
Building social capital and learning environment in university – industry relationships

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Abstract: University – industry interactions have become an important phenomenon in recent years. Universities are viewed as engines of economic growth in the era of a knowledge economy. The recent literature on this topic is somewhat restrictive, as it has taken a resource-based view. We have argued here that an often over looked contribution that a university can make in its relationships with industrial firms is the building of social capital. On the basis of a study of university industry research centres in the US, we have identified three dimensions of the interaction patterns analogous to the dimensions of social capital in terms of communication structure, sharing of visions and priorities, and building of a trusting relationship. We also explore the factors that help build these dimensions and their effect.

Keywords: intellectual capital; social capital; technology and knowledge transfer; university – industry collaboration.

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1 Introduction

In recent years, universities have gained a growing prominence as engines of economic development. With the emergence of the post industrial era dominated first by information and communication technology and now by biotechnology, universities are viewed as an important asset for regional growth and development. Studies in regional economics, Saxenian [1], Markusen [2], Florida [3], are a few examples that depict universities as drivers of economic growth. The economic resilience of regions in the Silicon Valley and Route 128 corridor has attracted the attention of many to the role that universities play in these regions. The recent development of clusters of high technology industries in the Helsinki, Olulu, and Tampere regions in Finland and the biotechnology cluster in the San Francisco bay area also point to the importance of universities as agents for economic development. To understand the role of universities in recent years, one needs to understand the challenges faced by the firms in the rapid changes in technology and market conditions for geo-political reasons. Universities are not unscathed; they too face an uncertain and dynamic environment in terms of public funding and expectations of their stakeholders.

Research in organisational strategy continue to illuminate a competitive landscape characterised by increasing global competition, rapid technological change, and shorter product life cycles [4–6]. To meet these challenges in the current competitive environment, firms need to advance knowledge and new technologies to ensure long-term prosperity and survival [4,7]. This has necessitated firms tap outside resources, including universities. Firms cannot afford to be constrained by limited expertise and resources available in-house [8–12]. University – industry alliances represent an evolving trend that can help spur the advancement of knowledge and new technologies [13–16].

Although university – industry (U/I) relationships have a long history [17,18], the literature is limited to emphasising access and the sharing of monetary and intellectual resources. Studies conducted by the National Science Foundation [19,20] pointed out that benefits to universities include corporate funding and employment opportunities for the students and graduates. Benefits to a firm include access to highly trained students, facilities, and faculty as well as an enhanced image when collaborating with a prominent academic institution [14,19,21]. Thus, the resource-based view underpins much of the literature on U/I relationships.

This resource-based view of U/I interaction while important, tells only part of the story. In their forthcoming book, Richard Lester and Michael Piore [22] at Massachusetts Institute of Technology consider the university a public space for knowledge exchange. University centres provide a forum for discussion and an ‘interpretive’ process for the development of technology. They have concluded that:

“the most important contribution the research university can make to industry, above and beyond the quantity and quality of its graduates, is to help expose private companies to a broad range of new ideas. A company that demands an exclusive, proprietary research relationship may not only be damaging the university, it may also be reducing the value that it will ultimately derive from that relationship.” [23]

In this paper, we go beyond much of the current U/I literature and present a thesis that the U/I relationship is a way of building social capital for the participating firms and its community that can be conducive to propelling and sustaining economic development and growth. This view helps to clarify the entire process of university – industry collaborative relationships and their effectiveness. In the following sections we begin by defining social

capital, linking the importance of social capital to intellectual capital and knowledge creation, discussing these linkages within the context of U/I relationships, and concluding with implications for practice and future research.

2 Social capital in the context of university – industry relationships

2.1 Definition of social capital

Although social capital has been an intuitively attractive concept to explain the differences in economic development of regions or states, there appears to be some disagreement in terms of its meaning. Bourdieu [24] defined social capital as the potential resources linked to a durable network of social relations that is institutionalised. Coleman [25] defined social capital by its function. He viewed social capital as facilitating transactional activities through a preexisting social network. Robert Putnam at Harvard University first introduced his idea about the lack of social capital as the cause of some of the economic and social maladies of the USA in 1973 [26] and expanded in 2000 [27]. He defined social capital as: ‘connections among individuals – social networks and the norms of reciprocity and trustworthiness.’ Portes and Landolt [28] defined social capital as a supporting relationship among people involved in economic transactions. Burt [29,30] attributed social capital to ‘information and control advantages of being the broker in relations between people otherwise disconnected in social structure.’ In other words social capital is a resource that a person either has or can develop by being able to bridge the structural holes in a social network.

