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# Performance Spillover Effects in Entrepreneurial Networks: Assessing a Dyadic Theory of Social Capital

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**We study how social capital induces performance spillover effects in an industry network of entrepreneurs building their own hydroelectric micro-power plants. Most of them are farmers and novices living in rural areas. There is a link between social capital and performance at firm level. By expanding the level of analysis to dyads, we find that entrepreneurs lacking social capital can compensate for this through cohesion with colleagues rich in social capital. Entrepreneurs can also benefit by mimicking the networking patterns of successful colleagues, gaining access to equivalent resources developed in the niche.**

## Introduction

Several studies find that social capital helps people or firms to improve performance (e.g., Burt, 2004; Maurer & Ebers, 2006; Shaw, Duffy, Johnson, & Lockhart, 2005). The concept explains resources that are leveraged through collaborations with external agents. Burt (1992, p. 8) defines social capital as ". . . the structure of the player's network and the location of the player's contacts in the social structure of the arena [that] provides . . . [an] advantage. . . ." Social capital receives substantial attention in the literature, which is also the case for studies focusing on entrepreneurial activity (e.g., Anderson, Park, & Jack, 2007; Bruderl & Preisendorfer, 1998; Davidsson & Honig, 2003; Sanders & Nee, 1996; Shane & Stuart, 2002).

Despite general agreement on the importance of social capital, we know little concerning how social capital causes spillover effects on external agents. Any inter-firm network has an asymmetrical distribution of social capital; some are rich in social capital

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whereas others have less. This paper focuses on how asymmetry in the social capital of dyads affects value creation among nascent entrepreneurs. Research on social capital applying a dyadic level of analysis is scarce. The study by Bowey and Easton (2007) is a rare exception analyzing the inducements of social capital in dyadic entrepreneurial relationships.

We ask whether cohesion acts as a conduit for performance spillover on the firm with less social capital in the dyad. Dyads in a network influence each other either as an effect of direct interaction or through one or more mediating firms. Ahuja (2000) finds effects of indirect connections on innovative output. We define cohesion as: The more (fewer) actors A can reach within the same path length as exists between A and B, the less (more) cohesive is A with B (Burt, 1976, pp. 118–119). We accordingly define cohesion as a structural network property and not merely as a property of direct interaction or tie strength (cf. Granovetter, 1973).

Despite the fact that cohesion is a well-studied concept, its role in dyadic performance is not well understood. Hite and Hesterly (2001) argue for the importance of entrepreneurial firms being part of cohesive network structures, and studies show how cohesion implicitly predicts performance. Ahuja (2000) finds that closed networks of strategic alliances in the chemical industry result in higher innovative outputs. Rowley, Behrens, and Krackhardt (2000) find that interconnectedness of relationships among a firm's partners increases returns on assets in the steel industry. Dense friendship ties among managers in the Sydney hotel industry predict higher revenues (Ingram & Roberts, 2000). Nevertheless, the level of analysis in these contributions is the focal firm. Studying dyads enables us to go beyond the current body of knowledge in order to ask: Can a firm lacking social capital through cohesion gain spillover effects from a colleague rich in social capital? To our knowledge, no other study explicitly focuses on this issue.

There seems to be a consensus among scholars that social capital can be both a private and a public property (Ibarra, Kilduff, & Tsai, 2005). Salancik (1995, p. 348) calls for "a good network theory of organization" in describing "how structures of interactions enable coordinated interaction to achieve collective and individual interests." Burt (1992, p. 9) argues for individual gains from social capital, but he also points to collective properties: "[Social capital] is a thing owned jointly by the parties to a relationship. No one player has exclusive ownership rights to social capital." The research literature nevertheless lacks an explicit explanation of the interplay between different levels of analysis. We argue that a dyadic level of analysis, combined with actor-level characteristics, provides an ideal arena for studying social capital as both an individual and a collective property. Not only do we learn how social capital enables some actors to outperform others, but also we gain insight into how cohesion partakes in boosting joint output for dyads with asymmetric social capital.

We also ask whether structural equivalence boosts dyadic performance. Structural equivalence is a network position in which actors have similar network ties to other actors (Lorrain & White, 1971) occupying the same niche (Burt & Talmud, 1993). Studies find that structural equivalence causes similarity in behavior (Galaskiewicz & Burt, 1991; Mizruchi, 1993; Moody & White, 2003), but we do not know if it also boosts joint output through the sharing of social capital.

