

# **The Role of Knowledge Quality in Firm Performance**

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## **Introduction**

The role of knowledge in firm strategy and performance is well documented in the literature. There are numerous theoretical and empirical studies examining the relationship between knowledge and firm performance. The essence of these studies is that the higher the level of knowledge acquired or accumulated, the greater the level of firm innovation and performance. For example, Liebeskind et al. (1996) and Powell et al. (1996) investigated the role of social networks and found that they were important sources of learning and innovation for firms. In recent studies, Lane et al., (2001) found that knowledge acquired by an IJV from its parent company contributed to its performance, and Yli-Renko et al. (2001) found that knowledge acquisition contributed significantly to new product development.

In this study, we examine an element of knowledge acquisition that is not addressed in previous studies – that of the quality of the acquired knowledge. We examine not only the frequency of knowledge acquisition but whether the knowledge being acquired is *useful* to the firm and *innovative* in terms of its newness and novelty. The study incorporates three components – first, we investigate the impact of knowledge quality on two measures of firm performance – innovation and financial performance. Second, we investigate the antecedents to knowledge quality, examining the impact of the formal and informal networks (building on the work of network and social capital theorists such as Granovetter, 1992 and Nahapiet and Ghoshal, 1998) and Cohen and Levinthal's (1990) concept of absorptive capacity. Third, our data allows us to investigate the specific sources of useful and innovative knowledge, which provides us with a richer understanding of knowledge sourcing behaviours of organizations.

## **Theoretical Framework and Hypotheses**

There is an abundance of debate and dialogue in the literature on the role of knowledge in organizations. Researchers have investigated the phenomena from numerous angles – e.g., inter-firm knowledge transfer (Simonin, 1999; Appleyard, 1996), intra-firm knowledge transfer (Szulanski, 1996; Zander and Kogut, 1995), learning from problem solving (Leonard-Barton, 1995), and learning from networks and collaborations (Liebeskind et al., 1996; Powell et al., 1996). This paper builds on previous studies by incorporating various concepts such as social network theory (Liebeskind et al., 1996), social capital (Nahapiet and Ghoshal, 1998) and absorptive capacity (Cohen and Levinthal, 1990) in investigating the nature of

organizational knowledge acquisition and the impact on performance. Where this study differs from previous work is the development of the concept of knowledge quality – defined as the *usefulness and innovativeness* of acquired knowledge – and its impact on firm performance. Subsequent discussion will focus on the theoretical model and underlying constructs developed and tested in this study.

### **The Concept of “Knowledge Quality”**

Numerous studies have examined the process of knowledge sourcing and its impact on firm performance. For example, Appleyard (1996) examined inter-firm knowledge transfer, focusing on the method of transfer. In Mowery et al., (1996), Bierly and Chakrabarti (1996) and Almeida (1996), patent data was used to analyze knowledge transfer. In more recent studies (i.e., Yli-Renko et al., 2001; Lane et al., 2001; Frost 2001) knowledge transfer was investigated in the context of inter-organizational learning and innovation, and in Argote and Ingram (2000: 150), the authors argue that the creation and transfer of knowledge forms the basis of competitive advantage in organizations.

Despite the abundance of theoretical and empirical work in this area, the more fundamental questions are – “what is the nature of the knowledge being transferred?” In other words, we are interested in investigating not just the amount or frequency of knowledge transfer, but the quality of the acquired knowledge in terms of its (1) usefulness and importance to the firm and (2) the extent to which it is innovative, new or novel to the firm. The underlying motivation is that we are interested in whether the acquired knowledge adds value to, or makes an impact on the firm. In this study, the term “knowledge quality” is defined as the acquisition of *useful and innovative* knowledge.

We make several qualifications in our conceptualization of knowledge quality. First, we acknowledge that there are several concepts in the knowledge literature which we do not include in our definitions – such as Teece’s (1998) codified/tacit, observable/non-observable, positive/negative, and autonomous/systematic knowledge dimensions. Second, for the purpose of this study, we limit our definition of knowledge quality to that of *acquired* knowledge, excluding knowledge that is generated or created within the firm.

In the following sections, we develop our model of knowledge quality, its antecedents, and its impact on firm performance, which is presented in Figure 1.

