THE SYSTEMIC CAPACITY FOR TECHNOLOGICAL ABSORPTION (SCTA) AND INTERNATIONAL TECHNOLOGY TRANSFER (ITT):

HOW SOME KOREAN FIRMS SUCCESSFULY EXPLOIT RUSSIAN TECHNOLOGY

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ABSTRACT

This thesis examines issues of international technology transfer (ITT), focusing on the exploitation of foreign technology between countries with contrasting strengths and capabilities. The tendency in ITT is that it has mostly been limited to the triad countries and to some latecomer economies in East Asia. An explanation for this tendency is that the extent of this shared common ground between countries directly affects a recipient country's capability to exploit and absorb foreign knowledge. This thesis examines cases of ITT which successfully occurred without such common grounds and offers explanations for specific cases.

The conceptual framework was developed to explain how such extraordinary capabilities are created in order to overcome barriers to technological transfer. In addition, several other mechanisms and special factors are hypothesised as candidates for explaining the technology transfer process as one involving bridging and overcoming the barriers. These hypotheses are examined in relation to the Korean-Russian technology transfer, the main target of the investigation. Korea and Russia are countries that had no interaction prior to or during the Cold War period and shared little or no common ground. Nonetheless, after 1990 Korean firms have actively attempted to exploit Russian technology and some of them, though not many, have succeeded in exploiting and commercialising Russian technology.

Important contextual issues for this examination are the military and mission-focused body of Russia's technological knowledge and the often cheaper importation of Western technology. Taking these contextual issues into account, this thesis identifies two principal issues that were overcome in the cases of successful technology transfer: a) the tacitness of Russian technological knowledge and b) the locality of the Russian "context of origin" in terms of the socio-cultural, economic, and political environment.

The empirical content of the thesis involves a mixed approach with document analysis, interviews, a survey, and case studies. The research results show that the public agency programme's facilitating role as an intermediary (developed by the Korean government) creates the extra capacity to bridge the gaps involved in adapting Russian technology.

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Statement

I hereby declare that this has not been and will not be, submitted in whole or in part to another University for the award of any other degree.

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List of Abbreviations

CTTP	Core Technology Transfer Programme
GRIs	Government-funded Research Institutes
ITT	International Technology Transfer
KRITP	Korean Russian Industrial Technology Programme
MKE	Ministry of Knowledge Economy
MOST	Ministry Of Science and Technology
NIS	National Innovation System
OECD	Organisation for Economic Cooperation and Development
PLC	Product Life Cycle
SCTA	Systemic Capacity for Technological Absorption

CHAPTER 1. INTRODUCTION

1.1. RESEARCH ISSUES

This thesis examines the processes of international technology transfer (hereafter ITT) by developing and extending the concept of “absorptive capacity” (Cohen and Levinthal, 1990). In this thesis, ITT is defined as the external acquisition of foreign technology, excluding technology transfer that occurs via direct foreign investment where non-indigenous technology may be used by organisations in the recipient country.

In Cohen’s and Levinthal’s (1989) discussion of the absorptive capacity concept, they assert that the alternative to developing “necessary technology” through internal indigenous efforts is to acquire such technology from other who have developed it in order to adapt such necessary technology developed by others. It is assumed that developing technology internally is not easy because these activities are always uncertain and risky. As a result, adapting externally developed technology is often considered to be an attractive option. By acquiring technology externally, the firm acquiring the technology may avoid or reduce the risk of engaging with an uncertain or unknown field. What is even more surprising is that such late adopters of external technology may, sometimes, reap greater benefits than its original developer did by enjoying a free-ride on the frontier effort of prior innovation activities. This free ride is referred as the second mover advantage (Epstein, 2006; Lieverman and Montgomery, 1988). Outsourcing of technology is not something that only takes place within domestic boundaries: it also takes place across countries. For those firms that lack capabilities and experience with internal technology development, exploiting and acquiring external knowledge may be the only possible option to build their own technological capacity.

The existing literature establishes both theoretically and empirically that ITT occurs through particular patterns, channels, motivations, and mechanisms at both in the domestic and international level. My review of the literature found that many of the studies on ITT primarily focused on successful results of technology adoption or acquisition. As such, scholars have tried to identify and isolate the key factors influencing such successful results including firm capability, the role of public policy, the nature and level of technology in the country, and transfer transactions with both macro-level quantitative analysis as well as micro-level case studies (Mowery and Oxley, 1995; Trott and Seaton, 1995). The target of the majority of ITT studies has been the adoption of ITT in the triad countries (the countries of United States, the European Union, and Japan) and certain latecomer economies in East Asia, where most of the innovations over the last 40 years have taken place. According to a report of the Organisation for Economic Cooperation and Development (hereafter OECD), 96% of the assessed 1,250 technological alliances undertaken from 1980 to 1989 were conducted with only the triad countries (OECD, 2004).

According to RAND (2001), researchers are motivated to collaborate with foreign partners who share similar conditions and backgrounds, and who possess complementary capabilities and resources. Based upon these results, I hypothesise that an important basis for ITT is the extent of this shared common ground, the similarity of conditions and backgrounds, between countries and partners, which directly affects a recipient’s capability to exploit and absorb foreign knowledge. I propose that it is easier for countries with more common ground in cultural, technological or experimental terms to effectively exchange technological information and knowledge. The converse hypothesis is also proposed: those countries that share less common ground have more difficulty in exchanging such information and knowledge. In this case, the common ground not only includes technological similarities but also involves socio-economic, cultural, and political compatibility, as well as geographic proximity. The RAND (2001) report shows that EU countries, the British Commonwealth of Nations, and countries with colonial relations have historically achieved better results from ITT initiatives than countries without such common ground and relationships.

In this respect, the triad countries and certain latecomer countries in East Asia, such as the Asian Tigers, share similar socio-economic, cultural, and technological compatibility, as well as similar conditions and complementary resources for implementing ITT. Also, countries that exploit the technological strengths and knowledge of partner countries seem to have greater capability to exploit and absorb external knowledge. This phenomenon is explained and defined as absorptive capacity, first introduced by Cohen and Levinthal (1989). For this reason, even though most of the latecomer countries have been making every effort to encourage the inflow of foreign technology for their own economic growth, successful results have often fallen short of expectations (Li and Kozhikode, 2008).In this regards, understanding how the Tiger countries built their internal capability to effectively exploit foreign technology has been an important pursuit for scholars studying innovation from an absorptive capacity perspective.

While reviewing the ITT literature employing such assumptions, a question occurred to me. If successful cases of ITT have in fact occurred between partners who share no such common grounds, how could this be explained? Did they succeed solely by accident? Did the recipients, in successfully adapting technology from contrasting partners, have some “extraordinary capability” to overcome all barrier sand constraints? Extraordinary capability can be defined as some special capability accumulated within firms that are especially effective in overcoming the difficulties in the process of absorbing external technology. Or were there some mechanisms or special factors which allowed them to bridge the gaps and difficulties arising from a lack of common ground? In short, if valuable S&T knowledge exists in countries sharing no such common ground, how might these barriers, which ordinarily act to prevent the access and use of this knowledge and information, be overcome?

If conjectures about the emergence of an era of open innovation, in which a greater share of technologies are available to others without impediments from intellectual property rights, are correct, national boundaries will become less distinct, and firms will need to consider exploiting the world-wide stock of scientific knowledge more actively. If they only exploit the knowledge stock in countries with similar common social and cultural ground, they will miss valuable technological opportunities. I concluded that tackling this issue of ITT through systematic research would be a meaningful contribution to widening our perspective and understanding of ITT. Also, if some of the latter research questions (in chapter 5) might be positively answered, there would be the opportunity to draw meaningful policy conclusions to aid in exploiting and extending our scientific and technological knowledge from around the globe.