Our empirical setting is a network of entrepreneurs—mostly farmers—starting hydroelectric micro-power plants in rural Norway. The technology is new, and since the plants are small, they do not compete against each other. They consume part of their own production and sell the surplus to the national grid. There is an increased interest in micro-power worldwide due to market liberalization, environmental concerns, and demand for reliable power. Decentralized micro-power plants reduce dependence on the grid, which is particularly critical in the developing world (The Economist, 2000, 2001).

We argue that studies on social capital in our empirical setting are warranted. Although Western farmers cannot in general be described as entrepreneurial, there is today increased pressure on farmers to become entrepreneurs (Vesala & Peura, 2005). Bock (2004) states that farmers start new income-generating activities to compensate for reduced income from ordinary farming. Studying Dutch farm women, she finds that they become involved in entrepreneurial activities as a complement to, rather than a substitute for, ordinary farming. This is comparable with the current study in which the entrepreneurs—in addition to ordinary agriculture—exploit access to a river on their property as a resource for other income-generating activities. Further examples of farmers involved in entrepreneurial activities are production of locally branded food and agritourism (Asebo, Jervell, Lieblein, Svennerud, & Francis, 2007; Che, Week, & Veeck, 2005; Marsden & Smith, 2005).

The micro-power technology is different from ordinary farmwork, and all but two of our respondents report that they are novices in the field. We therefore define them as nascent entrepreneurs. Research documents the importance for nascent entrepreneurs of access to social capital (Davidsson & Honig, 2003; Mueller, 2006). Our study adds knowledge about how social capital benefits a group of actors facing increased pressure to be involved in entrepreneurial activities. Finally, we argue that the empirical setting is also well suited for studying our particular research questions. Once a plant has been completed, its output is stable with negligible variation. We identify the year of start-up for each plant to disentangle not only joint dyadic output, but also to discover which of a pair of actors may gain a premium in performance through cohesion or through structural equivalence.

## Theory and Hypotheses

A central network position—without relying on mediators for access to nonredundant information—provides social capital (Burt, 1992, 2004). The node's network position and the surrounding structure of the network predict the effects of social capital at the actor level (Burt, 2000). Below, we argue that cohesion acts as a conduit for firms lacking social capital, and then we describe how the sharing of social capital through structurally equivalent network positions can increase performance for pairs of firms.

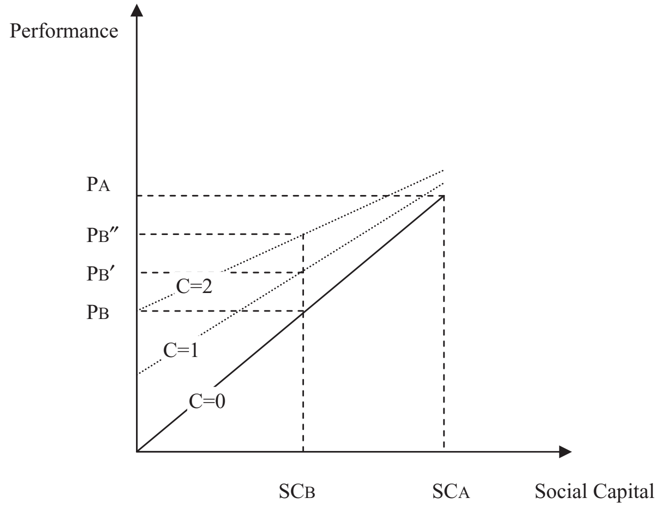
### Social Capital and Cohesion

Cohesion may be counterproductive under some conditions (Gargiulo & Benassi, 2000), but Harkola and Greve (1995) find the concept to be an effective mechanism during the early stage of technology diffusion. Reagans and McEvily (2003) argue that cohesion affects willingness and motivation to invest time and energy in sharing knowledge. They find that network range and absorptive capacity enable knowledge transfer. Thus, while cohesion may lead to redundant information (Burt, 2005), it is also an important knowledge transfer mechanism.

If we assume a linear relationship between social capital and performance at the actor level, then those with more social capital perform better than those with less. If we also assume that a pair of actors are independent of each other (cohesion in the dyad equals 0), then we would expect their social capital to reflect performance along the bold line in Figure 1 (C = 0). We observe that A is rich in social capital ($SC_A$) and is accordingly a high

Figure 1

Social Capital, Cohesion, and Performance Spillover Effects




performer (PA). B, on the other hand, is a low performer (PB) due to lack of social capital (SCB).

Dyads in a network structure influence each other either as an effect of direct interaction or through one or more mediating firms. As noted, Ahuja (2000) finds effects of indirect connections on innovative output. Actors who are close to each other have more cohesive links than those more distant from each other (Burt, 1976).