## **Social Capital and Knowledge Quality**

The role of the firm's network ties as a valuable resource for learning and resource exchange is well documented in the literature. Nahapiet and Ghoshal's (1998) model of intellectual capital creation regards the role of social capital (in terms of network ties, shared language, trust, obligation, etc.) as the driving force behind the exchange of intellectual capital.

Numerous studies have emphasized the important role played by network interactions in facilitating information and knowledge transfer. According to Powell et al., (1996: 118) "a network serves as a locus of innovation because it provides timely access to knowledge and resources that are otherwise unavailable". Henderson and Cockburn's study (1994: 67) showed that the firm's ability to "encourage and maintain an extensive flow of information across the boundaries of the firm" was a significant contribution to research productivity.

Social network theorists advocate the importance of informal personal interactions as a source of resources and knowledge exchange. According to Granovetter (1992: 25), "economic action (like all action) is embedded in ongoing networks of personal relationships rather than carried out by atomized actors". Liebeskind et al.'s work on biotechnology firms (1996) found that knowledge exchange between firms occurred in the context of social networks, rather than being driven by a formal contractual agreement. Similarly, Yli-Renko et al.'s (2001) study found a positive relationship between social interaction and knowledge acquisition.

Studies in the areas of joint ventures and strategic alliances have also investigated the issue of knowledge exchange between partners. Contractor and Lorange (1988: 9) assert that "...it is important that the partners have complementary strengths, that they together cover all relevant know-how dimensions needed..." In recent studies, both Stuart (2000) and Steensma and Lyles (2000) found that a major contributing factor to the growth, innovation rate and survival of interorganizational alliances was the resources and knowledge flowing from the alliance partners. Building upon existing studies, we examine both social networks and formal alliances are sources of useful and innovative knowledge for organizations:

*Hypothesis 1: There is a positive relationship between formal networking and knowledge quality*

*Hypothesis 2: There is a positive relationship between informal networking and knowledge quality*

### **Absorptive Capacity and Knowledge Quality**

Although the firm's formal and informal networks of interaction can be important sources of knowledge, the firm's own innate capacity to absorb and learn is crucial. Cohen and Levinthal's (1990: 128) concept of absorptive capacity acknowledges that "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends" represents an important element in a firm's ability to innovate and learn. Many empirical studies have investigated the role of absorptive capacity in organizational learning and innovation. In their study of strategic alliances, Mowery et al. (1996) examined the role of absorptive capacity in the firm's ability to acquire its partner's capabilities and found that experience in an area related to the alliance partner's increased the chances of inter-firm knowledge transfer. Similarly, Pennings and Harianto (1992) found support for the hypothesis that prior accumulated experience in a certain technological area increased the likelihood of innovation adoption. In their study on international joint ventures, Lane et al.'s (2001) concluded that the ability to understand and apply external knowledge contributed to learning and performance.

In this study, we investigate the role of absorptive capacity in the firm's ability to not only acquire knowledge, but to acquire knowledge that is both useful and innovative:

*Hypothesis 3: There is a positive relationship between absorptive capacity and knowledge quality*

### **Knowledge Quality and Firm Performance**

Discussion thus far has centred on the various antecedents to knowledge acquisition, focusing on the role of formal and informal networks and absorptive capacity on the acquisition of knowledge that is useful and innovative (our definition of "knowledge quality"). In this section, we focus discussion of the impact of knowledge quality on firm performance – both innovative and financial performance.

There is a significant literature supporting the argument that organizational innovation is facilitated to a large by the continuous sourcing and renewal of knowledge. The need to

overcome the various forms of uncertainty arising from innovation has led to the importance of sourcing new knowledge from both within and outside the organization. Work on social networks and interorganizational relationships have argued that learning and knowledge transfer among firms are essential to the innovation process (e.g., Powell et al., 1996; Liebeskind et al., 1996). Theories of “dynamic capabilities” (Teece et al., 1997) also emphasize the role of knowledge (particularly its constant renewal) as a source of innovation and competitive advantage. Similarly, the concept of “knowledge integration” (Grant, 1996; Iansiti and Clark, 1994) emphasizes the ability to integrate different types of specialized knowledge to develop new innovation-enhancing capabilities. Henderson and Clark (1990) investigated the relationship between knowledge and innovation in their study of “architectural innovation”. The basic premise of their argument is that firms need to develop and renew their architectural knowledge continually to prevent their knowledge from being obsolete in the event of radical innovation. As an illustration of the importance of accumulated knowledge stock for the firm’s innovative capabilities, Helfat (1997) found that during periods of environmental instability, firms with greater amounts accumulated knowledge undertook greater amounts of R&D. In a more recent study, Yli-Renko et al. (2001) found a significant positive relationship between knowledge acquisition and new product development.

