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Credibility and legitimacy in policy-driven innovation networks: Resource dependencies and expectations in Dutch electric vehicle subsidies

Frank van Rijnsoever
Utrecht University
Innovation Studies, Copernicus Institute
f.j.vanrijnsoever@uu.nl

Leon Welle
Utrecht University
Science & Innovation Management
l.welle@students.uu.nl

Sjoerd Bakker
TU-Delft
OTB
s.bakker-1@tudelft.nl

Abstract

The aim of this paper is to empirically examine the influence of different types of credibility on the legitimacy to grant individual actors within consortia an innovation subsidy. Theorizing from the resource dependence view and the sociology of expectations, we hypothesize that four types of credibility are related to legitimacy: scientific credibility, market credibility, expectation track record, and social capital. Further, we operate on two levels of analysis, the actor and the consortium level.

Empirically, we quantitatively analyze the Dutch electric vehicle subsidy program as a case study. We develop a model that accurately forecasts which consortia are most likely to receive subsidies. We demonstrate that social capital and market credibility positively influence the likelihood of receiving innovation subsidies, while scientific credibility sources and expectation track record have a negative influence. Based on these findings we provide policy recommendations and avenues for further research.

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Keywords: Electric Vehicle Technology, Expectations, Resource Dependence View, Legitimacy, Innovation Policy

1. Introduction

Over the last decades, efforts to develop a technology that can replace the internal combustion engine vehicle have increased (Frenken, Hekkert et al. 2004). From 2006 and onwards the (battery) electric vehicle is seen as the most prominent candidate to do so (Bakker 2010). Following these high expectations, the Dutch government introduced innovation policy to support the development of electric vehicle technology (EVT) and the necessary charging infrastructure. Between 2009 and 2011 65 million Euros has been invested by the government to support a number of test and demonstration projects for electric vehicles. It was anticipated that this investment would result in complementary investments by other parties, totaling to about 500 million euro (Ministry of Economic Affairs 2009). With these investments, the government aims for the Netherlands to become an international test site for electric vehicles. Further, the Dutch government aims at the deployment of 1 million electric vehicles by 2025 (Ministry of Economic Affairs 2009). Though promising, following ideas about (technological) innovation systems (Edquist 1997; Hekkert, Suurs et al. 2007), electric mobility can only become successful when firms, societal organizations, knowledge institutes, local authorities, and the national government collaborate in developing this new technology (Ministry of Economic Affairs 2009). Therefore the most important goal of the innovation policy was to promote collaboration between stakeholders through the creation of innovation networks.

A prominent approach to explain collaborations between actors is the resource dependence view (Pfeffer and Salancik 2003; Hillman, Withers et al. 2009). This perspective argues that actors try to control their environment in order to gain access to crucial resources. One of these crucial resources is legitimacy (Hannan and Freeman 1989; Pfeffer and Salancik 2003; Rao, Chandy et al. 2008), which can be defined as a social judgment of acceptance, appropriateness, and desirability

(Scott 1995). Legitimacy is a prerequisite for organizations to gain access to certain resources needed to fulfill organizational aspirations (Cyert and March 1963).

Additionally, several studies pointed out the significance of expectations in guiding interests and investments in innovation (Berkhout 2006; Borup, Brown et al. 2006; Van Lente and Bakker 2010; Alkemade and Suurs in press). A technological expectation can be defined as a 'real-time representation of future technological situations and capabilities' (Borup, Brown et al. 2006, p286). Actors can use positive expectations about an emerging technology to substitute uncertainties around this technology (Brown and Michael 2003). From a resource dependence perspective this means that voicing credible positive expectations about an emerging technology can contribute to legitimizing the allocation of resources for further development of the technology. This legitimacy partly depends on the credibility of the voiced expectations (Berkhout 2006) and characteristics of the actor that voices these expectations (Deeds, Mang et al. 2004; Rao, Chandy et al. 2008). Voicing credible expectations can thus be seen as a strategic action to gain access to crucial resources.

The granting of government subsidies that aim to further develop a technology through the building of innovation networks are a specific opportunity for innovators where legitimacy is required to gain access to available resources. Although these subsidy programs make financial resources available to the technological community, such resources are often scarce. Therefore individual members of the technological community usually need to further show their credibility in order to legitimize them getting a share of this resource.

The aim of this paper is to empirically examine the influence of different types of credibility on the legitimacy to grant individual actors within consortia an innovation subsidy. We hypothesize that four types of credibility are related to legitimacy: scientific credibility, market credibility, expectation track record, and social capital. Further, we operate on two levels of analysis, the actor and the consortium level.

Theoretically, we combine the resource dependence view (RDV) with the sociology of expectations. Within the RDV, many scholars have researched the formation of inter-organizational relationships or innovation networks between firms (see Hillman, Withers et al. 2009 for an overview) and to a lesser extent between science and industry (Van Rijnsoever, Hessels et al. 2008). However, little empirical attention has been paid to intangible resources, such as the sources of legitimacy. Deeds et al. (2004) and Rao et al. (2008) form notable exceptions, but their studies are limited to firms only, while we study consortia that consist of firms and knowledge institutes such as universities. Further, much of the empirical research concerning the role of expectations and their credibility in innovation dynamics relates to effects on entire scientific and technological communities (van Lente and Rip 1998; Bakker, Van Lente et al. 2011). However, there are no studies that specifically focus on the benefits of articulating expectations for individual actors when funds are actually distributed. The question whether or not expressing expectations by individual actors (or project networks) leads to direct individual benefits is highly relevant to the analysis of the role of expectations in processes of innovation. The popular assumption that technology developers, willingly or not, create a hype by voicing high expectations, builds partly on the idea that those actors are actually rewarded directly for raising highly positive expectations (Rip 2006). When actors in a later stage are only rewarded indirectly, through rewards for their technological community in general, they are less likely keen on hyping the emerging technology.

Empirically, we quantitatively analyze the Dutch electric vehicle subsidy program as a case study. We develop a model that accurately forecasts which consortia are most likely to receive subsidies. We demonstrate that social capital and market credibility positively influence the likelihood of receiving innovation subsidies, while scientific credibility sources and expectation track record have a *negative* influence.

The outcomes of this research are particularly interesting for industrial organizations and knowledge institutes that attempt to gain access to these types of 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. The results are also of interest to policy makers. Recently the, Dutch court of audit (2011) published a report in which the effectiveness and efficiency of the Dutch innovation policy was analyzed. Their research concludes that, while the amount of innovation subsidy doubled from €1.8 billion to €3.7 billion between 2003 and 2011, the effectiveness and efficiency of Dutch innovation policy cannot be determined. Policy makers may use the results of this study to improve the method in which subsidies are distributed among projects in order to increase effectiveness.

