

DETERMINANTS OF R&D COOPERATION:
AN INSTITUTIONAL PERSPECTIVE

*FACTORES DETERMINANTES DE COOPERACIÓN EN I + D:
UNA PERSPECTIVA INSTITUCIONAL*

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ABSTRACT

Existing literature on the determinants of research & development (R&D) cooperation discusses mainly the factors which are specific to organization. But the issues of institutional environment in which such interactions take place remain relatively less explored. This study identifies some particular institutions such as 'Research and Technology Transfer', and the 'regulatory' institutions which promote R&D cooperation in a country. The study is limited to some particular formal institutions which help improve R&D cooperation. The conclusions of the study have important policy implications for less developed countries so that they could improve the R&D resources of their organizations by attracting foreign organizations through the establishment of institutions necessary for R&D cooperation.

Keywords: R&D Cooperation; Institutions; Research and Technology Transfer Institutions; Regulatory Institutions.

RESUMEN

La bibliografía sobre los factores que determinan la cooperación en investigación y desarrollo (I+D) estudia principalmente los factores que son específicos de la organización. Pero los aspectos relacionados con el entorno institucional, en el que tales interacciones tienen lugar, permanecen relativamente menos estudiados. Este trabajo identifica algunas instituciones específicas como “centros de investigación y de transferencia de tecnología” y las instituciones regulatorias que promocionan la cooperación en I+D en un país. El estudio está limitado a algunas instituciones específicas pero formales que ayudan a mejorar la cooperación en I+D. Las conclusiones del estudio pueden tener implicaciones políticas importantes para los países en vías de desarrollo que pueden mejorar los recursos de I+D de sus organizaciones atrayendo a las organizaciones externas por medio del establecimiento de las instituciones necesarias para la cooperación de I+D.

Palabras clave: Cooperación en I+D; Instituciones; Instituciones investigación y transferencia de tecnología; Instituciones regulativas.

JEL Classification: O17, L38.

1. INTRODUCTION

Technologies are changing rapidly around the world, which alter the competition basis (McGahan, 2004) in marketplace. This situation requires the firms to be efficient and innovative so that they could timely produce their products at a lower cost. It, however, needs a lot of resources (Li, 1995). It might be difficult for a single firm to generate these resources within a given framework of time. In this complex situation, higher costs and risks associated with innovation have increased the importance of Research and Development (R&D) cooperation (Hagedoorn, 1993; Dogson, 1993). R&D cooperation opens to the firms, the opportunities such as; access to external resources, knowledge and new technology (Piller, 2004). These opportunities enable the firms to involve in product innovation at a reduced cost and with a shared risk. So it can be said that firms cooperate (in R&D activities) with each other and/or with research organizations to improve their efficiency and competitiveness at a lower cost and lesser risk.

Existing literature from Industrial Organization (IO) and Management has examined the importance of R&D cooperation among firms. The focus in IO literature is on knowledge spillovers which benefit the cooperative firms when they invest in improving their absorptive capacity (Cohen and Levinthal, 1990). This literature studies the performance and incentive side of R&D cooperation among competing firms (Amir et al., 2003). The Management Literature looks the R&D cooperation from the point of view of complementarities of know-how among partner firms (Kogut, 1988; Das and Teng, 2000). Management literature focuses on two perspectives; transaction cost economics and resource based view (Barney, 1991). The transaction cost approach (Williamson, 1975) looks at the transaction cost differences with and without cooperation. The resource based view looks the cooperation as firms' resource to improve their efficiency. In addition to the literary research on 'inter firm' cooperation; the both strands of literature also look at the efficiency impact of cooperation between firm and university/research institutes. In his work on some specific U.S. manufacturing industries over the period of 40 years, Adams (1990) found a positive relationship between academic knowledge and productivity. University-Industry cooperation has been seen as an important link between basic and applied research, which improves the technological potential of partners (Mora et ál., 2004).