Several studies have also investigated the impact on knowledge acquisition on firm performance. For example, Tsai (2001) concluded that the interaction between absorptive capacity and network centrality had a positive impact on business unit performance. Both Stuart (2000) and Lane et al. (2001) found evidence to support their hypotheses that knowledge acquired from alliance partners contributed significantly to alliance performance. In summary, we build upon previous studies to investigate whether the sourcing of useful and innovative knowledge by firms have an impact on the level of innovative and financial performance:

*Hypothesis 4: There is a positive relationship between knowledge quality and innovative performance*

*Hypothesis 5: There is a positive relationship between knowledge quality and financial performance*

## **Innovation and Financial Performance**

There is substantial empirical evidence in the literature pointing to a positive relationship between innovation and financial performance (at both the firm and industry levels). Banbury and Mitchell (1995) found that the introduction of incremental product innovations strongly influenced the market share and business survival of an industry incumbent. In other studies, innovative output has been attributed to improved stock price performance (Chaney and Devinney, 1992) and the persistent profitability of firms (Geroski et al., 1993), after controlling for factors such as industry differences and the type of innovation. Soni et al. (1993) also found a significant positive relationship between innovation and sales growth. At the industry level, Chakrabarti (1990) found evidence to suggest that productivity growth in the chemical and textiles industries was associated, in part, with the rate of innovative output in those industries. Building on the positive relationship between innovation and financial performance established by numerous studies, a positive relationship is hypothesized between innovation and financial performance:

*Hypothesis 6: There is a positive relationship between innovation and financial performance*

## **Methods**

### **Measures**

Our model and hypotheses were tested using data from a questionnaire survey. The questionnaire consists of both *formative* measures – i.e., observed indicators that cause or form the latent constructs – and *reflective* measures – i.e., observed indicators that are caused or formed by the latent constructs (Bollen, 1989). Formative measures are used for the constructs of formal and informal networking, knowledge quality and innovation, while absorptive capacity and financial performance are measured by reflective measures. Each is discussed in detail in the sections below. All survey questions (except those pertaining to demographics) use a 7-point Likert scale.

#### *Formal and Informal Networking (formative)*

To measure formal networking activities, respondents were asked to rate the frequency of *formal* collaborations (e.g., joint ventures, strategic alliances, and research collaborations)

with a list of 7 parties, namely customers, suppliers, competitors, research institutes, sales and marketing agencies, consultants, and parent company/subsidiaries. government, universities, parent company, etc. To measure informal networking activities, respondents were asked to rate the frequency of social interactions with a list of 8 parties (the parties listed previously, plus fellow colleagues). The aim was to construct a comprehensive and “generic” list of external and internal parties that can represent a *network of formal and informal interactions* for firms across a variety of industries. This approach is adopted from Appleyard’s (1996) study on knowledge flows.

### *Knowledge Quality (formative)*

To measure the construct of knowledge quality, a three-step approach was taken. First, respondents were asked to rate the frequency of acquiring knowledge<sup>1</sup> from a list of 10 sources (the 8 sources listed in the previous section, plus published material and the internet). Second, respondents were asked to rate the usefulness and innovativeness of the knowledge that is acquired from each of the listed sources. Preliminary analyses showed a strong correlation between the usefulness and innovative scores, and thus both are combined to form a “quality” score. Third, both the “frequency” and “quality” scores are combined to form the measure for knowledge quality.

