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Measuring social capital and innovation in poor agricultural communities. The case of Cháparra - Peru

By Dominik Hartmann[1] and Atilio Arata[2]

Abstract:

In the last decades substantive advance has been made in the measurement and understanding of frontier innovation in highly industrialized settings. However, little research focused on the process of learning and the introduction of novelties in smallholder farming of poor agricultural communities. Considering that 1.5 billion people in developing countries live in such smallholder households this is an essential shortcoming. In addressing three crucial questions about the measurement and promotion of endogenous local development this paper contributes to close this research gap. The three questions are: a) how can we measure social capital and innovation in poor agricultural communities, b) what is the impact of external agents on local structures and c) what are the relations between the social capital and the innovative performance of the farmer. In a first step a comprehensive questionnaire with 89 questions on diverse dimensions of social capital and innovation has been elaborated and applied to the agricultural valley of Cháparra in the South of Peru. The results allow for an in-depth analysis of the capabilities, network position and innovative behavior of the farmers. In a second step, we apply social network analysis techniques to analyze the role and position of the relevant actors in the local as well as in the external technical information networks with a special focus on the influence of an external NGO. The analysis reveals a deep structural impact of the NGO and significant correlations between the network position of the farmers and their innovative performance. Three crucial issues for research on smallholder innovation are identified. First, diverse dimensions of social capital and innovation have to be differentiated when studying endogenous development. Second, it has to be assessed to which degree the modification of the existing social structures by external agents can be harmful or beneficial. Third, social network analysis can help us to gain a better understanding of the complex relations between social capital and innovation and how these can contribute to foster sustainable development projects.

Key words: social capital, innovation, smallholders, Cháparra, Peru, network analysis

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1 Introduction:

Despite of the fast expanding interest in clusters and regional innovation systems in developing countries (e.g. Rabellotti and Schmitz, 1999; Mytelka, 2000; Cassiolato et al., 2003, Schmitz, 2004; Giuliani et al, 2005; Arora, 2009), slow progress has been made in measuring quantitatively the disposition and capacity of actors like smallholder farmers, to introduce novelties into their local agricultural production systems. Some substantive advances have been made in taxonomies to measure industrial innovation in developed and developing countries (OECD, 1997, 2005; Jaramillo et al., 2001). Furthermore, there is a increasing number of studies investigating the role that agro-businesses and agricultural systems of innovation play in development of economies (Hall et al., 2006; World Bank, 2006). However, this cannot be said about low technology innovation in smallholder agriculture. This constitutes an important research gap, considering that 1.5 billion people, approximately one out of four people in the world, are living in smallholder households in developing countries (World Bank, 2008). Furthermore, considerable innovative activity and high levels of creativity can be found in local agricultural communities all over the world (e.g. Mytelka, 2000; Srinivas and Sutz, 2008). Driven by scarcity, the access to microcredit as well as the external intervention (e.g. by development projects), many novelties are introduced into local agricultural systems, leading to new products, processes, inputs and new forms of organizing the productive activities. Thereby, social network structures are decisive for the individual´s capacity to engage in entrepreneurial activity and innovation (Aldrich and Zimmer, 1986; Hoang and Antoncic, 2003; Grebel et al, 2003). Despite the common perspective on entrepreneurs as individual heroes, they are embedded into social network structures which influence their desire and capabilities to introduce novelties into the local production system (Liñán and Santos, 2006). Entrepreneurs need to form and draw upon social networks in order to have access to critical factors such as information and finance (Aldrich, 1987; Casson and Della Giusta, 2007, Dahl and Sorenson, 2009). This is true for developed settings, but even more so for underdeveloped regions, where people are still largely relying on each other in their personal achievements. Due to institutional weaknesses and instability, in underdeveloped settings strong ties (Coleman, 1988, 1990) such as kinship and close friendship networks become essential features for the success of the individuals and any venture they undertake. Furthermore, the social networks deeply affect the type and direction of individual learning activities and the capacity to engage in entrepreneurial action and introduce novelties into the local innovation system (Rogers, 1995, Mytelka, 2000; Giuliani et al. 2005; Giuliani and Bell, 2005). The methodology of social network analysis allow us to analyze the position, role and embeddedness of individuals in social structures and is, thus, a suited technique to investigate the questions at hand (Wasserman and Faust, 1994; Borgatti et al., 2002; De Nooy et al., 2005).

In this study, we apply social network analysis to scrutinize different dimensions of social capital and innovative behavior of wine producers in the local production and innovation system of Cháparra, a small agricultural valley in the South of Peru. Specifically, we address three research questions:

R1: How can we measure and visualize social capital and innovation in poor agricultural communities; and what specific dimensions do we have to consider for the case of Cháparra? (chapter three)

R2: What is the impact of external agents (e.g. NGOs) on the local information flows and social structure? (chapter four)

R3: Is centrality in local information networks correlated with the innovativeness of the smallholders? (chapter five)

Cháparra is a useful comparator case, because it shares some typical features of many poor agricultural communities around the world, such as: a) the dominance of smallholder farmers, b) the scarcity of water, c) small-scale production of basic commodities (here grapes, pears, avocados) and ethylic products (here: wine and liquors), d) incidences of civil war and guerilla movements in the social structure and the levels of mutual trust and e) the presence of external agents with decisive influences on the local system. However, there are also limitations to be considered, most importantly the peculiarity of any local community and production system and their embeddedness in national and international structures.[3]

The paper proceeds as follows. Chapter two briefly resumes the main insights of the network-based literature on social capital, entrepreneurship and innovation. Chapter three presents a comprehensive questionnaire on social capital and innovation in Cháparra. Chapter four scrutinizes the role and impact of a NGO on the local information flow. Chapter five analyzes the relations between different measures of social capital and the innovative performance of the smallholders. Chapter six concludes and derives research and policy suggestions.

