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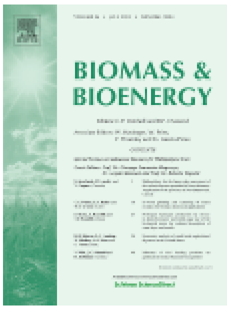

The importance of social networks in the Norwegian firewood industry

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Abstract: This study examines the relationship between social network size, innovation and firm performance among firewood producers in Norway. Moreover, it investigates how this relationship is affected both by the structure and variations in networks and by firm size and age. A questionnaire-based survey was sent to managers of firms (including one-person firms) in the firewood industry in Norway. A total of 645 usable replies were received, and the theoretical model was tested using structural equation modeling. The findings show that social network size has a positive effect on firm performance via innovation by firewood producers. Furthermore, the results show that firewood producers with fewer involved family members and more variation in occupation and entrepreneurial experience in their networks benefit more from larger social networks than other producers do.

Keywords: networking, innovation, firm performance, bioenergy, renewable energy, micro firms

Introduction

Today, traditional firewood is an important component of world bioenergy use in both the developed and the developing worlds. Primary solid biomass accounts for approximately 10% of the world's total primary energy production [1]. In developing countries, almost all of the traditional uses of biomass require firewood and charcoal [2]. Furthermore, more than half of the wood production enterprises in the world produce traditional firewood. In most European countries, the traditional use of wood as firewood is still more common than the industrial use of biomass for energy purposes. However, there has been little research on traditional firewood. The programmes of major bioenergy conferences that have been held in Europe during the last ten years have not addressed the future of traditional firewood. This dearth of attention to traditional firewood systems may be attributable to the perception of these systems as mature and having few research challenges.

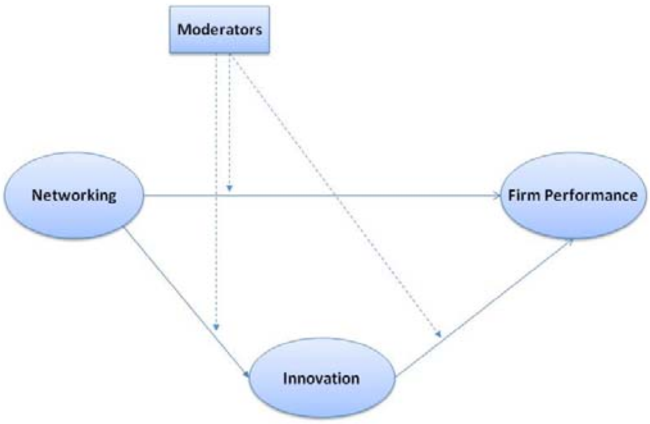
In most cases, the production of firewood is a small-scale activity for farmers, forest owners and small rural workshops [3]. Accordingly, this industry has been important to the agricultural sector and to rural development in many countries. Even in high-cost countries, such as those in Scandinavia, the firewood industry has been highly competitive. Norwegian consumption of firewood has not decreased, even in periods during which welfare has substantially improved [4]. This steady consumption may be because people cut and handle firewood for their own consumption, either as a recreational activity or because they have free access to wood. Indeed, firewood is a part of the Norwegian cultural identity [5]. Recent decades have seen an increase in firewood production [6]. The production and sale of firewood now constitute an important industry in rural Norway [7] as well as in many other European countries [8]. However, in this paper, we argue that improvements in the traditional firewood chain can be achieved by emphasising two important factors: social networks and innovation.

Social networks are an important component of social capital, which can be defined as the resources and subsequent advantages resulting from social structures [9, 10]. Coleman [9] stressed the positive effect of network closure on the production of social norms and sanctions that facilitate trust and cooperative exchange. A social network can be seen as a set of linkages among a given set of people [11]. Such networks are an important aspect of social capital [9]. To be regarded as a network link, a relationship must entail more than an accidental meeting. Social networks can also be defined as patterns of lasting social relationships among people [12]. Several scholars have studied the importance of social networks in various contexts, including farming [13] and forestry [14].

Access to resources and knowledge through external relationships is important for innovation [12, 15] and firm performance [16]. Despite the breadth of the literature on innovation, there is no general consensus regarding the definition of innovation [17]. Thompson [18] defines innovation as the generation and implementation of new ideas, processes and products. Other authors argue that adopting something new constitutes innovation [19]. Accordingly, an innovation must be new to a firm; however, it does not need to be new to the marketplace [20]. Genuine innovations (new-to-the-world innovations) are often referred to as radical innovations, whereas improvements in existing products, processes, markets and organisations are referred to as incremental innovations [21]. For primary low-technology firewood producers, the incremental view of innovation is most relevant because few significant radical innovations are likely to occur. In fact, because of the nature of firewood, it is reasonable to assume that there are few significant relevant product innovations. Consequently, we define innovation in the firewood industry as the creation or adoption of new manufacturing processes, new ways of marketing and new ways of organising a business.

The majority of business models and tools are developed for large firms, although there has been a great deal of research on small and medium-sized businesses. Due in part to the increased focus on climate change and renewable energy, the bioenergy sector has received significant attention. In contrast, little research has been conducted on the firewood industry. There is a rich body of literature on innovation and social networks, but little or no attention has been paid to how social networks influence innovation and performance in the firewood industry. Therefore, our paper focuses on firewood producers and their relationship to their business environment.