It has been observed that existing literature on the determinants of R&D cooperation is mainly focused on organization specific factors to study the motives of cooperation among organizations and how these motives alter the initial settings and outcomes (Hagerdoorn, 1993, Chung et al, 2000). These studies are mainly concerned with the initial conditions i.e. the organizational features or partner's routines (Doz et al., 2000) to determine the interaction among R&D partners. But the issues of institutional factors in which such interactions take place remain less significant.

In this paper, we argue that institutions can play an important role in setting cooperative (or non cooperative) behavior of organizations. In a study on comparison of industrial policy of Japan and Korea, Sakakibara and Cho (2002:674) found that "Closer examinations of the structure of Korean R&D consortia reveal that Korean R&D consortia did not fully promote R&D cooperation, knowledge-sharing, or scale economies equivalent to the Japanese level, even to the level reached by Japan in the 1960s. The organizational and *institutional structures developed under Korean industrial policy became an obstacle to the effective implementation of cooperative R&D*". It implies that the institutional structure of a country might have some significance in explaining the support for and implementation of R&D cooperation. It is, however, important to explore the institutions which promote such cooperation. This article is aimed to discuss some specific institutions that determine and impact the R&D cooperation in a country.

It is widely accepted among the economists that the institutions are the 'rule of game', the broad legal regime and the ways of its enforcement, and a set of widely accepted norms which constrain individual and collective behavior in a society (North, 1990). Institutions also refer to the 'governing structures' in an economic system, for example; the ways to manage and organize the firms (Williamson, 1975, 1991). These governing structures and rules are *needed to solve cooperation dilemmas that, if left to individuals, would not be solved* (Tummolini and Castelfranchi, 2006).

The purpose of this study is not to engage in the philosophical discussion on institutions nor introduce the whole set of institutions affecting cooperative behavior in an economy. But the purpose is to shed light on some concrete/particular institutions which once placed well in a country, enhance cooperation in research and development. Economists like Veblen (1899, 1915) and Hodgson (1988, 2006) relate the 'institutions' with customs, standard and expected patterns of behavior in particular contexts (Nelson, 2008). While considering 'R&D Cooperation' we note that there is need to study some particular institutions that affect the patterns of cooperation among organizations. For this motive we present a discussion on; the research and technology transfer institutions and, the regulatory institutions. We believe that the existence and well functioning of these institutions will enhance R&D cooperation in a country. The rest of the work is organized as following. Section 2 looks at the institutions related to research and technology transfer, and explains how

these institutions support R&D cooperation. In the same way, section 3 studies regulatory institutions and their role in enhancing R&D cooperation. Section 4 presents conclusions and policy implications.

2. RESEARCH AND TECHNOLOGY TRANSFER INSTITUTIONS

The possibility and success of R&D cooperation depends much on the institutions which create an environment of research, access to knowledge and technology transfer. These institutions regulate and facilitate knowledge movement and interaction between research organizations and business actors by establishing a framework of procedures and incentives. These institutions not only provide the knowledge base but also a suitable infrastructure to cooperative R&D activities. Higher Education Institutions (HEIs), Technology Transfer Offices (TTOs) and Science Parks (SPs) are among the most important actors in this regard. HEIs develop and maintain human capital which provides the base for interaction between knowledge seeking innovative firms and universities. TTOs enhance R&D cooperation by reducing uncertainty and easing technology transfer among partners in a formalized way. SPs bring together the researchers and firms and provide an infrastructure for university-industry and inter-firm cooperation. In this section the role of HEIs, TTOs and SPs in R&D cooperation has been discussed briefly.

2.1. HIGHER EDUCATION INSTITUTIONS

Higher education, in a broad sense, includes universities, institutes of technology and public/private research institutions. Traditionally, the role of HEIs as the centers of basic research is well known. These institutions are an important source of new knowledge creation (World Bank 2008) and inputs for private sector innovation. They provide a high level skill base to the economy. They also transform new knowledge from science base to innovative products, services and processes.

Education provides strong basis for R&D and Innovation in an economy. It is associated with a higher capability to innovate or assimilate outside innovation (Nelson and Phelps, 1966). A higher education system with science orientation improves the scientist pool (Varsakelis, 2006) of a country. Scientists are the output of education system, but they are also input to knowledge creation (Grilleches, 1990; Acs et al., 2002). In an economy, the existence of a large number of good quality scientists will improve R&D and innovation activities (Varsakelis, 2006).