2 A network perspective on innovation and endogenous development

Social capital theory is about the understanding that social relations contain an economic value (Lin, 1999, 2003; Burt, 1992; Putnam, 1993, 2003; Woolcock and Narayan, 2000). Economic agents are embedded in a variety of social networks (Granovetter, 1973, 1985) from and through which they learn, and have access to a set of different resources and opportunities (De Herdt and Deneulin, 2007). Modern innovation research identifies innovation as a collective and cumulative process (Freeman, 1987; Lundvall, 1988; Pyka, 1999; Pyka and Scharnhorst, 2009). The network of contacts an individual has, determine the information an agent can access, use, diffuse and recombine. Therefore, networks are crucial for learning, entrepreneurship and innovation (Grebel et al., 2003). Schumpeter (1912) identified innovation as new combinations leading to new products, process, markets, organization and inputs. This new combinations typically do not fall like “Manna from

[3] In the case of Cháparra - as in most other Peruvian valley and villages- highly unidirectional national information and resource flows are common. Resources and human capital flows from the villages to the next bigger city and from there to the capital city and finally to the exterior. In contrast, the other direction of information and resource flow is rather of limited scale and scope.

heaven", but built upon previous experiences and knowledge (List, 1841; Nelson and Winter, 1982). Hence, technological and economic development follows evolutionary paths within complex systems (Nelson and Winter, 1982; David, 1985; Dosi et al., 1988; Arthur, 1994). In this process the interaction (e.g. trade, competition, cooperation) between heterogeneous agents on the micro levels lead to the structural dynamics on the meso level and to the aggregated outcomes on the macro level (e.g. Pyka and Fagiolo, 2007).

2.1 The role of networks for innovation and local development:

An increasing set of literature on networks, clusters and (local, sectoral and national) innovation systems highlights the role of interactive learning between a multitude of actors from the business, public, academic, finance and civil sector (Becattini, 1979; Freeman, 1987; Lundvall, 1988, 1992; Cooke and Memedovic, 2003; Cassiolato et al, 2003). The underlying argument is that interaction and mutual learning allows the actors to discover new combinations of existing knowledge, find entirely new solutions to known problems as well as to identify new areas and markets for technological advance (Schumpeter, 1912). This puts the role of social networks into the focus of economic research. It paves the way out of the mechanic understanding of the economy as being made up of representative rationale agents defining equilibrium prices through market interaction, towards a more realistic picture of the economy as a complex system populated by heterogeneous and bounded rational agents embedded in a variety of social networks. By this it acknowledges the fact that social interaction enables the individual to learn, reflect its action and satisfy its desires. In the words of Peter Blau (1964): "It is in the social relations men establish that their interests find expression and their desires become realized." For example, entrepreneurs, may they be economic, political or social entrepreneurs, draw upon social networks and social capital (Hoang and Antoncic, 2003; Bornstein, 2004). The success of a venture decisively depends upon the capacity of the entrepreneur(s) to built and make use of personal network relations (Casson and Della Giusta, 2007). Thereby the entrepreneurs require different types of networks at the different stages of their ventures business cycle to gather information on market opportunities, to access finance, to establish distribution networks etc. (Casson and Della Giusta, 2007; Hoang and Antoncic, 2003; Gruber, 2007). The innovation system and networks literature stresses that producers interact with users, suppliers and competitors to access information, solve problems and advance their products and services (Lundvall, 1988, 1992). Within an increasingly complex world, no single individual or firm is able to oversee all types of technological advances, existing problems and solution, but has to draw upon networks of specialized partners (Pyka, 2002).

Recently, studies on innovation systems and clusters make increasingly use of social network analysis techniques to investigate the structural features of development, learning patterns and the role of individuals within local and global innovation networks (e.g. Cantner and Graf, 2006; Giuliani and Bell, 2005; Pyka and Scharnhorst, 2009). Inter alia, network analysis

allows for a better distinction and analysis of the importance of local and international network relations and the feedbacks between them (e.g. Giuliani and Bell, 2005). A central point in these concepts is that knowledge is not evenly distributed and freely available within clusters and regional innovation systems, but highly dependent on individuals and their specific skills (human capital) and social relations (Breschi and Lissoni, 2001; Grebel et al. 2003; Giuliani and Bell, 2005). Many, if not most, learning and innovation networks are constituted or underpinned by informal relations and social capital (Von Hippel, 1987; Pyka, 1999).

2.2 Network structures in less advanced regions

The development literature puts the focus on the importance of endogenous capability upgrading, external embeddedness as well as proper absorption of external information and capabilities. (e.g. Vazquez-Barquero, 2002; Juma, 2001; Rabellotti and Schmitz, 1999). Technology transfer can be a useful factor for economic development, but it is not enough and can even lead to structural dependence and underdevelopment if no proper endogenous capability upgrading takes place (Myrdal, 1957; Patel, 1974). Therefore the promotion of local absorptive capacity and the creation of so-called non-knowledge are crucial for endogenous capability upgrading, innovation and technological development (Arocena and Sutz, 2005; Evers et al., 2006). Often it is precisely the knowing about our lack of knowledge and the knowing of the critical problems that allows us to advance. If technological products are just considered a "black box" - e.g. donated computers for poor communities, a hydraulic water pump installed by external agents etc. - without the local population having any knowledge about the processes, usage and possible problems of the product, any type of difficulty will cause further demand for external help or the obsolescence of the imported artifacts. However, when the people have knowledge about the constitution and the functioning of the product and processes they may even be able to adapt them to the local needs and innovate themselves (Arocena and Sutz, 2005).