The aim of this study is to gain a more in-depth understanding of the importance of social networks in the firewood industry. In the context of Norwegian firewood production businesses, we hypothesise that a larger social network has a positive and direct effect on firm performance, with innovation acting as a mediating factor (Figure 1). Furthermore, we propose that tie strength, firm size, firm age and varied entrepreneurial experiences and occupations within the social network are all moderating factors that enhance the impact of social networks on innovation. Likewise, we propose that varied entrepreneurial experiences and occupations in the social network are moderating factors that enhance the impact of innovation on financial performance (Figure 1).



Moderators: Tie strength and variation within a network

Figure 1. Theoretical model

Hypotheses

Direct and indirect effects of social networks on financial performance (H1 through H4)

Scholars have frequently discussed the positive effect of larger external networks (e.g., numbers of ties) on organisational innovation [12, 22-24]. Several studies have also been conducted with farmers, forest owners and rural micro firms. For example, Nybakk et al. [25] found a positive link between networking and innovation. As argued above, larger networks provide firms with more varied resources [12] than smaller networks do. Networks may increase knowledge sharing [24, 26] and provide access to complementary knowledge resources [24, 27]. In other words, collaboration increases the information, knowledge and other resources available to the partners in the relationship.

In discussing the successful commercialisation of innovation, Teece [28] argues that dependence on access to complementary assets (e.g., resources required in addition to a basic idea) is essential. From this perspective, networks are a source of complementary resources. Although the results of research on innovation and performance are mixed, several studies indicate the positive effect of innovation on performance [29-31].

Based on the literature that confirms the effect of social networks on innovation and that of innovation on firm performance, it is reasonable to assume that network size has an indirect positive impact on firm performance via innovation. Nybakk et al. [25] found that small nature-based firms that were more involved in networking were more innovative and exhibited improvements in firm performance. A qualitative study on bioenergy firms in different European countries also emphasised the importance of social networks as an innovation driver [32]. However, network size may also have a direct effect on performance.

Researchers have shown that a direct relationship exists between network size and financial performance. For example, researchers found that a higher number of weak and strong ties have a direct positive impact on entrepreneurial success [12]. The effect of networks on financial performance may also be related to factors other than innovation. In some cases, networks may channel resources in areas that do not necessarily stimulate innovation but instead stimulate financial performance through other factors such as legitimacy.

Our arguments about networks, innovation and performance lead us to form the following hypotheses:

H1: A higher level of network size in firewood firms leads directly to a higher degree of firm performance.
H2: A higher level of network size in firewood firms leads to a higher degree of innovation.
H3: A higher degree of innovation in firewood firms leads to a higher degree of firm performance.
H4: Network size will positively influence firm performance via innovation in the firewood industry.

Tie strength as a moderating effect (H5 and H6)

The literature has emphasised the importance to innovation of both strong [33] and weak ties [26]. According to Krackhardt [26], weak ties provide a variety of information. However, a wide spectrum of information does not provide all of the resources needed for innovation. Thus, Grannovetter [33] argued that strong ties are also important and provide resources that may not flow through relationships with acquaintances. For instance, social support and knowledge may be better transferred through close and trusting relationships. One might argue that strong ties only circulate old ideas and have limited importance for innovation. However, it is probably important for entrepreneurs without the support of an organisation to have trust and support from a social network.

We believe that for rural firms in small local environments, relationships outside the realm of family and friends are especially critical. These companies are likely to be less dependent on costly and complicated production facilities. We suggest that a variety of customer relationships and distribution channels is important [28]. To the authors' knowledge, no scholars have addressed this issue in the context of firewood producers. We therefore advance the following hypotheses:

H5: The larger the proportion of family members in a network, the weaker the relationship between network size and financial performance in the firewood industry.

H6: The larger the proportion of acquaintances in a network, the weaker the relationship between network size and financial performance in the firewood industry.

The impact of network variation on innovation and performance (H7 through H10)

Researchers have argued that diversity is important because it provides access to a greater variety of resources. This principle is the basis for the weak tie argument proposed by Granovetter [26]. However, for Burt [34], tie strength was correlated with diversity but not with a cause. A low degree of redundancy indicates there are structural holes in a network's information flow because the focal firm's contacts generally are not linked to one another [24, 34, 35]. Thus, the different ends of the holes (structural holes in the network) have access to different flows of information [36].

In contrast, Coleman [9] and later Ahuja [24] suggested that a greater degree of redundancy is conducive to innovation. They believed that the positive effects of a redundant web of interrelated firms, such as a high degree of trust, cooperating routines and a low degree of opportunism, are greater than the benefits of diversity in a low-redundancy network.

Densely related firms may invest large amounts of resources in relationships, thus increasing the positive effects of cooperation [37]. Firewood producers can, for example, invest in a common distribution system for the sale of wood. Closely related firms may also operate as referral agents for each other and use their relationships to promote collaboration and sharing between previously unrelated firms [38, 39]. Furthermore, densely knit relationships reduce opportunistic behaviour because information spreads rapidly [9, 37].