This section looks at the twofold role of higher education in R&D cooperation: a- higher education increases the possibility of R&D cooperation directly by participating in R&D with industry/firms; b- higher education fosters R&D cooperation indirectly by providing base for inter-firm R&D cooperation.

Higher Education Institutions are important in their role as participants of R&D with firms. Collaboration between higher education institutions and industry improves the absorptive capacity (Cohen and Levinthal, 1990) of firms and makes them able to access and use external knowledge (OECD, 2008). Higher Education Institutions, being the centers of scientific research which is necessary for technological change and innovation, attract the firms to collaborate with them in R&D activities. HEIs provide opportunity to the firms to access the complementary research activity and key university personnel (Hall et al., 2001) which motivate the firms to participate in R&D with these institutions. So, the presence of high quality HEIs in an economy will increase the possibility of R&D cooperation between firms and HEIs.

In R&D cooperation literature there is much evidence on the direct participation of higher education in R&D collaboration with industry but less evidence has been found on its indirect role in inter-firm collaboration. To look at this role of higher education, first, it is argued that higher education, by developing human capital which is complementary to R&D (Aghion and Howitt, 1998), creates an environment in which highly qualified and skilled labor facilitates firms to invest in R&D (Redding, 1996). To relate this argument with inter-firm R&D cooperation, it is further argued that within an environment of R&D, firms need to cooperate with each other because their skill and knowledge are heterogeneous. Sharing skills and knowledge of heterogeneous firms creates knowledge which is valuable for partners. In his study about Japanese R&D consortia, Sakakibara (1997a) stresses the importance of the “skill-sharing” motive of R&D cooperation as opposed to the “cost-sharing” one. This implies that skill and knowledge sharing are among the major motives of firms to cooperate in R&D projects. But such cooperation is less probable to take place if each partner doesn’t possess a certain level of skills which can attract other partner to participate in R&D cooperation. The skill portfolios of firms highly depend on the higher education institutions of the country. So, it can be said that higher education institutions have a positive impact on inter-firm cooperation by improving skill portfolios which make firms more attractive for R&D cooperation. Second, it is argued that quality education in a country creates awareness among firms to be innovative and competitive. In this way, education improves the pool of a country’s entrepreneurs who demand innovation and efficiency in production (Varsakelis, 2006). Moreover, as innovation is encouraged by quality conscious customers (Furman et al., 2002), education increases the demand for quality goods and services by improving cognitive abilities of customers (Varsakelis, 2006). Both these demands can create an environment of competition and innovativeness which will force the firms to invest in R&D. As the importance of competition in R&D cooperation has been well recognized in literature, HEIs will level the playing field for inter-firm R&D cooperation. So, higher education increases the possibility of inter-firm R&D cooperation by creating demand for new products and services, and innovativeness. Finally; as it is well known that most of the basic research is conducted at HEIs/universities but its further

development for commercialization is done by the firms (Etzkowitz, 1998). The results of basic research can increase the possibility of inter-firm R&D cooperation during the commercialized development phase. So, the higher the basic research conducted at universities the higher the probability of inter-firm cooperation.

2.2. TECHNOLOGY TRANSFER OFFICES

Technology Transfer Offices (TTOs) coordinate the interactions between university and industry and manage the university Intellectual Property. They act as mediators for the technology transfer from the public to the private sector. They facilitate the diffusion of technology by licensing the university research to industry. In literature, the importance of TTOs has been seen in the context of university-industry partnership and technology transfer. Hall et al. (2001) assume such partnership as a formal contractual relationship, like licensing agreements between universities and firms and research joint Ventures managed through TTOs. In United States, almost all research universities have established TTOs to manage their relationship with industry, and commercialize and transfer their research.

