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Credibility and Legitimacy in Policy-driven Innovation Networks: Resource dependencies and expectations in Dutch electric vehicle subsidies

By

Frank J. Van Rijnsoever. Leon Welle and Sjoerd Bakker

Danish Research Unit for Industrial Dynamics

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Frank J. van Rijnsoever
Innovation Studies, Copernicus Institute of Sustainable Development
Utrecht University
P.O. Box 80115
3508 TC Utrecht, The Netherlands
Tel: +31 (0) 300 253 7484, Fax: +31 (0) 30 253 2746
E-mail: f.j.vanrijnsoever@uu.nl (corresponding author)

Leon Welle
Science and Innovation Management
Utrecht University
P.O. Box 80115
3508 TC Utrecht, The Netherlands
E-mail: l.welle@students.uu.nl

Sjoerd Bakker
OTB Research Institute, Delft University of Technology
P.O. Box 5030
2600 GA Delft, The Netherlands
E-mail: 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 viewpoint of resource dependence theory 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. We operate on two levels of analysis, the actor and the consortium.
We quantitatively analyze the Dutch electric vehicle subsidy program as case. 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.

Keywords: Electric Vehicle Technology; Expectations; Resource Dependence Theory; Credibility; Legitimacy; Innovation Policy

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1. Introduction

Over the last decades, efforts to develop a technology that can replace vehicle with an internal combustion engine have increased [1]. From 2006 onwards the (battery) electric vehicle has been seen as the most prominent candidate to do so [2]. Following these high expectations, the Dutch government introduced an innovation policy to support the development of electric vehicle technology (EVT) and the infrastructure necessary for re-charging. Between 2009 and 2011, 65 million euros was 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 investment by other parties, totaling to approximately 500 million euros [3]. With these investments, the government aims to make the Netherlands an international test site for electric vehicles. The Dutch government aims to deploy 1 million electric vehicles by 2025 [3]. Though promising, according to the ideas about (technological) innovation systems [4-5], electric mobility can only become successful when firms, societal organizations, knowledge institutes, local authorities, and the national government collaborate in developing this new technology [3]. 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 explaining collaborations between actors is resource dependence theory [6-7]. 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 [6, 8-9], which can be defined as a social judgment of acceptance, appropriateness, and desirability within a socially constructed system of beliefs [10]. Legitimacy is a prerequisite for organizations to gain access to certain resources needed to fulfill organizational aspirations [11].

Several studies have pointed out the significance of expectations in guiding interests and investments in innovation [12-15]. A technological expectation can be defined as a 'real-time representation of future technological situations and capabilities' [13, p286]. Actors can use positive expectations about an emerging technology to substitute uncertainties about this technology [16]. 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 [12] and characteristics of the actor that voices these expectations [9, 17]. Voicing credible expectations can thus be seen as a strategic action towards gaining access to crucial resources.

The granting of government subsidies that aim to further develop a technology through building innovation networks creates 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, and therefore individual members of the technological community usually need to further demonstrate their credibility in order to legitimize them in obtaining a share of this resource.

The aim of this paper is to empirically examine the influence of different types of credibility on the legitimacy of granting 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. We operate on two levels of analysis, the actor and the consortium.

We combine resource dependence theory (RDT) with the sociology of expectations. Within the RDT, many scholars have researched the formation of inter-organizational relationships or innovation networks between firms [see 7 for an overview] and to a lesser extent between science and industry [18]. However, little empirical attention has been paid to intangible resources in innovation development, such as sources of legitimacy. Deeds et al. [17] and Rao et al. [9] form notable exceptions, but their studies are limited to firms, while we study consortia that consist of firms and knowledge institutes such as universities. Additionally, 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 [19-20], and there are no studies that specifically focus on the benefits of articulating expectations for individual actors when funds are actually distributed. Combining the sociology of expectations with the RDT gives a micro-foundation to this meso-level theory. The question of whether expressing expectations by individual actors (or project networks) leads to direct individual benefits is important 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 directly rewarded for raising highly positive expectations [21]. When actors at a later stage are only rewarded indirectly, through rewards for their technological community in general, they are likely to be less keen on promoting the emerging technology.