1.2. RESEARCH OBJECTIVE

The primary aim of this study is to identify and understand the underlying processes and mechanisms that make successful ITT between partners not sharing a common ground. For this reason, it is very important to find proper cases to elaborate the condition my study aims to. In order to focus on the central theme and make my research more feasible, I limited the scope of my research to a single domain: Korean firms' exploitation of Russian technology since the 1990s.

The exploitation of Russian technology by firms in capitalistic economies is often considered very difficult (Dyker, 2004). The difficulties of exploitation, noted by Dyker, stem from the different nature of Russia's socio-economic and innovation system, as well as the nature of its technological knowledge from a Western perspective. These difficulties make ITT from Russia less attractive for firms in capitalistic economies. Historically, Russia had created a particular type of strength in technology development and innovation that met its national goal of building a powerful R&D sector appropriate for a socialist state (OECD, 1997). The question of what the concept "appropriate for a socialist state" might mean can be legitimately raised, since the various socialist states emphasised different types of R&D activities. For Russia, two elements were particularly important: (1) using technology successes for the propaganda purpose of demonstrating the superiority of the socialist system, and (2) emphasis on developing military technology in part because of the extraordinary costs in human life and property of World War II (Cowan and Foray, 1995). Therefore, economic development was oriented towards large-scale industrialisation and expansion of the military-industrial complex. For this reason, after the end of the Cold War, only special areas of Russian technology such as those from military, nuclear, and aerospace, etc., have received much attention from Western countries (OECD, 1994). Despite this condition, some Korean firms, though not many, have achieved considerable success in making use of Russian technology, regardless of the gaps and difficulties. This raises the question of how they managed this achievement.

Even though Russia and Korea are two sharply contrasting countries, they fortunately share some complementary strengths and resources for ITT. This seems to have motivated Korean firms to adopt Russian technology as a supplemental or alternative source of external knowledge, which had previously relied heavily on imported technology from advanced countries. Russia has a high level of advanced scientific knowledge, but little of it commercially linked (Dyker, 2001; Michailova, 2011). On the other hand, Korea has extensive capabilities in advanced industrial applications, but possesses a weak scientific knowledge base, largely because of its legacy pattern of following instead of leading in innovation. Table 1-1 shows the strengths of Russia and Korea, and illustrates the complementarity of these strengths.

Table 1-1: Comparison of S&T strengths between Korea and Russia

Korea	Russia
Downstream	Upstream
Applied Research	Basic Research
Private Sector	Public Sector
IT, etc.	Aerospace, etc.

Source: Author

Korea has strategically focused on downstream technology that enhances applied technology and production capabilities as a way to compete with advanced countries in global markets (Kim, 1997b; Kim and Dahlman, 1992). However, Korea's advanced industrial structure demands ever more complex and sophisticated technology, requiring fundamental knowledge across the entire spectrum of innovation from basic science to applied technology (MOST, 2001; Chung, 2006). Fortunately, Russia, to some extent, may be able to provide complementary strengths, and this turns out to be an ample foundation for technological exchange. Taking this into consideration, Korean firms may be reasonably planning to exploit Russian technology as a strategy for diversifying their sources of advanced scientific knowledge. And considering the technological exchanges from a Russian perspective, its hunger for foreign financial support and lack of intellectual property recognition in early 1990s were the drivers that stimulated cooperation between the two countries (MOST, 2001 and 2004).

In addition, we will examine the case of Korean exploitation of Russian technology for implications affecting other latecomers who are currently coping with technological partners other than their traditional counterparts, notably the triad countries, the three developed markets of Japan, North America, and Western Europe. As such, this thesis may shed light on the nature of the gaps between contrasting systems of innovation, and identifies the measures that may prove helpful in overcoming barriers and gaps in exploiting or absorbing technological knowledge from partners who share little or no common ground.

1.3. THESIS STRUCTURE

Chapter 2 discusses the background of the conceptual framework, which is catching up. The issues of catching up are direct components of the conceptual framework, but they provide a relevant background for explaining how and why Korean firms were motivated to exploit Russian technology. The Korean approach to Russian technology seems to be influenced by the legacy of the catching up paradigm although there are some differences in pattern and process of acquiring external technologies. The concepts of latecomer, product life cycle, and social capability are discussed from the perspective of catching up.

Chapter 3 explains the relevant literature that is assembled to make the conceptual framework employed in this thesis. This literature serves to explain how Korean firms succeed in Russian technology transfer by overcoming the gaps and barriers. These are (1) absorptive capacity, (2) national innovation systems (NIS), and (3) barriers in ITT. These three concepts are the main components of the systemic capacity for technological absorption (SCTA), the conceptual framework discussed in chapter 5.

Chapter 4 explores how the two contrasting and complementary innovation systems of Korean and Russia emerged. This chapter gives an overview of the processes undergone by both countries, of the nature of innovation systems, and how these relate to the Korean-Russian technology transfer. This chapter is not intended as a comparative study of the two economies. Its purpose is to analyse the features of the innovation systems and capabilities of each of the economies in order to explain the nature of barriers to technology transfer in the contrasting systems of innovation which are core components of the conceptual framework.

Chapter 5 serves to introduce the SCTA which is the conceptual framework of this thesis. The SCTA concept is proposed to explain the situation and cases where technology acquisition through ITT requires the involvement of public actors as intermediaries in order to overcome the gaps between contrasting partners. The concept is focused specifically on the facilitating and bridging roles that intermediaries play in assisting technology recipient firms. The principal barriers to ITT are characterised as arising from the tacitness of knowledge that must be acquired and adapted in the ITT process and the distinctive qualities of technology arising from “locality”, the context of the technology to be acquired and adapted. Both tacitness and locality are “gaps” that are addressed by the “capacity” in the SCTA concept and which are bridged using this “capacity”. The SCTA concept is based upon a process having four stages: (1) recognition, (2) acquisition, (3) assimilation or transformation, and (4) exploitation. These processes provide a framework for gathering Chapters 7 and 8.

Chapter 6 explains the research methodology of this thesis including the rationale for choice of countries (Korea and Russia), the choice of methodological approach, and the process of selecting surveyed firms as well as the particular case studies employed in this thesis.

Chapter 7 gives details of the survey results. The survey is based on results of a survey of 93 firms. These are firms that have been involved in the Korean-Russian technology transfer, and the majority of them have benefited from cooperation with public organisations and programmes. Data analysis is based on descriptive statistics, correlations and factor analysis. A detailed analysis of Korean-Russian technology transfer projects is presented in order to establish how Korean firms perceived the difficulty of adapting Russian technology, and what were the factors overcoming the difficulties in absorbing and exploiting Russian technology.

Chapter 8 contains case studies with information from the intermediary’s point of view. Two public agency programmes developed by Korean government are introduced in order to discuss the link between role of the Korean NIS and the intermediary role in facilitating the local firms' technology transfer activities.

Chapter 9 examines four successful Russian technology transfer projects which are discussed and analysed in order to develop a deeper understanding of motivation, gaps, and processes for Russian technology transfer, to explore the utility of the SCTA framework and to identify the role of intermediary organisations in enhancing firms' absorptive capacity.

Chapter 10 summarises the findings, implications, conclusions and contributions, both from conceptual and empirical perspectives. It also acknowledges the limitations of the analysis and suggests some further possible lines of research.

CHAPTER 2. CONCEPTUAL BACKGROUND

2.1. INTRODUCTION

The purpose of this chapter is to provide conceptual background to explain how and why Korean firms were motivated to exploit Russian technology. In recent years, Korea has had remarkable success in technological innovation, and has attained the position of global market leader in some major industries such as semiconductors, mobile communication devices, and automobiles (Kim, 2008). Nonetheless, in terms of building its own technological capacity, the Korean pattern of innovation activities can still be considered to be engaged in a catching up process (Lee and Cheng, 2011).