Ahuja [24] noted that the research findings addressing the effect of redundancy have been ambiguous. He argues that whether redundancy has a positive or negative impact on innovation is context dependent. When it is vital to develop a collaborative milieu and overcome opportunism, low-redundancy networks are likely to be beneficial. However, when rapid access to diverse information is essential, structural holes are likely to be advantageous.

Knudsen [40] discussed the concept of *variety of experience* and argued that such variety can create diversity in a network independently of tie strength or redundancy. If this is so, increasing the number of relationships may not always increase diversity. Therefore, our hypotheses reflect the argument that the effect of size depends on relationship variety (i.e., experience, occupation and location).

If, as Ahuja [24] argued, context is an essential factor, our hypotheses must take into account the particularities of the Norwegian firewood industry. This industry has longstanding traditions and is generally rural. Furthermore, many of its firms are family owned and operated [5]. Consistent with H1, we suggest that firewood producers depend on a diverse network, partly to compensate for a limited local environment and especially to ensure innovation. Based on these arguments, we propose the following hypotheses:

H7: In the firewood industry, the more varied the entrepreneurial experience in a network, the stronger the relationship between network size and innovation.

H8: In the firewood industry, the more variation in entrepreneurial experience in a network, the stronger the relationship between network size and financial performance.

H9: In the firewood industry, the more variation in occupation in a network, the stronger the relationship between network size and innovation.

H10: In the firewood industry, the more variation in occupation in a network, the stronger the relationship between network size and financial performance.

Firm age and size as moderating effects (H11 and H12)

Are a firm's size and age moderating effects of networks? As discussed, several studies have emphasised the importance of external relationships on innovation [41-43], and others have emphasised that a large social network influences the capacity for innovation, particularly among small firms and one-person businesses [14]. Large firms are more able to absorb risks than small firms, which may not have the resources to invest in new, high-risk projects [44]. Small firms may have to cooperate with other firms to share and minimise risks. In addition, large firms can justify innovation because of their greater potential for economies of scale [45].

Large organisations process more information [44] and have a wider variety of internal resources, including information and expertise, whereas small firms must cooperate with others to acquire such resources. Because small firms face relatively little bureaucracy [46], it is reasonable to argue that they can build external relationships easily.

There has been little research on how firm age moderates the effects of social networks on innovation in small firms. Therefore, we rely on our own rationale. It is likely that mature businesses and older firewood producers have accumulated sufficient knowledge and experience to process information and begin innovation projects. Therefore, established companies may have developed organisational procedures and norms that in actuality limit their ability to innovate. However, it is logical to assume that new businesses and young firewood producers are more dependent on large social networks for innovation because they have less experience. Furthermore, young firms may exhibit an open and entrepreneurial approach to business. Thus, we formulated the following hypotheses:

H11: The smaller the firewood-producing firm, the stronger the relationship between network size and innovation.
H12: The younger the firewood-producing firm, the stronger the relationship between network size and innovation.

Data and Methods

Questionnaire development and measurement

A questionnaire was developed that addressed the following latent variables: social network size, innovation, firm performance and network structure and variation within the network. The questionnaire also included a section on descriptive information concerning items such as total sales and firm age. All of the latent variables were measured using multiple items, as recommended by Churchill [47]. When possible, the measurement of the latent variables was based on previous studies. However, because of the lack of studies on this industry, some of the items were developed specifically for this study. All of the items were measured using a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The innovation scale was based on Avlonitis et al. [48], Deshpande et al. [49] and Wang and Ahmed [50]. The scale consisted of three dimensions: process innovation, market innovation and organisational innovation (see Table 2). The firm performance scale consisted of six items: three related to overall profit and three related to the cost of production (Table 3). The social network size scale consisted of three items and was developed following Antia and Frazier [51] (see Table 3). The single items presented in Table 1 were used to measure the moderating effect variables.

Table 1. Moderator variable names

Moderating variable name	**Full items used**
Strong ties – family	A large part of my/our network consists of family members.
Strong ties – acquaintance	A large part of my/our network consists of acquaintances.
Variation in entrepreneurship experiences in network	In my/our network, there are people with different types of entrepreneurial experience.
Variation in occupation in network	In my/our network, there are people from many different professions.
Firm size	What are your total sales (value added, tax not included)?
Firm age	When did your business start producing firewood?

Sampling and data collection

The targeted population consisted of private Norwegian firewood producers, including one-person businesses and larger firms. The minimum annual total sales amount was set to 1783$ (converted from Norwegian kroner using the average exchange rate USD/NOK 5.61 for the year 2011) to exclude firewood producers that only produce firewood for household use. Because no complete list of Norwegian firewood producers exists, we used the member list for the interest group of Norwegian firewood producers Norsk Ved, which consists of 4,200 members. Of these members, 3,000 were randomly selected.

Norsk Ved stipulated that a paper version of the survey would need to be sent out first and that the survey would need to be anonymous. To comply with these restrictions, a modified Dillman [52] approach was used. In December 2010, a one-page notice was sent out with the membership magazine. This notice included information about the survey and the importance of participation. The following month, a full questionnaire packet was sent out that included a cover letter, the questionnaire and a return envelope. A third wave of questionnaires was subsequently sent out along with reminder letters. These letters also included a URL, giving the respondents the option of completing the survey online. Additionally, an e-mail was sent to the 1,550 members who had registered their e-mail addresses.