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 who wish to gain access to these types of resources. The results provide insights in what strategic actions should be taken in order to increase legitimacy of both knowledge institutes and industrial organizations. The results are also of interest to policy makers. In 2011 the Dutch court of audit [22] published a report in which the effectiveness and efficiency of the Dutch innovation policy was analyzed. Their research concluded that, while the amount of innovation subsidy more than doubled from €1.8 billion to €3.7 billion between 2003 and 2011, the effectiveness and efficiency of Dutch innovation policy could not be determined. Policy makers may use the results of this study to improve the methods by 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. Resource dependence theory and university-industry collaborations

Following Van Rijnsoever et al. [18] the collaboration between science and industry can be approached from a resource based view [see 23, 24]. This perspective argues that a firm can be seen as a bundle of resources and capabilities [25]. The resource based view suggests that the various rare and inimitable resources possessed by firms can be translated into a sustainable competitive advantage [24]. These resources can be both tangible, such as human resources, equipment, buildings, and financial capital, as well as intangible, such as brand equity, in-house knowledge or credibility [24-25].

Resource dependence theory [RDT: 6] can be seen as an extension of the resource based view. It places more emphasis on the relationship between an organization and its environment [25]. According to the RDT 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 critical external resources [6-7].

Resource dependence theory suggests several reasons for both firms and universities engaging in university-industry collaborations. Firms can gain access to highly trained students, high quality knowledge, university facilities and faculty, as well as improving their image by collaborating with a prominent academic institution [26-27]. Universities primarily engage in industry collaborations for additional research funds, the exposure of students and staff to practical problems, job opportunities for graduates, and access to specific areas of technology [28-29]. Individual scientists can also benefit from collaboration in terms of reputation, career, publications, and other forms of productivity [18, 30-32].

However, it can also be argued that the expected resource benefits of collaboration do not outweigh the investment required; otherwise there would be no need for policies that stimulate university-industry collaboration. For example, university researchers have different aspirations than do firms. Studies have shown that scientists strive for scientific recognition, which is more difficult to gain when collaborating with industry [18, 33]. Firms need to bridge cognitive and cultural barriers in order to apply scientific knowledge [32], which is often problematic. Alongside the time and effort required to maintain network ties [34], 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 [2, 13, 35]. According to Borup et al. [13, p285], expectations can be seen as fundamentally 'generative', providing structure and legitimacy, guiding various activities, attracting interest, and fostering private and public investment. Expectations are most powerful when they are part of a collective repertoire of ideas and statements. In such 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 about which they are expressed, which can lead to both public and private funding. Assessment of the credibility of expectations and of the actors that express them is made continuously [20]. 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 of the organizational environment. The credibility of the actor expressing the expectations is an important resource if this strategy is to function.

2.3. Innovation policy and legitimacy

Innovation policy developed over the past decades with the objective of encouraging and facilitating the generation, application, and diffusion of new ideas [36]. Network failures in the innovation system is one rationale for government involvement in technological advance and innovation [37-38]. These occur when organizations interact poorly with their environment, resulting in a lack of collective vision, technological expectation, and coordination of investment. To reduce network failure, Carlsson and Jacobsson [37] argue that actors should be tied together by means of reciprocal flows of information and knowledge in order to achieve a good connectivity.

One way of for reducing network failure is subsidizing collaborative innovation projects [3]. Innovation subsidies are thus dedicated to collaborative R&D projects around an emerging technology. This distribution of funds can be seen as a two-stage process. First, the choice of technology is made, partly based on voiced expectations [13]. Once the subsidy program has been established, consortia consisting of organizations and knowledge institutes, can obtain subsidies by sending in project proposals. From RDT 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 more crucial for survival. Next to this, the subsidized innovation networks can become an important source from which organizations acquire other resources [39].

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 [40-41], making legitimate decisions about funds becomes increasingly important [42]. Therefore actors that decide about the distribution of public funds need to act as 'legitimacy maximizing' agents.

2.4. Research model

Our research model is presented in Figure 1, each variable and relationship is explained below.

Insert figure 1 about here

2.4.1. Legitimacy

Legitimacy can be a property of many things such as forms of organization [8, 43], industry [17], technology [12] and policy [36]. In this paper we refer to the legitimacy of a policy decision in granting a subsidy to an actor or consortium. 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. The reason we use the legitimacy of a latent construct is because government committees usually also rank proposals according to certain criteria (see methods section). These rankings can be seen as a proxy for legitimacy used by the government. Using our independent variables we aim to predict this legitimacy.

