology with the use of innovation subsidy. The data used for the analysis, collected from NL Agency, consists of 23 project groups and a total of 79 unique actors. After a governmental decision committee assessed the projects, 16 of the initial 23 projects were elected to receive subsidy. Since innovation subsidy is allocated to project groups, expectations are aggregated to an actor and a project level to separate organizational effects from project group effects. The results of the logit regression revealed a significant negative influence of expectations on the likelihood of receiving innovation subsidies. This effect is remarkably stronger on the project level compared to the actor level. The results also revealed that organizations with electric vehicle technology as their core business significantly increase their likelihood of receiving innovation subsidies. Recently, the Dutch court of audit criticized Dutch innovation policy for their inconsistencies and difficulties in evaluating their effectiveness and efficiency. In line with their report, this research argues for a more transparent decision process and consistency in policy regulations between different governmental departments. Further research should be performed to analyze what characteristics increase the likelihood of receiving innovation subsidies and to confirm the plausibility of a combined theoretical framework of the resource dependence view and the sociology of expectations.

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1. Introduction

The last decades, there is a growing interest for a technology to success the conventional internal combustion engine vehicle (Economic affairs, 2009). Two promising technologies emerged over the last decades; hydrogen vehicles and (battery) electric vehicles. After the emergence of these new technologies, technological expectations varied largely. A technological expectation is defined as a 'real-time representation of future technological situations and capabilities' (Borup et al., 2006, p.286). The last years, from 2006 onwards, the (battery) electric vehicle seems to be the most promising successor according to the articulation of expectations throughout the field (Bakker et al., 2010). Consequently, due to the high promises and expectations, the Dutch government introduced innovation policy to support electric vehicle technology. In 2008, the Dutch government launched a plan to invest a maximum of 65 million euro between 2009 and 2011 to stimulate the adoption of electric vehicles. With this investment, the government aims to be a guiding country and to become an international lab for electric vehicles. The government expects that this investment will result in investments from 'others' in electric vehicle technologies for about 500 million euro (Economic affairs, 2009). Aim of the government is to implement a total of 1 million electric vehicles in 2025 (Economic affairs, 2009). According to the Dutch government, the introduction of electric mobility is very promising, but can only lead to success once cooperation between firms, societal organizations, knowledge institutes, local authorities, and the government is achieved (Economic affairs, 2009, p.1). The aim of the current policy is to promote collaboration between actors in innovation networks. It should be noted that this policy was recently criticized. The Dutch court of audit recently published a report analyzing Dutch innovation policy. According to their report, the amount of innovation subsidy and projects vastly increased, but the effectiveness of the billions spent between 2003 and 2010 cannot be determined (Algemene Rekenkamer, 2011).

Although many scholars have researched the characteristics of innovation networks, most of this inter-organizational literature is devoted to the collaboration between two or more industrial organizations (e.g. Shan et al., 1994; Bower, 1992; Pisano, 1990; Jarillo, 1988). Further, various researchers have shown the potential of collaboration between university and industry as an instrument to enhance national competitiveness and to create wealth (Gibbons et al., 1994; Kaufmann & Tödtling, 2001; Merz & Biniok, 2010). Accordingly, several scholars researched the success factors, and determinants of university-industry collaborations (e.g. Rosenberg & Nelson, 1994; Santoro, 2000; Santoro & Chakrabarti, 2001; Gulbrandsen & Smeby, 2005; Merz & Biniok, 2010). From a network perspective, a broad discussion among researchers already pointed out the advantages of forming networks in the context of innovation, both with other firms and universities (Sternberg, 2000; Fritsch, 2001; Fritsch & Lukas, 2001; Borgatti and Foster, 2003). Various empirical studies provided evidence that networks are beneficial for innovation (Kauffeld-Monz & Fritsch, 2008). However, according to Kauffeld-Monz & Fritsch (2008; p.3), all these analyses are lacking insights into the network structure which result into the benefits for innovation. A notable exertion is Sohn et al. (2009), who already implemented this network structure. In their

article a social network analysis is performed to examine the role of innovation policy on the development of university-industry collaborations.

A prominent approach to explain network collaborations between actors is the resource dependence view (Pfeffer & Salancik, 1978). This perspective argues that organizations need to negotiate access to crucial resources with other external actors. The current research departs from the resource dependence view to explain the motives for universities and industries to collaborate. Further, several studies pointed out the significance of expectations in science and technology innovation, and their importance in guiding interests and investments (Rosenberg, 1976; Berkhout, 2006; Borup et al., 2006; van Lente, 1993; van Lente & Bakker, 2010). Brown & Michael (2003) exemplify the dynamics between expectations and innovation policy. In their article, a model is offered for understanding how expectations will predictably vary according to some key parameters. Such a model is necessary for policy to make intelligent sense of past and present expectations (Brown & Michael, 2003; p.5). However, the role of expectations on the development of policy driven collaborations is underexposed. In this research, the resource dependence view and the sociology of expectations are combined to analyze the influence of expectations on policy driven university-industry collaborations. According to the resource dependence view, organizations can not generate all the necessary resources internally and therefore have to mobilize resources from their external environment. Therefore, financial resources resulting from policy measures can be seen as important resources for both universities and industries to obtain. Following from the sociology of expectations, to acquire these resources several expectations have to be articulated towards various stakeholders in order to create legitimacy for accessing these resources (Pfeffer & Salancik, 1978; Scott, 1995; Suchman, 1995; Zimmerman & Zeitz, 2002). Defined by Zimmerman & Zeitz (2002; p.414), legitimacy is a social judgment of acceptance, appropriateness, and desirability, enabling organizations to access other resources needed to survive and grow. Legitimacy can be enhanced by strategic actions taken by the organization (Zimmerman & Zeitz, 2002). In the current research, the influence of articulating expectations as a strategic action to enhance legitimacy and access to innovation subsidies is examined. Bornmann et al. (2010) already studied governmental funding decisions and access to innovation subsidies. In their research, individual researchers are analyzed on grant and fellowship applications with scientometric performance indicators.

The current research distinguishes two levels of aggregation, the actor and the project level. Due to budgetary limitations, actors only acquire innovation subsidy as a group when their submitted project is approved by a committee. Therefore, the actor level analyses expectations articulated by single actors, the project level analyses the combined expectations articulated by a project group. Besides the level of aggregation, three types of expectations are thought to be of influence on gaining access to policy resources; scientific expectations (Bornmann et al., 2010; Brown & Michael, 2003), valorization expectations (Borup et al., 2006), and societal expectations (Brown & Michael, 2003).