Data screening and non-response bias

We received a total of 917 responses for a response rate of 30.5%. Of the respondents, 123 reported that they did not sell firewood, and 60 reported that they worked for the municipality and were therefore excluded from the sample. The remaining 734 responses were carefully examined for missing values. This analysis resulted in the exclusion of 89 additional responses with excessive missing responses for the main constructs. Thus, the final dataset consisted of 645 usable observations.

Overall, the dataset was highly balanced; however, some issues were observed, including missing observations and responses with multiple gaps. Listwise deletion would have resulted in the loss of 135 responses (20%). After checking for randomness in the missing patterns, we inputted non-demographic variables using the set of variables and the EM algorithm. The resulting ML estimates of means and covariances appeared to be adequate. Forty-one additional observations were omitted from the analyses because the ‘size’ field was blank.

We tested for non-response bias using an independent sample t-test, in which the first third of the responses (based on the reception date; n=215) was compared with the last third, as suggested by Armstrong and Overton [53]. The different groups were compared for innovation, network degree, firm performance, size (sales) and age. The results from the t-test did not indicate any significant differences between the two groups at a 5% level; thus, there was no evidence of bias.

Analyses and measurement model

The latent nature of the factors under analysis and the complexity of the model led us to choose structural equation modelling using EQS for the statistical analysis [54]. The presence of some missing data and non-normality led us to choose robust estimators for the parameters and fit indices.

A theoretical model was the basis for the original measurement model, which we modified based on fit, reliability and validity. After refining the measurement model, we partially aggregated some factors using composite indicators. However, we first checked for unidimensionality and the reliability of the items in the dimension to be aggregated into a composite. For innovation, the construct was measured using three composite indicators representing process, market and organisational innovation (Table 2).

Table 2. Composite reliability on market innovation, process innovation and organisational innovation

Composite	Items	Correlation	Cronbach's Alpha
Process innovation	1. Early adopter of new production processes and new methods of distribution. 2. Good at designing new methods of production and/or distribution	.82	.90
Market innovation	1. Early adopter of new marketing methods 2. Good at designing new marketing methods	.89	.94
Organisational innovation	1. Early adopter of new ways of organising the firm 2. Good at designing new ways of organising the firm	.90	.95

The refined measurement model fit the data well with CFI*=0.974, RMSEA*=0.048 [0.034-0.061], SRMR=0.044, and 98% of the residuals distributed in the [-0.1 to 0.1] range (Table 3). All of the loadings were highly significant. All of the pairs of factors showed discriminant validity (Bollen's test), and the reliability levels of all of the factors were adequate.

Table 3. Measurement model with standard loadings and fit values.

	Loading	Error
Firm Performance (Alpha=0.73, CR=0.93)		
Achieved my/our objectives for profitability	Deleted	
Obtained better profitability than other firewood producers I/we know	0.65	0.77
Achieved improved profitability	0.56	0.83
Achieved our goals for operating costs per cubic meter of firewood	Deleted	
Achieved lower operating costs per cubic meter of firewood than other firewood producers I/we know	0.69	0.73
Reduced operation costs per cubic metre of firewood	0.66	0.75
Size of Social Network (Alpha=0.80, CR=0.93)		
Part of a large network	0.71	0.71
More network contacts than our competitors.	0.82	0.57
Many people we/I talk with about common problems compared with others	0.89	0.46
Innovation (Alpha=0.85, CR=0.95)		
Process innovation (composite – see table above)	0.79	0.62
Market innovation (composite – see table above)	0.82	0.58
Organisational innovation (composite – see table above)	0.68	0.74
Fit values		
* Satorra-Bentler χ^2 (SB χ^2) (df =32 p <0.01)	79.0	
Comparative Fit Index (CFI)*	0.97	
Incremental Fit Index (IFI)*	0.97	
Bentler-Bonett Non-normed Fit Index (NNFI) *	0.96	
SB χ^2/df	2.5	
Standardised Root Mean Residual (SRMR)	0.044	
Root Mean Square Error of Approximation (RMSEA)*	0.048 [0.034, 0.061]	
Bollen's Rho	0.87	