Close university-industry collaboration is necessary to fully exploit the scientific and technological resources controlled by the universities, otherwise these resources will remain under-utilized and the universities will be unable to play a positive role in industrial competitiveness of the country. But, as explained by 'two culture problem' (Snow, 1959; Declercq, 1981), the university and industry have different norms and attitudes which separate university from industry (Lee, 1996). These differences are barrier to close university-industry collaboration (Rosenzweig, 1982). Under such circumstances, many potential university-industry cooperative agreements on R&D might not take place or will fail to be completed. This situation suggests a strong rationale for TTO which can act as mediator to minimize 'two culture problem' and enhance cooperation. Moreover, TTOs can play a vital role in institutionalizing the university-industry cooperation by defining well the objectives of R&D cooperation (Dierdonck and Debackere, 1988). Mora et al. (2004) find a positive relationship between the degree of institutionalization and the success of cooperative agreements.

University-Industry cooperative relations are prone to uncertainty problem attached with the results of research when the research project is sponsored by the industry. Firms will be reluctant to invest in an invention if they are uncertain about the value of new technology. In a theoretical model developed by Hoppe and Ozdenoren (2005), firms looking to invest in an invention are uncertain about the value of technology. In this model, TTOs play a role of reducing uncertainty problem. The reduction of uncertainty will increase the possibility of cooperation between university and industry. Moreover, TTOs also play an important role in identifying the new opportunities of university-industry collaboration.

2.3. SCIENCE PARKS

Neoclassical Economist Alfred Marshall (1890), in his famous book “The Principles of Economics”, presented the concept of Industrial District, “The Marshallian industrial district”. The idea behind the concept of industrial district is the geographical clustering of firms to exploit external economies, facilitate knowledge transfer and improve skill and learning. The Marshallian industrial district allows the firms in district to access easily to skilled labor and exchange useful information rapidly. The concept of Science Park is highly related to the concept of the Marshallian industrial district. Science Park is a constructed cluster which is (normally) induced by public policies. According to MacDonald (1987) “Science parks are high technology property developments associated with universities”. There is a lack of uniformity in the definition of Science Park and that the different terms (Löfsten and Lindelöf, 2002) have been used to describe this concept. The establishment of Science Parks has been given consideration in the innovation models like; “Triple helix” (Etzkowitz and Leydesdorff, 2000) and “National System of Innovation” (Lundvall, 1992).

Among the core objectives of science parks are to promote university-industry cooperation, and create spin-offs and new technological based firms (Westhead and Batstone, 1999). According to Löfsten and Lindelöf (2005), Science Parks provide an important resource network for New Technology Based Firms (NTBFs). Science Parks also attract existing firms into a given location (Felsenstein, 1994). These parks work as bridge between technology, industry, and R&D into specific locations (Bass, 1998).

The importance of Science Parks in R&D cooperation comes from the notion of positive effect of geographical proximity (Lundvall, 1992; Mowery et al., 1996; Vedovello, 1997) which establishes an infrastructure to create and transfer technology (Benko, 2000). Geographical Proximity develops direct contacts between customers, competitors, universities and research centers (Baptista and Swann, 1998). These direct contacts help to enhance inter-firm and university-industry cooperation, and also enhance informal exchanges through social network development. Such social networks increase the possibility of cooperation not only among vertical production chains but also among competitors. In Porter (1998), it is found that geographic proximity improves communication, trust and coordination which are considered key to the success of cooperative R&D arrangements. Mora et al. (2004) positively relate geographic proximity to the success of R&D cooperation between firms and research organizations.

3. REGULATORY INSTITUTIONS

Regulatory institutions are an important source of organizations to find out conflict solution (Ewing, 1989) and collect information (Casey et al., 1983). Market imperfections like monopolies and externalities are dealt with the incentives and penalties framework of legal system (Burk 1985). Regulations play an important role in setting the investment behavior of firms in research

and development. Regulations which protect patents may encourage (Carlin and Soskice, 2006), while the regulations which restrict price and impose product market rules may discourage (Crafts, 2006) R&D investment. Firms' R&D activities and cooperative alliances are influenced by the legal and regulatory environment in which they operate. In this section, we will discuss on intellectual property rights, competition law and contract enforcement.