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 [44], which is our domain of interest. We are concerned with actor credibility as a source of legitimacy for rewarding project proposals for innovation subsidies, therefore we specifically study source credibility. This form of credibility has been extensively studied and debated previously [45-46, see 47], however, authors rarely define the concept explicitly, referring instead to elements of that concept, commonly 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 depends partly on the credibility of the actors who submit the proposal, and 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 if they have a strong scientific track record. This type of credibility contributes to the legitimacy of granting the subsidy.

2.4.3. Actor and consortium level

Rao et el [9] claim that legitimacy has both external and internal sources[1]. Internal sources are the types of credibility an actor controls within an organization. External sources are the types of credibility in an organizational environment on which an actor relies. RDT states that if an actor does not control a critical resource internally, it needs to rely on other agents in the same environment, such as members 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

[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. In our opinion the term credibility also better fits the relationship studied here.

the subsidy program in our current investigation. 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:

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 an actor or consortium in the domain of the emerging technology. It originates largely from past publication records [31, 48-49]. Scientific credibility demonstrates that applicants are able to work with the latest scientific ideas in the field [9], 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 in obtaining innovation subsidies.

2.4.5. Market credibility

The practical application of knowledge is a specific goal of innovation policy. This means that ideas, concepts, products, processes or other applications need to emerge from scientific knowledge. Market credibility is the commercial trustworthiness, expertise and reliability of an actor or consortium. Partners and consortia who are familiar with the targeted market and its technology can be expected to be assessed as more credible than those who are not. In the case of an emerging technology, past performance in 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 8]. The first 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. Secondly, there are generalist firms already active in a number of other markets who are looking for new commercial opportunities. These generalists are often older and larger enterprises. According to Hannan and Freeman [8], specialists are usually the first to enter new markets and are initially able to outcompete generalists. Further, since their survival depends on market success, these entrepreneurs are more motivated to take risks in order to innovate successfully [50]. For these reasons we expect that actors who have specialized in the emerging technology are more likely to receive subsidies than those who have not.

Hypothesis 3: Market credibility is positively related to legitimacy in 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 their being granted a subsidy. By voicing expectations an actor can steer the direction of technological development and policies [4, 13]. For example, expectations can influence which types of technology are subsidized and which are not. By voicing expectations, actors can steer funds towards their own area of expertise. Openly voicing expectations also 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 in 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' [39, p17]. Social capital is extremely important when controlling the organizational environment [6]. Actors can gain direct or indirect access to crucial resources using their network ties [51], and this means they can use these ties to gain access to the types of credibility required to gain subsidies. By visibly tying themselves to a strategic partner, some these intangible resources can be associated with the actor (for example: reputation). By forming project consortia, the partners involved can share credibility and compensate for each other's shortcomings, thereby increasing the chance of obtaining subsidies. Social capital represents the social structure through which this sharing of credibility takes place. Social capital can be found at the actor level, but the consortium itself also represents social capital. Based on social network analysis [52] 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 in obtaining innovation subsidies.

2.4.8. Control variables

Alongside types of credibility there are other variables that might influence legitimacy and must be taken into account. We control for the type of organization: this can be a Small or Medium-sized Enterprise (SME), Large Enterprise (LE), or Knowledge Institute (KI). SMEs are usually credited with being more innovative, while LEs have more resources and experience [53]. KIs are assumed to bring in the required scientific knowledge for innovation. The specific program in our study required the presence of at least one SME and one KI in a consortium.

We also control for the age of the organization. The effects of age on innovation are ambiguous and mixed [53]. A popular thought, voiced by a large number of authors is that older firms are less prone to develop innovations than younger firms [54-56]. A common argument is that older firms suffer from inertial forces [57]. On the other hand, older firms usually have the resources to develop new innovations. Chandy and Tellis [53] 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 record in developing innovations and the experience to do so. If these firms were successful, then past innovation success can be seen as breeding future success [9, 58]. 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 capable of replacing the incumbent technology or even in counter strategies [59]. 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 involving 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 the 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). We choose EVT as a case study since it is an emerging technology that is actively stimulated by the Dutch government, which fits with our theoretical framework. Further, sufficient data was available to empirically test our hypotheses. We stress that results are primarily applicable to the Dutch EVT situation, although other subsidy programs operate in a similar fashion. Consortia consist 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 for obtaining subsidies; the full scheme can be found online in the Dutch “Staatscourant” [60]. 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 in granting a subsidy. Criterion 2 (quality of the consortium) is most relevant to our research.