In this research, it is argued that these three types of expectations influence the likelihood of receiving innovation subsidies. This leads to the following research question:

"What is the influence of expectations on both actor and project level on the likelihood of receiving innovation subsidies?"

This research tries to understand which level and which type of expectation is dominant on the likelihood of receiving innovation subsidies. Of course, next to expectations, other factors such as project quality or lobbying activities also play an important role in order to obtain external resources. However, these factors are difficult or even impossible to measure and therefore not included within the current research.

To answer the research question, a social network analysis will be performed using the Dutch electric vehicle related sector as a case study. The Dutch electric vehicle case is exemplary for this research because the government supports this technology with the use of innovation subsidy to accelerate the technological development. The outcomes of this research could be particularly interesting for industrial organizations and knowledge institutes when attempting to access external resources. The results provide insights in what strategic actions are to be taken in order to increase legitimacy for both knowledge institutes and industrial organizations. Policy makers may use the results to improve the method in which resources are distributed among projects.

The following chapter elaborates the theoretical framework used to ground this research; theories which explain most of the factors and aspects of the research question. Thereafter, in chapter three the research design is covered. The results are presented in chapter four. Thereafter, the conclusions are drawn in chapter five. In chapter six, several limitations and implications of the current research are discussed.

2. Theoretical Framework

In the current research, the resource dependence view is applied at the organizational level to explain the motives for universities and industries to collaborate. Thereafter, the sociology of expectations is introduced. Expectations have shown their decisive and shaping role in establishing new scientific and technological fields and attracting interest and investments for these fields. Innovation policy is introduced to explain government strategies in order to accelerate emerging technologies through innovation subsidies. Finally, the hypotheses resulting from the theoretical framework are proposed.

2.1 A resource dependence view on university-industry collaborations

Following Van Rijnsoever et al. (2008), the interaction between science and industry can be explained from a resource based view (Penrose, 1959; Barney, 1991). However, the resource based view in itself does not provide clear motives to understand why firms should interact with their environment. As a result, the resource dependence view was developed to overcome the resource based constraints and explains the motives why firms interact with their environment. The resource based view argues that a firm can be seen as a bundle of sticky and difficult-to-imitate resources and capabilities (Mowery et al., 1998). The resource based view analyses the various resources possessed by firms, which can be translated into a competitive advantage (Penrose, 1959). These resources can both be tangible, such as product designs, patents, copyrights, human resources, and production techniques, as well as intangible, such as brand equity, in-house knowledge, and technological and managerial resources (Mowery et al., 1998; Penrose, 1959; Wernerfelt, 1984; Das & Teng, 2000). Therefore, the organizational resource base is a possible source of competitive advantage, which can be transformed into economic rents (Penrose, 1959; Das & Teng, 2000).

From the resource based view, Pfeffer & Salancik (1978) developed the resource dependence view. According to them, corporations are open systems, constrained and affected by their environments, acting to attempt to manage resource dependencies. As such, firms can not generate all the necessary resources internally and therefore have to mobilize resources from other organizations and institutions in their environment to survive. Acquiring this critical knowledge means that firms have to interact with other organizations which possess and control this knowledge (Pfeffer & Salancik, 1978, p.25-28). Santoro & Chakrabarti (2002) also state that firms can acquire knowledge and technology from various external sources e.g. competing firms, industrial research associations, government laboratories, knowledge institutes, and universities. The resource dependence view explains several motives for both firms and universities to engage in university-industry collaborations. On the *micro-level*, firms gain access to highly trained students, high quality knowledge, university facilities, and faculty as well as the firms' enhanced image when collaborating with a prominent academic institution (Fombrun, 1996; Santoro & Chakrabarti, 2002). On the contrary, universities primarily engage in industry collaborations for additional funds, particularly for research, exposure of students and staff to practical problems, job opportunities for graduates, and access to specific technological areas (Nieminen & Kaukonen, 2001; Harman, 2001; Gibbons, 2003; Vermeulen, 2003). For scientists, contributing in collaborations could positively

influence their scientific development in terms of reputation, career, and publications (Kuhlmann, 2004, van Rijnsoever et al., 2008), and could enhance scientists' productivity (Lee & Bozeman, 2005; Harman, 1999).

On the *macro-level*, universities fulfill a crucial role in society as producers and transmitters of knowledge (Este & Patel, 2007). Recently, the discussion for universities to also encompass a 'third mission' of economic development, received greater attention (Mansfield, 1995; Branscomb et al., 1999; Leydesdorff & Meyer, 2003). The third mission, also referred to as 'Mode 2 knowledge production', and other alternatives (Gibbons et al., 1994; Hessels & van Lente, 2008), should enhance the linkage between universities and the external economic and social worlds. Within this remit, university-industry research collaborations are seen as extremely important mechanisms to enhance and deploy external linkages by means of generating both technological and knowledge spillovers. University-industry collaborations reduce market failures and realize full social returns of R&D investments (Martin & Scott, 2000; Siegel & Zervos, 2002). As a result, a growing body of empirical literature shows the increasing level of academic commercial activities such as the generation of spin-off companies, licensing, and patenting (Shane, 2004; Thursby & Kemp, 2002). The increasing commercial commitment of universities is accomplished by both research joint ventures (Hall et al., 2001) and joint scientific publications (Calvert & Patel, 2003). The potential to involve universities in technology transfer to society also became aware amongst governments, increasing their range of policy measures to encourage this third mission (Bornmann et al., 2010; Este & Patel, 2007).

2.2 The role of expectations

In a seminal contribution, Rosenberg (1976) described the prominent role of technological expectations as a prime determinant for entrepreneurs whether or not to adopt certain innovations. It became clear that technological expectations can influence the optimal timing of innovations. Furthermore, articulating technological expectations provides the opportunity to determine some of the innovation's characteristics, rules and laws dedicated to the new technology. Since the importance of expectations became clear, this field of study received increasing attention. The specific body of literature focusing on the role of expectations in shaping scientific and technological change is called the sociology of expectations (Borup et al., 2006; Brown & Michael, 2003; van Lente, 1993; Bakker et al., 2010).