Studies on agricultural innovation in less advanced regions have focused mostly on qualitative aspects of specific cases and technologies or on the institutional aspects at the national / sectoral level (Omamo and Lynam, 2003; Hall et al. 2006; World Bank, 2006, 2008). Most case studies on endogenous development, local cluster, social capital and innovation systems in less advanced countries highlighted agglomeration effects and the local top-down institutional setups (e.g. Cassiolato et al, 2003). Only recently have local structural features and the embeddedness of heterogeneous agents within networks of techno-economic relations received increasing attention (Giuliani and Bell, 2005; Arora, 2009). Similar in content but different in the scope and scale is the finding that within clusters there is typically no "free floating knowledge in the air" for everybody (e.g. Breschi and Lissoni, 2001), but the agents have significantly diverse and unequally distributed access to knowledge and absorptive capacities (Giuliani and Bell, 2005). Especially in developing countries there is often a large

gap between the technological capabilities and network contacts of medium and large enterprises on the one hand and small entrepreneurs or smallholder farmers on the other. Due to the very limited resources and absorptive capacities of the agents in underdeveloped settings the linkages and information exchange between advanced and less advanced agents is rather scarce. Hence, one key issue in any attempt to foster development in such setting is the promotion of education and infrastructure for the agents with less network contacts and lower absorptive capacities. But we also need a better understanding of the innovative behaviour of small entrepreneurs and how novelties are introduced in advanced regions In order to do this we need to advance and broaden our measurement methodology.

2.3 The need of quantitative and network techniques

So far the focus of measurement and analysis has been put on industrial innovation in advanced countries (OECD, 1997, 2005; Jaramillo, 2001). Only recently, efforts are made to better understand innovation in low-technology (von Tunzelmann and Acha, 2005) and agricultural innovation systems on the national or sectoral level (Temel, 2004; Hall et al., 2006; Arumapperuma, 2006; World Bank, 2006, 2008). However, we still do not know enough about the measurement, analysis and promotion of learning, entrepreneurship and innovation in poor agricultural communities. Fact is that all around the globe, people in local agricultural communities innovate and introduce novelties in their respective local system. Typical examples are access to information about crop prizes via mobile phone in rural areas, new solutions to water and energy scarcity (e.g. irrigation systems), new products for the local region etc. Existing studies are mostly restricted to the qualitative analysis of successful cases. However, in order to create proper institutional incentives and design more efficient and effective development projects we also need to be able to compare and measure entrepreneurship and innovation in local agricultural communities,. Quantitative measurement in combination with network analysis can help us to get new insights into the complex interrelations between different dimensions of social capital, learning and innovation on the local level as well as about their external embeddedness. Naturally, quantitative measurement alone is not sufficient and will never be able to cope with the complexity of the real world. However, in combination with network analysis it can help us to design some best-practices for the agents engaged in the promotion of development (e.g. local and national governments, NGOs and the civil society) and discover structural phenomena that otherwise could be overlooked. The general purpose thereby is to provide the involved agents with the knowledge and tools to discover hidden structural problems and promote more efficient and sustainable development policies.

3 Measuring social capital and innovation in Chaparra

We developed an in-depth questionnaire to measure and visualize various facets of social capital and network structure and the innovative behavior of the wine farmer community in the southern Peruvian valley of Cháparra. For any case study, close cooperation with the local population and experts during the questionnaire elaboration phase is crucial to prevent measurement errors, conceptual misunderstanding and data bias. The meaning of terms, especially regarding the evaluation of social contacts, can vary significantly across cultures. Therefore, during the whole process of the data gathering (pre-test phase, adaptation, final application and analysis) a close cooperation with local farmers and experts was ensured.[4] The result has been a comprehensive set of 89 indicators on the innovative performance, human capital, access to finance, social capital and other socioeconomic indicators of the local wine farmers. Thanks to the relative ease in defining the spatial and social boundaries, a total sampling method could be applied considering the 49 smallholders wineries. Farmers who just produce some wine for self consumption have not been considered in the sample; notably, these smallholders also have not been indicated by any other farmer to be an important source of technical information. The final questionnaires has been distributed and collected during February 2009. The questions on social capital made up the network relations, but in order to draw a comprehensive picture on the social structure and patterns of cooperation within the village, we also employed several indicators for other important dimensions such as collective action and mutual assistance have been considered.

3.1 The valley of Chaparra

The Chaparra river valley lies in the dry landscape of Southern Peru and descends from over 3500 meter in the high Andes towards the Pacific Ocean. Most people there live from agriculture, trading and informal mining activities (Arata and Toro, 2005; Arata, 2007, 2008; MINAG, 2007). Grape and wine production has always been of importance for the local economy. As mentioned by Raimondi (1929) in his travel notes from 1863, there has been a prosperous wine "industry" in Cháparra and Caravelí, which "commercialized" its wines and piscos in the villages of the neighbouring provinces Paucar del Sara Sara, Parinacochas and Lucanas. According to Arata and Toro (2005), the prosperity of the local wine industry continued until mid of the 20th century, but due to diverse reasons declined in the following decades in size, importance and technological level. Main reasons for this decline have been: (i) the boom of cattle-breeding in the decade of the 1950s, which led to the substitutions of cultivated areas towards alfalfa, (ii) excessive taxation and the state control of liqueur

[4] Noteworthy, one of the authors has long-time experience in development projects in the region and other areas of Peru, the other author spent during a research stay several months in the region. Multiple discussions and interviews with the local population and experts from the policy, educational, civil space within the village and in neighbouring villages have been led.

production through the *estanco de alcohol* (i.e. a state monopoly on alcohol production, giving rights to farmers to produce and sell in change of high contributions) and (iii) subversive tendencies (civil war, guerrilla group Sendero Luminoso], which cut the already deteriorated commercial articulation with the south of Ayacucho. Today, the total area of grape and wine production is rather small but providing the living for many people of Chaparra. Many people who left the valley in the civil war, are now coming back so thatthe population and with it the agricultural production are increasing again (INEI, 1993, 2005; Arata and Toro, 2005; Arata and Vargas, 2008). Since some years NGOs and governmental institutions (such as SENASA, the Peruvian national state agency for agricultural health) foster the technological upgrading and control of crop plagues and prevention of diseases (Arata and Toro, 2005). Regarding the general level of socioeconomic development, Cháparra shows with 0.6 on a 0 to 1 scale a medium human development. People can expect to become 68 years old, learn how to read and write and earn approximately 130 Euro a month (UNDP-Peru, 2006).