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); as some actors were involved in multiple projects this resulted in 118 observations. The average consortium size was 5.13 partners. Of these 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 Euros, the average subsidy was 4.06 million Euros.

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 ensured that the data is objective, non-reactive and therefore more reliable.

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

3.2. Measurement

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

Scientific credibility was measured through published scientific articles about EVT. The data source was the scientific database 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 the websites of actors. If the majority of products in the portfolio of a firm was intended for EVT-related purposes, the firm was regarded a specialist. 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 the number of articles that contained positive statements by an actor about EVT in the Dutch newspaper media prior to the tender [see 2, 15]. 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.

[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.

Social capital measures were calculated using social network analysis [see 52, 61]. Actors are linked to each other in project consortia. Together the consortia form a large network consisting of all organizations that applied for the subsidy. The ties between actors are thus formed through 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 measured by the total number of network partners in all projects. This number ranged between 1 and 43 ties (mean=12.7 median=7). The position of the actor in the entire network was calculated using the betweenness centrality measure, which indicates the probability that an actor is on the shortest path in the entire network between two nodes [52, 61]. It thereby reflects the extent to which an actor is involved in communication, 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 [62] of the R-program [63]. On the consortium level we measured social capital as 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 [64] companies with less than 250 employees were classified as SMEs, 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 they are correlated, with the risk 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 [65, p 246]: for scientific credibility, market credibility, expectation track record and age we first regressed the consortium level variables at 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 at the consortium level. The result is that the unbiased estimators at the consortium level are retained and that the effects of the actor level variables are made visible.

3.3. Analysis

As argued above, decision makers are assumed to maximize legitimacy. For the Netherlands, which is a European democratic open access order [66] with very little corruption [67] and regular policy evaluation [e.g. 22], 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 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 [68] of the R-program. The random intercept takes into account the effect of actors who 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 credibility variables at the actor level. Step three consists of the control variables and the credibility variables at 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 [69]. 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 [70]. 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 whether the relationship 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; $p<0.01$). Also, the betweenness centrality measure shows that there are significantly more KIs at the center of the network than 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 of granting 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 highly, then 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 the 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 equally with the combined model ($X^2 = 3.27$, df=5, $p<0.66$). This supports hypothesis 1.

Insert figure 3 about here

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.

Insert table 1 about here

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. Market credibility of the consortium is positively related to legitimacy, supporting hypothesis 3. Expectation track record at 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.

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

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

legitimacy. From a resource dependence perspective this implies that 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 obtaining subsidies. The same explanation also applies to the negative effect of consortium on expectation track record. Taking into account social capital, expressing expectations publicly appears ineffective and might even jeopardize chances of gaining innovation subsidies. It should be noted that for the latter we only looked at the number of positive expectations expressed and not at the quality of the statements, which might also have had some unobserved influence. However, a possible reason for both negative effects is that the committee making decisions 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 on which to evaluate the proposals. Another possible explanation for scientific credibility is that proposals by consortia scoring high on this resource were too scientifically oriented and too far from the market, therefore not meeting the project goals.

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 greater chance of obtaining subsidies. The SME term in the model thus captures only non-specialized firms. Non-specialized SMEs can be considered redundant and therefore harmful to the chances of 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 of granting innovation subsidies to individual actors .

We proposed a combination of resource dependence theory and the sociology of expectations. Based on this, four types of credibility operating at two levels were expected to influence the legitimacy of 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 resource dependence thoery by focusing explicitly on the role of intangible resources [see 9, 17] in policy driven collaborations between science and industry. Our results demonstrate that the likelihood of an actor receiving an 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 possibly a result of the fact that objective measures of credibility were not required for gaining a subsidy and therefore not taken into consideration. Another possible explanation is that proposals by consortia with high scientific credibility are considered to be too far from the market.

Further, the combination with RDT added micro-foundations to the sociology of expectations, since we explicitly focused on the rewards for individual actors when expressing technological expectations. Expressing expectations provides legitimacy to policy makers so as 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 the chances of individual actors gaining subsidies. This finding contradicts the idea that articulating positive expectations [see 21] 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 considered 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 breakthroughs against an incumbent regime.