Returning to Figure 1, we assume that the dotted line C = 1 reflects the level of cohesion between A and B. A is an early starter with social capital SCA and performance PA since start-up. B is a late starter with less social capital than A. Without any effects of B's cohesion with A, we would expect B's performance to be PB. However, the influence from A to B—due to cohesion—may alter this picture: A can share social capital with B. Since A is rich in social capital, we expect positive spillover effects and B's performance will equal PB′. A cohesive network structure transfers the benefits of social capital more easily than a noncohesive one (Reagans & McEvily, 2003).

The dotted line in Figure 1 (C = 1) illustrates the relationship between B's access to social capital and B's performance, given A's social capital and the level of cohesion. We observe that for any level of social capital between 0 and SCA, B will gain a premium in performance, and the effect will be greater the less social capital B possesses. If B is low in social capital, then the firm is in a vulnerable position. Spillover of social capital from A is critical, and matters more the less social capital B possesses. Similarly, the premium in performance is lower if B is close to A in social capital, since the additional social capital is marginal. If the level of cohesion increases and SCB remains constant, then B will gain further positive spillover from A due to better conditions for sharing social capital. The dotted line C = 2 reflects this: We observe that B's performance increases to PB″. B's performance premium is higher the larger the asymmetry in social capital (the less social capital B possesses compared with A). Dyadic performance is the sum of A and B's performance. We control for the sum of social capital in the dyad and hypothesize:

**Hypothesis 1:** Dyadic performance (DP) is a function of the interaction between the level of cohesion (C) and the asymmetry in social capital (ASC): $DP = a + \beta_1 C + \beta_2 ASC + \beta_3 C^*ASC + e$, while $\beta_1 \approx 0$; $\beta_2 \approx 0$; $\beta_3 > 0$.

If B is inferior to A in social capital, an increase in cohesion increases B's performance and the dyadic performance. The larger the asymmetry in social capital in B's disfavor, the more it will boost B's performance and dyadic performance, given a fixed level of cohesion.

## Social Capital and Structural Equivalence

Structural equivalence explains similarity in behavior better than other network measures (Burt, 1982). Burt (1987) and Galaskiewicz and Burt (1991) receive empirical support for this proposition in studies of the diffusion of a medical practice and a corporate philanthropy. Another study finds that firms jointly receiving defense contracts perform similar political actions (Moody & White, 2003). In a study of inter-firm networks, Mizruchi (1993) also finds that structurally equivalent U.S. manufacturing firms are similar in political behavior, but the effects are not robust.

This review indicates that structural equivalence induces actor similarity. One explanation is an imprinting effect of resource sharing and information through similar third-party actors. Structurally equivalent actors share social capital and develop a common pool of intangible resources. An inefficient entrepreneur increases performance through imprinting effects from a more efficient structurally equivalent colleague, inducing symmetry in dyadic performance. This increases total dyadic output:

**Hypothesis 2:** Structural equivalence within a dyad increases dyadic performance.

# Methods

We tested the hypotheses on a network of hydroelectric micro-power start-ups in Western Norway. Our respondents are entrepreneurs establishing their own plant. We focus on this region for three reasons: First, the Norwegian Water Resource and Energy Directorate (NVE) provided data showing that the growth of micro-power is predominantly taking place in this region. Second, Western Norway is a homogenous climate zone with abundant precipitation. Third, Western Norway has a homogenous geological structure. These conditions enable valid comparisons of performance.

The development of new technology, increasing demand for electricity, limited capacity for import, constraints on large-scale domestic investments in hydroelectricity, and a generally enhanced interest in environment-friendly energy all pave the way for hydroelectric micro-power in Norway. Large hydroelectric stations require the construction of dams, but small plants can be adapted to rivers with few modifications. They are also close to the end user.

Moreover, hydroelectric micro-power is a rural phenomenon, and many entrepreneurs are farmers with property rights to a nearby river. Political pressure to reduce subsidies to farmers is strong, and the possibility of gaining extra income (and also saving money on electricity bills for the household and the farm) can be an incentive for some farmers to keep running their farms. Hydroelectric micro-power therefore has positive effects beyond what can be measured in macroeconomic terms. Personal communication with a representative of the technical department in a local municipality also revealed that they considered the emergence of small hydroelectric plants as having potential for new economic growth in the area.