In the next section we present our theoretical framework, in which we formulate our hypotheses. Next we discuss our research methods after which our empirical results follow. Finally, we draw conclusions and discuss the implications of this research.

2. Theoretical Framework

2.1. A resource dependence view on university-industry collaborations

Following Van Rijnsoever et al. (2008) the collaboration between science and industry can be approached from a resource based view (see Penrose 1959; Barney 1991). This perspective argues that a firm can be seen as a bundle of sticky and difficult-to-imitate resources and capabilities (Lewin, Weigelt et al. 2004). The resource based view claims that the various resources possessed by firms can be translated into a sustainable competitive advantage (Barney 1991). These resources can both be tangible, such as human resources, equipment, buildings, and financial capital, as well as intangible, such as brand equity, in-house knowledge credibility or legitimacy (Barney 1991; Lewin, Weigelt et al. 2004).

The Resource Dependence View (RDV: Pfeffer and Salancik 2003) can be seen as an extension of the resource based view. It places more emphasis on the relationship between the organization and its environment (Lewin, Weigelt et al. 2004). According to the RDV organizations are constrained and affected by their environment. Firms cannot generate all the necessary resources internally and therefore have to rely on resources from their external environment. Organizations behave strategically to control external critical resources (Pfeffer and Salancik 2003; Hillman, Withers et al. 2009).

The resource dependence view explains several motives for both firms and universities to engage in university-industry collaborations. 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 and Chakrabarti 2002). Universities primarily engage in industry collaborations for additional research funds, exposure of students and staff to practical problems, job opportunities for graduates, and access to specific technological areas (Harman 2001; Nieminen and Kaukonen 2001). Further, individual scientists can benefit from collaboration in terms of reputation, career, publications or other forms of productivity (Siegel, Waldman et al. 2003; Kuhlmann 2004; Lee and Bozeman 2005; Van Rijnsoever, Hessels et al. 2008).

However, it can be argued that the expected resource benefits of collaboration do not outweigh the required investments; otherwise there would be no need for policies that stimulate university-industry collaboration. University researchers have different aspirations than firms. Studies have shown that scientists strive for scientific recognition, which is more difficult to gain when collaborating with industry (Carayol 2003; Van Rijnsoever, Hessels et al. 2008). Further, firms need to bridge cognitive and cultural barriers in order to apply scientific knowledge (Siegel, Waldman et al. 2003), which is often problematic. Next to the time and effort required to maintain network ties (Burt 1999), these are barriers that hamper the formation of science-industry networks. Innovation policy can help to overcome these barriers.

2.2. The strategy of voicing credible expectations

The central claim of the sociology of expectations is that positive expectations of an emerging technology can help to stimulate, steer, and coordinate the innovation process (Van Lente 1993; Borup, Brown et al. 2006; Bakker 2010). According to Borup et al. (2006, p285), expectations can be seen as fundamentally 'generative', providing structure and legitimacy, guiding various activities, attract interest, and fostering private and public investments. Expectations are most powerful when they are part of a collective repertoire of ideas and statements. In those cases, these expectations cannot be ignored even by those actors that do not share exactly the same ideas; such expectations are then simply part of social reality. This grants certain legitimacy to the technology they are expressed about, which can lead to both public and private funding. Assessment of the credibility of expectations and of the actors that express them are made continuously (Bakker, Van Lente et al. 2011). This greatly influences the legitimacy of the emerging technology. Trying to impose legitimacy upon a new technology by expressing expectations can be viewed as a strategic action to gain control on organizational environment. Credibility of the actor expressing the expectations is an important resource required for this strategy to function.

2.3. Innovation policy and legitimacy

Over the past decades, innovation policy developed with the objective to encourage and facilitate the generation, application, and diffusion of new ideas (Nooteboom and Stam 2008). A rationale for government involvement in technological advance and innovation are network failures in the innovation system (Carlsson and Jacobsson 1997; Chaminade and Edquist 2010). Network failures in the innovation system occur when organizations interact poorly with their environment resulting in a lack of collective vision, technological expectations, and coordination of investments. To reduce network failure, Carlsson and Jacobsson argue that actors should be tied together by means of reciprocal flows of information and knowledge in order to achieve a good connectivity.

One instrument to reduce network failure is subsidizing collaborative innovation projects (Ministry of Economic Affairs 2009). With this instrument innovation subsidies are dedicated to collaborative R&D projects around an emerging technology. This distribution of funds can be seen as a two-stage process. First, partly based on voiced expectations (Borup, Brown et al. 2006), the choice for a technology is made. Second, after the subsidy program has been established, consortia consisting of organizations and knowledge institutes, can obtain subsidies by sending in project proposals. From the RDV it is clear that these subsidies are a valuable resource for firms and knowledge institutes alike, while for start-up ventures in a new technological domain these subsidies are even crucial for survival. Next to this, the subsidized innovation networks can turn out as an important source for organizations to acquire other resources (Adler and Kwon 2002).

Funds are often scarce and only a limited number of projects can receive funding. Those who decide which projects are rewarded need to legitimize their decision. Seeking this legitimacy is important since the subsidies are funded with public (e.g. tax-payers) money. In a society where science and innovation become increasingly more accountable to the general public (Gibbons, Limoges et al. 1994; Hessels and van Lente 2008), making legitimate decisions about funds becomes increasingly important (Van Merkerk and Robinson 2006). Therefore actors that decide about the distribution of public funds need to act as 'legitimacy maximizing' agents.

2.4. Research model

We try to explain the legitimacy of allocating funds to actors participating in research consortia. Our research model is presented in figure 1 and explained below.