### *Absorptive Capacity (reflective)*

To measure Cohen and Levinthal’s (1990) concept of absorptive capacity, we go beyond the authors’ emphasis on R&D investment, recognizing that this may not be applicable across industries. Hence, in order to develop generalizable measures as well as adhering tightly to the authors’ definitions, we designed measures to capture two important aspects of absorptive capacity: first, *active information-seeking behaviors*; i.e., the degree to which respondents actively seek external information, record it for future reference, use the acquired information in their work, and distribute the information to fellow colleagues. Second, we recognize that the development of absorptive capacity is essentially path-dependent; that is, it is a function of both past and on-going *investments in knowledge accumulation*. To measure this, we investigated the degree to which respondents participate in academic/industry conferences,

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<sup>1</sup> In the survey, respondents were given a definition of knowledge which included both tacit and explicit knowledge, based on Machlup’s (1980) definitions. At this stage, we are not investigating the effects or quality of different types of acquired knowledge.



update their skills through training and self-learning, and keep abreast with the latest technology and knowledge related to their organization's business. Our measures are organizational – i.e., the extent to which the firm has policies and procedures that encourage employees to seek external information and invest in knowledge accumulation.

It is important to emphasize that our operationalization of absorptive capacity is both broader and more direct than previous empirical work where the emphasis is on the *proxies* of absorptive capacity. For example, Pennings and Harianto (1992) measure past accumulated technological experience as a proxy for absorptive capacity. Lane and Lubatkin (1998) hypothesize that absorptive capacity is a function of the similarity between the student and teacher firms' compensation practices and organizational structures. In contrast, we employ a more direct approach by examining the extent to which a range of *actions* are taken to recognize, absorb and assimilate new external information and knowledge into the organization.

#### *Innovative Performance (formative)*

To measure a firm's level of innovation, we compiled a list of 14 innovative outputs, incorporating new (and modified) products, services and processes (organizational, administrative and production), patents, licenses, publications and conference presentations. The aim was to construct measures generic enough to be applicable to firms from multiple industries. Respondents were asked to rate their firm's frequency of producing these innovations compared to their competitors. As before, measures are aggregated using the entropy formula.

#### *Financial Performance (reflective)*

Financial performance was measured using both market measures – market share and annual sales growth – and financial measures – after-tax return on investment and growth in total after-tax profits. These are commonly used in the strategy and marketing literatures (e.g., Banbury and Mitchell, 1995) and reflect the multidimensional pressures managers face on a day-to-day basis. Following Johansson and Yip (1994) and Roth and Morrison (1990), these measures were treated as reflective indicators of an existing latent “performance” construct.

### *Control Variables*

We use firm and industry controls – i.e., industry dummy variables, firm size, R&D intensity and ownership structure – to control for industry and firm effects that are known to exist with respect to innovation and performance (e.g., Acs and Audretsch, 1987), as well as knowledge quality. Controlling for these effects allows us to better identify the real impact of the model's focal constructs.

### **Data**

Our questionnaire was pre-tested through interviews and a pilot sampling trial. The final version was then mailed to 2,137 organizations (all with more than 20 employees) randomly selected from 17 manufacturing and service industries (based on two-digit SIC codes). The objectives of this procedure were to ensure generalizability of results across industries and to target industries where issues of knowledge acquisition and innovation are *important and relevant*. Specifically, we targeted industries facing dynamic and competitive environments - hence the need for continuous knowledge acquisition and learning. The issue of relevance is also crucial to obtaining a reasonable response rate and high quality responses (questions are more easily understood if they are important and relevant).

The questionnaire was addressed to the CEO or managing director of each organization. To minimize the limitations of using single informant methodology, we took precautions to ensure informant competency. First, the key objectives of the study and its central themes were outlined in a cover letter. If the CEO was unable to complete the survey, they were asked to give it to a middle/senior level manager with sufficient knowledge of the study's objectives. Second, we included criteria for assessing informant competency, such as tenure in the organization, industry and current position.

The number of responses totaled 343 (yielding a 16% response rate). After eliminating 26 surveys due to large proportions of missing data. The final 317 used in the analysis were fairly evenly distributed across manufacturing (44%) and service (56%) sectors as well as across the 17 industries. Firm size was also well distributed, with 40% small firms (100 or less employees), 30% medium-sized firms (100 to 400 employees) and 30% large firms (more than 800 employees). The average and median sizes of these firms were 2,024 and 175

employees respectively. Tests of the distribution of returned surveys indicate that no industry or size bias existed in the responses received.