** Robust values*
Alpha = Cronbach’s Alpha; CR=Composite Reliability

Table 4. Correlations and discriminant validity among factors

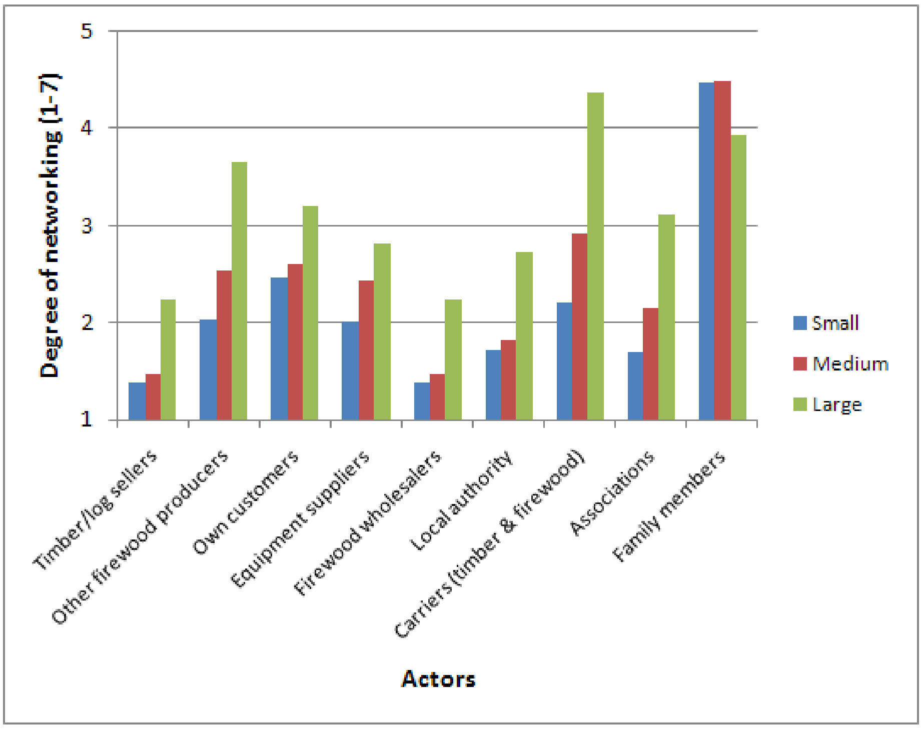
		Correlation		DV	
	Mean*	NW	IN	NW	IN
1. Networking (NW)	2.46	1			
2. Innovation (IN)	3.38	0.45	1	✓	
3. Firm performance (FP)	3.82	0.30	0.35	✓	✓

V: Bollen’s discriminant validity test passed. * Mean of items.

Results

Descriptive information

The single most important actors with whom the firewood producers cooperate, regardless of whether they are small or large businesses, are family members (see Figure 2). Fewer producers cooperate with timber sellers, wholesalers and local authorities. Furthermore, larger firewood production businesses tend to cooperate with others more than smaller businesses, especially with carriers and other firewood producers.



*Size categories: Small (1783 $ to 8912 $ in total sales), Medium (8913 $ to 26738 $ in total sales) and Large (more than 26738$ in total sales (USD is converted from Norwegian kroner using the average exchange rate USD/NOK 5.61 for the year 2011)

Figure 2. Degree of networking by actor and size*

Structural equation model

The refined structural model fit the data well with CFI*=0.929, RMSEA*=0.067 [0.057-0.078], SRMR=0.078, and 85% of the residuals distributed in the [-0.1 to 0.1] range. All of the loadings were highly significant. Network size had a positive direct effect on firm performance (H1: $p<0.05$). Additionally, network size had an indirect effect on innovation (H2: $p<0.01$), which size' observed variance in firm performance and 19% of the variance in innovation. Of the control variables, 'size' had a significant and positive effect on innovation ($p<0.05$), as did performance to a lesser degree ($p<0.1$). Firm age was not significant for either factor.

Furthermore, we hypothesised that innovation would have a mediating effect on the relationship between network size and firm performance (H4). To test this hypothesis, we used the bootstrapping procedure outlined by Shrout and Bolger [55]. We simulated 1,000 sub-samples and calculated the empirical parameters. The indirect effect was found to be significant because of the non-inclusion of zero in the confidence interval (H4: $p<0.05$). The fact that the direct structural path between network size and firm performance remained significant indicates that innovation partly mediated the networking–performance relationship. The total effect of network size on firm performance was 0.25 (0.15 direct + 0.10 indirect), which implies an almost equivalent effect within the innovation-performance relationship (0.26) (Table 5).

Table 5. Structural effects

Path	Beta	Effects
H1: Network size -> firm performance (total effect =0.25)	0.15**	Direct
H2: Network size -> innovation	0.39***	Direct
H3: Innovation -> firm performance	0.26***	Direct
H4: Network size -> firm performance	0.10**	Indirect
SB $\chi2$= 183.3, df =49 p <0.0, CFI*= 0.93, IFI*=0.93, NNFI*=0.91, SB $\chi2$/df=3.7, SRMR=0.078, RMSEA*= 0.067 [0.057-0.078], *=robust values		

** Significant at 5%, *** significant at 1%

To test for moderating effects, we employed a multi-group approach, as recommended by Byrne [56]. The invariance of the structural coefficients was tested using the results of the Lagrange multiplier test and $\chi2$ univariate increments from constrained and released parameters (Table 6).