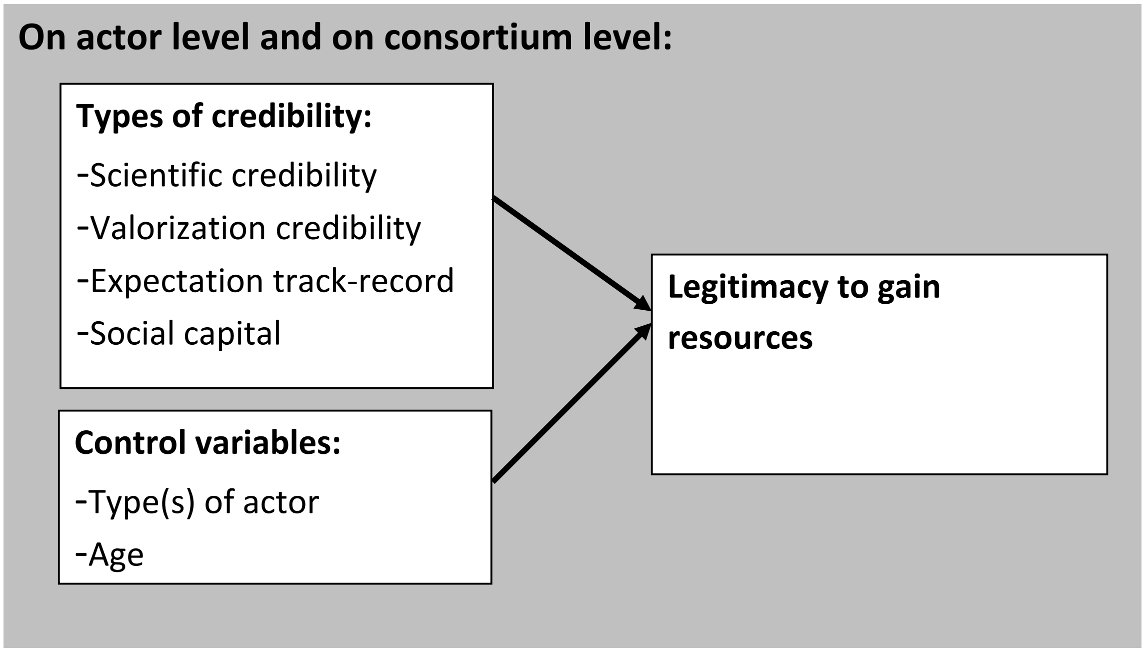

Figure 1: Conceptual model

2.4.1. Legitimacy

Legitimacy can be a property of many things such as organizational forms (DiMaggio and Powell 1983; Hannan and Freeman 1989), industries (Deeds, Mang et al. 2004), technologies (Berkhout 2006) or policy (Nooteboom and Stam 2008). In this paper we refer to the legitimacy of a policy decision to grant a subsidy to an actor or consortium. In case we refer to another form of legitimacy this shall be mentioned explicitly. Legitimacy is the main dependent variable in our research, and being an intangible resource, it is assumed to be a latent construct. This means that it is not observed directly, but rather its value is inferred from the policy decisions taken.

2.4.2. Credibility

We refer to the independent variables as types of credibility. Credibility is a broad concept with many dimensions that has been studied in many scientific fields and. It is especially important when communicating messages (Rieh and Danielson 2007), which is also the domain we are interested in. We are concerned with actor credibility as a source of legitimacy to reward project proposals for innovation subsidies, therefore we specifically study source credibility. This form of credibility has also been extensively studied and debated in earlier studies (see Hovland and Weiss 1951; Sternthal, Ruby et al. 1978; Pornpitakpan 2004). However, authors rarely explicitly define the concept. Rather they refer to elements of it. Common elements of source credibility used are trustworthiness, expertise and reliability. For this study we therefore define source credibility as the trustworthiness, expertise and reliability of an actor.

The legitimacy of a subsidy decision partly depends on the credibility of the actors that submitted the proposal. Credibility depends on characteristics of the actor in relation to the goals of the subsidy program. For example, if the goal of the program is to develop scientific knowledge, then an actor might have an increased credibility with a strong scientific track record. This type of credibility contributes to the legitimacy for granting the subsidy.

2.4.3. Actor and consortium level

Rao et el (2008) claim legitimacy has both external and internal sources[1]. Internal sources are the types of credibility the actors controls within the organization. External sources are the types of credibility in the organizational environment on which the actor relies. The RDV states that if the actor does not control a critical resource internally, it needs to rely on others in its environment, such as member of a project consortium. Internal credibility is thus found at the actor level, external credibility is located at the consortium level. Many innovation subsidy programs anticipate this by explicitly calling for applications by consortia rather than individual actors. This is also the case for the subsidy program that we are currently investigating. Decisions to grant subsidies are not made for specific actors, but rather for the consortia of which these actors are a part. Therefore we expect that the influence of credibility at the consortium level is stronger than the influence of credibility at the actor level. This results in our first hypothesis:

[1] Roa et al. (2008) define these sources in terms of legitimacy. To avoid confusion with our dependent variable we refer to these sources as credibility. To our opinion the term credibility also better fits the relationship studied here.

Hypothesis 1: Credibility at the consortium level has a stronger influence on legitimacy for obtaining innovation subsidies than credibility at the actor level.

2.4.4. Scientific credibility

Scientific credibility is the scientific trustworthiness, expertise and reliability of the actor or consortium in the domain of the emerging technology. It mainly originates from past publication records (Baruch and Hall 2004; Bozeman and Corley 2004; Lee and Bozeman 2005). Scientific credibility demonstrates that applicants are able to work with the latest scientific ideas in the field (Rao, Chandy et al. 2008), and thus can contribute to developing cutting-edge technology. Scientific credibility is strongest for knowledge-institutes and is a resource that makes this type of actor an attractive consortium partner.

Hypothesis 2: Scientific credibility is positively related to legitimacy for obtaining innovation subsidies.

2.4.5. Market credibility

Practical application of knowledge is a specific goal of innovation policy. This means that out of scientific knowledge, ideas, concepts, products, processes or other applications need to emerge. Market credibility is the commercial trustworthiness, expertise and reliability of the actor or consortium. Partners and consortia that are familiar with the targeted market and its technology can be expected to be assessed as more credible than those that are not. In the case of an emerging technology past performance on the market is often limited since the technology is new and therefore the market is immature. Such immature markets can draw two types of commercial actors (see Hannan and Freeman 1989). First, there are specialist firms that are almost solely dedicated to the market of the emerging technology. These firms are often new start-ups and therefore relevantly small. They depend for their survival on innovation subsidies. Second, there are generalist firms already active in a number of other markets, but who are looking for new commercial opportunities. These generalists are often older and larger enterprises. According to Hannan and Freeman (1989), specialists are usually the first to enter new markets and are in the beginning able to outcompete generalists. Further, since their survival depends on market succes, these entrepreneurs are more motivated to take risks to innovate successfully (Van Rijnsoever, Meeus et al. Forthcoming). For these reasons we expect that actors that are specialized in the emerging technology are more likely to receive subsidies than those that are not.

Hypothesis 3: Market credibility is positively related to legitimacy for obtaining innovation subsidies.

2.4.6. Expectation track record

As mentioned above, openly voicing positive expectations creates legitimacy for the emerging technology, which can result in government investments such as subsidy programs. The expectation track record of an actor is its past history of openly voicing expectations about the technology. These openly voiced expectations can also contribute to the legitimacy of being granted a subsidy. First, by voicing expectations the actor can steer the direction of technological development and policies (Borup, Brown et al. 2006; Hekkert, Suurs et al. 2007). For example, expectations can influence which types of technology are subsidized and which not. By voicing expectations, actors can steer funds to their own area of expertise. Second, openly voicing expectations contributes to building a reputation. This reputation can cause the actor to be perceived as an expert in the technological domain, and as an enabler who is important in the field.