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

5.1. Limitations and further research

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

Due to the number of observations being 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 studying larger programs should aim to replicate our findings and possibly include additional parameters.

A variable that we did not include in this study was experience in obtaining government subsidies. Past experience implies that capabilities and routines have been learned that allow building and managing these types of consortia and writing credible proposals. They are therefore likely to play a role in the later chances of success for obtaining these types of funds. Related to this is the question of past experience in actually executing these types of projects. Having conducted successful projects in the past increases an actor's credibility. Future research should consider these variables.

Finally, simply because the data was not available we did not study the performance of the consortia that received subsidies. All subsidy decisions are based on expected performance, but we 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 [22], our results lead to four recommendations that contribute to making the subsidy process more transparent and legitimate.

Firstly, under 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 the legitimacy of the program by specifically adding factual achievements to the criteria for evaluating project proposals. Assuming that consortia with proven track records have a higher probability of innovating successfully, this increases the efficiency of the subsidy program.

Secondly, expressing positive expectations is currently not rewarding for individual actors. It has a negative effect on the creation of the 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 by which to grant subsidies. An additional advantage, as well as creating legitimacy for the program itself, is that it would contribute 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 later stages of the innovation process. Policy makers do need to take care that such expectations are measured objectively and also that they do not lead to overly optimistic ideas that eventually lead further to disappointment.

Thirdly, 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 [57]. Incumbent LEs might therefore be unwilling to collaborate in an innovation network to develop a new technology. In this case a strategy could 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. We therefore recommend rewarding the inclusion of LEs in a consortium.

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

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Appendix A: Literal translation of the criteria for granting subsidies and explanation (See: Staatscourant (Nr. 16803): 1-8)

Added definitions:

HTAS-EVT-project: An innovation project consisting of experimental development or a combination of experimental development and industrial research that contributes to and fits within the strategic main goals of the 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 a collaboration consisting of two or more, participating members, not in a single group, 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 subsidy proposals. HTAS EVT-projects are judged on four equally important criteria. The novelty of the technology or its applications are central to Part A. This also emphasizes the [62]SMEs in the consortium), possibilities for returns on investments and turnover, distinguishable market trends and the position of competitors in the market play a role . One can also consider the follow-up activities that are required to gain a sustainable perspective. If Criterion C is more often fulfilled this will have a positive impact on employment. The criterion in Part D, relates to the added themes and its specific goals and focus areas described in Appendix 6.3 . 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

		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	***

Table 1: 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.