The concept of social capital became prominent in the business literature in 1998. Pennings, Lee *et al.* [31] defined social capital as supporting relationships. Nahapiet and Ghoshal [32] and Woolcock [33] provide comprehensive definitions of social capital that are similar in many respects. Nahapiet and Ghoshal [32] defined social capital as

“the sum of the actual and potential resources embedded within available through, and derived from the network of relationships possessed by an individual or social unit. Social capital thus comprises both the network and the assets that may be mobilised through that network.” [32]

Woolcock [33] defined social capital in terms of networks and norms that enable people to work collectively. Based on the review of a number of studies, Adler and Kwon [34] defined social capital as the ‘goodwill available to the members of a social network’ where information, influence and solidarity are provided to the members by the network.

2.2 Empirical research on social capital theory

Social capital theory has recently been applied to a number of studies at both micro and macro organisational settings. Some of the phenomena explained using social capital theory are summarised by Adler and Kwon [34] and include:

- career success [35–37]
- executive compensation [29,38]
- job search [39–42]
- enrichment of pool of candidates for recruitment [43]
- inter-unit resource exchange and product innovation [36,44,45]
- creation of intellectual capital [32,46]
- cross-functional team effectiveness [47]
- employee turnover [48]
- organisational performance and dissolution rates [31]
- entrepreneurship [49,50]
- success of start-up companies [51,52]
- strength of supplier relations [53–59]
- regional production networks [60]
- inter-firm learning [61]
- internationalisation of firms [62].

One of the criticisms raised about the social capital concept is that it has been used as a panacea for all types of organisational issues [28,63] and a key causal explanatory variable by economists for economic development [64]. While we concur that social capital theory is not applicable to all organisational and economic circumstances, social capital theory needs to be further examined within the context of U/I relationships.

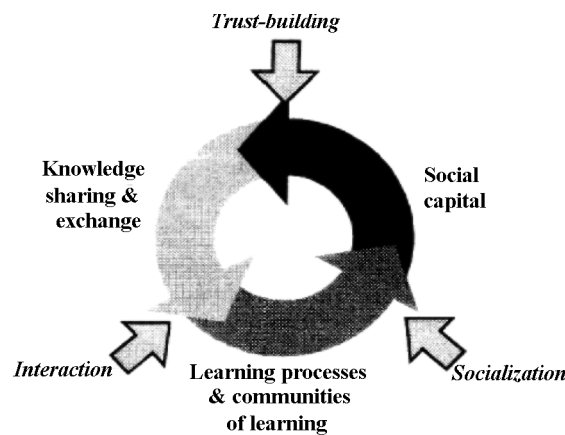
2.3 Importance of social capital in intellectual capital and knowledge creation

Studies conducted to explore R&D organisational performance and knowledge creation provide especially relevant information about the applicability of social capital theory in university – industry relationships. For example, Gabbay and Zuckerman [36] and Regan and Zuckerman [65] found that the performance of R&D scientists is related to the creation of social capital as exemplified by R&D scientists' network connections. To further understand the knowledge exchange process, we look at the mode of transfer of knowledge and the nature of knowledge in terms of its communicability.

Transfer of knowledge takes place either through personal or impersonal channels. Nonaka and Takeuchi [66] differentiated knowledge as tacit or explicit. Explicit knowledge is codifiable and easily expressible. Tacit knowledge is not visible, difficult to formalise, not easily expressible, and often highly personal. In order to implement new technology in product or processes, industry needs tacit knowledge. Thus there remains a chasm between what industry needs and what universities are generally geared to offer. Universities are often engaged in developing generic theoretical knowledge that is codified and transmitted through papers, patents and presentations. Industry needs tacit knowledge that can be applied and interpreted for specific problem situations. The chasm between the needs of industry, i.e. applications and specific problem solutions, and

what universities generally offer, i.e. papers, patents, and presentations, can be described in three dimensions: structural, cognitive and informational. Traditionally, a structural mechanism for industry to interact with academic professionals in universities is often lacking. Cognitively, industrial firms and universities differ in terms of their philosophies, cultural orientation, and priorities. As a result, the information that is conveyed when industrial firms and universities interact is not very meaningful or beneficial to each of the partners. Carayannis, Alexander and Ioannides [67] showed that the knowledge exchange process is symbiotically related with the learning process and the building of social capital based on trust, socialisation and member interaction.