Hypothesis 4: Expectation track record is positively related to legitimacy for obtaining innovation subsidies.

2.4.7. Social capital

Social capital can be defined as 'the goodwill that is engendered by the fabric of social relations that can be mobilized to facilitate action (Adler and Kwon 2002, p17)'. Social capital is extremely important when controlling the organizational environment (Pfeffer and Salancik 2003). Actors can gain direct or indirect access to crucial resources using their network ties (Davidsson and Honig 2003). This means that they can use these ties to gain access to the types of credibility required to gain subsidies. By visibly tying to a strategic partner, some these intangible resources can reflect on the actor. By forming project consortia involved partners can share credibility and compensate for each other's shortcomings, thereby increasing the chances to obtain subsidies. Social capital represents the social structure through which this sharing of credibility takes place. Social capital can be found on the actor level, but the consortium itself also represents social capital. Based on social network analysis (Wasserman and Faust 1994) we distinguish two types of social capital, the number of network partners and the position of the actor in a network. Both are expected to positively influence legitimacy.

Hypothesis 5: Social capital is positively related to legitimacy for obtaining innovation subsidies.

2.4.8. Control variables

Next to the types of credibility we take some other variables that might influence legitimacy into account. First, we control for the type of organization, this can be Small or Medium-sized Enterprise (SME), Large Enterprise (LE), or Knowledge Institute (KI). SME's are usually credited with being more innovative, while LE's have more resources and experience (Chandy and Tellis 2000). KI's are assumed to bring in the required scientific knowledge for innovation. The specific program we study, required the presence of at least one SME and one KI in a consortium.

Second, we control for the age of the organization. The effects of age on innovation are ambiguous and mixed (Chandy and Tellis 2000). A popular thought, voiced by a large number of authors is that older firms are less prone to develop innovations than younger firms (Nelson and Winter 1982; Henderson and Clark 1990; Henderson 1993). A common argument is that older firms suffer from inertial forces (Hannan and Freeman 1984). On the other hand, older firms usually have the resources to develop new innovations. Chandy and Tellis (2000) demonstrated that organizational age does not influence the likelihood of introducing radical new innovations. An advantage of older firms is that they have an observable historical track when developing innovations and the experience to do so. If these firms were successful, then past innovation success breeds future success (Rao, Chandy et al. 2008; Van Rijnsoever, Meeus et al. Forthcoming). Further, older firms often have vested interests in the incumbent technology. Not involving some of these older firms might result in a lack of market power to replace the incumbent technology or even in counter strategies (Howells 2002). Decision makers thus have to balance the inertia argument against experiential and counter-strategy arguments when granting subsidies.

3. Research methods

3.1. Empirical case and data collection

Our empirical study is based on government data about subsidy grants to proposed projects. The primary data stems from the HTAS-EVT program (www.htas.nl) and was made available by NL Agency, which is the executive innovation office of Dutch Ministry of Economic Affairs, Agriculture & Innovation. The goal of the program was to stimulate innovation networks that develop innovations in the field of Electric Vehicle Technology (EVT). Consortia consisted of at least two organizations, of which one is an SME, and the other is a KI or another firm (either LE or SME). Consortia could apply for a subsidy between 1 and 5 million euros, but also had to dedicate own resources to the project. Criteria for granting were (1) technological newness, (2) the quality of the consortium, (3) sustainable economic perspectives and (4) fit with the core themes of the program. All criteria were of equal importance. Appendix A summarizes the translated conditions to obtain subsidies; the full scheme can be found online in the Dutch "Staatscourant" (2009). A committee ranked the proposals based on their scores on the criteria. Provided that the minimum standards were met, the highest ranked proposals received subsidy. The criteria form the basis of the legitimacy to grant a subsidy. To our research criterion 2 (quality of the consortium) is most relevant.

The data comprised all projects that applied for a subsidy and information about whether subsidies were granted or not[2]. In total 23 project consortia consisting of 78 unique actors applied (7 KI, 57 SME, 14 LE), since some actors were involved in multiple projects this resulted in 118 observations. The average consortium size was 5.13 partners. Out of the 23 projects 16 were granted a subsidy; corresponding to 76 grants out of 118 observations. These 76 observations consisted of 55 unique partners. Since the total budget was 65 million euro, the average subsidy was 4.06 million euro.

To find additional actor characteristics, the data was augmented with information from other sources such as Scopus publication data, LexisNexis newspaper data, actor Web pages and information about the actors from the Dutch Chamber of Commerce. This ensures that the data is objective, non-reactive and therefore more reliable.

3.2. Measurement

Legitimacy is approached as a latent construct. It cannot be observed directly, but rather its value is inferred from the decisions to grant a subsidy or not to actor *i* in project consortium *j*. The observed variable is thus of a dichotomous nature.

[2] Unfortunately the data does not provide rankings on the criteria.

Scientific credibility was measured as published scientific articles about EVT. The data source was the scientific data base Scopus. On the actor level scientific credibility was measured as the number of scientific articles published by the actor. The number of articles ranged between 0 and 21 (median=0). Since this variable was heavily skewed, its natural logarithm was used[3]. Theoretically this implies that there are diminishing returns in terms of credibility with each additional article published. In other words, the first 10 articles contribute more than next 10 articles. On the consortium level scientific credibility was measured as the average number of scientific articles published by all project partners[4].

Market credibility was measured using websites of actors. If the majority of products on the organizations website was intended for EVT related purposes, the firm was regarded a specialist, otherwise not. 20.5% of the actors was a specialist, all were SMEs. On the actor level the variable is dichotomous; on the consortium level the average of all actors was calculated.

Expectation track record was measured as expressed positive statements in the Dutch newspaper media about EVT (see Bakker 2010; Alkemade and Suurs in press). The data came from the LexisNexis data base in which all newspapers are archived. The number of articles varied between 0 and 21 (median=0). The measures for actor level and consortium level were calculated in the same manner as for scientific credibility.

Social capital was measured using social network analysis (see Wasserman and Faust 1994; Butts 2008). Actors are linked to each other in project consortia. Together all consortia form a large network consisting of all organizations that applied for the subsidy. The ties between actors are thus formed by collaborations in the project consortia. Since actors often participate in multiple projects, consortia are linked to each other. On the actor level social capital is represented by the total

[3] A value of 1 was added to all observations in order to be able to calculate the natural logarithm for cases with value 0. After the transformation these values were 0 again, since ln(1)=0.