As mentioned in the introduction, a technological expectation in this research is defined as a 'real-time representation of future technological situations and capabilities' (Borup et al., 2006, p.286). The most difficult and uncertain aspect about existing, developing, and not yet existing technologies is making predictions about future situations. However, in some cases, research shows that technology develops according to the expectations (Borup et al., 2006). It could be argued whether the expectations were right, or the technological development followed the articulation of expectations as a guideline. Research made clear that the role of expectations on technological development is specifically important in the fluid-phase, a state in which directions, development, and practical utility of the technology are uncertain (van Merkerk & van Lente, 2005). According to Borup et al. (2006, p.285), expectations can

be seen as fundamentally 'generative', providing structure and legitimation, guide various activities, attract interest, and foster private and public investments. Especially in social studies of science, technology, and society, expectations have shown their decisive and shaping role in establishing new scientific and technological fields and attracting interest and investments for these fields (Bornmann et al., 2010; van Lente & Rip, 1998; Guice, 1999; Martin, 2003; Selin, 2006).

In the current research, three types of expectations will be distinguished; scientific expectations, valorization expectations, and societal expectations. In this research, it is argued that these three types of expectations influence the likelihood of receiving innovation subsidies. The general objective of innovation policy is to encourage and facilitate the generation, application, and diffusion of new ideas (Nooteboom & Stam, 2008). A specific instrument to fulfill this objective is innovation network development. The goal of policy on innovation network development is to accelerate the development of an emerging technology. In financial terms, the government can be compared with a venture capitalist; seeking for optimal profit from the investments. However, governments expect more types of returns than just financial profits. Their goal is to comprise the whole innovation system, trying to alter the structural conditions under which innovation and technological development occurs (Carlsson & Jacobsson, 1997) instead of only altering the cost and pay off associated with R&D (Hauknes & Nordgren, 1999).

2.3 Innovation policy

Over the past decades, innovation policy developed with the objective to encourage and facilitate the generation, application, and diffusion of new ideas (Nooteboom & Stam, 2008). Two main rationales for government involvement in technological advance and innovation appear; *market failures* and *system failures* (Hauknes & Nordgren, 1999). Market failure is the traditional neo-classical justification, stating that markets may fail to operate efficiently due to various reasons such as externalities, uncertainty, inappropriability of investments, economies of scale and scope, indivisibilities, barriers to entry, and asymmetric provision of information (Nelson, 1959; Arrow, 1962). However, market failure rationales are limited in comprising the key elements of technological development. Therefore, market failure as justification to guide innovation policy is limited (OECD, 1998).

With the development of evolutionary economics, the basis for system rationales emerged. It was recognized that innovation occurs in a complex institutional system, interacting with many different actors and institutions. The system failure rationale goes beyond the market failure rationale in the sense that it comprises the whole innovation system, it attempts altering the structural conditions under which innovation and technological development occurs (Carlsson & Jacobsson, 1997) instead of only altering the cost and pay off associated with R&D (Hauknes & Nordgren, 1999). The system approach can therefore be seen as complementary to the market failure approach, trying to enhance the technology possibilities that firms face by improving their access to knowledge (Lipsey, 1998). The improvement of knowledge is one of the most important aspects in the system approach. Carlsson & Jacobsson (1997) therefore divide system failures into network failures and institutional failures. Network failures in the innovation system are organizations which

interact poorly with their environment resulting in a lack of collective vision, technological expectations, and coordination of investments. To reduce network failure, it is argued that actors should be tied together by means of reciprocal flows of information and knowledge in order to achieve a good connectivity (Carlsson & Jacobsson, 1997). The government introduced innovation policy to reduce network failure. One of their instruments is innovation network development through subsidizing collaborative projects (Economic affairs, 2009). With this instrument, a specific amount of innovation subsidy is dedicated to an emerging technology chosen by the government to support. A project group, consisting of organizations and knowledge institutes, can obtain a part of this subsidy by sending their innovative projects to a governmental committee before a fixed deadline. After the deadline, the committee decides which projects suits best in order to develop the supported technology. Accordingly, the innovation subsidy is divided among the selected projects and the government keeps track of the progress to evaluate the success of this specific policy instrument (Economic affairs, 2009). In this study it is thought that expectations can contribute to a higher likelihood of dividing this subsidy to the most suitable projects.

From the resource dependence view it became clear that mobilizing resources from other organizations and institutions in their environment is crucial in order to survive. In this respect, innovation networks can act as an important source for organizations to acquire their resources. More specifically, network position and individual actor importance in the network can be of influence on the likelihood of acquiring resources from the network. Among others, two important measures derived from social network literature emerged; degree centrality and betweenness centrality. Both measures describe the importance of an individual actor in the total network. Degree centrality is defined as the number of ties an individual actor has to other actors in the network graph. The degree centrality can therefore be calculated by summing up all ties of an individual node. Betweenness centrality defines whether a particular actor might be able to control interactions between pairs of other actors within the network (Wasserman and Faust, 1994; p.178-188). According to Wasserman and Faust (1994, p.20), an actor with a high centrality level, as measured by its degree, is “where the action is” in the network. For this research, the above mentioned definitions and properties of social network analysis are sufficient and added to the model as control variables.

2.4 Hypotheses

Societal expectations

If the government decides to grant innovation subsidy to develop an innovation network for an emerging technology, it is likely that partners are chosen and project groups are formed which articulate positive expectations about the technology in the media to ensure an image of public responsibility to the society. If this is the case, a network will be developed consisting of actors already interested, positive, and active within the emerging technology. Connecting these actors through an innovation network will lead to a collective identity and shared technological vision, accelerating the development of the technology. Therefore, articulating positive expectations about an emerging technology in the media is thought to

be of positive influence on the likelihood of receiving innovation subsidies, leading to the following hypothesis:

Hypothesis 1. Articulating positive expectations about an emerging technology in the media positively influences the likelihood of receiving innovation subsidies.

Scientific expectations

Following from the innovation programme on electric vehicles, knowledge production and more importantly the dissemination is crucial to introduce the electric vehicle successfully. Therefore, it is likely that actors already committed and interested in the emerging technology are stimulated. A knowledge institute with a large scientific output and a developed knowledge base on the emerging technology will have a higher success rate in a collaboration compared to a knowledge institute without publications regarding this technology, leading to the following hypothesis:

Hypothesis 2. Publishing scientific articles about an emerging technology positively influences the likelihood of receiving innovation subsidies.

Valorization expectations

Departing from the previous argument, encouraging knowledge transfer from knowledge institutes towards the industry, it is likely that actors which are not only committed and interested in the technology, but already have tried to commercialize the emerging technology are stimulated. Partners who already hold patents regarding the emerging technology, in some form articulate their expectations by transforming their knowledge into commercialization. Connecting knowledge institutes and the industry in the form of an innovation network will accelerate the valorization of knowledge. The goal of the third mission is to encourage valorization of knowledge. It is therefore argued that a positive contribution regarding the valorization expectations is of influence on the likelihood of receiving innovation subsidies, leading to the following hypothesis:

Hypothesis 3. Holding patents in the field of an emerging technology positively influences the likelihood of receiving innovation subsidies.