Korea has considerable experience in ITT, however, much of this experience is particular to adapting working commercial technology rather than further developing and transforming technology produced in a non-commercial context or for which only “proof of concept” type knowledge exists. The Korean use of Russian technology follows a different pattern and process than technology acquisition processes from the triad countries. Nonetheless, ITT involving Russia still seems to be influenced by the legacy of the catching up paradigm. Korean firms are accustomed to learn from others, and the Korean government is also active in supporting firms’ ITT activities

Thus, some concepts of catching up may contribute to underpinning the motive for this study by improving the understanding of the Korean-Russian technology transfer. And they could also provide some of the relevant concepts from the literature for the conceptual framework discussed in Chapter 4. In this regards, this chapter discuss why and how catching up takes place by latecomers and what make differences in latecomer's catching up performance. The concept of product life cycle, second and first mover advantage, and social capability are discussed to elaborate the catching up concepts and the background of the Korean Russian technology transfer.

2.2. CATCHING UP AND LATECOMERS

It is accepted that one major pattern of industrialisation of a latecomer economy has been the adoption and application of technology developed by other advanced economies (Mowery and Oxley, 1995). In other words, a latecomer country's industrial development and technological progress heavily relies on exploiting an international pool of already available technologies from Western advanced countries (Madison, 1995; Gerschenkron, 1962).

Many successful latecomers have combined the importation of foreign technology with indigenous efforts devoted to building their own technological capability (Kim and Dahlman, 2001; Kim and Seong, 2010; Lee and Lim, 2001).These efforts were complemented by improvements in domestic infrastructure and investment in education and training activities with sound policy measures. Success also requires an institutional set-up which is able to exploit these opportunities, and which complements them with domestic technology accumulation (Radosevic, 1999). This suggests that the specific processes and their contexts are very critical in understanding why some countries have successfully used the pool of foreign technologies and why others have not. East Asian countries, including Korea, are exemplary models among the latecomers of successfully catching up to technologically advanced nations.

The process and mechanism by which latecomer firms managed to enter international markets through technological catching up has been examined by several authors, e.g. Amsden (1989) and Kim (1980). Each of these studies highlights the utilisation of foreign sources of knowledge in economic development leading to catching up with the triad countries in particular industries. Hobday (1995) and Kim (1997a) explored in more detail the catching up process of firms in East Asia's lately industrialised economies. Since the 1960s, these countries have been quite successful in adapting foreign technology from the triad countries by importing mature, packaged, and codified forms of technologies from mature industries through the channels of technical assistance, licensing, acquiring turnkey industrial plants, and DFI (Kim, 1980).

Latecomer countries also serve as production locations for advanced countries' firms and, through this process, companies in latecomer countries have successfully acquired, assimilated, and sometimes improved transferred foreign technologies, repeating the process with higher-level technologies and products (Kim, 1999). Assembly processes, product specifications, technical personnel, and components and parts are all taken on by the companies in latecomer countries. Once learned by one or several companies, production and product design is diffused within the country. This process holds true for both well-established and newly-developed technology. This involves both the transfer of technology and a substantial investment in R&D and education. Once a substantial number of industries have reached this stage, the latecomer countries may be considered to have succeeded in catching up, at least in technological terms (Caloghirou et al., 2004). Through such processes and efforts, firms in latecomer countries accumulate the technological capability to compete with firms from advanced nations in some global industrial markets. These firms have also made strenuous efforts to enhance their own R&D capabilities, while simultaneously adapting and improving foreign technology.

2.3. SECOND AND FIRST MOVER ADVANTAGE

This section discuss more specifically why and how catching up take place from the perspective of the second mover advantage. The complexities of first mover advantage are also discussed.

It has been observed that the emergence, growth and dominance of a large number of firms from emerging economies have had humble beginnings. However, over a considerable period of time, these firms have become competitors for the global leadership position with respect to market share (Li, 2011). For example, Korea's Samsung Electronics, a global leader in mobile phones, memory chips, digital televisions, and consumer electronics, is a good example. Samsung was a latecomer, starting far behind the multinational incumbents in terms of their technological and production capabilities (Mathews, 2006; Kim and Seong, 2010). They rapidly accumulated technological capabilities by learning, combining, and integrating imported technology. Samsung continues, in many cases, to take the position of being a fast follower rather than a front-runner, waiting until technological risk is lower and market demand clearer before devoting great amount of financial resource and technological effort to overtake front runner firms (S. Hwang, personal communication, April 15, 2010). However, in certain cases, such as memory chips and flat panels, Samsung has aggressively pursued the challenge of achieving a front-runner position by incurring high technological and financial risk.

This advantage utilised by latecomers is known as the second mover advantage (Epstein, 2006). Second-movers can leverage forerunner's investments and efforts by following and imitating their best practices, while at the same time avoiding their mistakes. Considerable barriers may exist, but second-movers may be able to surpass the forerunners with intense efforts, luck and by developing more effective institutions (Dean & Master, 1991). Second mover's follower strategy is not only for latecomers who lack technological capabilities. Even well established firms can choose to be a "late entrant" for strategic reasons. They can delay their entry into an industry until technological and market trends are clear, and then move in with superior forces to take the lion's share of the market. For example, Shamsie, Phelps and Kuperman (2004) argue that firms are more likely to attract customers to ensure their survival, even if they enter later, based on a study of 165 late entrants in 15 different new product categories.

As successful latecomers approach the technological frontier, they may come to face a situation where a strategic choice needs to be made between continuously following the second mover's advantage or switching to pursue a first mover's advantage. By the 1980s, as a small number of large Korean firms had become potential competitors in the international market, while the catch up model of innovation became more difficult because of foreign companies' reluctance to transfer technologies to Korea (OECD, 2009). Accordingly, leading South Korean firms appeared to confront a strategic dilemma about whether to continue with a catch up strategy whether to try to compete on the basis of new products supported by in-house R&D (Hobday, Rush and Bessant, 2004).

In similar contexts, Mathews (2002a; 2003) uses Penrose's resource-based view (1959) to analyse learning and competitive advantages of the second mover firms. He asserts that second mover firms do not have to adopt a passive stance in relation to global developments. They can make strategic choices and, by making such choices with conscious understanding of their latecomer advantages, they can expect to become players in the global economy, and thereby contribute to the development and upgrading of technologies from countries which they seek to emulate.

However, the optimism regarding the potential benefits for catching up is not held by all scholars. For example, it is claimed that prior capital, knowledge, and skills are required to produce the new capital, knowledge, and skills associated with catching up strategies (Cohen and Levinthal, 1990). The dynamics of this process help explain how the rich get richer, while the poor get poorer, and the gap continues to widen for those left behind. This argument is related to what is now known as the first mover advantage, which is gained by the initial occupant of a market segment, and which may be referred to as the role of technological leadership (Lieberman and Montgomery, 1988). This advantage may stem from the fact that the first entrant in the market is able to gain control of resources and the rules of the game, shielding them from competitors, and then retaining the advantage by protecting their R&D through patents (Grant, 2003). The technological pioneers can indeed retain their advantage if they protect their R&D through patents or if they successfully keep them as trade secrets, or if they continue to move forward more rapidly than rivals (Lieberman and Montgomery, 1988).

Over time, innovation front runners have created numerous barriers, denying or complicating the entry for latecomer competitors (Perez and Soete, 1988). These barriers include the establishment of technological standards, the construction of complex supply networks, the creation of superior distribution and support networks, patent and copyright protections, and other factors. Even latecomers that have accumulated their own capabilities may be able to develop a product without violating the network of patents established by the front-runners.