Figure 1 Knowledge sharing, learning and social capital [68]



For universities to be effective in fostering high technology entrepreneurship, one needs to bridge the gap as we have outlined above. The dimensions gap between industrial firms and universities are components of social capital [32] that consists of 'networks of strong, cross-cuttings personal relationships developed over time that provide the basis for trust, cooperation and collective action'. Nahapiet and Ghoshal [32] further suggested that 'social relationships – and the social capital therein – are an important influence on the development of intellectual capital' where intellectual capital requires 'contextually embedded forms of knowledge.'

The combination and exchange of intellectual resources leads to the development of intellectual capital. This combination and exchange process depends on four factors:

- 1 access to the parties involved
- 2 perceived value of such interactions
- 3 motivation for engaging in such activities
- 4 creative capability of the parties.

Since much of this knowledge is socially embedded [32] the three dimensions of social capital affect all four factors that are antecedent to knowledge creation.

3 The changing role of universities and nature of scientific research: examples from Finland and the US [68]

The primary missions of universities are learning and knowledge creation. The culture of academic freedom creates a conflict when a firm or an agency dictates the terms and conditions of support for research including the ownership of intellectual property rights and restrictions on publication. Faculty norms dictate intellectual freedom and the ability to disseminate knowledge through published material [70].

Research in universities is often viewed on a continuum of basic to applied research. While descriptive, this one-dimensional analysis does not help us to understand the complexity of the issues involved. Stokes [71] developed a quadrant model (Figure 2) of scientific research based on two dimensions that inspire research. These two orthogonal dimensions include

- 1 quest for fundamental understanding
- 2 considerations for use

Research in atomic structures by scientists like Nobel laureate Niels Bohr was driven by a quest for fundamental understanding with little consideration for its commercial use. In contrast, Thomas Edison's work was driven mainly by considerations for use and little by quest for fundamental understanding. Louis Pasteur was concerned with fundamental understanding as well as use. Employing Stokes' schema, if academic research needs to be utilized more, then the Pasteur quadrant appears most appropriate.

Figure 2 Pasteur's quadrant of scientific research [72]

		RESEARCH INSPIRED BY	
		CONSIDERATIONS OF USE	
QUEST FOR FUNDAMENTAL UNDERSTANDING	YES	NO	YES
	NO	PURE BASIC RESEARCH (BOHR)	USE-INSPIRED RESEARCH (PASTEUR)
			PURE APPLIED RESEARCH (EDISON)

To understand how the Finnish technical universities and institutions differ from the US technical universities and institutional structure, we can compare the nature and applicability of knowledge developed in Finnish universities to US universities. First, we categorise knowledge in two ways: theoretical and problem solving. In terms of applicability of knowledge, it can be either generic or context-specific. Finnish universities tend to be high on the problem-solving type of research mostly in specific situations. The institutional system in Finland promotes this type of focus. For example, Tekes, the technology development agency funds academic research only if the research is jointly sponsored by one or more companies. In projects such as these, companies have much control over intellectual property rights and as a result most of the theses and doctoral dissertations in Finland are focused on solving corporate problems. In developing technology policy and identifying priority areas for funding, Tekes often relies on committees consisting of both academics and corporate executives. Finally, the boundaries between the academic and industrial organisations are much more permeable and fluid than in the USA. Consequently, many of the top executives in the corporate and public organisations move from or to universities at different points in their careers.

In the USA, universities are motivated to work more on theoretical knowledge development since reward systems in the USA academic institutions encourage faculty to be primarily engaged in theoretical and a more generic type of research. While public funds can seldom be used to further the interests of a specific company, there are some notable exceptions. For example, the Small Business Innovation Research (SBIR) programme at the National Science Foundation is aimed at rectifying this situation and is geared to helping small companies further their innovative activities. Unfortunately, programmes such as these are too few and often small companies are not properly equipped to tap into them. Moreover, most collaborative programmes funded at the universities by public money are aimed at pre-competitive technology development, meaning that the output from these programmes needs additional investments to help bring new technologies to the marketplace.