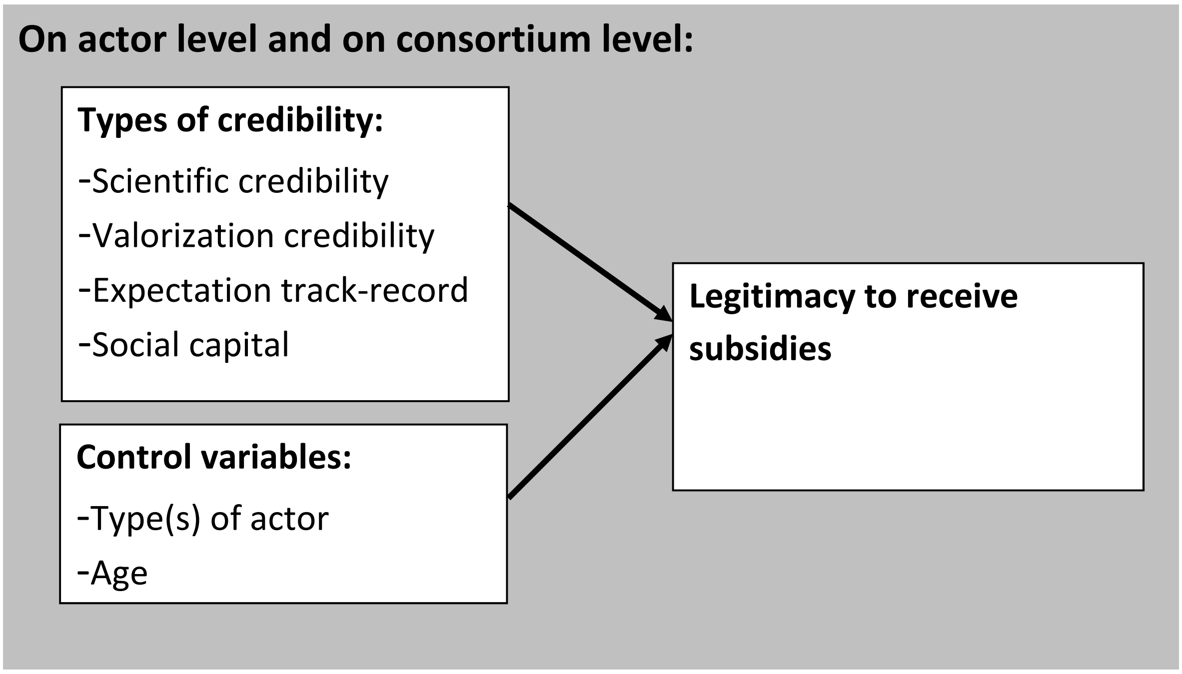

Figure 1: Conceptual model

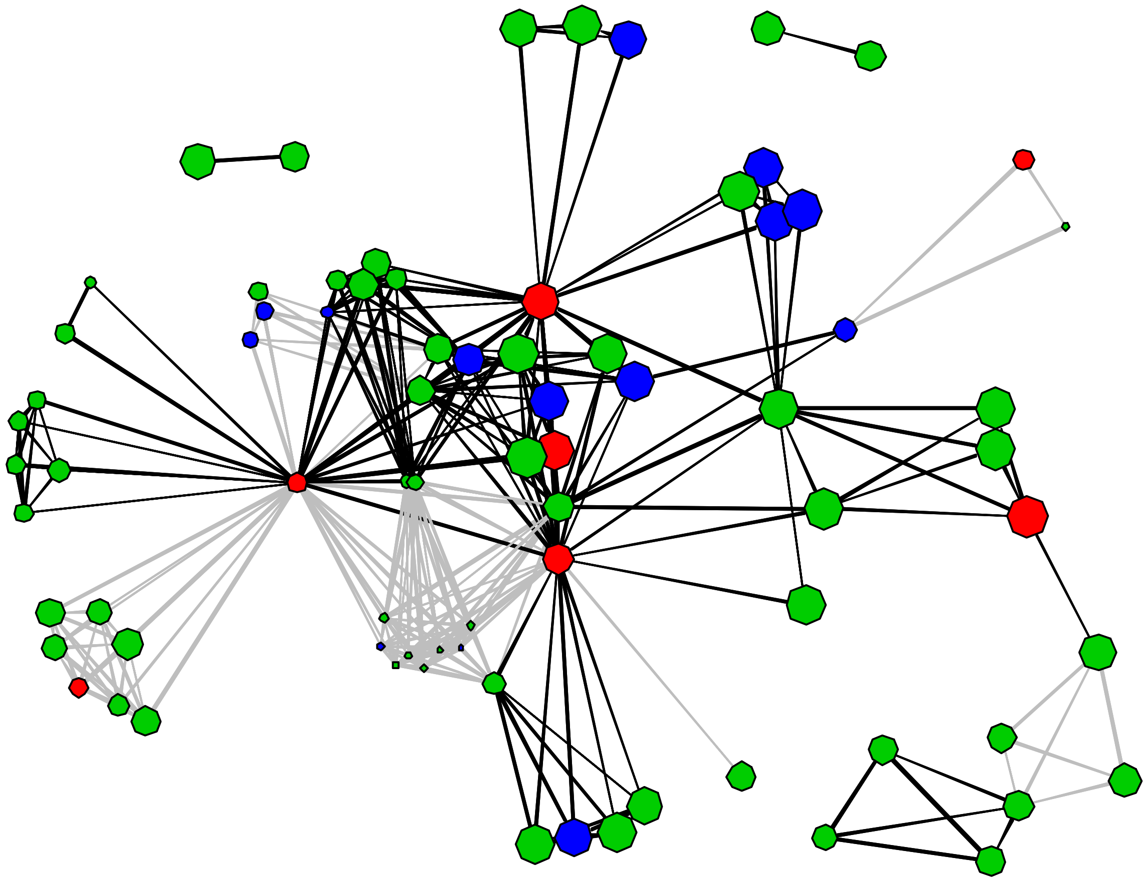

Figure 2: Social network graph. The color of the nodes indicates the type of actor (red=KI, green=SME, blue= LE), the size of the node represents legitimacy predicted by the mixed logit model. The larger the node, the more legitimacy the model predicts for the actor. The lines represent the ties between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