The process of catching up does not always have equal effect across companies, due to the dynamics of capitalist markets and the leaders' strategies. In short, catching up may be impeded or delayed by patent barriers; in consequence, the costs of catching up must include the processes of inventing around existing barriers which go beyond patents. For example, Toyota's innovations stemmed from a search for ways to save on investment costs in automobile manufacturing. This was done by finding new methods of production that overcame the advantages (and barriers to entry) of the large scale investments of Western firms.

In short, catching up processes involve the resolution of the contradictory conclusions of the first and second mover advantages, between the indefinitely long leadership by leading firms and successful challenging strategies by second movers. When first mover advantage prevails, catching up will be blocked. When second movers can secure distinct patent and productive advantages, they are likely to be able to overcome first mover advantage and to be successful in catching up. The next section discusses the complementary changes that are necessary for catching up to occur from an organisational viewpoint.

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2.4. PRODUCT LIFE CYCLE

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The concept of Product Life Cycle seems to be very useful in explaining the success that some latecomers have in catching up. This concept is about how technological progressive industries evolve from birth through maturity.

The Product Life Cycle concept states that, once a product's technology matures, its production moves away from the point of the original invention. Ultimately, that product may come to be imported into the country where it was originally invented (Vernon, 1966). Vernon's argument was associated with the fact that mature technology could benefit from wage differentials and the lower costs of adaptation in the transfer process.

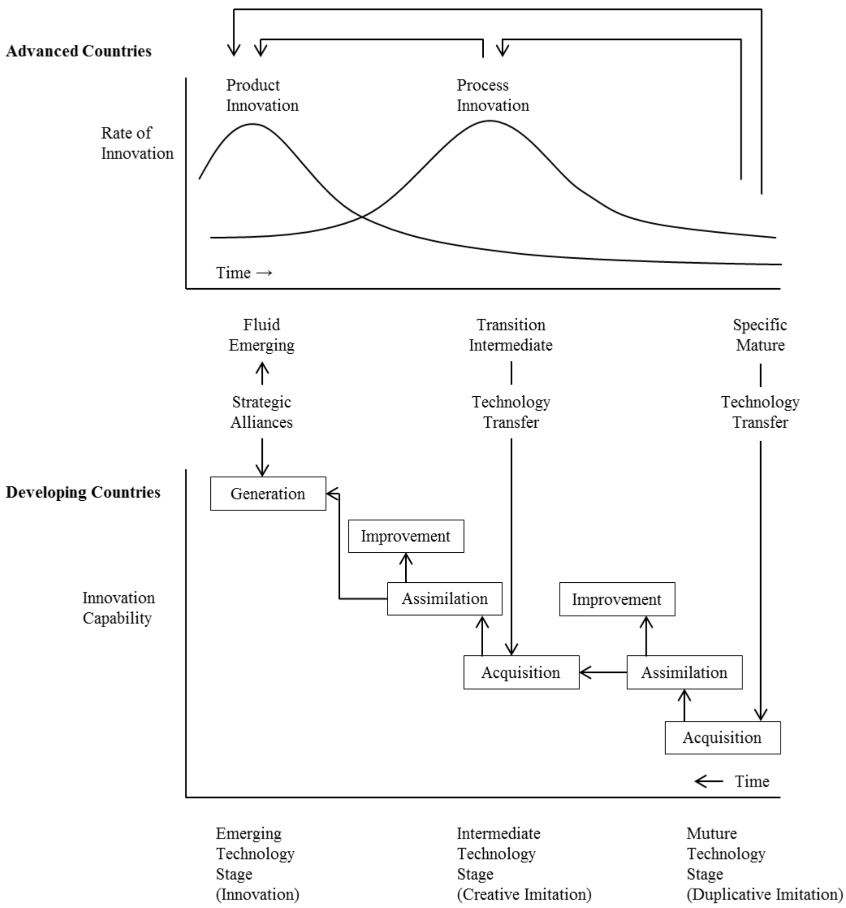
This concept can be understood in relation to the activities of multinational corporations. A global production network created by multinational corporations, as well as the interconnected global economy, has boosted international knowledge diffusion, providing new opportunities for capacity formation by local suppliers in latecomer countries (Ernst, 2002). In other words, an international division of labour created by Foreign Direct Investment can provide the opportunities for latecomers to form collaborative relationships with multinational corporations. A good example is when multinational corporations in advanced countries relocate production plants to developing countries in order to achieve cheaper production costs and larger volumes of production (Blanc, 1999).

Utterback and Abernathy (1975) developed a model showing that firms follow different pattern of technological development along the phases of a technological trajectory. They distinguish three phases of the evolution of technology within an industry: fluid, transition, and specific. The fluid stage is characterised by diverse technological opportunities and risks (Abernathy and Utterback, 1978; Utterback, 1994). The market for a specific technology is not settled at this point and therefore the level of technological uncertainty remains very high. The change of product design and function is frequent and failure rates high. When the market for the technology stabilizes, surviving first developer firms enjoy first-mover advantage. The transition phase occurs as the technological risks decrease and the needs of the market are more clearly understood. At this point, a highly standardised product can be produced. Technological knowledge becomes codifiable and transferrable. In the third phase, technological possibilities related to the dominant design are gradually exhausted (Gardiner and Rothwell, 1985). Price competition becomes intense, with some firms trying to differentiate their products for niche markets in order to avoid price erosion. Production processes are automated and integrated for efficiency, with the side effect that the production process may become so rigid that it is difficult to improve. At this stage, developer firms may begin to relocate their production facilities to lower cost areas. A window of opportunity for latecomers opens at this point. Kim (1980) added to this perspective by noting that it is possible to enter during the second phase if a very intense effort is made to reduce the development time in order to achieve a competitive position as one enters in the third phase.

The literature is full of examples of how latecomer firms catch up by initially adopting mature low level technology and then improving it to a higher level of performance or productivity (Kim, 1980, 1997a; OECD, 1992; Dahlman et al., 1985). As discussed before, latecomer firms normally acquire mature foreign technology in packaged form, complete with turnkey plants, assembly processes, product specifications, technical personnel, parts, and components (Kim, 1999). During this process, the technology is diffused throughout the receiving country, and other firms not involved in the importation process also benefit. Firms in the receiving country may discover ways to improve imported technology by reverse engineering their designs and then modifying them. In this process, latecomer firms find themselves at the beginning of a new product life cycle. When a substantial number of a latecomer country's industries reach this stage, the country is considered to have succeeded in catching up. This is why developing countries are sometimes said to reverse a technology's trajectory from matured to emerging. Kim (1980) or Hobday (1995), examining the experience of more recent catching-up economies, have emphasised the role of creative imitation and development of these adopted technologies to address how these more modern latecomer countries and their firms achieved even greater benefit from their adoption of foreign technologies.

Figure 2-1 illustrates both the product life cycle process and the reversing of a technology's trajectory (Cooper and Schendel, 1976; Utterback and Kim, 1986; Anderson and Tushman, 1990). Firms acquire mature foreign technologies during the early phase of industrial development, and in the second phase, intermediate technology like process development and product design technologies. And in the third phase, R&D is applied to develop emerging technologies (Hobday et.al., 2004).

Figure 2-1: PLC process and the Reversing of a Technology



Source: This figure is modified by Authour (Kim, 1997)

Although useful, these patterns are not universal, and they have encountered criticism from those who believe that the PLC concept fails to take the idiosyncratic nature of industries into account (Day, 1981). Innovation in latecomer countries must be understood differently from innovation in lead countries. The strategic goal of leaders is to maintain their lead, while that of latecomers is to catch up (Amsden, 1998; Mathews, 2001).