3.2 Local innovation in Cháparra:

The innovative activities in Cháparra are rather local (Mytelka, 2000) and certainly not close to the global technological frontier, but they implicate important learning by doing and self-discovery processes within the technological frontier (Klinger and Lederman, 2006 Rodrik and Hausmann, 2003). Cháparra will probably not develop completely new techniques for the global markets in the near future, but the people introduce, - sometimes autonomous and sometimes with the help of external agents - a variety of new products, processes and organizations which fit the local context. The farmers, for example explore new crop varieties, fertilizers and irrigation systems, design brand names, explore new distribution possibilities etc. This might not be new to the world, but it is certainly new to the local market and innovation system (Mytelka, 2000). Although knowledge is often introduced from external agents (such as a NGO or national development agencies), the related learning processes often takes place in trial- and error procedures (with new crops, production techniques etc.) in cooperation between local actors and external agents. There is no systemic analysis and adaptation of existing knowledge. Considering the innovative activity within this and other valleys in less developed or emergent settings as mere knowledge transfer and catching-up would ignore or underestimate the necessity to build endogenous capabilities in producing novelties and adapt existing knowledge to the local environment (Arocena and Sutz, 2005).

3.3 Multidimensional measurement of social capital and innovation

The general purpose was to create a questionnaire which provides an in-depth- picture matching the specific conditions of the local conditions and, at the same time, allows for easy

adaptation and comparison to other cases. Therefore, diverse aspects of social capital and innovation in wine-farming communities in South Peru have been considered. Table 1 gives an overview on the main pillars of the questionnaire.[5]

Dimensions of social capital and innovation

Social Capital:	**Innovation:**
• Social networks	• Product and Process, • Organisation, • Marketing
• Collective action	
• Group assistance	• Flexibility and prevention of unexpected situations
• Access to ICT	
• Access to finance	• Desire to innovate
• Commercial contacts	• Motives for innovation

Table 1: Building blocks of the questionnaire

The measurement of social capital is essentially based on the questions and indicators proposed from researchers of the World Banks Social Capital Initiative (e.g. Grootaert et al. 2004). Therefore, questions on social networks, group assistance, collective action, access to ICT and finance have been considered. Emphasis has been put on questions which provide us with relational data on diverse types of overlapping social networks (e.g. kinship, friends, and information networks, strong and weak ties). Furthermore, we included more prominently commercial ties, as both the information flow and the negotiation power of the local farmers is essentially influenced by their ties to external traders who buy their products and sell them to external wholesalers. The first pre-test with farmers from Acaville a neighboring valley in the province of Caraveli provided interesting and useful insights for the final questionnaire. Several farmers did not understand properly several of the questions on social capital (e.g. on groups, associations and collective action) suggested by a standardized questionnaire applied by the World Bank to local communities all over the world (Grootaert et al., 2004). This shows once again that there can be essential differences in the significance and meaning of terms across countries, regions and cultures. Therefore close cooperation with experts and local farmers and the adaptation of the questionnaire to the local language and cocnitive structures is crucial.

[5] The detailed questionnaire is available from the authors upon request.

Regarding the dimension of innovation we draw upon Schumpeter's typology of innovation and the suggestions in the Oslo Manual (OECD, 1997, 2005) and the Bogota Manual (Jaramillo et al., 2001) concerning their measurement. To measure innovation we included several questions on product, process, organization and marketing innovation. Furthermore we also introduced questions on the desire and motives of the smallholders to innovate as well as questions on their capacity to deal with unexpected situations such as droughts, crop disease and prize fluctuations. Flexibility in unexpected situations and prevention of exogenous shocks is essential for the survival and competitiveness of any agricultural business (Arrumapperuma, 2006). This is especially true for smallholders in developing countries, with their smaller range of options and resources to cope with crises. The question on the desires and motives for innovation provides us with insights into psychological dimensions of entrepreneurial action and innovation, and gives us an idea of the type and reasons of the entrepreneurial action: wether the farmers innovate and engage in entrepreneurial action by necessity or by opportunity (e.g. Reynolds et al., 2006; Liñán and Santos, 2007 ; Gries and Naude, 2010); wether they act due to their own intrinsic motivation or are driven by external agents or even forced by internal and external pressure. Noteworthy, the farmers did not have that much difficulty to distinguish between different types of innovation (product, process, organization etc.) than we might expect. They intuitively understood what innovation is and had quite similar and converging ideas about what different types of innovation mean. Only in two cases they seemed to underestimate their own innovative performance and only in one case thought to be innovative in all respects. Therefore, the data of these three agents has been excluded; the aggregated innovation performance of the agents has been estimated by the Arata and Vargas (2008) comparator data on innovation and technological competences in the region.

For the initial identification of the farmers and the complementation of our data we draw upon census data (INEI, 1993, 2005) and recent survey data raised by Arata (2008) on socioeconomic and production indicators in the region. In sum, we got an in-depth data set with 89 indicators on diverse aspects of human capital, social capital and innovation in the region. The number of 49 direct respondents is rather small, but allowed us to perform a comprehensive in-depth data-based case study on the local social structures and the single farmers, their technological learning and innovative behavior.