3.1. INTELLECTUAL PROPERTY RIGHTS

Within the legal system of a country, well defined intellectual property rights help in establishing an environment of knowledge creation and innovation. In such an environment investment in knowledge based business activities increases and firms enjoy the rewards of resulting innovation. Intellectual property rights (IPRs) have been considered as the foundation of modern information economy (Gallini and Scotchmer, 2001) and the engine of economic growth in modern economies (Gilbert, 1995). IPRs improve the overall R&D environment of the country.

R&D cooperation is an important source of knowledge creation and knowledge spillovers, but it can threaten the competitive position of the firms if it is not done under well defined intellectual property rights, especially when cooperating with competitors and/or customers and suppliers. There are always the chances of free-riding (Kesteloot and Veugelers, 1995; Eaton and Eswaran, 1997). That's why the firms give special consideration to intellectual property protection before engaging in such cooperation (Brouwer and Kleinknecht, 1999). Further, when the purpose of cooperation is to discover new technology, the end product (technology) needs protection and can be qualified for intellectual property protection (Karalis, 1992).

Firms participate in R&D cooperation with different type of knowledge assets which, later on, are applied to research and development. These knowledge assets are shared by research partners. Knowledge sharing and the knowledge differences increase the risk of knowledge leakage (Chi and Roehl, 1997; Hagedoorn, 2002). In this complex situation IPRs help partners by defining limits of the partnership's rights with respect to its technologies (Herzfeld et al., 2006).

Intellectual property rights help in forming research joint venture by tracking up each partner's contribution in new technology. If IPRs don't exist, the firms have to write many contracts specific to knowledge, technology etc. Intellectual property rights help firms to avoid from writing more detailed contracts specifying technology rights (Hertzfeld et al., 2006), which saves their time and money.

Among the legal instruments of intellectual property protection, the importance of patents has been well recognized in R&D cooperation literature. Patents are a form of legal protection of intellectual property. A large number of theoretical studies on IPRs actually deal with patent rights. Arora et al.,

(2001) look at the role of patent in technology transfer. Patents might be used to arrange technology transfer between partners (Brouwer and Kleinknecht, 1999) and are important while negotiating with potential partners (Blind et al., 2006). Small innovative firms which use science as base of their business, engage themselves in venture financed R&D activities. Patents are beneficial to venture capital financed small firms (Gans and Stern, 2003).

The importance of patents in University-Industry R&D cooperation increased after the enactment of Bayh-Dole Act in United States in 1980. Under this Act universities were allowed to patent government –funded innovation. The Act encouraged universities to cooperate with firms to commercialize new technologies, which boosted university-industry cooperation and brought tremendous results in U.S economy. After looking at the benefits of Bayh-Dole Act many other countries took such initiatives and brought changes in their legal framework to enhance university-industry cooperation. Policy makers in Europe also considered Bayh-Dole like legislation (OECD, 2003). Japan also enacted the Law for Promoting University-Industry Technology Transfer in 1998. The logic behind Bayh-Dole Act like laws is that by allowing universities to patent their research results will create an environment of knowledge protection across all publicly funded research. One can think that it is something against the free flow of knowledge which can hinder innovation. But to understand well it is necessary to know that most of research at universities is of basic nature which needs further applied research to be commercialized. Applied research needs more investment which needs funds. Private firms can provide these funds if they are sure that the basic research based on which they are going to conduct applied research is not publishes and is well protected, because no firm will be willing to invest in published or unprotected ideas. Patents protect ideas and that's why they are crucial to cooperation between university and industry. So, the legal and regulatory arrangements which encourage universities to patent their discoveries will enhance university-industry R&D cooperation.

A legal environment with weak IPRs protection reduces the possibility to cooperate in R&D because in such an environment new technologies are concentrated within the innovative firms. The firms use new technologies internally to protect their technological advantage of making a good use of them. So IPRs need to be protected to let the firms cooperate in R&D.

IPRs also play an important role in the formation of public private research joint ventures, and act against innovation market failure (Aghion and Tirole, 1994). So, there is no doubt that an environment in which IPRs are well defined and protected, uncertainty about future of joint R&D will be reduced and it will enhance cooperation.