Analysis of respondent characteristics indicated that they had sufficient knowledge of the key issues of the study – all respondents occupied middle-senior management roles, and the average tenure at the organization, industry and current position were 12, 17 and 5 years respectively. Following the procedures of Armstrong and Overton (1976) we also tested for non-response bias by examining the construct means of early versus late respondents, and found no significant differences.

With surveys such as this there is always a concern about single respondent bias. In a related study, the survey was used in conjunction with six case studies (see Soo, Devinney, Midgley and Deering, 2002) and an identical model was estimated for each company. In this situation, as many as 120 responses were received from a single firm, hence we had both repeated measures of firm variables and estimates of the variance of individual measures. Although the models differed in the magnitude of various effects (as one would expect), the general form of the model and key conclusions remained valid.

## **Analysis**

The data from the survey was analyzed using partial least squares (PLS), a well-established technique for estimating path coefficients in causal models (e.g., Johansson and Yip, 1994; Birkinshaw et al., 1995). Its conceptual core is an iterative combination of *principal components analysis* relating measures to constructs, and *path analysis* permitting the construction of a system of constructs (Barclay et al., 1995). The major advantages of PLS are that it: (1) accepts small sample sizes, (2) can deal with complex causal models, (3) does not require multivariate normality and (4) produces consistent parameter estimates. It is especially suited to “situations of high complexity but low theoretical information” (Barclay et al., 1995: 288), a point that is particularly relevant given that the field of organizational knowledge is relatively new with concepts and relationships still being developed, hence the emphasis is on theory building rather than theory testing.

## Results

For the PLS model, we are interested in two levels of analysis – the *measurement* model (i.e., the reliability and validity of the measures used to operationalize the underlying constructs) and the *structural* model (i.e., the relationships between the latent constructs). We present and discuss the results of the measurement model before proceeding to the latter.

### Measurement model

Examining the loadings and cross-loadings of each of the constructs' individual items assesses the reliability of the reflective measures. For an item to be reliable a minimum loading of 0.7 is required, indicating that more than 50% of the variance of the measure is accounted for by the respective construct. In our study, all items had a loading with their respective constructs of greater than 0.7. Other measures of reliability are Cronbach's alpha and Werts, Linn and Joreskog's (1974) measure of internal consistency (IC). Table 1 lists the alpha and IC scores for the reflective constructs, indicating satisfactory reliability with the IC scores of 0.92 and 0.87 for absorptive capacity and financial performance respectively.

Finally, we assess the discriminant validity of the constructs by using Fornell and Larcker's (1981) measure of average variance extracted (AVE). The AVE measures the amount of variance captured by the construct (through its items) relative to the amount of variance due to measurement error. To satisfy the requirements of discriminant validity, the square root of a construct's AVE must be greater than the correlation between that construct and other constructs in the model. The correlation matrix in Table 1 shows that all the diagonal elements are greater than the corresponding off-diagonal elements.

### Structural model

The results of the structural model are presented in Table 2 and Figure 2. From these we can see that the constructs of knowledge quality and innovative performance are well explained (R-squares of 33% and 23% respectively) and that of financial performance reasonably well explained (R-square of 17%). Four of the six paths estimated are significantly at the 0.001 level, with the other two being not significant. Overall the model fits well and supports the majority of our hypotheses. Subsequent discussion will focus on the individual hypotheses and the results of the path estimations.

### *Factors Contributing to Knowledge Quality*

Both informal networking and absorptive capacity have significant effects on knowledge quality but not formal networking, thus supporting Hypotheses 2 and 3 but not Hypothesis 1. The strength of the impact of informal networking (as compared to formal networking) supports the proposition made by social network theorists that “knowledge creation occurs in the context of a community, one that is fluid and evolving rather than tightly bound or static” (Powell et al., 1996: 118). Our results indicate that firms source useful and innovative knowledge predominantly through social interactions among employees of the firms. This implies that the transfer of useful and innovative knowledge occurs through socialization, described by Nonaka and Takeuchi (1995: 62) as a “process of sharing experiences and thereby creating tacit knowledge such as shared mental modes and technical skills”.

Absorptive capacity contributes significantly to the acquisition of useful and innovative knowledge by firms. This implies that the firm’s propensity for sourcing useful and innovative knowledge is affected by its ability to absorb new knowledge (measured in terms of active knowledge seeking behaviours and investments in knowledge development and learning). These results support the findings of previous studies (e.g., Pennings and Harianto, 1992; Lane and Lubatkin, 1998) where knowledge acquisition and learning were influenced by accumulated experience.