## Sampling and Data Collection

We follow the NVE's definition of a micro-plant as having a maximum capacity of 100 kWh (kilowatts produced per hour). We searched publicly available information to get an overview of the sector and interviewed an authority in the field. We then interviewed a micro-power entrepreneur who also evaluated the questionnaire. Finally, we talked to an engineer who was expert in small-scale hydroelectricity. By searching archive information from NVE and contacting numerous local municipalities, we identified 27 entrepreneurs. To study novices, we excluded two of the identified plants built by a vendor of micro-power systems. To map unlisted entrepreneurs, we asked respondents to name other newly established plants, which identified two more respondents. Despite a number of attempts, we were unable to get in touch with one start-up, and three plants were built before 1994. We excluded these plants from the study. Our respondents all established their plants between 1994 and 2001.

We listed in the questionnaire a number of vendors and micro-power system consultants. In the following columns, we asked respondents to give information about the content of communications they currently have or have had with the different providers. People accurately recall regularly occurring relations as opposed to *ad hoc* contacts (Freeman, Romney, & Freeman, 1987). Next, we asked the respondents to report the year they established contacts and when contacts were terminated. Respondents could also add current or past vendors and consultants not included in our list. In the second part of the questionnaire, we listed all the micro-power and miniature power plants we could identify. We included miniature plants because there is no substantial difference in technical terms between the two types of hydro turbines apart from size (the NVE classifies miniature power plants as having a maximum capacity of 1,000 kWh). We asked the same questions about possible relationships as in the previous part of the questionnaire and left space for respondents to add network ties to unlisted contacts. Only one respondent mentioned a tie to a plant that was not already on the list. This indicates that the region represents a natural boundary for this field. In the third part, we asked respondents to report the month and year they started electricity production and their plants' performance in kWh, the maximum capacity in kWh, and their total investments excluding the costs of connection to the electricity grid. We also asked if they had previously been involved in similar projects. Only two respondents reported such experience. Finally, we asked respondents about personal characteristics such as year of birth, level of education, and whether building the plant was an individual project or not.

After first communicating by telephone with all candidates—requesting participation and giving a brief overview of the study—we mailed the questionnaire. We finally received 23 usable responses out of 25 candidates for modeling network data. These represent a response rate of 92% (88.5% if we consider the start-up we were unable to reach). It appeared that the most challenging task was to gather reliable data on electricity production. With the aim of getting this information from as many respondents as possible, we mailed the candidates for whom this information was lacking or insufficient, informing them that we would call them for this information. This resulted in accurate data on electricity production and other autonomous characteristics from 20 respondents.

Altogether, we have data from 80% of the entire population. To compare investments made over an 8-year period, we adjusted the investments based on the consumer price index from Statistics Norway.

## Modeling Network Ties

We apply Krackhardt's (1990, p. 352) operational definition of a tie: A network tie exists between A and B if one or both report that a relationship exists. This enables us to model network data between micro-power start-ups and their external relations with vendors, consultants, and miniature power plants. The network includes 59 actors with 115 ties in 2002 (density = .07). To analyze the development of the network structure, we focus on initiation dates and duration of network ties. Almost all respondents report the year they established the relationship. Missing years are set as ties established in the early phase, because it is easier to correctly identify the exact time of recent events compared with events that are more distant in time.

The most intuitive way to handle terminated network ties is to use the year of termination. However, this underestimates the enduring influence a network tie has on the actors involved. If a contact between A and B is reported as terminated in 1997, does this necessarily imply that there is no influence of this tie after 1997? We argue that this is not the case. If B established a contact with C 2 years later, then it is likely that what B gained through cooperation with A will be passed on and further developed when working with C. To account for the influence of terminated ties, we added 5 years to the year of termination. This reflects the time it takes for technology development to become outdated. To assess the validity of this assumption, we modeled network data by adding 3 and 7 years, respectively. Unreported analyses at actor level indicated no substantial differences in the results.

Figure 2 shows the development of the network structure during the years 1995, 1997, 1999, and 2001. We observe—with the exception of one unconnected dyad in 1995 and 1996—a coherent and connected network. The figure indicates a continuous increase in both the number of actors and the density of the network.