Actor and project level

In the current research, the distinction is made between actor and project level. This distinction follows from the manner in which governments use the innovation network development instrument for emerging technologies (Bornmann et al., 2010). The instrument is executed in the form of a tender procedure for which project groups can apply. These project groups are formed by and consist of one or more knowledge institutes and one or more industrial organizations which collaboratively apply for the tender procedure on accurately specified subjects. Due to budgetary limitations, a selection procedure takes place which results in a limited number of project groups. These project groups consist of various actors which all more or less articulated their expectations about the emerging technology. Logically, the individual actors articulate expectations which might be of influence on the

likelihood of receiving innovation subsidies. Besides, the project group articulates the cumulated number of expectations from all actors together. There is a difference between these two levels when the likelihood of receiving innovation subsidies is considered. One actor could receive innovation subsidy (actor level) although it did not articulate positive expectations about the emerging technology, just because this actor is positioned in the right project group which articulated an above average amount of expectations (project level). The project level is thought to be dominant since the subsidy is allocated to projects instead of individual actors, leading to the following hypothesis:

Hypothesis 4. Hypotheses 1-3 have a stronger influence on the project level compared to the actor level.

Control variables

In the current research, several control variables are used to increase robustness and reliability of the model. The control variables can be divided into network position characteristics and actor characteristics. The control variables of the network characteristics consist of *degree centrality* and *betweenness centrality*. The control variables of the actor characteristics consist of *age* of the organization (in years), *mean age* of the project group, *EV as core business* (whether electric vehicle technology is a core business for the organization), *EV as core business mean* of the project group, *links with knowledge institutes* (the amount of knowledge institutes connected to an actor in the total network), *links with large organizations* (the amount of large organizations connected to an actor in the total network), *links with small and medium sized enterprises* (the amount of SMEs connected to an actor in the total network), a*mount of knowledge institutes, large organizations, and SMEs in a project,* and *organizational type* of the specific actor (divided into knowledge institute (KI), SME, and large business).

2.5 Conceptual model

The theoretical framework elaborated on the various subjects that are necessary to understand and ground the influence of expectations on the development of policy-driven innovation networks. The conceptual model has to be interpreted as follows; (1) innovation policy in the form of a tender enrollment procedure is put in place to accelerate the promising technology and the buildup of an innovation network (2) knowledge institutes, SMEs, and large companies submit their collaborative research projects resulting in a pre-tender network (3) due to budgetary limitations not all projects can be honored and a selection procedure takes place (4) after the selection procedure is finalized, a post-tender network has emerged. The post-tender network consists of project groups of knowledge institutes, SMEs, and large businesses with collaborative efforts to succeed the research project, leading to the following conceptual model:

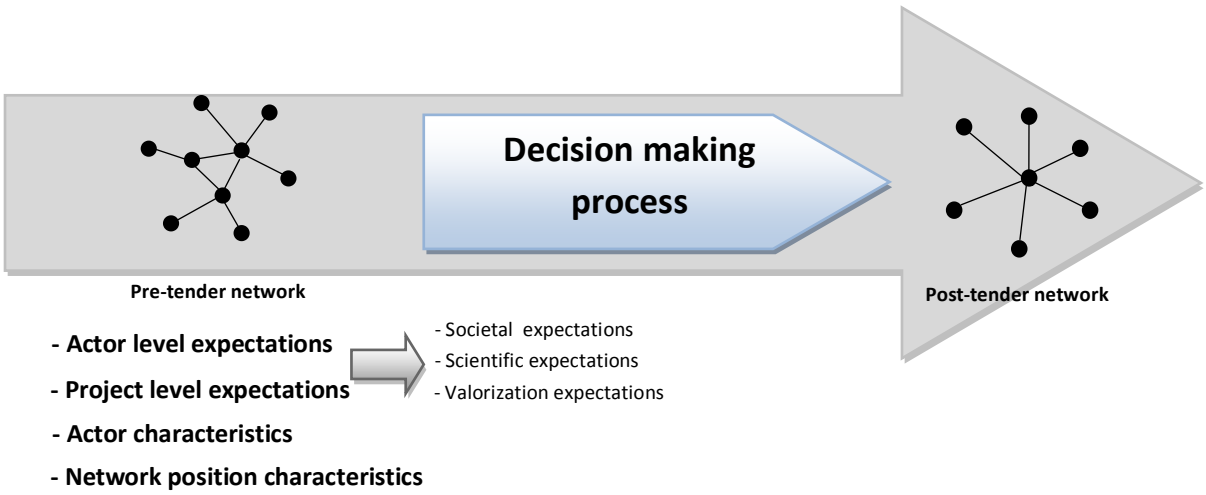

Figure 1: Conceptual model

3. Research Design

3.1 Method

This research performs a single case study analysis based on quantitative data. Within this case study, two techniques are used; social network analysis and multivariate statistics. According to Yin (2003, p.14), the case study as a research strategy comprises an all-encompassing method, covering the logic of design, data collection techniques, and specific approaches to data analysis. Therefore, the case study is not only a design- or data collection tool (Stoecker, 1991), but a comprehensive research strategy. Because social network analysis in innovation research is rather new, this technique with emphasis on university-industry linkages will first be introduced.

3.1.1 Social network analysis

The last decades, social network analysis as an academic discipline evolved towards a mature technique for the measurement and analysis of relational structure between social actors. Scholars applying social network methods seek to predict the structure of relationships among social entities, as well as the impact of the predicted structure on other social phenomena (Butts, 2008). Social network analysis is an interdisciplinary research programme built around a shared core of concepts and methods for measuring, representing, and analyzing social structure (Butts, 2008). According to Wasserman and Faust (1994, p.17), social network analysis provides a precise way to define important social concepts, a theoretical alternative to the assumption of independent social actors, and a framework for testing theories about structured social relationships. Social network analysis has proven to be fruitful in various domains, ranging from the analysis of construction project coalitions (Pryke, 2004), and the corporate partners of higher education associations (Metcalfe, 2006), to the study of war between nations (Wimmer & Min, 2006). Social network analysis is even applied to study the role of the Korean government in creating university-industry linkages (Sohn et al., 2009).