3.1 A social capital perspective on the university – industry relationships in the USA

In examining U/I relationships in the USA, we have focused on university research centres because these centres encourage diverse collaborative activities, have identifiable formal structures, and an explicit mission to transfer knowledge with industrial firms [16,72]. The National Science Foundation in the USA has taken a significant role in helping universities to organise research centres such as Engineering Research Centres (ERCs) and Industry – University Cooperative Research Centres (IUCRCs) in order to promote industry participation and stimulate technological advancement in certain key technology fields. Many university research centres have been established without any direct NSF support and these centres are also included in our work. While unique structural and contractual features distinguish university research centres, our focus is more holistic; on the key industry factors associated with various I/U relationship alternatives across a variety of university research centre models.

U/I relationships usually encompass four major inter-related components: research support, cooperative research, knowledge transfer and technology transfer. We describe each of these relationship components in the following section.

Research support is the least interactive of the four U/I relationship components since research support embodies financial and equipment contributions made to universities by industry. Financial and equipment contributions can be unrestricted gifts or endowment trust funds that the university uses to upgrade laboratories, provide fellowships to graduate students, or provide seed money for promising new projects [73]. In the past, industry often contributed large amounts of unrestricted funds and equipment for university research [73]. Industry support for university research is now more targeted and often tied to specific research projects that pay dividends by providing industry with knowledge and new technologies for the long-term [74].

Cooperative research relationships are more interactive than research support and include contract research with individual investigators, consulting by faculty, and certain group arrangements specifically for addressing immediate industry problems [20]. The firm works with the university research centre's faculty and staff through industry advisory boards and centre-sponsored research seminars so the firm can pursue a specific initiative through a formal network with a coordinated research agenda [75].

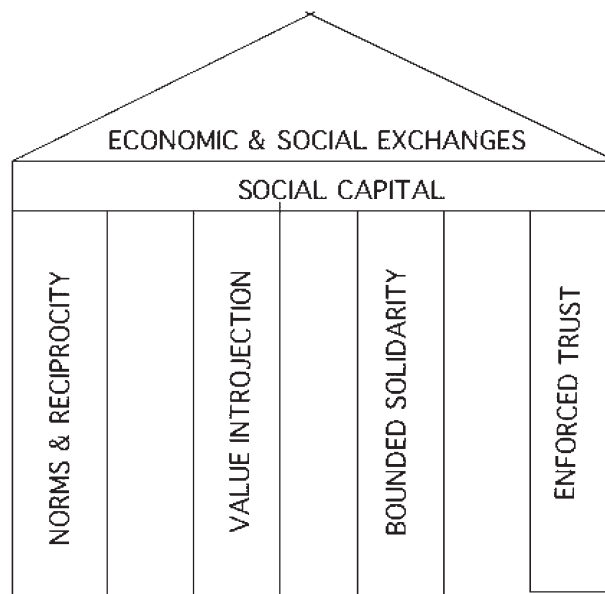
Knowledge transfer encompasses a much broader array of highly interactive activities that include ongoing formal and informal personal interactions, cooperative education, curriculum development, and personnel exchanges [73]. Ongoing formal and informal personal interactions to transfer knowledge takes many forms. Examples of knowledge transfer mechanisms are industry – university research consortia, trade associations, and the co-authoring of research papers by university and industrial firm members [14,76]. Recruitment of recent university graduates and employing student interns continue to be chief ways knowledge is transferred between industry and academe [77]. Knowledge transfer also happens through cooperative education programmes which are designed to encourage information exchanges and on-the-job training experiences for undergraduate and graduate students [77]. Cooperative education programmes help universities train students in state-of-the-art techniques ensuring that graduates meet industry's needs [78].

Technology transfer is the fourth U/I relationship component and like knowledge transfer also involves a number of highly interactive activities. Compared to knowledge transfer the focus here is on addressing immediate and more specific industry issues by leveraging university driven research with industry expertise and parlaying these complementary contributions into commercialised technologies needed by the marketplace [14,79]. Often the university research centre provides both basic and technical knowledge along with technology patent and/or licensing services while the industrial community provides knowledge in a specific applied area along with a clear problem statement related to market demand [80]. Technology transfer occurs in many ways such as through technological consulting arrangements, the firm's use of centre-sponsored extension services, and jointly owned or operated ventures. Joint ventures usually represent large-scale commitments by both the firm and university to transfer technologies and are often based on successful prior relationships between the firm and the university research centre [19].