## Dependent Variable

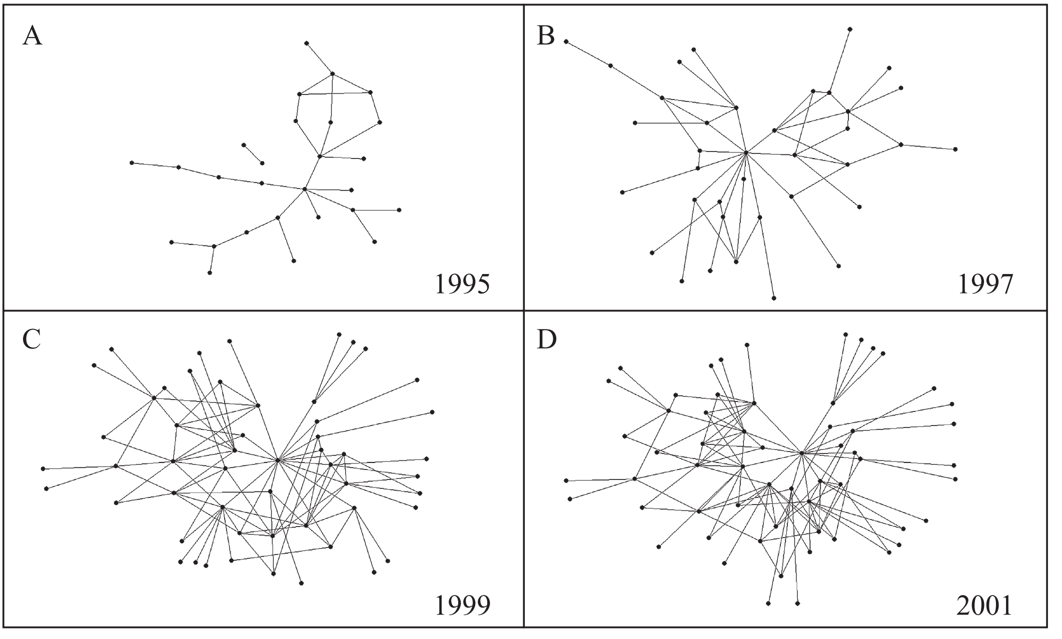
***Dyadic Performance.*** Firm-level performance is the yearly electricity production divided by financial capital invested, adjusted for inflation. We used average yearly production in cases with more than 1 year of production. Dyadic performance is the sum of the performance of each pair of firms.

## Independent Variables

***Asymmetry in Social Capital.*** We measure social capital at firm level as a normalized score of flow betweenness at the year of start-up for each plant (Freeman, Borgatti, & White, 1991). We exclude the unconnected dyad in the calculations for 1995 and 1996. To measure asymmetry in social capital, we calculate the absolute difference in social capital within each dyad and then apply the natural logarithm to achieve a normal distribution.

Figure 2

A Graphic Display of the Network Structure in the Emerging Field. (A) 1995; (B) 1997; (C) 1999; (D) 2001




***Cohesion.*** Burt's (1976) frequency decay function measures cohesion as the geodesic network distance between A and B set to one minus the proportion of other actors that are as close to A as B is. When A (B) is a late starter, we apply the network structure for A's (B's) start-up year. Since A and B's network boundaries in most cases are dissimilar, their cohesion will also be dissimilar. We apply A's (B's) cohesion when A (B) is a late starter, because spillover effects are more critical during the investment phase than after start-up. When a pair of actors started production in the same year, we use their average cohesion.

***Structural Equivalence.*** To calculate structural equivalence, we standardize the rows and columns of the network matrices to yield equal means and variances, and compute correlation coefficients from these matrices (Wasserman & Faust, 1994, pp. 368–375). When A (B) is a late starter, we apply the network structure for A's (B's) start-up year.

## Control Variables

***Dyadic Social Capital.*** We control for dyadic social capital, which is the sum of A and B's social capital. After summing social capital for each pair of firms, we apply the natural logarithm to achieve a normal distribution.

***Dummy for Late Starter Relatively Rich in Social Capital.*** Our line of reasoning leading to hypothesis 1 assumes that A is an early starter relatively rich in social capital and B is a late starter relatively low in social capital (SCA > SCB). Yet, the non-negative value of asymmetry in social capital does not reveal whether A is superior or inferior to B in social capital. We therefore include a dummy variable controlling for the dyads where B is a late starter relatively rich in social capital (SCA < SCB).

## Results

Table 1 reports the QAP (quadratic assignment procedure) correlations for dyads. This procedure calculates significance levels by randomly permuting rows and columns for a matrix 2,500 times (Borgatti, Everett, & Freeman, 2002; Krackhardt, 1987). By expanding the level of analysis to dyads, we have 190 observations. We used Ucinet 6.79 for the network analyses (Borgatti et al.).

To test our hypotheses, we applied the double Dekker semi-partialling multiple regression QAP method with 2,000 random permutations (Borgatti et al., 2002; Dekker, Krackhardt, & Snijders, 2007). We mean-center the interaction term of cohesion (C) and asymmetry in social capital (ASC) (Cronbach, 1987). Table 2 shows the results.