[4] Other proxies were also tested, such as the sum, the maximum or the natural logarithms of the number of articles published. However, the average number gave the best model results for all types of credibility.

number of network partners in all projects. These ranged between 1 and 43 ties (mean=12.7 median=7). Further, the position of the actor in the entire network was calculated using the betweenness centrality measure. It indicates the probability that an actor is on shortest path in the entire network between two nodes (Wasserman and Faust 1994; Butts 2008). Thereby it reflects the extent to which the actor is involved in communications and resource flows between actors. Values ranged between 0 and 2097.8 (mean= 154.9, median=0). Both measures were calculated using the sna-package (Butts 2012) of the R-program (R Development Core Team 2010). On the consortium level we used the number of ties per actor type per consortium.

All actors were classified by *type*. Universities and applied research institutes were classified as KI. Following the common EU recommendation (European Commission 2003) companies with less than 250 employees were classified as SME´s, companies with more employees were classified as LE. This information was found in the project proposals and augmented with data from the Dutch Chamber of Commerce.

The *age* of an actor was found through company websites, Dutch Chamber of Commerce records or (in two instances) through direct contact with the organization. Age ranged from 2 to 167 years (mean=26.2, median=15). Since the distribution of this variable was heavily skewed, the natural logarithm was taken. On the consortium level, the average age of all partners was taken.

Since the consortium level variables are the aggregates of the actor level variables, it is inevitable that these variables are correlated. The risk is that effects on one level are falsely attributed to the other level or vice versa. To partial out the net effects of the actor level variables we followed Greene (1997, p 246): for scientific credibility, market credibility, expectation track record and age we first regressed the consortium level variables on the actor level variable. We used the resulting unstandardized residuals of these regression models as predictors in the model instead of the original correlated consortium level variables. For social capital we did the same, except for that we regressed the actor level on the consortium level. The result is that the unbiased estimators on the consortium level are retained and that the effects of the actor level variables are made visible.

3.3. Analysis

As argued above the decision makers are assumed to maximize legitimacy. For the Netherlands, which is a European democratic open access order (North, Wallis et al. 2009) with very little corruption (Transparancy International 2011) and regular policy evaluation (e.g. Dutch Court of Audit 2011), this assumption seems valid. However, the decision to grant subsidy to a project j is not only based on the credibility of the actors and consortia, but also on the other criteria. Since we have no information about the other criteria, we do not know to what extent these influence legitimacy. We model legitimacy to be explained by the set of observed variables and an unknown error term. All other factors, including the remaining criteria, but also bounded rational decision making or special circumstances are encompassed by this error term. This gives the following model:

$$L_{ij} = \beta_{0ij} + \beta_{Ci} C_i + \beta_{Cj} C_j + \beta_{CVi} CV_i + \beta_{CVj} CV_j + \varepsilon_{ij}$$

Where L is legitimacy to grant a subsidy to actor *i* in project consortium *j*, C_i represents the types of credibility of actor i, C_j the credibility of the project consortium *j*, CV_i and CV_j are sets of control variables at the actor and project levels. β_{0ij} is the model intercept dependent on actor and consortium, the other βs represent the regression coefficients for the predictor variables, and ε is the error term associated with the decision to grant a subsidy to actor i in project j.

Based on this, we tested our hypotheses by fitting a mixed-logit model containing a random intercept dependent on the individual actor. This was done using the lme4-package (Bates and Sarkar 2006) of the R-program. The random intercept takes into account the effect that actors were allowed to participate in multiple projects. The model was fitted in four steps with legitimacy as dependent variable. The first step contained only the random intercept and the control variables. Step two added the credibility variables on the actor level. Step three consists of the control variables and the credibility variables on the consortium level. Finally, step four is called the combined model and contains all variables. As model performance indicator we calculated the McFadden R-square based on the log-likelihoods (McFadden 1974). Further, for each model step the Receiver Operating Characteristic (ROC) curve is calculated to determine the extent to which the model is better than random chance when making predictions (Fawcett 2006). The ROC curve plots the share of correctly predicted cases, against the share of falsely predicted cases. The larger the area under the curve, the better the model is at classifying correctly: a value of 0.5 means that the model predicts no better than random chance, a value between 0.7 and 0.8 means an acceptable fit, a value between 0.8 and 0.9 means an excellent fit.

Hypothesis 1 was tested by comparing the model performance between the actor level and consortium level model. This was done by comparing model log-likelihoods using a chi-square test. Hypotheses 2 to 5 were tested directly in the combined model.

4. Results

Prior to discussing our model results, we present a descriptive network graph (Figure 2) made using the sna-package of the R-program. This provides insights into how the actors are formally related to each other. In the graph actors are represented as nodes, the color of the nodes indicates the type of actor (red=KI, green=SME, blue= LE), the size of the node represents legitimacy predicted by the mixed-logit model. The larger the node, the more legitimacy the model predicts for the actor. The lines represent the ties between the actors. The color of the line indicates if the relation was a part of a project that was rewarded (black) or not (grey).