A similar line of argument was developed by Akamatsu (1962) who paints the metaphor of “flying geese” to describe industries as they rise and fall and move from country to country. He asserts that a complementary international setting is conducive to the division of labour, and that it contributes to success in catching up. The paradigm postulated that some Asian nations will catch up with the West as part of a regional hierarchy where the production of commoditised goods continuously moves from more advanced countries to those not as advanced. The lead “goose” in this pattern is Japan. The second tier of nations consists of the newly industrialised economies of Korea, Taiwan, Singapore and Hong Kong. This argument implies that the countries in the lagging tier attempt to learn the policies of the countries in the front tier. Chiang (2008) analysed the international diffusion of information technology based on this flying geese model using the production and trade data for the period 1980-2005. According to the data analysis, the production of IT goods was led by the USA, followed by Japan, which was again followed by Taiwan, South Korea, and China. Akamatsu’s idea is similar to Vernon’s in that the international diffusion of technology related to standardised assembly allows countries with lower wage rates to boost their economy.

However, this idea of the product life cycle and flying geese has been shown to have some limitations. In some industries, highly automated production systems and process engineering reduce the cost of labour. This argument suggests that the cost advantage of latecomers alone does not provide a sufficient condition for catching up. Wealthier countries are able to preserve their competitiveness in manufacturing areas with higher investment in production facilities, accelerating the pace of innovation and developing complex supplier networks.

Lee and Lim (2001) also argue that successful latecomers will ultimately confront the need for more expensive technology necessary for obtaining a higher level of technological building capacity. At later stages of development, successful latecomers become potential rivals of leading countries. As this occurs, incumbent firms may become reluctant to transfer their technology. Therefore, a competitive advantage based on cheap labour cannot be sustained when numerous latecomers are succeeding in the “catching up” process.

In summary, there are a number of different factors that might prove relevant for the catching up strategies of latecomer countries. Catching up countries (and firms) must consider their potential to achieve a second mover advantage at an early stage of the product life cycle and their ability to exploit their experience and growing capabilities to establish a first mover advantage in later stages of the product life cycle, initiating a new product life cycle. For any particular country, the nature and timing of entry is not dictated by this outline of strategic opportunities, nor are the possibilities mutually exclusive. Latecomer countries may engage, to a certain extent, in several different strategies depending on available resources and context. Overall, the entry timing and product life cycle models underscore the alternatives of 1) learning from Foreign Direct Investment and the diffusion of this learning through the economy, 2) fostering targeted efforts to exploit second mover advantages that may lead to a position of market strength and the ability to eventually become a first mover, and 3) the processes of creative imitation and adaptation leading to a second mover advantage. However, as I will argue in next section, the single most relevant factor for catching up strategies is the social capability of countries and firms, as defined by their social capacity to adapt and effectively exploit novel technologies from abroad.

2.5. CATCHING UP AND SOCIAL CAPABILITY

The number of unsuccessful cases of catching up is much larger than successful ones (Fagerberg et al., 2006). Unsuccessful results are attributed to poor public policy, inability to adapt to external technology, and a flawed approach to economic plans (RAND, 2001). This is especially true in regards to poor transfer of technology from industrialised nations. Successful ITT is closely linked with firms' capabilities, including their indigenous efforts, policies, and institutional surroundings. This section discusses strands of the literature that are based on the ideas of social capability to enhance educated human resource, strong expansion of indigenous efforts, and latecomer's learning capability.

There are a number of studies that attempt to explain the role of social factors in how and why technological catching up takes place (Hobday, 1995; Kim, 1997a, 1999; Kim and Nelson, 2000). But scholars have diverse perspectives on the matter.

With his argument for the importance of nationalism and "mobilisation", a kind of solidarity of purpose, Gerschenkron (1962) claimed that latecomer countries may be able to accelerate their growth rates and skip several stages by building strong institutions, making effective government intervention and public policies. Gerschenkron emphasised the importance of public policy, the role of government, and learning in the process of catching up. This also involves embracing the attributes and qualities of people and organisations that influence economic and technological opportunities. This argument is supported by scholars who have observed that though East Asian countries have access to the same set of technology as developing countries in other regions, the difference in economic performance has been huge. Through this argument, it is seen that East Asian countries' attention to policy detail and investment in technological learning explains much of their success in catching up (Lall, 2000; Kim and Nelson, 2000). Other factors include the priority given to investments in education and the intensity with which educational achievement was pursued and important technological shifts in electronics, the automobile industry and shipbuilding.

This argument for the importance of policy and technological learning is linked with the concept of social capability. Choosing appropriate policies and success in technological learning imply a related set of social factors and processes. The explanation of catching up could be restated as requiring exploitable technological opportunities (a "gap" that can be addressed) combined with an adequate social capability to take advantage of those opportunities. From this perspective, the factors of successful technology transfer may be considered partly as a reflection of a national social capability involving the capability to absorb, effectively use, and improve imported technology. Some countries make good use of external opportunities by effectively absorbing, utilising, and further developing imported technology. Others do not.

Abramovitz (1989) emphasises the importance of social capability, indicating the ability to absorb new technology and attract capital investment. Gerschenkron (1962) focuses more on the role of public policy, indicating governmental substitution for missing links in the facilitation of economic and social development. Dyker (2001) explains that social capability covers the elements in social and political infrastructure such as educational systems, the banking system, and the political system. The concept of social capability provides the basis for arguing that the concepts of NIS (national innovation system) and NAC (national absorptive capacities) are relevant to the prospects for catching up. And according to the social capability perspective, effective catching up requires more than just the acquisition of technological capability: it also requires social capability to smoothly absorb and improve those transferred technologies. This is closely related to social capital, which places an emphasis on social trust and participation of a society. It is useful to consider effective performance as a dependent on already-mastered "social" and "physical technology" (Nelson and Sampat, 2001). Mazzoleni and Nelson argued that social technology is embodied in organisational forms, bodies of law, public policies, codes of good business and administrative practices, customs, and norms. The concept of social technology is closely linked with the social capability.

A shortcoming of the "social capability" perspective is that it is difficult to assess. Thus, it risks implying that those societies that are successful in catching up have social capabilities and those are not successful, do not have social capabilities. Focussing on specific elements of social capability is one way to avoid this circular reasoning. Technological catching up appears to require an educated population and firm-specific capabilities accumulated within the process of innovation activities, both of which support the technological learning process (Hobday, 1995). The successful latecomer economies including Korea and Taiwan support the proposition that investments in education and training programmes can make a major contribution to catching up (Wong, 1999).The rapid expansion of higher technical education, seen in follower countries such as Korea and Taiwan, directly results in an increase of employment opportunities for engineers and scientists. Thus, for these countries, industrial, technological and educational policies are complements, not substitutes, and the ability to carry out these policies in a sustained and coordinated fashion explains their economic success (Dollar and Sokoloff, 1994).

The accumulation of educated human resource is also likely to require mobility in education and training. The combination of studying abroad and hosting foreign experts such as professors or technical personnel has offered important human resource inputs for Korea’s catching up efforts (Shin, 1996). Human resource policies implemented as educational policy and international mobility in training have a synergistic effect in building the absorptive capacity of latecomer firms. By having a more highly educated workforce, it is possible to draw upon a greater range of problem solving capabilities to address the problems of adapting technologies acquired from abroad, and this adaptation is further augmented by having individuals who have been trained or worked within foreign contexts.

2.6. CHAPTER SUMMARY

During the latter decades of the 20th century, there was an increasing amount of effort devoted to catching up based on increased research effort, and this research effort was central to the strategies of firms that entered the technological race during this period. Through reviewing the concept of catching up in this chapter, there are two important perspectives that address this concept and experience. A first perspective focusses on how latecomer firms overcome disadvantages such as the lack of technological know-how, scarce human resources, and access to well-established markets. The concepts of product life cycle and second mover advantage describe the context and mechanism employed in catching up. The other perspective focusses on the role of the state and public environment in the firms' process of catching up including the concept of social capability.