4 Power over the knowledge flow, endogenous development and the role of external agents

Knowledge and the control over information flows provide people with power and the capabilities to learn and innovate. One type of information crucial for technological advance of the farmers in their business activity is the access to technical information and knowledge on production and distributions processes. Therefore, we scrutinize the technical information network of Cháparra. We start with data based upon one key indicator and expand the

informational base in the following chapter. To raise data on the technical information networks, we asked the smallholders with which persons they have spoken most actively about technical information and received valuable information from the conversations within the last five years. This provides us with relational data required for the application of social network analysis and graph-theoretical measures (Wasserman and Faust, 1994; Borgatti et al., 2002; Hanneman and Riddle, 2005; De Nooy et al., 2005; Borgatti et al., 2009). This allows visualizing and measuring both the network structure (e.g. cohesion) and position of the farmers (e.g. centrality of the farmers) in the local technical network. Thereby we asked deliberately for strong ties with frequent interaction because in the local social setting - which suffered just a decade ago severe incidence of guerilla groups and cruelties of civil war - strong levels of trust are necessary for fine-grained information exchange between people (Coleman, 1988). Furthermore, the underlying question also indicates the social recognition, knowledge and power of the mentioned peers, whom the farmers consider an important, reliable and valuable source of technical knowledge and whom not.

4.1 Network position as indicator for the social capital of the individuals:

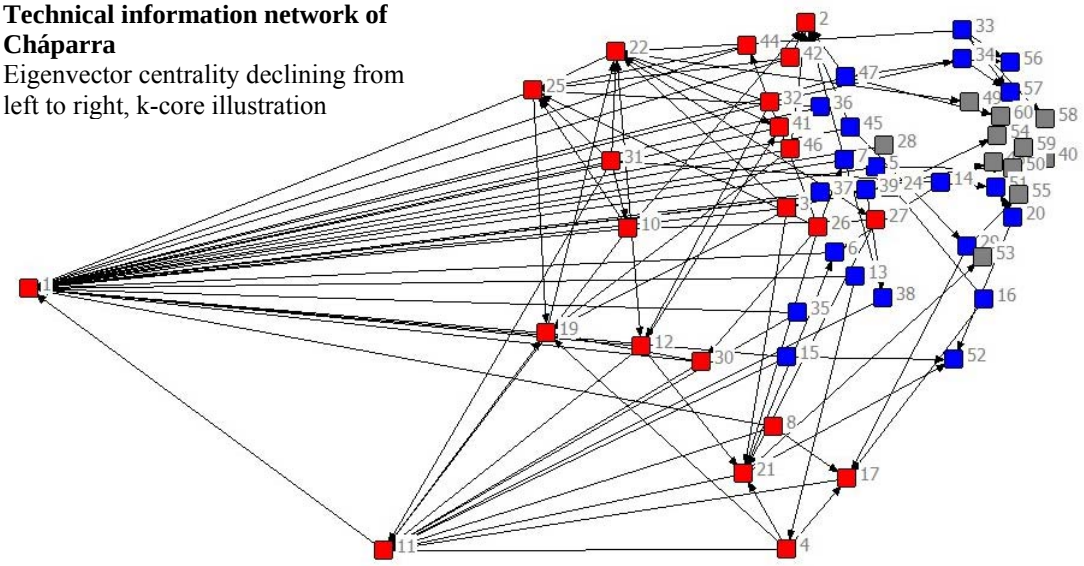
Lin (1999:36) points out that "network location is a key element of identifying the social capital of the individuals". A main technique to measure the power and social capital of the individuals in a network, therefore, is to calculate their centrality (Borgatti et al. 1998; Hanneman and Riddle, 2005). According to the concept of centrality, the actors who are most embedded in the network and or most strongly control the knowledge flow, have a central role in the network. In contrast to the so-called ego-network-measures (e.g. homophily and composition of ties), centrality measures require complete samples (Borgatti et al 1998). In the case of Chaparra a total sampling technique and hence the standard centrality measures could be applied. To analyse the role of the farmers and external agents in the local system we calculated the degree-, betweenness and eigenvector centrality of the interviewed and mentioned network partners. Furthermore to analyse how fast information can spread within the system and what impact single actors have on the technical information network, we calculated the average path length and the (degree, eigenvector and betweenness) centralisation of the system. Based upon the calculation of each actors centrality, the network centralization indicators measures to which extent the network is dependent from a single agent. The basic ideas and formulas of the network measures we applied, can be seen in the appendix one.

4.2 The technical information network of Chaparra

Striking fact of our analysis is the dominant role of an external NGO in the local technical information exchange network. Regarding all centrality (and key player measures), this external agent is the absolutely central actor in the network. It has by far the most ties and is connected to a diverse range of people. The following graph illustrates the local technical

information network. Thereby, nodes with just one inwards tie are in grey, nodes with two or three ties are blue, and nodes with four or more ties are red. Furthermore, the eigenvector centrality declines form the left to the right side of the graph. In other words, the red nodes on the left side are much more central and strongly connected with the well-connected than the rather peripheral grey nodes on the right side of the graph. The NGO (node 1) is by far the most central and powerful actor in the technical network.

Technical information network of Cháparra
Eigenvector centrality declining from left to right, k-core illustration



Furthermore, the NGO has a decisive impact on the local power distribution and plays an important role for the social cohesion of the system. If we calculate the network centralities first without and then with the NGO we can observe significant changes in the centrality ranking of the individuals and the cohesion of the system (tables 2 and 3). The NGO introduces centrality in the local system and shortens the average distance path length of the information flow (table 2). Hence, due to the presence of the NGO, technical information can flow and spread faster within the local community.

System centralisation and cohesion		
	With NGO	Without NGO
Degree Centralisation	44,18%	18,73%
Eigenvector Centralisation	70,04%	56,89%

Node Betweenness Centralisation	47,24%	28,11%
Average distance (among reachable pairs)	3,181	**3,507**

Table 2: System centralization and cohesion

But, importantly, the presence of the NGO also changes the ego`s centralities, inter alia the betweenness centrality of the farmers within the local community (table 3). Between centrality measure to which degree an actor is one the shortest path between two other agents.