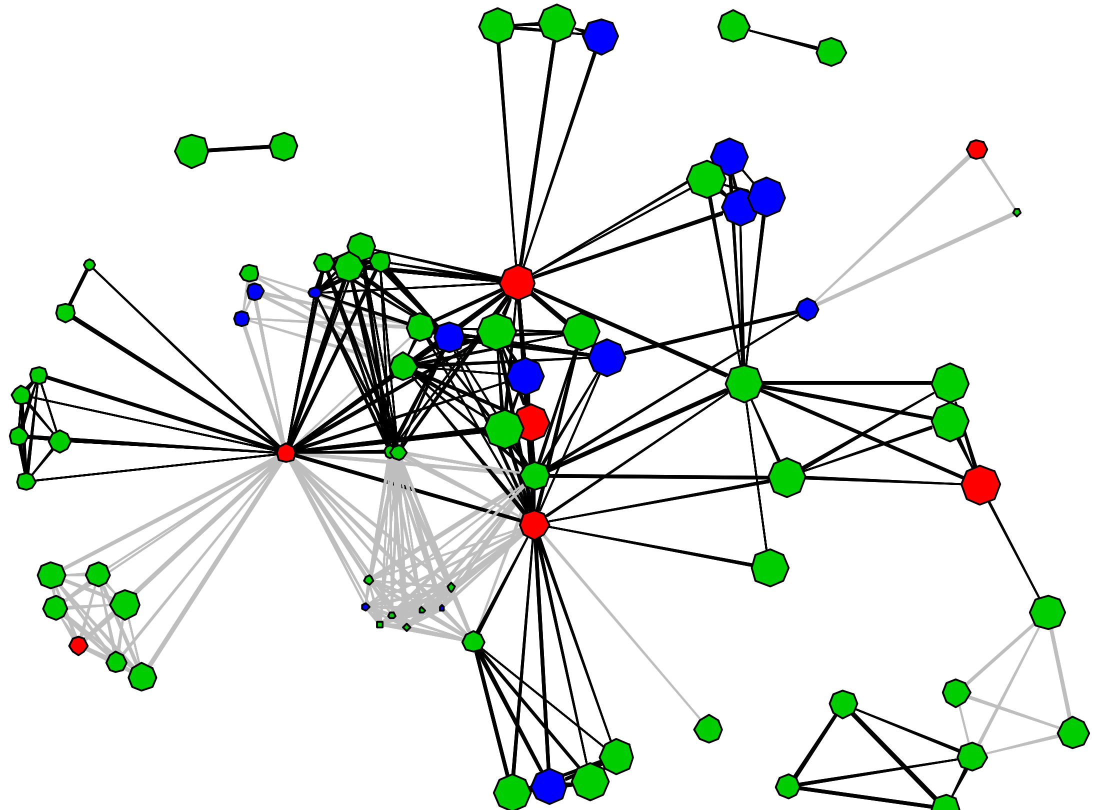

Figure 2: Social network graph. the color of the nodes indicates the type of actor (red=KI, green=SME, blue= LE), the size of the node represents legitimacy predicted by the mixed-logit model. The larger the node, the more legitimacy the model predicts for the actor. The lines represent the ties between the actors. The color of the line indicates if the relation was a part of a project that was rewarded (black) or not (grey).

The graph shows that KIs have a relatively central place in the network. This is confirmed by an analysis of variance: KIs have on average 17.43 ties, which differs significantly ($p<0.001$) from SMEs and LEs (resp. 7.05; $p<0.001$, and 7.29; $p<0.01$). Further, the betweenness centrality measure shows that KIs are significantly more at the center of the network than the other types of actors ($p<0.001$).

Table 1 displays the results of mixed-logit models. The ROC area indicates that the control model predicts only slightly better than random chance. The actor level barely has an acceptable fit (0.70), while the consortium level (0.88) and combined model (0.90) show an excellent fit. Both models are able to predict very accurately the legitimacy to grant a subsidy to actor *i* in project *j*. Even though quality of the consortium accounted for only 25% of the subsidy decision (see Appendix A), the model predicts far better than that. This can mean two things: consortium quality was weighed more heavily in the decision, or there was correlation between scores on the other criteria and consortium quality (e.g. if consortium quality scores high than other criteria were also likely to be higher).

The ROC curves are displayed in figure 3. It can be seen that the control model at some point predicts worse than random chance (represented by the diagonal line). The combined model predicts about 67 % of the observations correctly before classifying 9% of the observations falsely. It can also be seen that the consortium level model drastically outperforms actor level model. A chi-square test reveals that the consortium level model has a higher model performance compared to the actor level model (X^2 =52.87, df=1, $p<0.001$), and performs equal to the combined model (X^2 =3.27, df=5, $p<0.66$). This supports hypothesis 1.

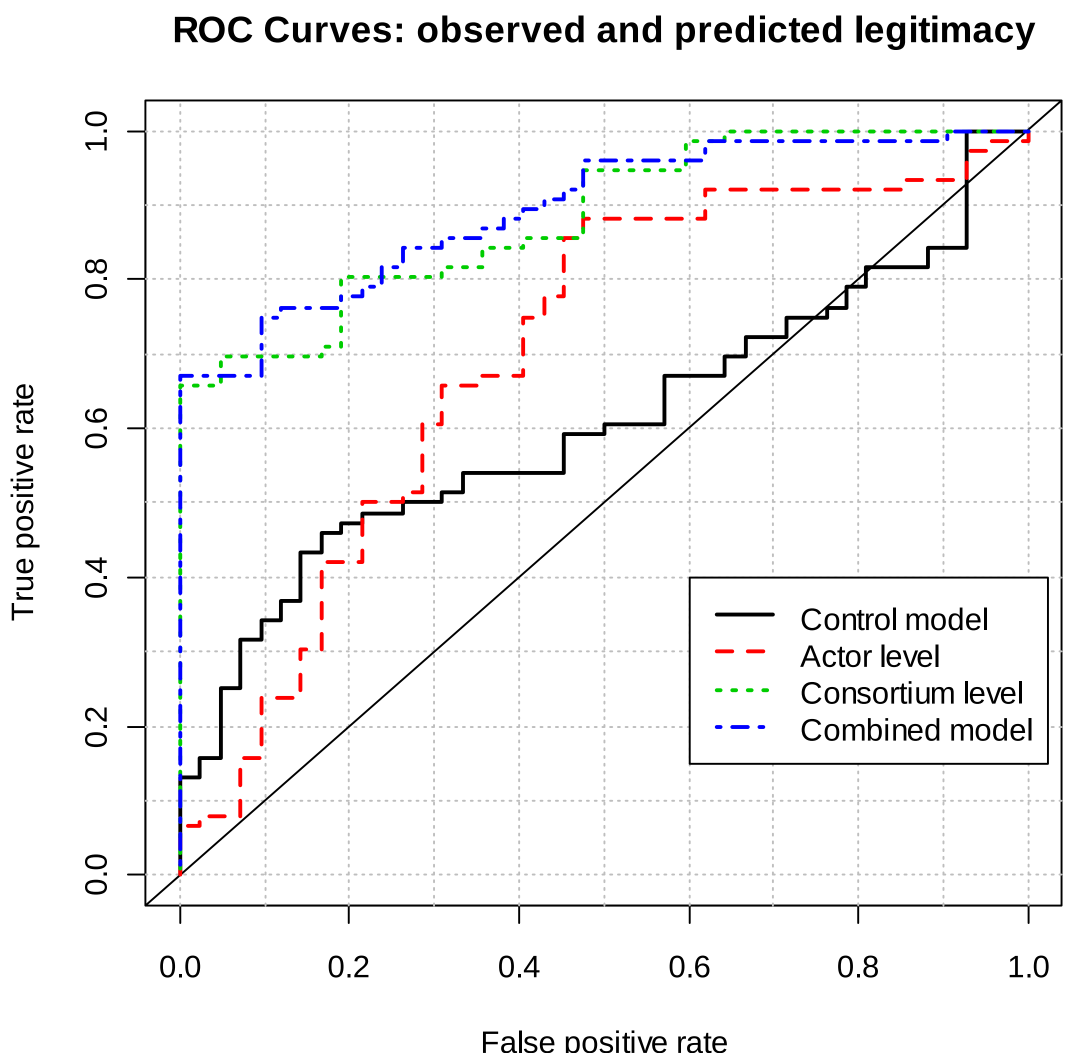

Figure 3: ROC-curves of the different models.