All university-industry collaborations together can be seen as an innovation network, consisting of various network characteristics. The research of Powell et al. (2005) describes various network characteristics. According to the article, networks consist of nodes and ties. The nodes consist of all kind of entities such as organizations, people and nations. The ties then define the relations amongst these entities. According to Wasserman and Faust (1994, p.20), a social network consists of a finite set or sets of actors and the relation or relations defined on them. A relation is defined as the collection of ties of a specific kind amongst members of a group. In this definition, a group is defined as the collection of all actors on which ties are to be measured (Wasserman and Faust, 1994; p.20). Ties that define relations for instance are the set of friendships among pairs of students on a university, or the set of formal ties between nations in the world. However, the theory of social network analysis is very elaborate and comprises far more than described here, see for instance Wasserman and Faust (1994).

3.2 Case selection

To answer the research question, the case of the electric vehicle will be studied. This case is interesting to study because it is an emerging technology competing despite comparative disadvantages of the fossil fuel transportation infrastructure (Ahman & Nilsson, 2008). Because of these disadvantages, innovation policy is in place to accelerate the technology, and expectations are articulated to represent future technological perspectives. From 2009 onwards, the Dutch government introduced innovation policy for the electric vehicle related sector. As mentioned in the introduction, 65 million euro will be invested by the government between 2009 and 2011. The goal of this investment is to develop an innovation network and accelerate the knowledge production and valorization of the technology. The government used the tender procedure as described in the theoretical framework. Because an excessive amount of project groups applied for the tender, a selection procedure took place to assign the innovation subsidy to a limited amount of projects. Therefore, the case of the electric vehicle is suitable to answer the main research question and hypotheses.

3.2 Data collection

The data needed to perform the analysis has to be collected from different sources. The data necessary for the social network analysis was gathered from the 'NL Innovatie' division of AgentschapNL. AgentschapNL is part of the ministry of economic affairs, agriculture and innovation, and executes innovation policy imposed by the government. This department is also responsible for the allocation of innovation subsidy in the electric vehicle sector. From this department, two databases were gathered. The first database consists of 23 project groups, the total number of projects that proposed a research collaboration on a specific electric vehicle topic, in an attempt to receive innovation subsidy. The second database consists of 16 projects, the total number of project groups which indeed received innovation subsidy to perform their project. A project group consists of a varying amount of knowledge institutes and industrial organizations. The data of the project groups which did not receive innovation subsidy is confidential, the actors and topics of these project groups are therefore not mentioned by name. The number of valid cases resulting from these databases is 118. Additionally, actor characteristics were gathered from the following sources; company web pages, LexisNexis newspaper database, esp@cenet patent data, chamber of commerce data for organizational type and existence, and Sciverse Scopus for scientific articles.

3.3 Measurement

Three types of expectations are distinguished; scientific expectations, valorization expectations, and societal expectations. Besides the expectations, also several control variables will be analyzed.

3.3.1 Variables

Dependent variable:

Participate in subsidized project

Whether or not an organization is present in the post tender network is the dependent variable of this research.

Independent variables:

Societal expectations

Societal expectations are measured by the amount of articulated expectations about electric vehicle technology in the media. The type of media used for this research are newspaper articles. The LexisNexis database is used to determine the amount of expectations about electric vehicle technology in newspaper articles. Because only Dutch newspaper articles are examined, the search string is defined as follows: 'name of organization´ AND 'elektrisch'. The resulting newspaper articles are read individually to examine whether the organization articulates positive expectations about electric vehicle technology.

Scientific expectations

Scientific expectations are measured by the amount of scientific publications on electric vehicle technology, providing insight in the efforts and expectations of a knowledge institute about this technology. Furthermore, past performances contain a signaling value for future performances, and can therefore be seen as a valid measure for expectations. Sciverse Scopus is used to determine the amount of scientific publications. The search string for Delft University is defined as follows: AFFILORG(Delft university) AND AFFILCITY(Delft) AND ABS("electric vehicle"). If no articles are found with this string, the search will continue with the following string: AFFILORG(Delft university) AND AFFILCITY(Delft) AND ABS("electric"), from these results the abstracts are scanned to check whether the article is about an electric vehicle related technology.

Valorization expectations

Valorization expectations are measured by the amount of patents. A patent is an exclusive right granted to anyone who invents any new product or article and claims that right in a formal patent application. Organizations apply for patents to protect their intellectual property with the thought that this intellectual property provides commercial benefits. A patent can therefore be seen as the link between knowledge and commercial application, and is therefore suitable to measure valorization expectations. The statement that past

performances contain a signaling value for future performances applies here as well, and can therefore be seen as a valid measure for expectations. Patents are measured with the use of esp@cenet which provides an extensive patent database for more than 80 countries. However, only Dutch patents were searched for. The first search string only contains the company name to see if they applied for any patents. When they do, a second query will filter the word 'electric' from the abstracts. From these results, the number of patents dedicated to electric vehicle technology are counted.

Organizational type

This variable analyses whether the type of organization is of influence on the likelihood of receiving innovation subsidy. Three types of organizations are being distinguished. The first type is the knowledge institute (KI), the second type is the small and medium sized enterprise (SME), and the third type is the large company (LC). SMEs are organizations which have between 0 and 250 employees. Large companies are organizations with more than 250 employees. Data from the Dutch chamber of commerce were queried to determine the amount of employees.

Links with knowledge institutes

This variable analyses whether more links with knowledge institutes in the entire network is of influence on the likelihood of receiving innovation subsidy. The number of links with knowledge institutes is counted in the pre-tender network data.

Links with large organizations

This variable analyses whether more links with large organizations in the entire network is of influence on the likelihood of receiving innovation subsidy. The number of links with large organizations is counted in the pre-tender network data.

Links with small and medium sized enterprises

This variable analyses whether more links with small and medium sized enterprises in the entire network is of influence on the likelihood of receiving innovation subsidy. The number of small and medium sized enterprises is counted in the pre-tender network data.

Amount of knowledge institutes, large organizations, and SMEs in a project

This variable analyses whether the amount of knowledge institutes, large organizations, and small and medium sized enterprises in a project is of influence on the likelihood of receiving innovation subsidy. The amount and type of organizations is counted in the pre-tender network data.

Age

This variable analyses whether the age of an organization, measured in years from founding date, is of influence on the likelihood of receiving innovation subsidy.

Age mean

This variable analyses whether the mean age of the project group, measured in years from founding date divided by the number of organizations in the project, is of influence on the likelihood of receiving innovation subsidy.

EV as core business

This variable analyses whether exploiting electric vehicle technology as a core business is of influence on the likelihood of receiving innovation subsidy. If the majority of products on the organizations website is intended for electric vehicle related purposes, the firm scores positive (1) on the variable 'EV as core business'. In all other cases the firm scores negative (0) on this variable.