Considering knowledge and the control over the information flow as power (Burt, 1992), this means that the NGO changes the local power distribution. Some farmers win and other comparatively lose in centrality and local power due to the presence of the NGO.

Agent‘s Betweenness Centralities			
With NGO		Without NGO	
Rank	ID	Rank	ID
1	**N1** (=NGO)	1	N11
2	N22	2	N22
3	N11	3	N17
4	N21	4	N21
5	**N47**	5	N19
6	N33	**6**	**N27**
7	**N5**	7	N25
8	N31	8	N32
9	N5	9	N31
10	**N46**	10	N33
...	...	..	...
14	N19	**19**	**N47**
18	N25	**20**	**N5**
19	N17	**29**	**N46**
20	**N27**		

Table 3: Between centralities

Of course, this finding is of rather hypothetical nature, because the NGO is actually in the place and we cannot predict how the system would precisely change without this agent. But the finding is still important and valid in the sense that:

a) many common analysis methods – e.g. based upon census data or closed network data - may have missed this crucial role of an external actor (who stays in the region on a temporal project base);
b) it is highly probable that the system structure and the roles of the individuals have changed during the presence of the NGO and will change again when the projects of the NGO in this regions finishes; and
c) it reflects a common situation in many agricultural communities around the world where external agents (NGOs, governmental development projects) engage in local development projects.

Naturally, these results need some further discussion, but a crucial point we want to highlight is that network analysis can help us revealing and analyzing the social structures and power relations within local communities.

4.3 Interpretation of the results

Within the development community there is an intensive discussion on the positive and negative effects of external intervention (e.g. with regards to the effects of international aid: Easterly, 2001, 2006 vs. Sachs, 2005). Many of the arguments also apply to regional development. The intervention of external agents into local production and innovation systems can have both negative and positive effects on the long-run development of the region. We briefly discuss the situation for cases like this, where an external agent, staying in the region on a temporal base, takes a dominant position in the local system.

On the one hand, the dominance of a NGO in a local system may threat the social stability and cause socioeconomic perturbations when the NGO leaves. The NGOs may destroy endogenously grown social structures and instead of fostering the technological upgrading rather cause technological and economic dependence from external agents and subventions (Patel, 1974; Easterly, 2001, 2006). Furthermore, the legitimization of alien intervention into local societies is highly discussable: from where do the external people take the right to know what is best for the community? Therefore, both from a radical free market and a radical anthropological perspective as little as possible external intervention is desirable. From an endogenous development perspective it is crucial to foster the endogenous capabilities without creating too strong external dependencies implying the threat so-called structural underdevelopment with parts of the society and sectors highly developed but dependent and oriented to the exterior and the other inwards directed part rather inefficient and poor (Furtado, 1961).

On the other hand, external intervention may overcome internal constraints for development (e.g. lack of knowledge, money and cooperation) and noteworthy: also be desired by the local population. External agents can introduce important new information and technical knowledge into the local system which helps the region and its actors to develop, by enabling

knowledge, agglomeration and cooperation effects (e.g. Hanusch and Pyka, 2007). Furthermore it may be exactly be the purpose of the NGO to change the social system in a positive way, create bridges and promote more cooperation between the actors. From this perspective, the central role of the NGO in local technical system could even be viewed as indicator for the success of the NGO and the willingness of the local agents to exploit the help and information offered by the external agent.

In our case the NGO has clearly become a central agent in the local community. Naturally, we cannot foresee how the social system will change when the NGO leaves. And yes there is the thread that at least some of the advances and ties introduced by the NGO will collapse in the absence of the NGO. But it is also crucial to state that the NGO has introduced important technical knowledge into the local system, created important linkages between formerly rather disconnected agents and decisively improved technological competences of many farmers and the overall productivity in the region (Arata and Toro, 2005; Arata, 2007, Arata and Vargas, 2008). Indeed, if one compares the general perception on infrastructure and agriculture in 2005 and in 2010, many advances have been made and the region seems to be on a promising path. The NGO is certainly is not the only factor, but contributed its part for the overall positive development.

However we think that both the positive as well the negative arguments for external development intervention are true and should be considered. External intervention can help and enable the development of backward regions, but also cause major harm and structural dependence. Therefore, we suggest that an ex-ante and ex-post network analysis can help to foster and design development projects which create a balance between positive and negative effects of external intervention, by having a better structural knowledge on the local power distribution. Thereby, on the one hand a more efficient and effective introduction of novelties and knowledge into the systems can be promoted, and on the other hand, the destruction of endogenous grown power structures and the creation of strong dependence on the external agents can be prevented.

To promote adequate types of network analysis and derivation of policies due to the results, we first have to know also more about the complex relations between different dimensions of social capital and innovative performance in agricultural communities.

5 Relations between social capital and innovation

Crucial building block to make network analysis work for development projects is to understand how different dimensions of social capital, human capital and innovation are related with each other. As shown in chapter two, the literature stresses the positive feedbacks between these factors. Human capital and social capital are considered of being crucial determinants and drivers of entrepreneurial action and innovation (e.g. Grebel et al., 2003). Viceversa, entrepreneurship and innovative activities draw upon and also create social capital

(Casson and Della Giusta, 2007). But what does the data of our small agricultural valley say about this? Is the innovativeness of the smallholders really correlated with their social capital? Does centrality in the local information flows matter for the innovative performance? Or are rather external ties important? Hence: Which dimensions of social capital are crucial for the innovative behavior of the smallholders and which are not? To shed some light on these questions we analyzed the Kendall Tau-b correlations between different dimensions of social capital (local and external ties), human capital and the innovative performance of the farmers of Chaparra. Furthermore, we controlled for the impact of selected control variables (age and desire to innovate) on the innovative behaviour. Due to the characteristics of our sample and the heterogeneity of the factors we applied a Kendall Tau- non-parametric correlation test (see also Appendix two for further information).