Model 1 includes the control variables, and we observe a significant effect of dyadic social capital on dyadic performance. We test hypothesis 1 in Model 2, which shows a significant positive effect of the interaction term of cohesion and asymmetry in social capital on dyadic performance. The effect remains significant in the full model (Model 4). Since the dummy variable is close to zero when we test hypothesis 1 (Models 2 and 4), we can infer positive performance spillover effects from an early starter relatively low in social capital to a late starter relatively rich in social capital (SCA < SCB). The effect increases (in B's favor) the more cohesive and asymmetric the firms are in social capital (i.e., the more social capital B has relative to A). This is illustrated in Figure 3. Cohesion has a significant effect on dyadic performance in Model 2, but this is most likely a reflection of the concept's correlation with structural equivalence (see Table 1). When modeled together with structural equivalence, cohesion becomes insignificant (Model 4).

Table 1

Quadratic Assignment Procedure Correlations

| Mean | SD | | DP | DSC | C | ASC | D |
|---|---|---|---|---|---|---|---|
| 1.136 | .404 | DP | | | | | |
| 2.573 | .862 | DSC | .632** | | | | |
| .451 | .250 | C | .264** | .285*** | | | |
| 1.973 | .962 | ASC | .504* | .733*** | .081 | | |
| .395 | .489 | D | −.333** | −.352** | −.390*** | −.273** | |
| .047 | .224 | Structural equivalence | .175* | .048 | .398*** | −.066 | −.250** |

* $p < .05$, ** $p < .01$, *** $p < .001$.
*Note:* Number of dyads = 190. Two-tailed tests.
DP, dyadic performance; DSC, dyadic social capital; C, cohesion; ASC, asymmetry in social capital; D, dummy for late starter relatively rich in social capital; SD, standard deviation.

Table 2

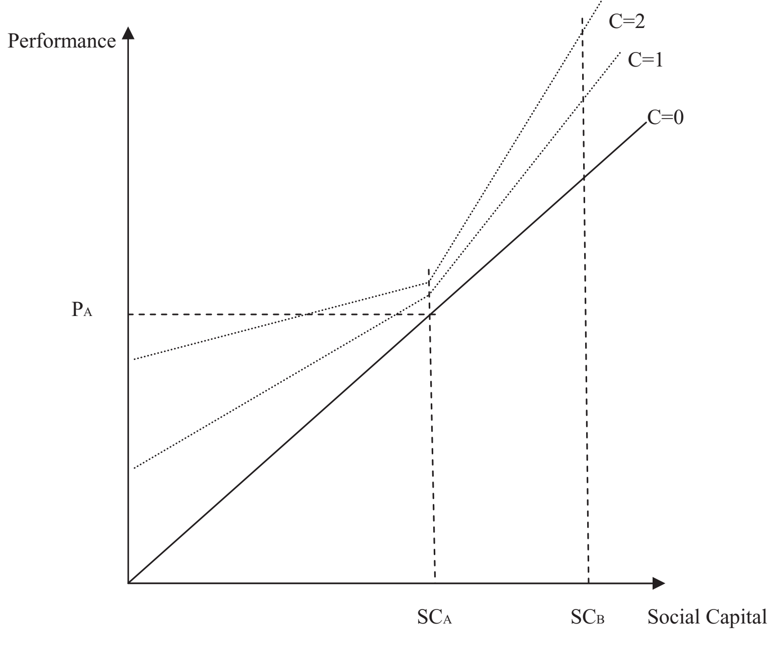
Quadratic Assignment Procedure Regressions

| | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| Dyadic social capital | .588** | .481* | .594** | .480** |
| Dummy for late starter relatively rich in social capital | −.126 | −.076 | −.093 | −.037 |
| C | | .139* | | .076 |
| ASC | | .024 | | .037 |
| Hypothesis 1: C*ASC | | .269*** | | .330*** |
| Hypothesis 2: Structural equivalence | | | .122 | .220** |
| $R^2$ | .414** | .481*** | .428** | .518*** |
| Adjusted $R^2$ | .412 | .476 | .425 | .511 |

* $p < .05$, ** $p < .01$, *** $p < .001$.
*Note:* Dependent variable: dyadic performance. Standardized coefficients. Two-tailed tests.
Number of dyads = 190.
C, cohesion; ASC, asymmetry in social capital.

Figure 3

An Empirical Model



We test hypothesis 2 in Model 3. The effect of structural equivalence is low, but close to being significant ($p = .057$). When we include cohesion, asymmetry in social capital, and the interaction term of cohesion and asymmetry in social capital, the effect is stronger and becomes significant (Model 4). Altogether, we therefore argue that hypothesis 2 is supported. Furthermore, we find in an unreported model that structural equivalence leads to similarity in performance, consistent with previously reported studies (Galaskiewicz & Burt, 1991; Mizruchi, 1993; Moody & White, 2003). We also find a relationship between social capital and performance at nodal level (see the Appendix).