### *Factors Contributing to Firm Performance*

Knowledge quality contributes significantly to innovative performance but not financial performance, supporting Hypothesis 4 but not 5. Innovative performance contributes significantly to financial performance, supporting Hypothesis 6. This set of results paints an interesting scenario – *organizations extract economic rents from knowledge only via innovative output*. In other words, when an organization absorbs or acquires new knowledge, this will impact its level of innovative output directly, which then contributes to financial performance. In essence, this supports previous research by Nonaka and Takeuchi (1995), Leonard-Barton (1995), Chaney and Devinney (1992) and Geroski et al. (1993). The results also imply that knowledge management can be viewed within the context of innovation management, as one cannot be separated from the other.

## **Additional Analyses**

In this study, our primary interest is to investigate factors contributing to knowledge acquisition, the nature of acquired knowledge, and whether its level of frequency, usefulness and innovativeness contributes to firm performance. We are concerned with the impact of overall knowledge quality (regardless of the specific sources of knowledge) rather than the effects of different knowledge sources. In our research, our construct of knowledge quality is formed by items measuring the frequency of knowledge acquisition from 10 different sources, and the rating of that acquired knowledge in terms its usefulness and innovativeness. Table 3 presents the breakdown of the frequency, usefulness and innovativeness scores according to the various sources of knowledge. An interesting point to note is that fellow colleagues is rated the highest in terms of the most frequent, most useful, and most innovative source of knowledge, followed by parent company and other subsidiaries with the second highest frequency and usefulness ratings. External parties such as suppliers and customers rated reasonably high on frequency and usefulness, but lower on innovativeness.

It is beyond the scope of this paper to investigate in detail the different sources of knowledge quality, or the effects (of knowledge sourced from different parties) on innovation. It is suffice to say at this point that these issues represent interesting future research questions.

## **Conclusions and Implications**

Firms are increasingly relying on acquiring knowledge from various sources to develop its capabilities for learning and innovation. According to Argote and Ingram (2000: 165), “ the processes underlying knowledge transfer provide a basis for understanding the competitive advantage of firms”. Previous studies have looked at the impact of knowledge acquisition on firm performance – e.g., Yli-Renko et al. (2001) and Lane et al. (2001). In this study, we investigate an aspect of knowledge acquisition that has not been addressed in previous work – i.e., the quality of acquired knowledge in terms of its usefulness to the firm and its innovativeness. The two primary objectives of this study are (1) to ascertain the impact of knowledge quality on two measures of firm performance – innovative and financial performance and (2) to investigate the factors contributing to knowledge quality.

Our results show that both informal networking and absorptive capacity contributes to knowledge quality, but not formal networking. This implies that social interactions (rather

than formal structured interactions) are more conducive to knowledge transfer (particularly the transfer of useful and innovative knowledge) thus supporting the work of social network theorists (Liebeskind et al., 1996; Powell et al., 1996). The significant impact of absorptive capacity implies that not only is it important for firms to nurture informal networks, their own ability to understand and absorb new knowledge is equally important. This “dual necessity” is suggested by Tsai (2001: 1003) – “the central unit may be able to access knowledge through its network links but may not have sufficient capacity to absorb such knowledge”.

The impact of knowledge quality on innovative performance rather than financial performance also yields interesting implications. These results indicate that firms extract economic returns from acquired knowledge only through its impact on innovation, suggesting a mediating effect of innovation on the relationship between knowledge and financial performance. This implies that managers need to think about whether (and how) knowledge that is acquired through its informal networks is subsequently utilized in firm’s innovative activities. In other words, acquired knowledge needs to be “acted upon” in innovative activities, which will then impact on financial output.