5.1 Operationalization of factors:

In order to measure the innovative performance of the smallholders we built a simple aggregated indicator, by summing up the values of the farmers in the various dimensions of innovation considered in the questionnaire: Innovation in Products, Processes, Marketing, Organisation and Prevention

$$\text{Innovation} = I_{Prod} + I_{Proc} + I_{Mark} + I_{Org} + I_{Prevention}$$

The reliability of this composed factor was controlled by measuring the correlations with another proxy indicator on the technical competences of the farmer made by a commission of (external) experts (Arata, 2008). Thereby we could scrutinize if the self-perception of the individuals on their innovation performance matches with the perception of qualified external experts on the farmer's technological competences and innovative performance. The expert commission of the Arata and Vargas study (2008) was constituted by two agronomists and two food technologists who frequently work in the region and interact with local agents. From a qualitative perspective the two indicators are related but provide different insights. While the indicator of Arata and Vargas (2008) focuses rather on the technical competence of the farmers (e.g. if the farmer use specific types of irrigation and packaging techniques etc.) the indicator used in this study measures more generally the novelties and innovations introduced by the farmers in the last years. Thereby, the indicator used in this study can be much more easily adapted and applied to other regions. If our indicator – based upon the self-evaluation of the farmers - would be completely different to the evaluation of local experts, the reliability of our innovation indicator would be rather low. But, with the exception of three outlier cases (one largely over-evaluating and two under-evaluating themselves), our self-perception measure was highly correlated (τ_B = 0,35 ; sig. = 0,003) with the external evaluation of the expert commission. This provides a solid ground for using our indicator.

Social capital is a complex concept, including a varied set of dimensions such as the ego´s kinship and professional networks, collective actions or group assistance. In this partial analysis, we focused on the position of the individuals within local technical information network and their access to external technical information (related to their agricultural business activities). To measure the role and social capital of the farmers within the valley, we calculated their degree-, betweenness and eigenvector centralities. (Information on centrality calculations in the appendix, chapter 7). Furthermore we considered the assistance and active role of the farmers in local associations which are related to the productive activities. In order to measure the external ties and social capital of the farmers we asked for their external kinship networks: if the farmers frequently speak with relatives living outside the valley about information related to the business activities. Additionally, we asked for the assistance to fairs, expositions and other professional activities in cities as well as other valleys as proxy indicator for the access to external technical knowledge.

Human capital was proxied by educational data and the assistance to technical training. Furthermore we controlled for the effects of *age* and the psychological variable *desire to innovate* of the farmer.

5.2 Results

There are significant correlations between the social capital - internal and external ties - of the farmer and their innovative behavior (see table 4). Farmer with a high degree centrality and many external weak ties tend to be more innovative than farmers with a weak local network position and few external linkages.

Correlations between innovation and the ego´s social capital
(Nonparametric correlation: Kendall's Tau coefficient; N=44)

Dimension	Indicator	Item	Tau	Sig.
Ego's local ties	**Technical information**	**Degree Centrality**	,345	**,003****
		Betweenness Centrality	,120	,274
		Eigenvector Centrality	,297	**,006****
	Active member of **local association**		,253	**,054**
Ego's external ties	**Kins** (tech. info exchange; other valleys, cities, countries		,047	,702
	Professional contacts (weak ties; technical information exchange in fairs, expositions, business trips in other valleys and cities		,424	**,002****
Human Capital	**Educational Level**		,177	,130
	Training in the use and processing of wine grapes		,321	**,014***
Control Variables	Age		-,140	,202
	Desire to innovate		,211	,082

**. correlation is significant on the 0,01 level; *. correlation is significant on the 0,05 level

Table 4: Correlations between social capital and innovation

However, much more theoretical and empirical research is necessary on the causal relations between different network measures (e.g. centralities, composition, key player metrics etc.) and dimensions of innovation (e.g. inputs and outputs). The causal directions between social capital and innovation are unclear: does social capital lead to innovation or innovation to social capital? Probably there is a feedback mechanism between both. Social capital leads to better access to valuable information and innovative performance leads to a more central position & prestige. Furthermore we have to think and scrutinize more in detail which network measures we should apply in local communities, were virtually everybody knows each other, but there still exists a significant heterogeneity in the quality and type of ties and the role of the individuals within this networks. Noteworthy, while degree and eigenvector centrality appear to be highly significant in our case, betweenness centrality is not. The main reason for this is in our case the fact that NGO dominates the network, interacting and connecting a varied set of agents. Thereby it outweighs the betweenness centrality of many other agents. Furthermore within close-knit local networks information can spread rather fast to all other agents of the local system. Therefore, in this types of communities betweenness centrality may rather matter in the sense of power - for example if individuals are able to create bridges between kinship or friend circles - but less to the extent of connecting local information sources.

Furthermore very interesting in our case is the fact that school education and external kinship networks do not correlate significantly with innovation. One might suppose that both would lead to important absorptive capacities and access to information and other resources. But the rural reality in the regions shows that specific training and practical learning are more important than codified school knowledge. Furthermore, the school curricula and the interests of family members in cities are often disconnected from the needs and reality of the agricultural communities (Hartmann, 2006).