These two perspectives, the product life cycle and the second mover advantage, on the one hand, and the social capability, on the other, do not exclude each other. On the contrary, latecomer countries might engage in these two kinds of catching up strategies, depending on their context and resource endowment. However, the social capability perspective is of particular relevance for analysing technology transfer processes, especially in the context of partners with significantly diverse social settings. In particular, the social capability perspective underscores the fact that, in the context of technology transfer, the collaboration between individual actors and institutions is a key defining factor of success. This is so because the technology transfer process, as will be argued in other parts of this thesis, is comprised of complex and stage-specific needs that may require that firms be assisted by specific partners in order to navigate this process. This is why another way to look at the process of catching-up is that it is a process of co-construction or co-evolution between the capabilities of individual firms and the interactions of these firms with a larger social context which includes other firms, the government, and other domestic actors (e.g. public research laboratories and universities) as well as the interactions with the larger world. The next chapter identifies the concepts that are necessary for elaborating this larger context leading to a specific framework for considering how ITT may be made more effective.

CHAPTER 3. KEY CONCEPTS EMPLOYED IN THE CONCEPTUAL FRAMEWORK

3.1. INTRODUCTION

This chapter discusses the concepts assembled to construct the conceptual framework employed in this thesis. These concepts are absorptive capacity, national innovation systems, and the barriers in ITT. The empirical context of this technology acquisition is examined in Chapter 4 and the conceptual framework, discussed in Chapter 5, focusses on public contributions (through specific parts of the NIS) to enhance local firm's capability (absorptive capacity) by reducing the barriers in the process of technological absorption from Russian partners through operating public agency programmes (intermediaries). In this case, the role of a public agency programme in providing an intermediary or bridging role that operates as the conduit for successful technology absorption is explained detail in chapter 8. Thus, these three concepts are components of the SCTA, the conceptual framework developed and employed in this thesis. The discussion of these concepts and their complementarity in this chapter provides the rationale for the SCTA framework.

3.2 ABSORPTIVE CAPACITY

The differences in the catching up performance among latecomers are an important issue. A plausible explanation for differences in the success of absorbing foreign technologies is due to the variation of firms' abilities to absorb and exploit technology from foreign sources. This ability is called absorptive capacity, introduced by Cohen and Levinthal (1990), and defined as the ability to recognise the value of external knowledge, assimilate it, and apply it to commercial ends.

It is not possible to clearly separate the sources of absorptive capacity from the factors involved. Education, indigenous development efforts, and technological experience and the learning provided by this experience all contribute to absorptive capacity. However, Cohen and Levinthal’s definition of absorptive capacity highlights capabilities that are not self-evidently the consequence of an educated work force, indigenous technology development efforts, or technological learning. In particular, the “ability to recognise the value of external knowledge” appears to be a cognitive capability that does not necessarily immediately follow and is not directly produced by the factors discussed above. Similarly, the abilities to commercialise, while partially gained through efforts to commercialise indigenous developments, imply further “forward looking efforts” in the process of latecomers' acquisition of external technology (Li & Kozhikode, 2008).

The following sections introduce the absorptive capacity concept, and connect it with ITT, examining this concept using the set of constructs and activities associated with it. This section also discusses mechanisms, interactions and structures within organisations that assist in building and maintaining absorptive capacity.

3.2.1. Concept of Absorptive Capacity

The concept of absorptive capacity has greatly evolved since its introduction. The concept is used in analyses conducted within several disciplines (Schmidt, 2005). It has been further developed by efforts to improve its theoretical foundations and it has been supported by a wealth of empirical evidence. Organisational learning and the capability to adopt incoming knowledge creates a framework to analyse this diverse organisational and intra-organisational phenomenon. For this reason, Cohen and Levinthal's seminal paper has been cited more than 1,300 times and more than 600 papers have been published incorporating the concept of absorptive capacity in ISI journals (Volberda et al., 2010).

In general, the term is used broadly to indicate a firm's receptivity to technological change and to measure its ability in making use of outside knowledge (Mu & MacLachlan, 2010). However, as established by Cohen and Levinthal the core concept of absorptive capacity emphasises that external knowledge is not freely and effortlessly absorbed. Effort, expertise, and strategy on the part of the firm are required to identify, assimilate, and exploit this external knowledge. One of the claims suggested by Cohen and Levinthal was that this capacity is primarily determined by a firm's prior related knowledge. Thus, investment in R&D is important for accumulating new knowledge and might contribute to absorptive capacity. In effect, absorptive capacity is treated by Cohen and Levinthal as a special kind knowledge that is itself generated, e.g. "by having already developed some absorptive capacity in a particular area, a firm may more readily accumulate what additional knowledge it needs in the subsequent periods in order to exploit any critical external knowledge that may become available" (Cohen and Levinthal, 1990: 136).

3.2.2. Absorptive Capacity and Prior Knowledge

Cohen and Levinthal (1990) hypothesise that an organisation's absorptive capacity depends on the absorptive capacity of its individual members and, as above, that prior knowledge is necessary for an organisation to identify and assess external knowledge.

In effect, Cohen and Levinthal propose that absorptive capacity is a distinct type of intangible capital, a stock of which may be accumulated through various inputs. However, indicators of this capability or measures of performance in its accumulation are less clear. For example, they do not propose a direct link between absorptive capacity and the proportion or number of highly educated employees, the performance of R&D or the ways in which technological learning is facilitated or blocked. Nonetheless, the intangible capital of absorptive capacity does seem to be related to each of these forms of knowledge accumulation. It also seems to be consistent with the larger "resource based" theory of the firm which considers firms' capabilities as unique bundles of resources yielding sustainable returns above normal profits (Garud and Nayyar, 1994).

What we do know is that Cohen and Levinthal propose that the firm's knowledge allows for better identification of the value of external knowledge, as well as a better understanding of appropriate product and service application. To the extent that this knowledge is related to an educated workforce, it would encourage the hiring of educated workers beyond immediate productive use. To that extent, it is related to R&D that would encourage continuing R&D efforts to adopt well established or new technology from outside. To the extent that this knowledge is built through experience, it would suggest beginning to accumulate productive experience as soon as possible.

Aside from the lack of a specific prescription for how to accumulate absorptive capacities, there may also be some problems with the accumulation of this type of knowledge. The nature of prior knowledge may also serve as a barrier to absorbing new knowledge from outside. "Firms often fail to identify and absorb valuable new external knowledge because they are hampered by their embedded knowledge base, rigid capabilities, and path-dependent managerial cognition" (Todorova and Durisin, 2007, 777). In other words, old knowledge may impede the absorption of new knowledge. For example, many analogue camera firms have failed due to their failure to effectively develop digital product offerings (Lucas and Goh, 2009). Their vast amount of analogue knowledge obscured the value of emerging technological opportunities in a digital era.

Furthermore, the absorptive capacity concept has some application limitations in explaining latecomer firms' performance in absorbing and assimilating foreign technology. Most of these latecomer firms started with no, or very little, prior knowledge relevant to international competitive performance in the specific industries which they were seeking to enter. However, differences between latecomer firms in their performance in absorbing and assimilating foreign technology were very large. Since latecomers' R&D investment is mostly targeted at internalising and modifying transferred technology rather than creating their own knowledge, it seems that there was little or no direct linkage between knowledge accumulated through R&D and the type of knowledge that would be needed for building absorptive capacity.

In a similar fashion, catching up focusses attention on the adaptation of specific technologies which may impede a more general accumulation of absorptive capacity stemming from productive experience or the qualities of the labour force employed. For these reasons, the absorptive capacity concept needs to be further developed if it is to be applied to explain the experience of latecomer country technology acquisition and adaptation. Doing so requires more closely examining absorptive capacity as a problem-solving capability and the socio-cultural context of building absorptive capacity, the subject of the next two sub-sections.