Our results have important theoretical and practical implications. Previous studies found that knowledge accumulation plays an important role in firm performance. In this study, we build upon these studies to show that the nature of the acquired knowledge (in terms of its usefulness and innovativeness) contributes directly to firm innovation, and indirectly to financial performance. Hence, we are able to develop and empirically validate a model linking the knowledge quality to firm performance, contributing to the work on social networks (Granovetter, 1992), social capital (Nahapiet and Ghoshal, 1998), and absorptive capacity (Cohen and Levinthal, 1990). In future research, we plan to investigate further the different sources of useful and innovative knowledge (as listed in Table 3) and their effects on different types of innovative outputs. In this paper, we are interested in whether knowledge quality “matters” and hence, we are concerned with aggregate effects only. However, the next step in our research agenda is to examine the effects of knowledge sourced from different parties on different types of innovation. We will endeavour to answer questions such as “why are some parties more important sources of knowledge” and “how does the knowledge acquired from different parties impact on different types of innovation?”

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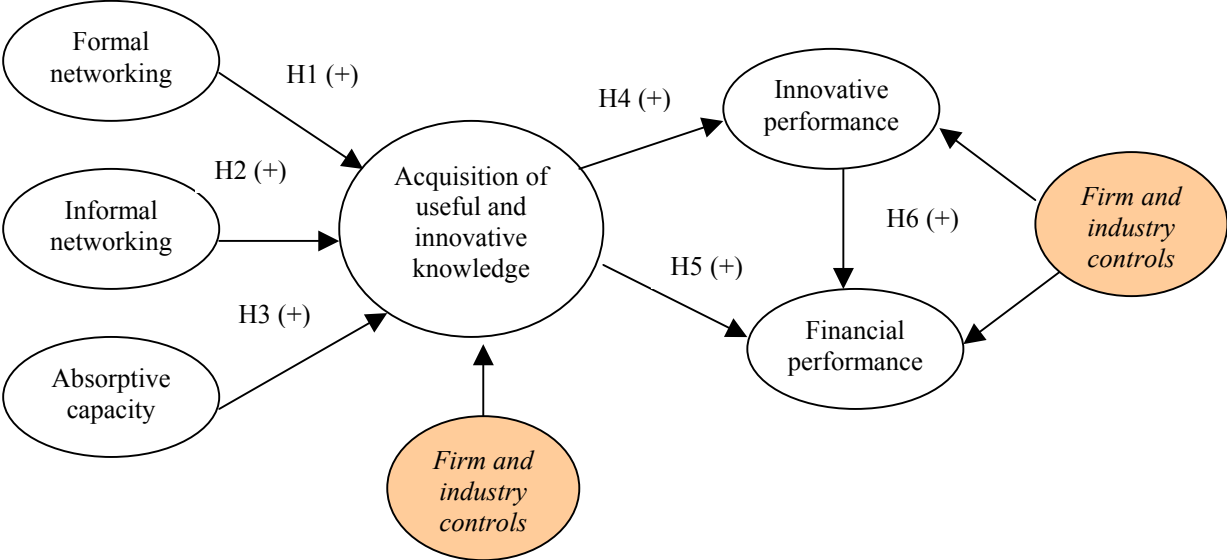
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**Figure 1: Hypothesized Model**



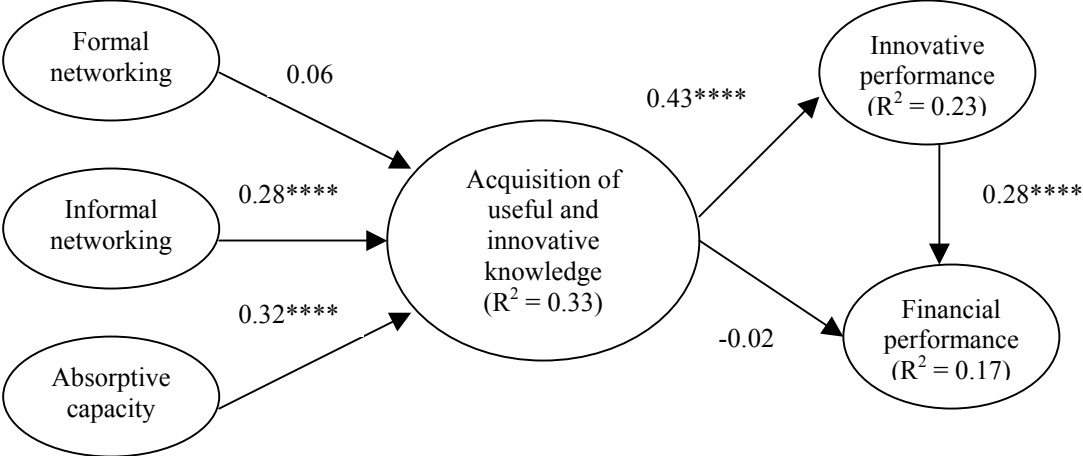
*Note:* This is a simplified representation of the model, it does not show the control variables or the measures for each construct.