6 Conclusions

In this paper we analyzed the various dimensions of the social capital and innovative performance using the example of the smallholder wineries of Chaparra, an agricultural valley in the South of Peru. In order to do so we collected a comprehensive data set of the different dimensions of innovation (e.g. product, process, organization) and social capital (e.g. internal and external ties). To visualize and analyze the data we employed the technique of social network analysis. This methodology allowed us not only to assess the implications of certain network structures but also the positions and roles that the individual actors have within the network. Exploratory social network analysis (e.g. Wasserman and Faust, 1994; De Nooy et al., 2005) in combination with econometric methods can reveal structural patterns and roles of agents which would be overlooked by common qualitative approaches, interviews and confirmatory analysis. In the investigated case – that can be assumed to be representative for many others agricultural communities in developing countries - a NGO that is active in the

region became the key player in the local information networks. By sampling the relevant data indirectly (i.e. available household data) this decisive actor and his influence on the network structure as well as on the individual indicators would have been missed. The positive and negative issues concerning NGOs, development projects and external intervention are highly disputed within development community. However, without any intention to engage in this discussion, we suggest that external intervention and development projects might gain significantly from applying network based analysis on the social capital and innovation capabilities within the respective communities both at the beginning and at the end of their projects. This would allow us to identify and evaluate the endogenously grown social structures as well as the internal and external boundaries which might hamper or foster the success of the project. Such information would help to design more efficient projects and to minimize the negative impacts of external intervention on the endogenously grown structures and competencies. However, in order to develop best-practices for network analysis and the promotion of endogenous development, a better understanding of the complex interrelations between the different dimensions of human capital, social capital and innovation is needed. Our analysis indicates that the individual innovation capacity is determined by both, internal as well as external linkages. However, the question of how to measure the role and position of individuals within local production and innovation systems while including their external relations is not yet clarified. While the qualitative importance of cooperation and participation as well as the role of innovation has been emphasized by the literature on local development (Mytelka, 2000; Vazquez-Barquero, 2002), our knowledge on the measurement of different types of innovation and network positions in local agricultural communities is still rather scarce. The same is true for our knowledge on the feedbacks between the different types of innovation and the different roles in the local and extra-local networks. Here, the methodology of social network analysis and the increasing availability of detailed data enable us to advance our understanding of socioeconomic development in local communities and the efficiency of external intervention.

7 Appendix on measures

7.1 Network measures

Social network analysis (SNA) provides a wide range of possibilities to measure and visualize the structures of networks and the role of individuals within them (Wassermann and Faust, 1994; Albert and Barabasi, 2002; De Nooy et al., 2005; Hanneman and Riddle, 2005; Borgatti et al, 2009). Thereby, SNA facilitates a) the use of the geographical intelligence of the human brain and b) provides techniques to reveal structural embeddedness and roles of individuals which common research methods tend to neglect or overlook (Borgatti et al., 2009). Some common network measures we apply in this study are network centralities and cohesion. Subsequently, an brief overiview over the network measures applied in this study.

- Degree-Centrality measures the number of direct connections of node i ∈ n to the n other nodes of the sample (C= Centrality; n= node; d=degree).

$$C_D(n_i) = d(n_i)$$

It is assumed that, the more connections a node has, the more central it is. Hence degree centrality shows how well connected the individuals are and can be interpreted as the direct influence of the agents (Borgatti et al. 2008).

- Eigenvector centrality measures if a node is connected to the well-connected. It can be considered as popularity and power measure and tends to identity centres of large cliques (Borgatti et al, 2008). A node has a high eigenvector score if it is connected to many nodes that are themselves well connected, or in other words: a node has a high eigenvector centrality if it has many contacts to other central players. Given an adjacency matrix A, the centrality of node i (denoted c_i), is given by

$$c_i = a*\sum(A_{ij}c_j)$$

where a is a parameter. The centrality of each vertex is therefore determined by the centrality of the vertices it is connected to. The parameter a is required to give the equations a non-trivial solution and is therefore the reciprocal of an eigenvalue (Borgatti et al., 2002).

- Betweenness centrality measures the number of times a node i falls along the shortest (=geodesic) path (g) between two other actors j and k.

$$C_B(n_i) = \sum_{j<k} g_{jk}(n_i) / g_{jk}$$

Actors with high betweenness centrality link together actors who are otherwise unconnected, creating opportunities for the exploitation of information and control benefits (Borgatti et al., 1998). These actors are often called as information broker, intermediates or gatekeeper. They are of great importance for the networks, because of their influence on the information flow and consistence of the networks.

- The average path length l_G measures the average of shortest paths (geodesic distance d) between all pairs of vertices v_i and v_j in a network graph G with n vertices (Albert and Barabasi, 2002).

$$l_g = \frac{1}{n*(n-1)} \sum_{i,j} d(v_i, v_j)$$

Hence, the average path length indicates how fast information can be spread within the system, or in other words: how many steps the agents needs in average to reach all other actors. Thereby it provides a proxy for the cohesion of the system.

7.2 Appendix 2: Kendall's Tau correlations

Kendall's Tau - b measures the non-parametric rank correlations between paired observations (Kendall and Gibbons, 1990). It provides a distribution free test of independence and a measure of the strength of dependence between two variables. Thereby it calculates the number of concordances and discordances in paired observations. Concordance occurs when paired observations vary together, and discordance occurs when paired observations vary differently.

The Kendall's Tau-b coefficient is defined as follows:

$$\tau_b = \frac{C - D}{\sqrt{C + D + T_x}\sqrt{C + D + T_y}}$$

where C is the number of concordant pairs, D the number of discordant pairs, T_x is the number of tied pairs of x and T_y is the number of tied pairs of y. The Values of tau-b range from −1 (=100% negative association) to +1 (=100% positive association). A value of zero indicates the absence of association.

In our case, the main reasons for using Kendall's Tau-b instead of Spearman's Rho or the Pearson correlation coefficient are (a) the ordinal or non-normal distribution of several considered variables (e.g. network centralities, the education data), (b) the rather small sample size, (c) the possible identification of outliers and (d) the reduction of the random correlation probability.[6]

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[6] The control calculation of Spearmans Rho led to the same qualitative results, however, higher test values and significance levels of the correlations. But as explained above, Tau is the more adequate measure in our case.

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CRFM:	Corporate Finance and Risk Management
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CM:	Communication Management
MM:	Marketing Management
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