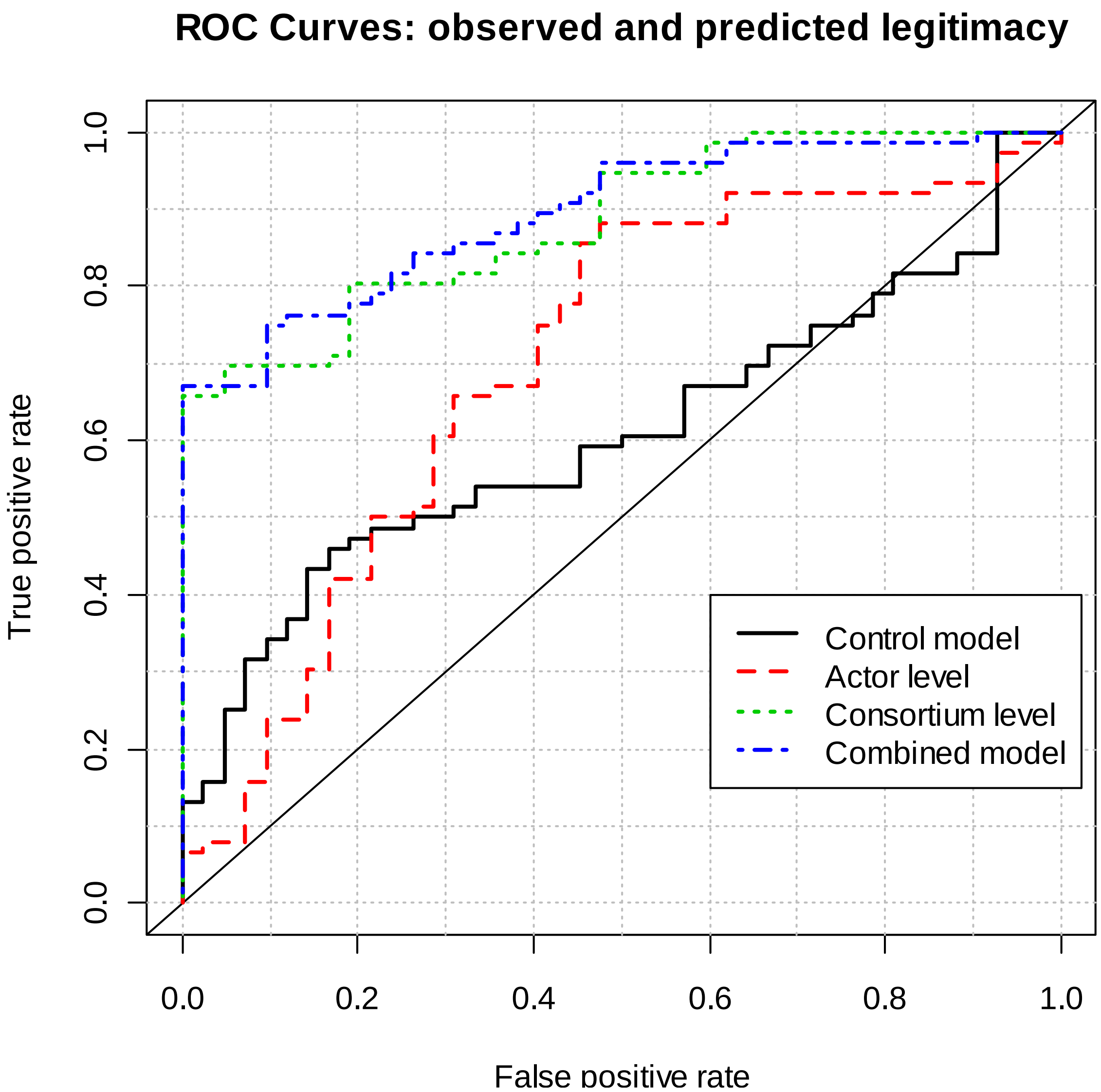

Figure 3: ROC-curves of the different models.