EV as core business mean

This variable analyses whether the mean of organizations in a project group exploiting electric vehicle technology as a core business is of influence on the likelihood of receiving innovation subsidy. This variable is calculated by taking the sum of the 'EV as core business' variable divided by the amount of project group members.

Degree centrality

This variable analyses whether degree centrality, the number of ties an individual actor has to other actors in the network graph, is of influence on the likelihood of receiving innovation subsidy.

Betweenness centrality

This variable analyses whether betweenness centrality, the degree to which a particular actor might be able to control interactions between pairs of other actors in the network, is of influence on the likelihood of receiving innovation subsidy.

3.4 Analysis

To statistically separate the project level from the actor level, an ordinary linear regression (OLS) is performed in which the actor level predicts the project level. The resulting residuals from the OLS were added to the database as the new project group variables. The 'age mean' and 'EV as core business mean' variables were also calculated this way to partial out the correlation between the actor and project level variables. The actor level, betweenness, degree, and age variables were skewed. The rate of increase of these variables was not equal to the increase in the effect size of these variables. Therefore, the natural logarithm is calculated to achieve a better distribution. With the use of UCINET, the pre and post tender network databases are converted into two usable adjacency matrices. The resulting matrices are analyzed by the R-program to calculate the network degrees and betweenness of all actors. UCINET was used to draw social network graphics of the pre and post tender networks. This data is used for the network variables and added to the database consisting of all actors, projects, and their characteristics.

To test the hypotheses, a mixed logit model containing a random intercept dependent on the individual actor was fitted. However, the random intercept equaled zero which means that the model collapses back to a conventional logit model. Therefore, a logit model was fitted in four steps. The first model only includes the actor level variables and tests hypotheses 1 to 3. The second model only includes the control variables to test them independently from the actor and project level variables. In the third model, the actor level variables and control variables are combined to test hypotheses 1 to 3. The fourth model is the final model, including actor level, project level, and control variables and tests the fourth hypothesis.

The result of the logit regressions will prove whether the hypotheses are true or false, providing an answer to the research question. Accordingly, the stepwise development of the logit regression model will show the increase of explained variation through the addition of a new group of variables.

	Variable	Mean	Std. deviation		Variable	Mean	Std. deviation
	Dependent variable						
	Participate in subsidized project	,64	,48				
	Independent variables						
Actor level characteristics	Societal expectations	3,62	6,50	**Control variables**	SME partners	4,25	2,57
	Scientific expectations	1,57	3,69		KI links in network	1,23	2,64
	Valorization expectations	,16	,76		LO links in network	,25	,59
Project level characteristics	Societal Expectations [1]	3,62	2,78		SME links in network	1,07	1,19
	Scientific Expectations [1]	1,57	1,27		EV core	,24	,43
	Valorization Expectations [1]	,15	,39		EV core mean [1]	,24	,18
Control variables	Organizational type	2,05	,61		Age	34,18	46,37
	KI partners	1,42	,96		Age mean [1]	34,36	18,08
					Pre degree	3,04	,95
	LO partners	1,11	,99		Pre betweenness	2,90	3,28

Table 1: Descriptive statistics. [1] The non-recomputed values are displayed.

4. Results

4.1 Pre and post tender network

First, the results of the social network analysis are presented. The difference between the two network graphs shows the implication of the decision process as described in the conceptual model. Figure 2 shows the pre tender HTAS-EVT network of all submitted projects, before the committee decided which projects were subsidized (79 unique actors, mean betweenness: 424,6; mean degree: 31,2; diameter: 7):

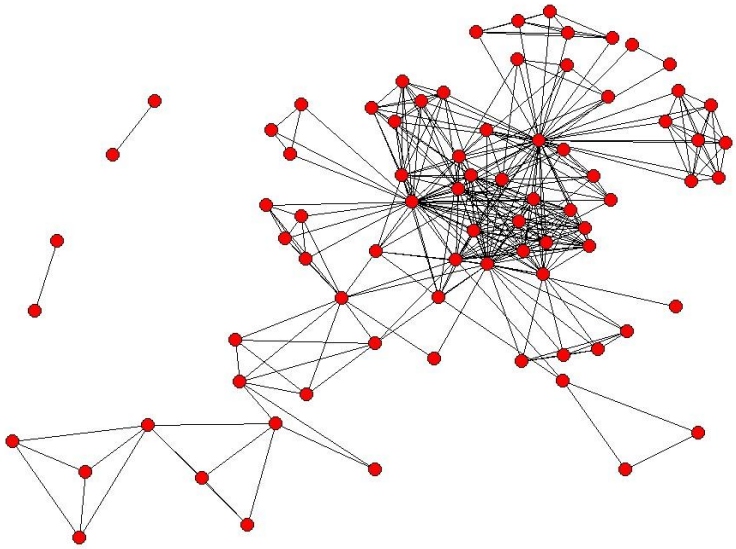

Figure 2: Pre tender network (actor labels removed)

Figure 3 shows the post tender HTAS-EVT network of all honored projects, after the committee decided which projects were subsidized (56 unique actors, mean betweenness: 121,1; mean degree: 21,0; diameter: 5):

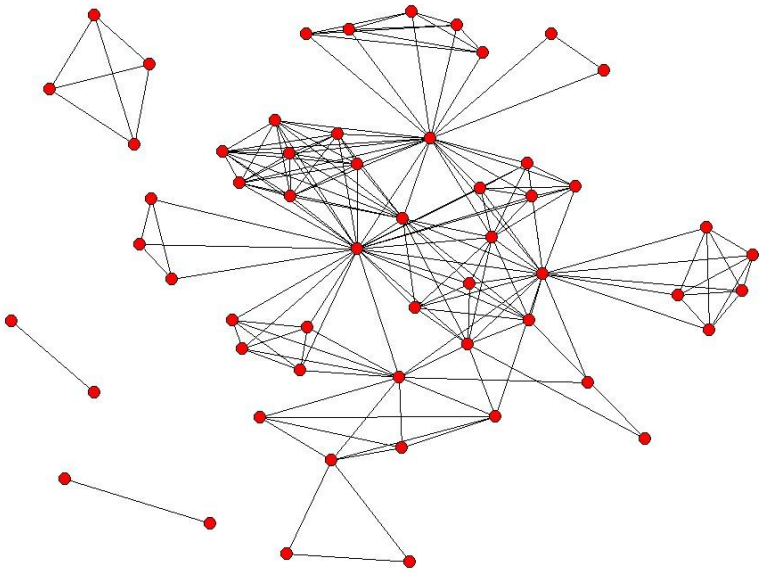

Figure 3: Post tender network (actor labels removed)

4.2 Multivariate statistics

Table 2 displays the results of the logit regression predicting participation in a subsidized collaboration. The logit regression is gradually built up until all variables are included. The first model only consists of actor level variables. The second model only consists of control variables. The third model consists of actor variables and control variables, and the final model includes all variables. Apart from the first model, all models predicting participation are highly significant. The pseudo R^2 of the models shows an increase towards the final model, indicating that the added variables are increasing the predictability of the model. With a pseudo R^2 of ,745 the final model performs very well. The Wald chi-square is included to allow for a comparison of the effect sizes.