## Discussion

This study contributes to our understanding of social capital as a collective property. By expanding the level of analysis to dyads, our results indicate that firms lacking social capital can gain performance through cohesion with firms rich in social capital. In line with other studies (Davidsson & Honig, 2003; Mueller, 2006), our analyses at firm level indicate the importance of access to social capital for their own sake for each nascent entrepreneur. Scholars emphasize the dual property of social capital as a private and public property (Burt, 1992; Ibarra et al., 2005; Salancik, 1995), but to our knowledge this is the first study that simultaneously finds that both effects may play a role.

Studies show how cohesion enables communication and knowledge transfer (Harkola & Greve, 1995; Reagans & McEvily, 2003), and leads to better performance (Ahuja, 2000; Ingram & Roberts, 2000; Rowley et al., 2000). Our study adds to this knowledge by indicating that cohesion may play a role for actors low in social capital. Moreover, previous research shows that structural equivalence causes similarity in behavior (Galaskiewicz & Burt, 1991; Mizruchi, 1993; Moody & White, 2003), but this study also indicates that structural equivalence increases performance for pairs of entrepreneurs. The study also finds that a late starter relatively rich in social capital may gain a premium in performance through cohesion. This premium appears to increase the more social capital the firm possesses (Figure 3). An explanation can be that entrepreneurs learn from the failures of their colleagues (Davidsson & Honig, 2003). Learning through failure is well documented (Arino & de la Torre, 1998; Sitkin, 1992), and social capital is also associated with failure-based learning behaviors (Carmeli, 2007).

Baron (1998, p. 290) argues that entrepreneurs operate in situations where they are prone to cognitive errors and pitfalls, but "a large body of research findings suggest that patterns of thought—and errors stemming from them—are often more amenable to change. . . ." A practical implication from our study is that entrepreneurs constrained from building social capital can compensate for this through establishing ties with at least one or a few colleagues acknowledged for rich access to social capital. For instance, an entrepreneur operating in a region where a network has yet to be developed should consider the possibility of cooperating with geographically distant actors. Structurally equivalent entrepreneurs have similar network ties to other actors, and entrepreneurs can also benefit by mimicking the networking patterns of successful colleagues and thereby gaining access to equivalent resources developed in the niche.

We have emphasized that the entrepreneurs in our study do not compete against each other. The practical implications we have outlined may thus be questioned when it comes to more competitive empirical settings. However, competition does not imply that the firms compete head-to-head along all dimensions. Von Hippel (1988) shows that firms cooperate most of the time when pioneering new technologies. In a study of organic farming in Wales and The Netherlands, Marsden and Smith (2005, p. 441) illustrate "how local innovation and non-conventional thinking [such as farmers who build and operate micro-power plants] can foster sustainable . . . development." Furthermore, our findings may be relevant for co-producing networks where firms and individuals are involved in complex large-scale projects (e.g., Greve & Salaff, 2001).

The potential for micro-power—particularly in rural and developing areas—is well documented (Dunn, 2000; The Economist, 2000, 2001). Our study illustrates the impact networking may have on entrepreneurial success in this sector. However, if our results can be applied to developing areas, we argue that the study has implications far beyond merely entrepreneurial success. Micro-power plants are the only option for reliable access to electricity in many developing areas (The Economist), and entrepreneurial success can accelerate the diffusion of this technology.

A limitation of this study is that we asked respondents to report on the history of their relationships. To gain more accurate data, an ideal solution (but impossible *ex post*) would have been to follow the sector over time. We have also limited our study to measuring average performance since start-up, but in most industries performance is a dynamic phenomenon. Analyzing a network structure that has been dichotomized—ignoring layers of multiplex relations—is a simplistic approach and a limitation. Finally, the population we have studied is small. A dyadic level of analysis boosts the number of observations, but we should be somewhat cautious when interpreting the results.

By conducting a similar study across time in another industry, we may learn more about how social capital creates spillover effects between pairs of firms. Huergo and Jaumandreu (2004) find that older firms tend to be less innovative than younger firms, and studies should investigate whether this process can be moderated through network mechanisms described in this paper. Beckman and Haunschild (2002) document benefits from multiplex relations, and future research should study whether this can explain performance spillover effects in entrepreneurial networks. Testing the hypotheses in a network of competing firms can also provide valuable knowledge. The effect of asymmetry in social capital on performance found in this study may be different in a more competitive network.