3.2.3. Absorptive Capacity as a Problem Solving Capability

Cohen and Levinthal (1990) argued that although learning capabilities involve the development of the capacity to assimilate existing knowledge and problem solving capabilities represent a capacity to create new knowledge, the two capabilities have a similar mode of development. Experience or performance on one learning task may have a positive effect on subsequent learning tasks. The prior possession of relevant knowledge and skills gives rise to creativity. They also argued that whether it be absorptive capacity for learning or problem solving, mere exposure to the relevant prior knowledge is not sufficient. Rather, the intensity of efforts is critical for the development of absorptive capacity (Cohen and Levinthal, 1990).

Kim (1997a, 1997b, 1998) emphasises that absorptive capacity depends upon the firm's existing knowledge as well as the intensity of efforts. For Kim, the absorptive capacity concept is understood as the capacity to identify and solve technological problems by utilising external knowledge. His argument is largely based on observation of the Korean experience.

As discussed in the previous chapter, the building process for Korean firms' technological capability is based mainly on learning and absorbing from more advanced foreign countries. Kim's term (1997) "intensity of effort" refers to the amount of energy expended by the organisation's members to solve problems. According to Kim, it is insufficient merely to expose firms to the relevant external knowledge without exerting effort to internalise it. The effort intensifies interaction among the organisation's members that in turn facilitates technological learning at the organisational level. Kim's view presents absorptive capacity as an organisational capacity that ensures a competitive advantage by strategically achieving goals through problem solving efforts. He emphasises that learning how to solve problems is built up after many practice trials on related problems. Thus, considerable time and effort directed toward basic problem solving is required before moving on to more complex issues.

Korean firms aim to improve imported technology, which is a process known as “creative imitation.” In this process, there are various problems in need of solving in order to continue their process of improvement. Solving new problems may require intensity of efforts. Kim (1997) argued that the successful development of the 64K DRAM was a combined outcome of high prior knowledge gained from new scientists and engineers recruited from the U.S. (thus, an educated worker input), and high intensity of in-house efforts in assimilating and developing new DRAM products.

The term “effort” is an input oriented concept, and it is not assured that “effort” will yield “capability”. In order for efforts to have a better chance of producing capabilities, it is necessary for the intensity of efforts to be guided by strategic direction about which problems to address, how these problems may fruitfully inform the adaptation process, and how lessons learned from solving these problems may be used for critically assessing other knowledge or possible acquisitions of equipment. Employees in Korean firms are well-known for working long hours, the longest among the members of OECD, and being part of a highly aggressive business culture. However, according to Kim’s analysis, it is not the effort, as such, that is the secret to Korea's success. Learning at an organisational level requires hard work by the individual, but more importantly, strategic direction in the leading of each individual. Such leadership forms a team with an excellent work ethic, enthusiastic to solve problems as a mean to success. Kim (1998) analyses the way Hyundai use “migratory knowledge” to increase the intensity of organisational learning. An existing knowledge base increases the ability to search, recognise, and accurately represent a problem. Base knowledge is applied to problem solving, combined with the assimilation and application of new knowledge. A firm's capability to absorb knowledge from external sources is a pillar in the process of transforming existent knowledge into new knowledge, and its conversion into new value.

3.2.4. Absorptive Capacity in a Socio-Cultural Context

Some scholars have argued that the fundamental structural characteristics of absorptive capacity can be deployed most efficiently within a relatively homogenous culture (Kedia and Bhagat, 1988; Lin and Berg, 2001). It is more likely that a group of individuals will adopt the concept in organisational context if the underlying characteristics of absorptive capacity are aligned with the features of their national culture. A national cultural environment creates social reinforcement contingencies that foster the pursuit of behaviour in organisations that fit (Steenkamp et al., 1999; Lin and Berg, 2001).

Rosenberg and Steinmueller (1994) argue that national culture influences corporate culture. Nations and cultures that diminish the priority of individualism are characterised by strong ties formed within group. Individuals are expected to define themselves by the adherence to their social group. Research has shown that organisations in these cultures are characterised by high degrees of informal communication and interaction, thereby matching the inherent nature of absorptive capacity (e.g. Chen et al., 1998). According to Doney et al. (1998), cooperation can be stronger in such group-oriented cultures, and a culture's dimensions directly affect the absorptive capacity of organisations within it. Hence, in Western cultures, considerable emphasis is placed on assuring that structural mechanisms are in place for fostering communication and cooperation since these may more often be a source of malfunction. Although there are exceptions, group-oriented cultures inherently show a high degree of communication and strong, continuous interaction between organisation members. These general observations have been further supported by a range of empirical organisational studies within the absorptive capacity research tradition.[1]

Zahra & George (2002) theorise that “social integration mechanisms can facilitate the sharing and eventual exploitation of knowledge” (p.194) The integration of individuals’ absorptive capacity in to an overall organisation's absorptive capacity can only be accomplished if these mechanisms are installed and intensive communication sharing is effective (Lane et al., 2006). This is especially important given that absorptive capacity is a multilevel construct. By means of communication, the acquired knowledge can advance in the process through assimilation, transformation, and final exploitation (Lane et al., 2006).

[1] The reader should notice that features of group-oriented cultures such as strong communication and interaction are indeed an advantage in the context of absorptive capacity. However, these same traits can represent a challenge when it comes to fostering innovation. Group-oriented cultures might experience problems associated with “group-thinking” and rigidity that stem from the consensus driven dynamics of this kind of cultures. On the contrary, non-group-oriented cultures might more easily adapt to disruptive and innovative practices.

More concretely, Cohen and Levinthal (1990) identify R&D, manufacturing, marketing, and design as major pillars of communication. Lane et al. (2006) considers an organisation's ability to share information as one of the major conditions necessary in achieving a high degree of absorptive capacity. These insights are confirmed by empirical studies that show the importance of cross-functional teams (Meeus, Oerlemans and Hage, 2001), allowing for the conclusion that formal integration mechanisms are crucial in order to guarantee the success of absorptive capacity (Gupta and Govindarajan, 2000).

Developing internal R&D capabilities and human skill with the use of external knowledge sources produce high added value and innovation. Efforts in establishing interaction mechanisms and openness to knowledge sharing are not a substitute for internal efforts, but rather a complement to the creation of new value. The concept of absorptive capacity presupposes opportunities in the external environment which suggests the need to look at actors outside the firm that may contribute to the identification, acquisition, adaptation, and utilisation of useful knowledge. It is also possible for these actors to play an important complementary role to the absorptive capacities of the firm. These issues have been considered in the innovation systems literature, the subject of the next section.

3.3. NATIONAL INNOVATION SYSTEMS

The concept of NIS was developed and advanced by Freeman (1987), Lundvall (1992), Nelson and Rosenberg (1993), and Edquist (1997) in order to explain the systemic nature of innovation and identify the role of institutions and organisations in the processes of innovation (Fagerberg et al., 2006). NIS may be understood as a set of interconnected institutions contributing to the development and diffusion of new technologies by creating, storing, and transferring knowledge. Both individual actors and contextual factors are important elements of NIS for the creation and use of knowledge (Sharif, 2006).

As the linear model of innovation, in which new technology is assumed to develop directly from scientific accomplishments, was discredited through the 1970s and the 1980s, innovation was increasingly understood as an interactive process. Interactions involving nonmarket relationships as well as the process of product innovations were considered, which framed innovations in a systems perspective, and studies took into account the interactions among universities, industry, the education and training system, and financial markets (Lundvall, 1999).

While the NIS concept was first developed in academia, it is closely linked with policy issues and a discussion of these issues with policy analysis groups such as the OECD (Sharif, 2006). The rapid take up and use of the concept seems to have been the consequence of the fact that many of the key proponents of the concept occupied roles in both areas. According to Keith Smith, however, the concept can better be described as a policy concept rather than a theoretical concept because the principal application of the NIS is in the practical issues surrounding national administrative structure for S&T development (as quoted in Sharif, 2006. 750).