Model results show that in all models the random intercept equals zero, which means that the variance that originates from participating in multiple projects is explained by the other fixed variables. The result is that the mixed-logit model is collapsed back to the conventional fixed-effects logit model. This has no effect on model estimators or their confidence intervals.

		Control model	Actor level	Consortium level	Combined model
Intercept	Random (variance)	0	0	0	0
	Fixed (intercept)	1.68 .	0.37	3.22 *	2.95
Control variables	Type: SME	-0.48	-0.42	0.01	-0.03
	Type: KI	0.14	2.78	-1.42	-1.92
	Type: LE	ref.	ref.	ref.	ref.
	Age (actor)	-0.28	-0.09	-0.40	-0.51
	Age (consortium)	-0.02	-0.02	0.03	0.05
Actor level	Scientific credibility		-1.06		1.07
	Market credibility		0.84		0.46
	Expectation track record		-0.10		-0.20
	Social capital: number of ties		-0.83 a		-1.13
	Social capital: network position		0.20		0.07
Consortium level	Scientific credibility			-1.22 *	-1.58 *
	Market credibility			7.35 *	8.65 **
	Expectation track record			-0.49 **	-0.46 *
	Social capital: KI			2.94 ***	3.37 ***
	Social capital: SME			-1.01 ***	-1.08 ***
	Social capital: LE			-0.16	-0.17
Model indicators	Deviance	150.20	142.40	89.54	86.27
	McFadden R^2	0.02	0.07	0.42	0.44
	ROC area	0.61 *	0.70 ***	0.88 ***	0.90 ***
	d.f.	6.00	11.00	12.00	17.00
	X^2 difference	ref	7.82	60.70 ***	63.97 ***

Model estimates for the mixed-logit model predicting legitimacy. ROC area p-values are against random change (0.5). Chi-square (X^2) model comparisons are made against control model. Number of observations = 118, n=78, *: p<0.05, **: p<0.01, ***: p<0.001.

The combined model shows that there are no significant effects by the control variables or the actor level variables[5]. Scientific credibility on the consortium level is negatively related to legitimacy, which contradicts hypothesis 2. Further, market credibility of the consortium is positively related to legitimacy, supporting hypothesis 3. Expectation track record on the consortium levels has a negative influence on legitimacy, which contradicts hypothesis 4. The results from social capital are mixed: social KI capital positively influences legitimacy, while social SME capital influences legitimacy negatively. Social LE capital has no effect.

[5] We extensively tested for interaction effects between type and credibility on the actor level, but this yielded no significant results.

The largest contribution to the model comes from social capital at the consortium level. The negative effect by scientific credibility is the result of adding social KI capital to the model. This means that given the value of social KI capital, scientific credibility negatively influences legitimacy. From a resource dependence view this implies that the social capital gained by allying oneself to multiple KI partners is a better resource than the more objectively measured scientific credibility of the consortium. The latter then forms a barrier to gaining subsidies. The same explanation also applies to the negative effect of consortium on expectation track record. Taking into account social capital, expressing expectations publicly is ineffective and might even jeopardize gaining innovation subsidies. The reason for both negative effects might be that the committee that decided about the subsidies did not look specifically at factual scientific publications and expectation track records, but rather inferred them from the type of actors present in the consortium (for example through reputation). These factual data were not a specific formal criterion to evaluate the proposals on. The negative relationships remain surprising however.

Another important resource is market credibility, measured by having a large share of specialist companies dedicated to the emerging technology in the consortium, these are all SMEs. However, having a large number of SMEs in the consortium is also of negative influence. This implies that consortia that consist of multiple KIs and a limited number of specialist SMEs have a larger chance of obtaining subsidies. SMEs that are not dedicated are harmful to obtaining subsidies. Having LEs in the consortium does not contribute anything to legitimacy, but there is no direct harm either. However, including LEs does lower consortium market credibility (the fraction of dedicated SMEs in the consortium). Adding LEs to a consortium lowers this fraction, and thus indirectly influences legitimacy negatively.

5. Conclusions & Discussion

The aim of this paper was to empirically examine the influence of types of credibility on the legitimacy to grant individual actors innovation subsidies.

Theoretically, we proposed a combination of the resource dependence view and the sociology of expectations. Based on this, four types of credibility operating at two levels were expected to influence the legitimacy for receiving subsidies for developing electric vehicle technology. Our main finding is that factual achievements by consortia members are less important (or even damaging) for gaining subsidies than the composition of the consortium by type of actor.

We extended the resource dependence view by focusing explicitly on the role of intangible resources (see Deeds, Mang et al. 2004; Rao, Chandy et al. 2008) in policy driven collaborations between science and industry. Our results demonstrate that the likelihood of an actor receiving innovation subsidy depends largely on the characteristics of the consortium. High market credibility and having more KIs were of positive influence, while scientific credibility, expectation track record and a larger number of SMEs in the consortium were of negative influence. The negative effects contradicted our theoretical predictions, and are most likely the result of the fact that objective measures of credibility were not required for gaining a subsidy and therefore not taken into consideration.

Further, the combination with the RDV added micro-foundations to the Sociology of Expectations by explicitly focusing on the rewards for individual actors for expressing technological expectations. Expressing expectations provides legitimacy to policy makers to initiate subsidy programs that stimulate the development of emerging technologies which are beneficial to the entire technological field. However, in the Dutch EVT case expressing these expectations negatively influenced changes of individual actors to gain subsidies. This finding contradicts the idea that articulating positive expectations (see Rip 2006) is beneficial to individual actors and thus implies a barrier for publicly promoting an emerging technology.

Another notable finding was the indirect negative influence of having LEs in a consortium. Even though LEs are not always known to be among the most innovative of firms, they do have resources (such as capital and market power) to develop radical innovations and to enforce a breakthrough against the incumbent regime.

Finally, empirically we tested a model that was excellent at discriminating between subsidies that were granted and those that were not. Notable is that we only looked at actor and consortia characteristics, there was no need to look at the content of the project proposals.

5.1. Limitations and further research

The main limitation of this study is that we only looked at the Dutch HTAS-EVT case. The case contained 118 observations from 78 actors in 23 project consortia. Though this sample is relatively small, it is the entire population. Our results are primarily limited to this specific subsidy program, but it can be expected that similar results are found in cases with the same subsidy criteria. Research on other programs and other countries is required to further confirm our results.