Table 6. Moderating effects (p-values and betas for each level of the moderator)

H	Moderator	Path	P-value	High	Low
H5:	Tie strength – Family	Network size -> innovation	0.01***	0.37	0. 40
H6:	Tie strength – Acquaintance	Network size -> innovation	0.45	N.S.	
H7:	Variation in network – Entrepreneurship	Network size -> innovation	0.43	N.S.	
H8:	Variation in network – Entrepreneurship	Innovation -> firm performance	0.10*	0.28	0.23
H9:	Variation in network – Occupation	Network size -> innovation	0.08*	0.37	0.34
H10:	Variation in network – Occupation	Network size -> performance	0.98	N.S.	
H11	Size	Network size -> innovation	0.40	N.S.	
H12:	Age	Network size -> innovation	0.04**	0.38	0.41

* = Significant at 10 %, ** significant at 5%, *** significant at 1%, N.S.= not significant, H=Hypothesis

In support of H5, we found that network size has a stronger effect on innovation when the share of networking among family members is low (H5: $p < 0.01$). However, network size did not have a stronger effect on innovation, regardless of the network's proportion comprised of acquaintances (H6: $p>.10$). In support of H8, we found that innovation has a stronger effect on firm performance when there is a high level of variation in entrepreneurship experience in the network (H8: $p < 0.10$). However, network size did not have a stronger effect on innovation when there was more variation in entrepreneurial experience (H7: $p>.10$).

In support of H9, we found that network size has a stronger effect on innovation when occupations vary greatly in the network (H9: $p < 0.1$). However, we did not find any moderating effect of variation in occupation on the relationship between network size and firm performance (H10: $p>.10$). Likewise, firm size did not moderate the networking–innovation relationship (H11: $p>.10$). In support of H12, we found that networking has a stronger effect on innovation when firewood producers are younger.

Discussion and implications

Clearly, firewood producers do not have large social networks. However, the type of the social network depends on the size of the firm. For instance, small companies interact predominantly with family members, and larger companies interact more with carriers and other companies.

This study investigates the relationship between network size and firm performance. Furthermore, it investigates the mediating effect of innovation among firewood producers. The findings show that network size has a positive effect on firm performance (H1: $p>.05$), which is consistent with the earlier literature [12]. Firewood producers with larger social networks will likely have better opportunities to create financial surplus in their businesses. A social network can, for example, give firewood producers access to market information or other valuable resources. Furthermore, by cooperating with one another, firewood producers may also achieve economies of scale through a mutual distribution system.

Moreover, the results indicate that network size has a positive effect on innovation (H2: $p<0.01$) and that innovation has a positive effect on performance (H3: $p<0.01$). These findings are also supported by previous empirical studies in other industries [e.g. 25]. A larger social network can increase the innovation capacity of small firms and promote innovation [41, 43]. The findings also indicate that social networks are important for innovation among firewood producers. A larger network can enable knowledge sharing, cost sharing in common innovation projects and access to new markets. Despite the low-technology nature of the firewood industry, more innovative firewood producers experience better firm performance.

The study indicates that the proportion of the social network made up of family members has a moderating effect on the relationship between network size and innovation (H5: $p<0.01$). This finding suggests that firewood producers whose networks include a lower proportion of family members are more able to turn network benefits into innovations. These results are consistent with Granovetter [26] and the literature following his work. Strong ties tend to circulate old information, but weak ties introduce new ideas that can be vital to innovation. However, the share of acquaintances in the network did not have the same effect.

The results indicate that variation in entrepreneurial experience in the social network has a moderating effect on the relationship between network size and firm performance (H8: $p<0.1$). Firewood producers with more varied levels of entrepreneurial experience were more able to turn large network benefits into better firm performance. Input from social networks is important only to a certain extent. If a large portion of a social network has a similar background, then the network will contribute less novel information. However, the significance level was below 5%. Furthermore, variation in occupation did not significantly moderate the relationship between network size and performance (H10: $p>0.1$).

The results confirmed the moderating effect of variation in occupation on the relationship between network size and innovation (H9: $p<0.1$). In other words, greater variation in entrepreneurial experience within social networks seems to give firewood producers an advantage in converting network benefits into firm performance. However, variation in entrepreneurial experience did not have a significant moderating effect on the relationship between social networks and innovation (H7: $p>0.1$).

The results concerning network properties such as size and its effect on innovation and performance confirm earlier theories in a context of an agriculture-related and low-technology industry mainly based in the countryside. A theoretically intriguing finding concerns the relationship between network properties and characteristics of the entrepreneurs' contacts such as experience. Our findings indicate, for instance, a moderating effect of entrepreneurial experience and occupational background. A discussion of such a relationship is absent in most of the literature on networks and entrepreneurship.

The moderating effect of firm age on the relationship between network size and innovation was supported (H12: $p<0.05$). In other words, social networks have a larger impact on innovation among young firms. Young firewood production firms will likely be more dependent on large social networks for innovation because of their need for experience and knowledge. Furthermore, young firms may be more open and motivated to use social networks to increase their innovation capacity. However, firm size did not have a significant moderating effect on the relationship between social networks and innovation (H11: $p>0.1$). This finding is not consistent with findings published in the previous literature [see e.g. 44] and may be a function of the size of the firewood producers, all of which are either small or micro-sized firms. These firms may have the need to cooperate to access the resources necessary for innovation.

Although firewood is the most significant source of bioenergy, there has been little research on business or management in this industry. To reach the ambitious goal of reducing carbon dioxide emissions, we must pay more attention to this industry. Additionally, effective, professional, large-scale firewood production could assist the agricultural sector, forestry and life in rural areas. Despite limited support, this industry has grown in recent decades. To promote further growth, policy makers should understand how the industry operates and develops. Furthermore, within the industry itself, more knowledge about its success factors will help producers improve their business and seek competitive advantage, especially by utilizing alternative energy sources such as oil and hydroelectricity.