		Model 1			Model 2			Model 3			Model 4		
	Variables	**B**	**Wald x^2**	**p**	**B**	**Wald x^2**	**p**	**B**	**Wald x^2**	**p**	**B**	**Wald x^2**	**p**
	Constant	,557	5,507	**	2,654	,877		4,599	1,127		7,967	2,753	*
Actor level	Societal expectations	,191	,602					-,697	2,538		-,945	1,465	
	Scientific expectations	-,237	,581					-,932	,146		,427	,008	
	Valorization expectations	-,202	,098					-,810	,500		-4,405	5,248	**
Project level	Societal expectations										-,713	4,853	**
	Scientific expectations										-2,641	6,788	***
	Valorization expectations										-5,880	7,576	***
Control variables	Organizational type					3,484			2,150			3,109	
	KI partners				1,181	4,210	**	1,342	4,861	**	4,530	9,035	***
	LO partners				,277	,620		,394	1,128		,698	1,547	
	SME partners				-,721	12,410	****	-,745	12,644	****	-1,481	14,705	****
	KI links in network				-,230	,249		,120	,036		,151	,012	
	LO links in network				-3,816	5,935	**	-3,816	5,722	**	-4,864	4,623	**
	SME links in network				-1,474	4,224	**	-1,459	3,869	**	-1,765	2,634	
	EV core				,815	,813		1,664	2,444		2,465	1,821	
	EV core mean				3,858	3,765	*	3,734	3,025	*	15,639	8,127	***
	Age				-,503	1,959		-,384	,895		-,717	1,594	
	Age mean				-,043	4,243	**	-,042	3,584	*	,102	2,686	*
	Pre degree				-,104	,013		-,509	,273		-2,283	2,947	*
	Pre betweenness				,419	5,621	**	,486	5,141	**	,625	4,056	**
	Chi-square	,738			51,034			55,385			92,333		
	Degrees of freedom	3			14			17			20		
	Sig.	*			****			****			****		
	Nagelkerke R^2	,009			,482			,515			,745		

Significance level (p): *p<0.10. **p<0.05. ***p<0.01. ****p<0.001.

Table 2: Results of the multivariate statistics.

At the actor level, all B-values are negative and only the valorization expectations variable has a significant (p=0,022) influence on the likelihood of participating in a subsidized project. This implies that the first three hypotheses at the actor level are not confirmed. The significant but negative B-value of valorization expectations (-4,405) indicates the opposite of the third hypothesis at the actor level. Thus, holding patents in the field of an emerging technology negatively influences the likelihood of receiving innovation subsidies. As indicated earlier, the project level is more important than the actor level due to the fact that the innovation subsidy is dedicated to a project instead of individual actors. This might be a possible explanation why the actor level variables disconfirm the stated hypotheses.

At the project level, all variables have a significant influence on the likelihood of participating in a subsidized project. However, all B-values are negative, rejecting the fourth hypothesis of this research. (Societal expectations, B=-,713, p= 0,028; Scientific expectations, B=-2,641, p=0,009; Valorization expectations, B=-5,880, p=0,006). It is indeed true that hypotheses 1-3 have a stronger influence on the project level compared to the actor level. However, this influence is negative and therefore contradicts the hypothesis. This implies that articulating positive expectations about electric vehicle technology in the media *negatively* influences the likelihood of receiving innovation subsidies. Publishing scientific articles about electric vehicle technology *negatively* influences the likelihood of receiving innovation subsidies. And holding patents in the field of electric vehicle technology *negatively* influences the likelihood of receiving innovation subsidies. The hypotheses and variables are constructed according to the existing theories of expectations and the resource dependence view. However, the outcome of the multivariate statistics are significant and show an opposite relationship to the hypothesis derived from the literature.

Besides the actor and project level variables, not all variables in the final model are significant. *Organizational type, Large Organization partners, Knowledge Institute links in network, SME links in network, EV as core business, Age mean* and *Age of the organization* seem to have no significant influence on the likelihood of participating in a subsidized project. The variable *Knowledge institute partners* (B=4,530, p=,003) is highly significant, indicating that a higher amount of knowledge institutes in a project positively influences the likelihood of participating in a subsidized project. The variable *SME partners* (B=-1,481, p=,000) is also highly significant but has a negative B-value, indicating that more small and medium sized enterprises in the project group negatively influences the likelihood of participating in a subsidized project. The variable *Large organizations in network* (B=-4,864, p=,032), is significant but has a negative B-value, indicating that being connected to a high amount of large organizations in the pre-tender HTAS network negatively influences the likelihood of participating in a subsidized project. The variable *EV core mean* (B=15,639, p=,004) can be seen as a key variable. This variable is highly significant and has a positive B-value, indicating that a project group with a high mean value of firms with electric vehicle technology as core business is of positive influence on the likelihood of participating in a subsidized project. This variable indicates that firms which have electric vehicle technology as core business, no matter what the historical achievements within this technology are, have a significant higher likelihood of receiving innovation subsidies. It should be noted that in this research only SMEs were labeled as having electric vehicle technology as core business. The

variable *SME partners* showed that SME partners in the network is of significant negative influence, but this variable shows that having SME partners with EV as core business is of significant positive influence. It is arguable whether these firms are established to seriously commit to the technology, or established to qualify for innovation subsidies since they entered an emerging technological field.

The network position variable *pre degree* (B=-2,283, p=0,086) is significant at the 10% level with a negative B-value, indicating that a higher number of ties an individual actor has to other actors in the pre-tender network negatively influences the likelihood of participating in a subsidized project. The network variable *pre betweenness* (B=0,625, p=0,044) is significant and has a positive B-value. Actors with a higher ability to control interactions between pairs of actors in the pre-tender network have a higher probability of participating in a subsidized project. The two network variables have contradicting B-values. Indicating that it is more important to have influence on the interactions in the pre-tender network than the amount of links with other actors in the pre-tender network. This is in line with the resource dependence view which states that it does not matter how much connections an organization has with its environment, but how they exploit their connections. Organizations more capable to exploit their connections have access to a higher resource base and have more influence on their connections which positively influences the likelihood of receiving innovation subsidy.