Finally, testing informal versus formalized relationships can also be an interesting avenue for further research. Studies of business-to-business relationships show that performance increases when actors combine relational (informal) governance mechanisms with formalized contracts (Cannon, Achrol, & Gundlach, 2000; Poppo & Zenger, 2002). Our knowledge of social capital can be further extended by comparing actors relying on a combination of informal and formalized relationships versus actors relying on either informal or formalized network relationships.

## Appendix

Table A1 reports the correlations among variables at a nodal level of analysis. The variable "One man project or not" is a dummy where 1 = built by one person, and 2 = built by more than one person. We define "Years of schooling" as: completed secondary school = 1, completed high school = 2, 1–3 years in college/university = 3, 4 years or more in college/university = 4. "Deviation in precipitation in %" is the average yearly deviation in precipitation from the most proximate weather station for each plant in the region. We observe that social capital is the only variable correlating significantly with performance. Educated entrepreneurs tend to build larger plants, and the negative correlation between year of start-up and deviation in precipitation is a result of decreasing precipitation in 1999–2001.

Table A1

Correlations at Nodal Level of Analysis

| Mean | SD | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| −.692 | .534 | 1 | Performance (natural logarithm) | | | | | | | | | |
| 1.736 | 1.091 | 2 | Social capital (natural logarithm) | .571** | | | | | | | | |
| 41.52 | 30.64 | 3 | Size of plant in kW | .368 | .290 | | | | | | | |
| 26.25 | 16.82 | 4 | Average age of plant in months | .261 | .212 | −.071 | | | | | | |
| 1,998 | 1.954 | 5 | Year of start-up | −.186 | −.171 | .428 | −.605** | | | | | |
| 99.9 | 55.62 | 6 | Waterfall elevation in meters | −.090 | .134 | .138 | −.257 | .157 | | | | |
| 1.3 | .470 | 7 | One-man project or not | −.240 | −.017 | −.079 | −.296 | .178 | .061 | | | |
| 53.1 | 10.90 | 8 | Age of entrepreneur | −.147 | .016 | −.203 | .114 | −.149 | .283 | .210 | | |
| 2.25 | .716 | 9 | Years of schooling | .298 | .299 | .514** | .043 | .047 | .118 | .078 | .057 | |
| 92.39 | 10.11 | | Deviations in precipitation in % | −.176 | −.138 | −.389 | .436 | −.787*** | −.123 | −.212 | .148 | .114 |

** $p < .01$, *** $p < .001$.
*Note:* N = 20.

Table A2 shows the regression analyses. Due to few observations and the fact that some of the control variables are highly correlated, we included only one control variable in each regression analysis. We observe that social capital is the only significant variable and that none of the control variables are significant. We also apply forward stepwise regression where all independent variables are candidates (significance probability of entering was set to .25 and the probability of leaving was .10). This procedure merely reproduced Model 6. However, these results need to be interpreted with caution due to the low number of observations.

## Table A2

### OLS Regressions at Nodal Level of Analysis

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 |
|---|---|---|---|---|---|---|---|---|---|
| Social capital (natural logarithm) | .571** | .507* | .540* | .555* | .593** | .570** | .573** | .529* | .557* |
| | (2.95) | (2.52) | (2.69) | (2.76) | (3.02) | (2.96) | (2.93) | (2.57) | (2.79) |
| Size of plant in kW | | .221 | | | | | | | |
| | | (1.10) | | | | | | | |
| Average age of plant in months | | | .147 | | | | | | |
| | | | (.73) | | | | | | |
| Year of start-up | | | | −.091 | | | | | |
| | | | | (−.45) | | | | | |
| Waterfall elevation in meters | | | | | −.169 | | | | |
| | | | | | (−.86) | | | | |
| One-man project or not | | | | | | −.231 | | | |
| | | | | | | (−1.21) | | | |
| Age of entrepreneur | | | | | | | −.157 | | |
| | | | | | | | (−.80) | | |
| Years of schooling | | | | | | | | .139 | |
| | | | | | | | | (.68) | |
| Deviation in precipitation in % | | | | | | | | | −.010 |
| | | | | | | | | | (−.50) |
| $R^2$ | .326 | .370 | .346 | .334 | .354 | .379 | .350 | .342 | .335 |
| Adjusted $R^2$ | .288 | .296 | .269 | .255 | .278 | .306 | .273 | .266 | .257 |
| *F*-value | 8.69** | 5.00* | 4.50* | 4.26* | 4.65* | 5.81* | 4.57* | 4.44* | 4.29* |

* $p < .05$, ** $p < .01$.
*Note:* Dependent variable: performance (natural logarithm). Standardized coefficients. Two-tailed tests. *t*-values in parentheses. N = 20.

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