Firewood is mankind's oldest energy source. This study emphasises the importance of social networks and interaction among managers in the firewood industry. Firewood businesses are small and do not have extensive resources to invest in research and development, and they do not have much contact with research institutes or universities. Managers may benefit from investing time in networking with various actors to develop new ideas for innovation and better business practices. To ensure optimal network use, managers should foster diverse social circles. A closed network comprised mostly of family members may simply circulate old information. Joining formal networks for the industry such as the forum Norwegian Firewood producers may increase networking.

The next generation of woodstoves will reduce pollution and significantly increase efficiency [57]. Furthermore, new and innovative ways of measuring, marketing and selling firewood may also reduce costs, and there is no indication that on-going efforts to develop innovations will decrease in the future. Clearly, discussions regarding renewable energy strategies should take firewood businesses into account. Currently, this industry is seen as having constant production and thus is not viewed as a worthwhile consideration. Further research should explore other antecedents to innovation and firm performance beyond social networks.

This cross-sectional study did not include longitudinal data, which prevents us from drawing conclusions about causality. However, the study is based on social network theory, which strongly indicates causality. Furthermore, this study was conducted in Norway. In other parts of the world, especially in less developed countries, firewood production is associated with the cutting and burning of native forests and deforestation and has caused local environmental disasters. Thus, generalising these findings to other countries or situations could lead to faulty inferences.

References

1. IEA. World Energy Outlook 2011. Paris: International Energy Agency, 2011.
2. Lindroos O. Residential use of firewood in Northern Sweden and its influence on forest biomass resources. Biomass Bioenerg 2011;35(1):385-90.
3. Kärhä K, Jouhiaho A. Producing chopped firewood with firewood processors. Biomass Bioenerg 2009;33(9):1300-9.
4. Statistic Norway SSB. [We burn 300 kg of firewood each]. Vi brente over 300kg ved hver. [Internet] 2011. [Cited 2012 Feb 2]. Available at: http://www.ssb.no/vis/magasinet/miljo/art-2011-06-17-01.html

5. Mytting L. Hel ved - Alt om hogging, stabling og tørking - og vedfyringens sjel [Firewood - Everything about harvesting, stacking and drying and the soul of firewood-burning]. Oslo: Kagge; 2011.
6. Norsk Ved. [Market survey 2011]. Markedsundersøkelsen 2012. Norsk Ved. 2012:12-7.
7. Trømborg E, Bolkesjø TF, Solberg B. Biomass market and trade in Norway: Status and future prospects. Biomass Bioenerg 2008;32(8):660-71.
8. Rametsteiner E, Weiss G, Kubeczko K. Innovation and entrepreneurship in forestry in central Europe. European Forest Institute 19. Joensuu, Finland; 2005
9. Coleman JS. Social capital in the creation of human capital. A J Sociol 1988;94:95-120.
10. Coleman JS. Foundations of social theory. Cambridge: Belknap Press; 1990.
11. Michell JC. The concept and use of social networks. In Michell JC, editors. Social Networks in Urban Situations. Manchester: Manchester University Press. 1969, p. 1-50.
12. Jenssen JI. Social networks, resources, and entrepreneurship. Int J Entrepreneurship Innovation. 2001;2:103-9.
13. Bodin Ãr, Crona BI. The role of social networks in natural resource governance: What relational patterns make a difference? Global Environ Change. 2009;19(3):366-74.
14. Nybakk E, Crespell P, Hansen E, Lunnan A. Antecedents to forest owner innovativeness: An investigation of the non-timber forest products and services sector. For Ecol Manage 2009;257:608-18.
15. Levinthal DA, Cohen WM. Absorptive capacity: A new perspective on learning and innovation. Admin Sci Quart 1990;35:128-52.
16. Stuart TE. Interorganizational alliances and the performance of firms: A study of growth and innovation rates in a high-technology industry. Strateg Manage J 2000;21:791-811.
17. Garcia R, Calantone R. A Critical Look at Technological Innovation Typology and Innovativeness Terminology: A Literature Review. J Prod Innovat Manage 2002;19:110-32.
18. Thompson VA. Bureaucracy and Innovation. Admin Sci Quart 1965;10(1):1-20.
19. Rogers EM. Diffusion of Innovations. 5th ed. New York: Free Press; 2003.
20. Lumpkin GT, Dess GG. Clarifying the entrepreneurial orientation construct and linking it to performance. Acad Manage Rev 1996;26(1):135-72.
21. Nybakk E. Innovation and Entrepreneurship in small firms: The influence of entrepreneurial attitudes, external relationships and learning orientation [PhD thesis]. Ås: Norwegian University of Life Sciences; 2009.
22. Jenssen JI, Nybakk E. Inter-organizational innovation promoters in small, knowledge-intensive firms. Int J Innovation Management. 2009;13(3):441-66.
23. Shan W, Walker G, Kogut B. Interfirm cooperation and startup innovation in biotechnology industry. Strateg Manage J 1994;15:387-94.
24. Ahuja G. Collaboration networks, structural holes and innovation. A longitudinal study. Admin Sci Quart 2000;45:425-55.
25. Nybakk E, Vennesland B, Hansen E, Lunnan A. Networking, innovation, and performance in Norwegian nature-based tourism. J Forest Products Business Res 2008;5:1-26.
26. Granovetter M. The strength of weak ties. Am J Sociol 1973;78(6):1360-80.
27. Arora A, Gambardella A. Complementary and external linkages: The strategies of large firms in biotechnology. J Ind Econ 1990;38:361-79.
28. Teece DJ. Profiting from technological innovation: implications for integration, collaboration, licencing, and public policy. Res Policy 1986;15(6):285-305.
29. Hurley RF, Hult GT. Innovation, market orientation and organizational learning: an integration and empirical examination. J Marketing 1998;62(3):42-54.
30. Damanpour F, Szabat KA, Evan WM. The relationship between types of innovation and organizational performace. J Manage Stud 1989;26(6):587-601.
31. García-Morales VJ, Lloréns-Montes FJ, Verdú-Jover AJ. Influence of personal mastery on organizational performance through organizational learning and innovation in large firms and SMEs. Technovation 2007;27(9):547-68.