3.2. COMPETITION LAW

Market competition plays important role in firms' strategic decisions toward technological adoption and innovation. Neoclassical economics assumes a model of perfect competition where market price is equal to marginal cost

and that the firms are price takers. Such a perfect competition model does not exist in the real world. Moreover, in such a model there is no incentive for innovation.

In real world we observe different forms of monopolistic competitions or monopolies. Monopolistic competition might exist with large or small number of firms. It is a more realistic model of explaining the real world market competition. Under monopolistic competition firms are not price takers and that prices are greater than marginal costs. Firms' profits under such type of competition depend on their ability to compete, and on the competition intensity (Dixit and Stiglitz, 1977). If the firms are less dynamic in improving their efficiency, high competition might leave them with moderate profits. Moreover, high market competition might become bankruptcy threat for inefficient firms. This threat and moderate profits compel the firms to learn more and be efficient. Adoption of new technology may increase the probability of earning higher profits and decrease the probability of bankruptcy threats. It can be said that the competition and the adoption of new technologies are connected (Canton et al., 2002), and that an increase in market competition leads to efficiency improvement (Griffith, 2001).

Competition is necessary for innovative activities in an economy but it is not true in case of perfect or fierce competition. The importance of competition doesn't necessarily reduce the importance of cooperation. As it is cited in Teece (1992), competition is essential for innovation, but so is cooperation. Teece further cites that finding a right balance between competition and cooperation is important and is a challenge for policy and management. Teece (1992) concludes that cooperation is necessary to enhance competition. Firms operating in a competitive environment are more likely to cooperate with each other because in doing so they will not face any hard budget constraint to invest in R&D complementary assets and that their access to new technologies might be less costly which can save them from bankruptcy threats and increase their profits. Even, cooperation among competitors is important especially in case of innovative firms if they want to be able to compete in global markets. But, the question here is; will the firms engage in cooperative R&D if they fear that antitrust actions (by state law) may arise against them? We believe that the firms will hesitate to cooperate under such situation.

Competition law (or "antitrust or anti monopoly law" in American terminology) has been considered important for well functioning of market economies (Vickers, 2005). Competition Law is necessary to apply for many economic and legal reasons. However, the basic purpose of such law is to prevent business activities and public policies that may unnecessarily impede the redeployment of scarce resources from lower to higher valued uses (UNCTAD, 2002). Many countries have their own competition policies which are based on multiple set of values and that the nature and scope of competition law varies in different countries (UNCTAD, 2002). However, the major objective of competition law is to promote competition and discourage monopolies for

the purpose of economic efficiency and overall welfare in the economy. But if competition law hinders cooperative activities in research and development, it can leave negative impact on innovative firms and overall innovation capacity of economic system. In United States, Sherman Anti-Trust Act, until early 1980s, left the firms reluctant to engage in R&D partnership because they were uncertain about the future of such cooperative arrangements if they were challenged in the court. So the application of this act was hindering the possible innovation activity i.e. R&D cooperation, which now a days is common even among competitors. U.S department of justice took notice of this negative impact of Act and in 1980 issued its antitrust guide which was concerned with joint research ventures. The guide encouraged cooperative research among the firms who were facing the threat of increasing competition (especially foreign competition) and needed to arrange joint efforts to improve technologies and maintain their competitive position.

In 2000, European Commission, by adopting the commission regulation EC-2659/2000, set limits to the application of Article 81 (1) of EU Treaty. Before 2000, this article prohibited the agreements *“which have as their object or effect the prevention, restriction or distortion of competition within the common market”*. However, EC-2659/2000 introduced exemptions for R&D agreements. Article 81 (1) was no more applicable to many R&D agreements.

This shift in the public policy in two main regions of the world shows that joint R&D efforts are important to enhance the competitiveness of firms. This also implies that cooperation should not be seen as a threat to competition and there is a need to find out a balance between competition and cooperation (Teece, 1992).