Second, because the number of observations was relatively small we included a limited number of parameters. For example we did consider including the number of EVT patents held by an actor as an additional measure for market credibility. However, we decided against this, since the number of patents held in the sample was very low. The model predicted very well, even though the number of parameters was limited. This is partly due to the limited number of observations. Future research that studies larger programs should aim to replicate our findings and possibly include additional parameters.

Finally, simply because the data is not available we did not study the performance of the consortia that received subsidies. All subsidy decisions are based on expected performance, but we therefore do not know what the actual successes of the projects are and, consequently, how effective the program is. Future research should relate the factors that influence the likelihood of gaining innovation subsidies to actual project performance.

5.2. Practical implications

In line with recommendations by the Dutch court of audit (2011), our results lead to four recommendations that contribute to making the subsidy process more transparent and legitimate.

First, under the current regulations actors need to build their consortia with sufficient KIs and market legitimacy. Factual achievements such as the number of scientific articles published by consortium partners are currently less important than the type of actor participating. Policy makers that establish subsidy programs can easily increase legitimacy of the program by specifically adding factual achievements to the criteria of evaluating project proposals. Assuming that consortia with a proven track-record have a higher probability to innovate successfully, this increases efficiency of the subsidy program.

Second, expressing positive expectations is currently not rewarding for individual actors. This has a negative effect on the creation of legitimacy of emerging technologies and related subsidy programs. Given the importance of expressing expectations in the innovation process, it is important that actors do not suffer negative consequences from this. Policy makers could take publicly expressed expectations into account as an extra criterion to grant subsidies on. An additional advantage, next to creating legitimacy for the program itself, is that it contributes to creating a positive image of the emerging technology at an early stage. This is important for gaining public acceptance for innovation, which is required in a later stage of the innovation process. Policy makers do need to take care that such expectations are measured objectively and also that it does not lead to overly optimistic ideas that lead eventually to disappointment.

Third, due to their power and resources LEs can play an important role in developing radical innovations and in overthrowing incumbent socio-technical regimes. It can thus be argued that including incumbents in a consortium should be rewarded by policy makers. On the other hand it can also be argued that developing innovations is not in the interest of large incumbent firms, since they have to exchange reliable institutionalized practices with relatively certain rewards for uncertain new ones (Hannan and Freeman 1984). Therefore incumbent LEs might be unwilling to collaborate in an innovation network to develop a new technology. In that case a strategy can be to bring in LEs from a neighboring market to substitute the required resources. A prominent example of this from the last decade is Apple conquering the mobile telephone market, which boosted development of the smart phone. Therefore we recommend rewarding the inclusion of LEs in the consortium.

Finally, the model itself can be used as a quick evaluation tool of subsidy programs to check the extent to which public funds were allocated to the right consortia. Advisory committees and external auditors can check the overall consistency of subsidy decisions, which is especially useful in case of many applications for subsidy.

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Appendix A: Literal translation of the criteria to grant subsidies and explanation see: Staatscourant (Nr. 16803): 1-8

Added definitions:

HTAS-EVT-project: An innovation projects consisting of experimental development or a combination of experimental development and industrial research that contributes to and fits within the strategic main goals of HTAS-program as mentioned in appendix 6.1[6] and the theme, the specific goals and focus areas as mentioned in appendix 6.3.

HTAS-EVT-collaboration: a non-legal personality owning collaboration consisting of two or more, not in a single group participating members, of which at least one is a SME-entrepreneur and another party is either an entrepreneur or a research organization, executing a HTAS-EVT-project.

Article 6.25

1) Criteria to grant subsidies
    a) Technological novelty or a substantial novel application of an existing technology
    b) Quality of the collaboration at least evident from the complementarity of the participants, the extent to which SMEs are involved and the novelty of the collaboration.
    c) Sustainable economic perspectives of the project results, extensiveness of the possibilities for application of the project results.
    d) The theme of the program and its specific goals and focus areas.

[6] Appendices can be found online, these contain technology specific details, but are of no further concern for this study.

2) When ranking the proposals all criteria are of equal weight.

Explanation of 6.25:

The minister grants subsidies in according to the ranking of the subsidie proposals. HTAS EVT-projects are judged on four equally important criteria. Novelty of the technology or its applications are central to part a. This also emphasizes the innovative character of a HTAS-EVT-project. The quality of the collaboration is also an important factor for a successful project (part b). With complementarity of the participants one could think of the extent to which the contribution of the participants are complementary. For the criterion, as referred to in part c, aspects play role such as the size of the potential market, the chances (for growth) of the applicants (including SMEs in the consortium), possibilities for returns on investments and turnover, distinguishable market trends and the position of competitors in the market. One can also think of follow-up activities that are required to gain a sustainable perspective. If criterion c is more fulfilled this will have a positive impact on employment. The criterion in part d, relates to the in appendix 6.3 added theme and its specific goals and focus areas. This is further elaborated upon in appendix 6.3 under the headings Background and theme HTAS-Electric Vehicle Technology, Specific goals, and Focus Areas.

Appendix B: Correlation Matrix

	Age (actor)	Age (consortium)	Scientific credibility (actor)	Market credibility (actor)	Expectation track record (actor)	Social capital: number of ties (actor)	Social capital: network position (actor)	Scientific credibility (consortium)	Market credibility (consortium)	Expectation track record (consortium)	Social capital: KI (consortium)	Social capital: SME (consortium)
Age (c)	0.00											
Scientific credibility (a)	0.53	-0.02										
Market credibility (a)	-0.45	0.08	-0.26									
Expectation track record (a)	0.24	-0.05	0.65	0.15								
Social capital: number of ties (a)	0.21	-0.05	0.68	0.07	0.52							
Social capital: network position (a)	0.18	-0.05	0.55	0.19	0.52	0.81						
Scientific credibility (c)	0.00	0.60	0.00	-0.02	-0.06	-0.21	-0.18					
Market Credibility (c)	0.18	-0.19	0.06	0.00	0.05	0.26	0.27	-0.24				
Expectation track record (c)	-0.15	0.19	-0.15	0.01	0.00	-0.11	-0.17	0.32	0.16			
Social capital: KI (c)	-0.06	0.01	0.16	-0.10	0.11	0.00	0.04	0.33	-0.21	0.26		
Social capital: SME (c)	-0.11	-0.28	-0.06	-0.12	-0.16	0.00	-0.09	-0.18	-0.26	-0.19	0.35	
Social capital: LE (c)	0.06	0.28	0.01	-0.10	0.04	0.00	0.05	0.01	-0.24	0.18	0.25	0.22

a = actor, c = consortium