5. Conclusions

The research question of the current research is: *"What is the influence of expectations on both actor and project level on the likelihood of receiving innovation subsidies?"* This research proposed a combination of the resource dependence view with the sociology of expectations. Three types of expectations were argued to influence the likelihood of receiving innovation subsidies: *societal expectations, scientific expectations, and valorization expectations.* These expectations were aggregated to the actor level and the project level. The results did not support all stated hypothesis and, against all expectations, revealed a negative influence of expectations on the likelihood of receiving innovation subsidies. It is argued however, that the opposite conclusions did not arise because of a lacking theoretical framework, but are caused by different possible reasons.

Firstly, the opposite conclusions could have been caused by inconsistencies in the innovation subsidy regulation among different governmental departments as stated by the Dutch court of audit (Algemene Rekenkamer, 2011). Recently, the Dutch court of audit published a report in which the effectiveness and efficiency of the Dutch innovation policy was analyzed. Their research concludes that the effectiveness and efficiency of Dutch innovation policy between 2003 and 2011 cannot be determined. In this same period, the amount of innovation subsidy doubled from €1.8 billion to €3.7 billion. They also conclude that the coordination of the Ministry of Economic Affairs was very limited, and that all different departments could follow their own subsidizing policy. Thus, although the innovation budget doubled, consistency between regulations and objectives is missing. These conclusions might indicate why the results in this report are contradicting towards the literature. Apparently, there is no general regulation regarding innovation subsidy decisions among different government departments.

Secondly, the opposite conclusions could have been caused by other aspects which are not included in this research. It could be that the decision makers were technicians and looked at the technological characteristics of the projects, instead of looking at historical achievements of single actors. It could also be that more informal power games are being played, or that some project leaders have performed lobbying activities to access innovation subsidies. However, this is speculative and difficult to prove within the current context.

This research also tried to understand what level and what type of expectation is dominant on the likelihood of receiving innovation subsidies. The results show that the articulated expectations have a stronger effect on the project level compared to the actor level which was thought to be reasonable, since the subsidy is allocated to projects instead of individual actors. The most dominant is the valorization expectations variable at the project level, indicating that holding electric vehicle related patents as a project group strongly negatively influences the likelihood of receiving innovation subsidies. Besides the expectation variables, the variable *EV core mean* is both highly significant and influential and is seen as a key variable.

6. Discussion

6.1 Limitations

A shortcoming for this research was the small sample size. Only 79 unique actors formed a total of 118 cases. However, the sample size was limited since only 79 unique actors in 23 project groups proposed a research collaboration on a specific electric vehicle topic in an attempt to receive innovation subsidy. Therefore, in statistical terms, the entire population is addressed. Due to the contradicting results and disconfirmed hypotheses, the generalizability of the results is limited. The current research only analyzed one case, further research could indicate whether these results also apply to other cases. Further research could also confirm the combination of the resource dependence view and the sociology of expectations. Unfortunately, this research was unable to come forward with clear motives explaining why innovation subsidy is designated to specific project. Furthermore, actions made by the organizations not subsidized in the pre tender network were not taken into account. It could be interesting to see whether the organizations did continue their projects without governmental subsidies, and how this non-subsidized network would develop. However, this data is not available.

6.2 Theoretical implications

The theoretical framework combined the resource dependence view and the sociology of expectations. Unfortunately, the hypotheses from the theoretical framework were all disconfirmed. However, combining the resource dependence view with the sociology of expectations in the same research still seems plausible. It is argued here that the opposite results did not come forward from an incorrect theoretical framework but it was caused by other factors which could not be measured scientifically. Therefore, the results do provide new input for further research. The current research only tested the electric vehicle case. Performing this analysis on other cases where innovation subsidy is divided amongst project groups by a decision committee can provide other insights than the current research. It could be that in other cases, the stated hypotheses will be confirmed, and the combination of the resource dependence view and the sociology of expectations do fit well. Otherwise, new variables have to be included to give insight in the factors and characteristics which are of influence on the likelihood of receiving innovation subsidies. Doing this type of research provides new insight in the governmental decision mechanism which is currently non-transparent to the industry and society.

6.3 Practical implications

Without further research into the organizational characteristics and the decision procedure, it is difficult to draw a general management advice. Following from this research, organizations eager to qualify for innovation subsidies have to set up a small new business and dedicate the core technology to the specific technology. This largely increases the likelihood of receiving innovation subsidies. The results of this research could also be taken into account by the decision makers to improve their subsidizing procedure. The statistics

came forward with the opposite of what was thought to come forward following from to the theory. Apparently, the theoretical background of the decision process is lacking. The decision makers can therefore make effort by implementing the theoretical background of the current research into the selection procedure. This way, decisions are not only made in the way they are made now, but also organizational past achievements are then taken into account. This increases the 'scientometric' and scientific value of the decision procedure which could lead to better performing project groups. Following the report of the Dutch court of audit, making the innovation subsidy funding procedure more transparent could also improve the effectiveness of the invested money (Algemene Rekenkamer, 2011). The United States could be taken as an example, where funding decisions are made public, and funded firms can be rated by their effectiveness of using innovation subsidies (FFATA, 2006). This way, society is more actively involved in the subsidiary activities of the government. More societal commitment will also lead to a wider societal support of invested innovation subsidies.

Acknowledgements

Firstly, I would like to thank my supervisor dr. Frank J. van Rijnsoever whose encouragement, guidance and support from the initial to the final level enabled me to develop this master thesis. His valuable input and enthusiasm always provided me with new inspiration to continue this research. I would also like to thank my second reader prof. dr. ir. Harro van Lente for providing some valuable comments on my research proposal. Secondly, I would like to thank NL Agency, and Dean van Vliet in particular, for providing the necessary data to conduct this research and helping me out with developing adjacency matrices from the data. Thirdly, I would like to thank Ottomar Kruseman and Sjoerd Wiersma for their valuable review of the final thesis. Finally, I would like to thank my parents for giving me the opportunity to study, and both my parents and my girlfriend for their support during the thesis.

"There are two possible outcomes: if the result confirms the hypothesis, then you've made a measurement. If the result is contrary to the hypothesis, then you've made a discovery."

Enrico Fermi (1901—1954), Italian physicist.

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