3.3. CONTRACT ENFORCEMENT ENVIRONMENT

Contract enforcement institutions represent the overall contract enforcement environment of a country. They might consist of contract laws, regulations, enforcement agencies, court systems etc., which are normally the state institutions—the formal institutions. However, there also exist informal or non-state institutions like customary law, social and cultural norms etc. Both types of institutions have their own mechanisms of enforcement. Relative costs of the use of these institutions determine their selection, depending on the type and duration of contract. An efficient contract regime will provide low cost contract enforcement.

Contractual arrangements are made within a contractual environment which is external to the cooperative alliance. The enforcement of such contracts is determined by the quality and ability of the contractual environment in which cooperation is being arranged. The study of contract enforcement environment in R&D cooperation is an important issue. Unfortunately this issue remains less explored in R&D cooperation literature. While looking at the cooperative arrangements in research and development, one cannot ignore

the opportunistic behavior (Oxley and Sampson, 2004) of the partners, which is a threat to cooperation and needs some special contractual arrangements to avoid it.

The matter of contract enforcement (especially in a complex and long term contracting) is largely concerned with the state of 'Rule of Law' in a country, which is imposed and enforced by state controlled legal institutions. Informal non-state institutions can play some role in replacing the weaknesses of state legal system, but they are and unable to compose and enforce contract in modern business environment. In a cooperative arrangement with strangers, informal contract enforcement mechanisms are less likely to be adopted because here the basic conditions (like joint collaboration experience and/or social ties etc.) of mutual trust are not fulfilled. Even when these conditions are fulfilled, formal contracting will reduce risk in future relations especially when high uncertainty is involved. In R&D cooperation agreements high risk and uncertainty are involved. Moreover, many such agreements are among partners who don't have any previous collaboration experience among themselves, and even they are from different countries. In such a situation formal contract enforcement environment becomes more important. Formal contract enforcement will reduce uncertainty and risk, and will provide initiative to unknown parties to cooperate with each other.

In short, in a strong contract enforcement environment, there is a high probability of R&D cooperation while in a weak such environment it is low. The World Bank report (2008) on doing business in China shows that firms under weak contract enforcement are less likely to engage in alliances.

4. CONCLUSION

The objective of the study was to identify some particular institutions and explain how these institutions promote cooperation in interorganizational research and development. Our findings suggest the institutions such as 'regulatory' and 'research and technology transfer' institutions may influence the interorganizational R&D cooperation in a country. Research and technology transfer institutions are fundamental to promote R&D cooperation in a country. In this framework HEIs provide strong basis for direct University-Industry cooperation by providing opportunity to the firms to access the complementary research activity and key university personal, while they also enhance inter-firm collaboration by providing to the firms a certain level of skills which can attract other partner to participate in R&D cooperation. HEIs also create an environment of competition and innovation which will force the firms to invest in R&D and cooperate with other firms for complementary resources. TTOs support R&D cooperation between University and Industry by overcoming the two culture problem and reducing uncertainty.

Within the framework of regulatory institutions, IPRs enhance R&D cooperation by reducing the possibility of free-riding and knowledge leakage,

and by establishing patent rights. A competition law which can maintain balance between competition and cooperation will promote R&D cooperation. An effective enforcement of inter-organizational R&D contracts will support cooperation by defending against the opportunistic behavior of partners.

The study has important policy implication for the less developed countries that they could improve the R&D resources of their firms and universities by attracting foreign firms and research institutions through the establishment of good quality institutions discussed above. The absence or bad quality of such institutions in a country has another implication that the physical and intellectual capital of a country will move towards the countries having these institutions. So, we will find higher levels of R&D activities in the countries with the stronger such institutions.

The study is limited to some particular but formal institutions which help improve R&D cooperation in a country. The study, however, does not explore the informal or normative domain of institutions. According to Yiu and Makino (2002: 671), "the normative domain refers to shared understandings and meanings ...that are embodied in the form of national culture, value, norms, and belief systems in a given country." No doubt, a country's culture and norms exhibiting honesty and trustworthiness will enhance the cooperation. Normative institutions might be considered for future research on R&D cooperation.

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