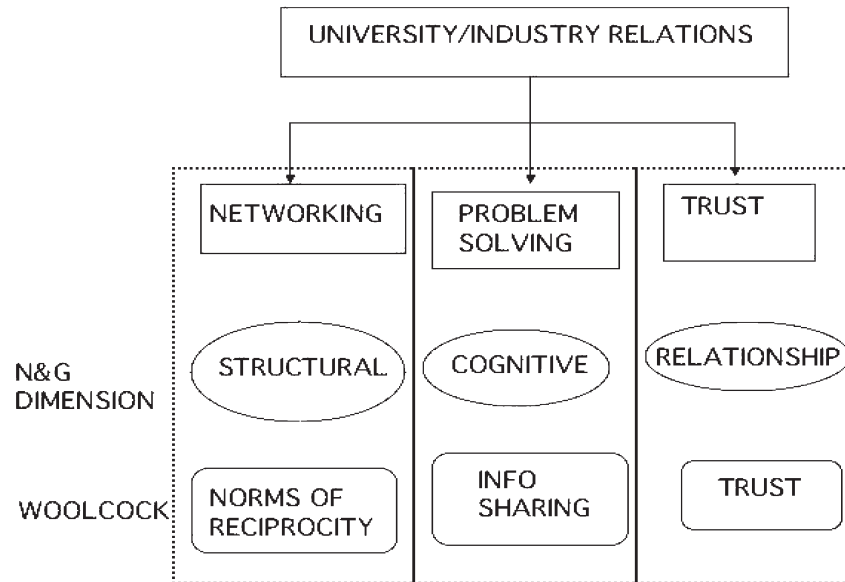
To summarise, in the preceding section we have presented four distinct yet highly related ways in which industrial firms and university research centres work together to provide firms with an array of possibilities for pursuing different objectives related to advancing knowledge and new technologies. Along with this resource-based view of U/I relationships, we now explore the role of social capital within this context.

Woolcock [33] presented a comprehensive definition of social capital anchored to established behavioural theories. Drawing from the work of George Simmel, Woolcock [33] identifies *reciprocity of transactions* based on the norms and obligations of a personal network as one foundation of social capital. Following Durkheim and Talcott Parsons, *value introjection* is the second pillar of social capital [33]. Existing values and moral standards constitute the value system that guides subsequent transactions, thus *bounded solidarity* among network members is the third element where this notion is rooted in the Marxist philosophy of social cohesion to deal with adverse situations. Finally, *enforced trust* is the fourth foundation of social capital as outlined by Max Weber in his theory of bureaucracy where organisational rules and policies are the means to enforce trust among the members. Figure 3 depicts Woolcock's model of the Four Pillars of Social Capital [33].

Figure 3 Four pillars of social capital



To better understand the U/I relationship dynamic, we studied 21 university research centres in the USA (for details please see Santoro and Chakrabarti [81]) in terms of their interaction with industry and their contribution to the development of intellectual assets. Following Nahapiet and Ghoshal's [32] definition, we used confirmatory factor analysis to identify three dimensions of interaction patterned after social capital. These three dimensions of interaction are networking, problem solving and trust. In Figure 4 we present our three dimensions of social capital and compare those with both Woolcock's [33] and Nahapiet and Ghoshal's [32] notions by overlaying all three contributions into one framework.

Figure 4 Mapping dimensions of social capital with university/industry relationship

From our work studying U/I relationships, the items that constituted the networking dimension are:

- student interns hired by the firm as a direct result of the u/i relationship
- recent university graduates hired by the firm
- level of participation in research centre sponsored consortia
- participation in trade associations
- number of personnel exchanges with research centre
- level of participation in jointly owned or operated facilities specifically for advancing new technologies.

These items set the structure for interaction between a university research centre and an industrial firm. Comparing what Woolcock [33] has described in his paper, we find that these procedures may be analogous to forming norms and reciprocity in U/I relationships.