32. Nybakk E, Niskanen A, Bajric F, Duduman G, Feliciano D, Jablonski K, et al. Innovation in the wood bio-energy sector in Europe. In: Weiss G, Pettenella D, Ollonqvist P, Slee B, editors. Innovation in forestry: territorial and value chain relationships. Wallingford: CABI; 2011, p. 254-75.
33. Krackhardt D. The strength of strong ties: The importance of philos in organizations. In: Nohria N, Eccles RG, editors. Networks and Organizations Structure, Form and Action. Boston, MA: Harvard Business School Press; 1992, p. 216-239.
34. Burt R. Structural Holes. The Social Structure of Competition. Cambridge, MA: Harvard University Press; 1992.
35. Burt R. The contingent value of social capital. Admin Sci Quart 1997;42:339-65.
36. Hargadon A, Sutton RI. Technology brokering and innovation in product development firm. Admin Sci Quart 1997;42:716-49.
37. Walker G, Kogut B, Shan W. Social capital, structural holes and the formation of an industry network. Organ Sci 1997;8:109-25.
38. Gulati R, Garguilo M. Where do networks come from? Am J Sociol 1999;104:1439-93.
39. Uzzi B. Social structure and cometition in interfirm networks: The paradox of embeddedness. Admin Sci Quart 1997;42:35-7.
40. Knudsen H. Reisen For Teorias Skyld. Kristiansand, Norway: Høyskoleforlaget; 1998.
41. BarNir A, Smith KA. Interfirm alliances in the small business: The role of social networks. J Small Bus Manage 2002;40(3):219-32.
42. Mazzarol T, Reboud S. The role of complementary actors in the development of innovation in small firms. Int J Innovation Management 2008;12(2):223-53.
43. Street CT, Cameron A-F. External relationships and the small business: A review of small business alliance and network research. J Small Bus Manage 2007;45(2):239-66.
44. McDade SR, Oliva TA, Pirsch JA. The organizational adoption of high-technology products "for use". Effects of size, preferences, and radicalness of impact. Ind Market Manage 2002;31:441-56.
45. Yap CS. Distinguishing characteristics of organisations using computers. Inform Manage 1990;18(1):971-1007.
46. Pavitt K, Robson M, Townsend J. The Size Distribution of Innovating Firms in the UK: 1945-1983. J Ind Econ 1987;35(3):297-316.
47. Churchill Jr. GA. A Paradigm for Developing Better measures of Marketing Constructs. J Market Res 1979 03/26/04;16(February):64-73.
48. Avlonitis GJ, A. Kouremenos, and N. Tzokas. Assessing the Innovativeness of Organizations and its Antecedents: Project Innovstrat. Eur J Marketing 1994;28(11):5-28.
49. Deshpandé R, Farley JU, Webster JFE. Corporate culture, customer orientation, and innovativeness in Japanese firms: a quadrad analysis. J Marketing. 1993;57:23-7.
50. Wang CL, Ahmed PK. The development and validation of the organisational innovativeness construct using confirmatory factor analysis. Eur J Innovation Manage 2004;7(4):303-13.
51. Antia KD, Frazier GL. The Severity of Contract Enforcement in Interfirm Channel Relationships. J Marketing 2001;65(4):67-81.
52. Dillman DA. Mail and Internet Surveys: The Tailored Design Method. 2nd ed. New York: John Wiley & Sons; 2000.
53. Armstrong JS, Overton TS. Estimating nonresponse bias in mail surveys. J Marketing Res 1977;14:396-402.
54. Bentler PM. EQS 6: Structural Equations Program Manual. Encino, CA: Multivariate Software Inc.; 2006.
55. Shrout PE, Bolger N. Mediation in experimental and nonexperimental studies: new procedures and recommendations. Psychol Methods 2002;7(4):422-45.
56. Byrne BM. Structural Equation Modeling with EQS. 2 ed. Manwah, NJ: Lawrence Erlbaum Associates; 2006.

57. Karlsvik E, Skreiberg Ø. Achieving low emissions and stable heat release from wood stoves and fireplaces firing at low load. In: Proceedings of Nordic Bioenergy 2011; 2011 Sep