**Table 1: Measures of Internal Consistency and Discriminant Validity (Correlations of Latent Constructs)**

	Formal networking	Informal networking	Absorptive capacity	Knowledge quality	Innovative performance	Financial performance
Formal networking (F)	<b>1.00</b>					
Informal networking (F)	0.50	<b>1.00</b>				
Absorptive capacity (R)	0.32	0.35	<b>0.82</b>			
Knowledge quality (F)	0.32	0.44	0.41	<b>1.00</b>		
Innovative performance (F)	0.32	0.38	0.38	0.42	<b>1.00</b>	
Financial performance (R)	0.03	0.09	0.13	0.10	0.28	<b>0.80</b>
Cronbach's Alpha	N/A	N/A	0.89	N/A	N/A	0.83
Fornell's Internal Consistency	N/A	N/A	0.92	N/A	N/A	0.87

(F) indicates a formative measure; (R) indicates reflective measures; diagonal elements are square roots of average variance

**Figure 2: Structural Model Results**



*Note:* Control variables are excluded; \*\*\*\* p < 0.001, \*\*\* p < 0.01, \*\* p < 0.05. R<sup>2</sup> are those obtained after controlling for (1) industry effects (industry dummy variables) and (2) firm effects—size, R&D intensity, and ownership structure.

**Table 2: Structural Model Results**

	Proposed effect	Path coefficient	t-value	Significance	Hypothesis supported?
<b>HYPOTHESIZED MODEL</b>					
<b>Effects on Knowledge Quality (<math>R^2 = 0.33</math>)</b>					
Formal networking	<b>H1 (+)</b>	0.06	0.89	n.s.	No
Informal networking	<b>H2 (+)</b>	<b>0.28</b>	<b>3.34</b>	<b>****</b>	<b>Yes</b>
Absorptive capacity	<b>H3 (+)</b>	<b>0.32</b>	<b>3.35</b>	<b>****</b>	<b>Yes</b>
<i>Firm control: R&amp;D intensity</i>		0.16	2.41	**	Control
<b>Effects on Innovative Performance (<math>R^2 = 0.23</math>)</b>					
Knowledge quality	<b>H4 (+)</b>	<b>0.43</b>	<b>4.39</b>	<b>****</b>	<b>Yes</b>
<i>Firm control: Local ownership</i>		0.17	2.14	**	Control
<b>Effects on Financial Performance (<math>R^2 = 0.17</math>)</b>					
Knowledge quality	<b>H5 (+)</b>	-0.02	-0.23	n.s.	No
Innovative Performance	<b>H6 (+)</b>	<b>0.28</b>	<b>4.10</b>	<b>****</b>	<b>Yes</b>
<i>Industry control: Transportation services</i>		0.12	2.43	**	Control

Note: Control variables with significance levels below 0.05 are excluded.

p-values: \*  $p < 0.10$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ ; \*\*\*\*  $p < 0.001$ ; n.s. = not significant

**Table 3: Breakdown of knowledge sources and knowledge rating**

	<b>Frequency score</b>		<b>Usefulness score</b>		<b>Innovativeness score</b>
Fellow colleagues	5.36	Fellow colleagues	5.47	Fellow colleagues	4.83
Parent/subsidiaries	4.38	Parent/subsidiaries	4.83	Consultants	4.38
Suppliers	4.15	Customers	4.82	Parent/subsidiaries	4.18
Published material	4.11	Suppliers	4.79	Published material	4.10
Customers	3.94	Consultants	4.75	Suppliers	4.09
Consultants	3.81	Published material	4.57	Competitors	3.96
Internet	3.53	Competitors	4.43	Internet	3.72
Sales/marketing	3.38	Sales/marketing	4.07	Customers	3.69
Competitors	3.09	Internet	4.02	Research institutes	3.63
Research institutes	3.04	Research institutes	3.96	Sales/marketing	3.63

*Note:* Figures presented are average scores on a scale of 1 to 7