The second dimension in our study was manifested in the following items:

- time spent interacting with centre personnel specifically for advancing new technologies
- level of joint decision making in technological consulting arrangements
- level of joint decision making with centre personnel specifically for advancing new technologies
- level of participation in research centre sponsored research seminars
- level of participation in co-authoring research papers.

We termed these activities as the problem-solving dimension and these are similar to Nahapiet and Ghoshal's [32] cognitive dimension of social capital and Woolcock's [33] notion of information sharing.

Our third dimension relates to trust as exemplified by the following three items:

- 1 extent the firm is willing to share ideas, feelings, and specific goals with the university research centre
- 2 extent the firm doubts the university research centre's competence as well its motives and fairness in sharing its abilities (reverse score)
- 3 extent the firm perceives that the university research centre adheres to a set of principles that the firm finds acceptable.

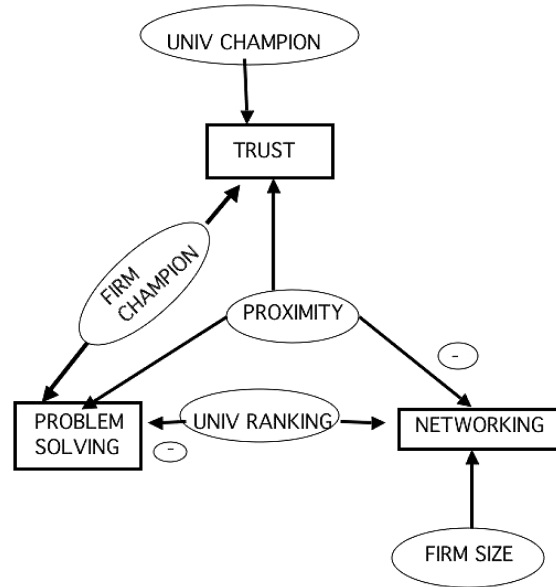
These three items capture what Woolcock [33] termed as trust and what Nahapiet and Ghoshal [32] described as the relational dimension of social capital.

3.2 Factors related to social capital in university – industry interactions

We concluded from our study of U/I relationships that determinants of the different dimensions of social capital are quite different. Specifically, we found that trust is affected by the presence of a dedicated champion in both the university and the firm. The individuals committed to promoting U/I relationships play a significant role in developing and nurturing the relationship. We also found that geographic proximity between the firm and the university research centre also helps in relation building.

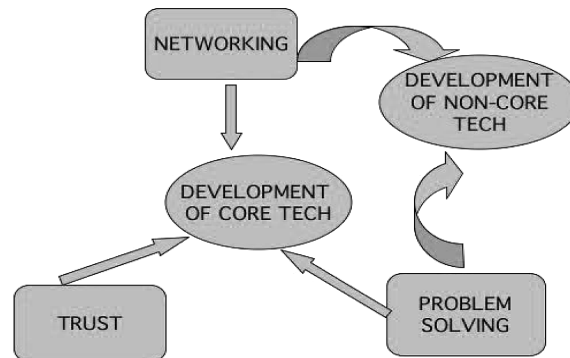
For the problem-solving dimension, we found that both geographic proximity and the presence of a champion [82] within the firm are important. In other words, there needs to be a certain individual within the firm who can work with the university centre to develop and maintain a bridge between the firm and the university in terms of the latter's ability to understand and solve problems. Here, close geographic proximity helps in maintaining this bridge. Quite unexpectedly, we found that higher university reputations were negatively associated with this problem-solving aspect. That is, the more prestigious a university the less inclined faculty are to work on the specific applied problems of a firm. Our most recent interviews in Finland support this finding.

With respect to the networking dimension, we find that a university's academic ranking is an important variable while geographic proximity between the industrial firm and university research centre is not. Examples of this abound where large companies such as Nokia and Novartis, to name just two, develop linkages with prestigious universities like Stanford, MIT, Harvard, and Cambridge even though their company headquarters are located far away. Burt's [29,30] notion of weak ties is appropriate here since it seems that university research centres bridge the many gaps and form weak ties with the faculty and research community surrounding these universities. In line with this dimension, we also found that large companies are generally interested in networking possibilities. Figure 5 provides the graphic representation of our findings in this area.

Figure 5 Underlying factors for university/industry relations

3.3 Effect of the three social capital dimensions

We explored how the three dimensions of interaction patterns affected technology development and commercialisation. All three dimensions, networking, trust, and problem-solving, are important in the development and commercialisation of a technology that is core to the firm. Firms need to be better integrated with university research centres in terms of a shared vision, understanding mutual needs, and information sharing, especially when the firm is working with a university research centre to help with a core technology. In the case of non-core technologies networking and problem-solving appear to be the two relevant dimensions. Figure 6 provides the pictorial presentation of our findings and offers a better understanding for managing the U/I collaborative process.

Figure 6 University/industry relation and its effect

4 Summary and conclusions

University – industry interactions have gained much attention in recent years since, in many countries, universities are viewed as significant engines of economic growth. With the emergence of a knowledge economy, the importance of universities as facilitators for developing and advancing high technology based industries has gained much prominence. Experience gained in regions such as the Silicon Valley, the 128 corridor around Boston, Cambridge UK, and Berkeley, California highlight the importance of universities in this role. The literature on university – industry interaction is rooted largely in the resource-based view since success of U/I relationships has traditionally been measured in terms of technology transferred, patents licensed, placement of students and graduates, and consulting and research contracts awarded.

In this paper, we have taken a different approach to understanding U/I relationships. We posit that the development of social capital is another way to measure the value of these relationships. Along these lines, Agrawal and Henderson [83] conclude that ‘patenting as a measure of impact of university research must be carefully qualified by the recognition that patenting may play a relatively small role in the transfer of knowledge out of the university’. There are many mechanisms for technology transfer from a university to a firm including patents and licenses, publications, consulting, informal conversations, co-supervising theses, conferences, research collaboration, and the placement of university interns and graduates. Agrawal and Henderson [83] also found that firms that collaborate on patented research are different from those that collaborate on published research and those who cite the research published by a university faculty. Many avenues are thus available for U/I interactions. Moreover, firms differ in their characteristics and needs; U/I interactions must be tailored accordingly.

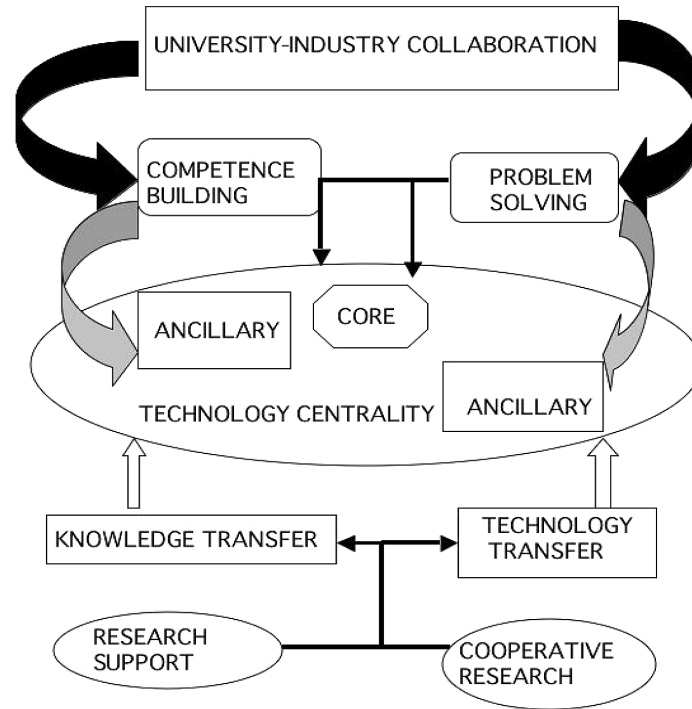
As drivers of economic growth, universities should also be the third component of a tripartite relationship involving private enterprises and public agencies to help foster knowledge intensive businesses [84]. To this point, Benner and Sandström [85] advocate changes in academic research funding in order to stimulate these tripartite engagements.

Our study of university – industry relationships punctuates the multi-dimensional contributions universities can make. As Figure 7 depicts, universities can aid industrial firms by helping them solve specific problems and by strengthening competencies in a firm’s core business area(s) or in areas ancillary to the firm’s core business.

Finally, many studies in the area of university – industry relationships have focused on the tangible benefits of technology transfer and knowledge transfer. We believe that the contribution of universities is much broader; the metrics for evaluation must recognise this.

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Figure 7 Multi-dimensional contributions of university-industry collaboration

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