Kaiser and Prange (2004) applied the concept of NIS to analyse the effect of science and technology policy in the German biotechnology sector. They adopted basic indicators of NIS which included regulation, the financial system, public policy regarding technology and innovation, the research and education systems, and corporate activities. According to their analysis, in the case of regulation, two major changes including a centralization of regulatory competencies within the German Federation along with the Europeanization of biotechnology regulation resulted in biotechnology regulation being organised across various territorial levels having multi-level characteristics (Kaiser and Prange, 2004). This type of analysis provides more practical implications for establishing and implementing science and technology policy than the neoclassical equilibrium analysis or growth accounting (Sharif, 2006).

In the context of ITT, dissimilar national systems of innovation need to be considered. For example, in the transfer of technology from Russia to Korea, an analysis of the dissimilarity of Russian and Korean NIS will help to understand the process of ITT. The dissimilarity affects the nature of innovations produced in each system, along with the supporting institutions available to help in ITT, and the enabling capacities for firms to absorb external knowledge. Though this is the central focus for considering the Russian NIS, all three factors are reasons for examining the Korean NIS.

3.3.1. NIS as the Government Role

The NIS approach may sheds a light on the government’s role in the innovation process. NIS reflects the politics and policies that promote the innovative process of nations. It provides a useful contribution to the systematic understanding of various economic developments of countries. Empirical studies suggest that a well-developed innovative system is essential for the catching up process of countries (Fagerberg and Srholec, 2008). One of the important reasons for the rapid catching up of East Asian countries is the active role of their governments (Hobday 1995). However, this does not mean that a government can develop or design an entire NIS. As Nelson and Rosenberg (1993) point out, some parts of a system can be consciously designed by a government, but many of the relationships defining an NIS have to evolve through experience and to be customised to the specific circumstances of the country.

The concepts of NIS can be described as a formal economic institutional approach which examines the relationships between the national institutions of finance, education, law, science and technology, corporate activities and government policies (Cvetanovic and Sredojevic, 2012; Fagerberg and Srholec, 2008). Another approach to defining the nature of NIS focuses on the importance of socially embedded knowledge and learning, and analyses the nature of business and social relations in a nation reflected in the way links between technology suppliers and users encourage shared learning (Dodgson, 2008). With these emphases on institutional and knowledge and learning, the NIS approach has gradually replaced prior models based on the “application” of scientific knowledge to commercial purposes, the so-called linear model, with a systems perspective on innovation which emphasises the interdependencies among the various agents, organisations, and institutions. This transformation leads policymakers to a different view of how government can stimulate the innovation performance of a country (Groenewegen and van der Steen, 2006).

More specifically, the role of government and the public sector is very important as they serve as facilitators in creating competitive advantage. One starting point for examining a country's NIS can be to examine elements of NIS such as public agencies, universities, private firms, and governments (Cvetanovic and Sredojevic, 2012; Katal, 2008). Public agencies support and perform R&D while universities focus more on training scientists and engineers. Private firms that invest in R&D and in the application of new technology are regulated by an array of laws that define intellectual property rights

(OECD, 1997). However, the public research budget of some countries is directed at academia. Other countries have larger and more articulated public research systems and universities play a more specialised role, sometimes involving close links with industry (Goldhor and Lund, 1983).

Government and the public sector provide complementary assets needed by firms to enhance innovation capability often by providing the proper institutional and infrastructural environment. These assets typically include high levels of domestic investment in human capital, tax incentives for R&D expenditure, and stable macroeconomic policy. According to OECD (1997), linkages between the public and private research sectors are also among the mechanisms that allow institutional interactions to take place and knowledge to flow in NIS. These linkages involve joint industry research, technology diffusion, and transfer of personnel.

The relative importance of public research sectors serving as a source for industrial knowledge varies considerably depending on the importance of these institutions in a national setting. In some countries, public research institutions serve as the main source for developing and diffusing applied technology necessary to an industry. The importance of public research, for example the contribution of university research funded by the U.S. National Institute of Health, as a source of new ideas fuelling innovation is emphasized (Toole, 2012). And universities and public research organization are key institutions in the process of catching up (Mazzoleni and Nelson, 2007). Moreover, the quality of a nation's public research infrastructure and its links to an industry are very important. In fact, the public research sector may be considered important as an indirect source of applied economic knowledge as well as a direct source of scientific and technical discovery

(Bartzokas, 2007; Mazzoleni and Nelson, 2007).

3.3.2. NIS in Supporting ITT

Although, the supportive roles of the NIS in innovation are well recognised, the ways in which the NIS might support ITT are less comprehensively examined in the literature. In this sub-section we will examine some of the ways in which the NIS might support the ITT process. This is followed in the next sub-section (3.3.3) by a more specific discussion of how the NIS might support firms' absorptive capacities.

Policies aimed at improving a firm's absorptive capacities have sometimes focussed on effective networking. Such policies put the stress on the role of joint research and other technical collaboration between enterprises and public sector institutions. Networking schemes that help promote research and advance technology partnerships within a government are quite valuable, as is evident in the technology transfer between Korea and Russia.

The degree of support provided by NIS and their policies for ITT varies depending on the size of firms, the level of economic development, and the nature of transferred technology (Mowery and Oxley, 1995). For example, NIS in developing countries plays a more active role in supporting a local firm's exploitation of foreign technology. However, public intervention is less likely to occur for large firms in advanced countries that already have strong capabilities in seeking and accessing needed foreign knowledge. However, Kim and Dahlman (1992) argue that with the help of NIS in latecomer economies, firms both large and small exploit relatively mature technology through licensing, turnkey plants, and capital goods. In this case, NIS does not directly affect a firm's ITT activities. Nevertheless, NISs in these countries' make contributions indirectly by fostering well-trained scientists and engineers, and by providing physical infrastructure and financial support (Mowery and Oxley, 1995).

An NIS is likely to be affected when firms change their innovation practices and the way in which they collaborate with external partners, sharing complementary resources (Wang et al., 2012). The supply of external knowledge is largely determined by a well-equipped and functioning NIS (Wang et al., 2012). Even for firms trying to adopt external knowledge from other countries, a well-functioning NIS is important to provide various indirect policy measures, as witnessed in some latecomer countries. The role of the external environment is to support the provision of R&D manpower, competence building, networking, and financing of the innovation process. All are crucial NIS activities. Firms wishing to make use of external knowledge are keenly aware of the importance of a strong NIS. These organisations know that they depend upon the use of inter-organisational collaborative agreements and networks to link knowledge flows. A preference for open innovation will create a demand for a strong NIS (Wang et al., 2012).

Notably, innovation networks, especially those that promote inter-firm cooperation for technology intensive sectors, are based on a balance of strong cooperation and flexibility. As Powell (1990) has argued, networks are both different from markets and hierarchical organisation, in such a way they can provide the diverse resources (organisational, financial and knowledge-based) without the limitations imposed by being either purely guided by short-term profit making, or by bureaucratic hurdles. Given this, networks are especially important for the development of technology initiatives, where trust, intense information sharing and cooperation are critical for the firms' success (Giuliani, 2010; Burt, 2011, Granovetter, 1985). However, in practice, developing countries tend to have weak or poorly governed networks that tend to weaken firms' absorptive capacity and flexibility (Velho and Saenz, 2002).

It is clear that there is a positive connection between a firm's participation in national innovation networks and its innovation performance. This kind of participation flourishes in an environment with strong public-private cooperation within a NIS environment. Only if there are strong ties among all of the key innovation players can an NIS respond to challenges like the current pressure to boost the effectiveness of technology markets. By the same token, the more firms participate in innovation networks, the more important those networks become. The process itself moves the locus of innovation out of a single firm into the network.

3.3.3. NIS and Absorptive Capacity

The enhancement of firms' innovative capacity is a major priority in developing national innovation policies and helps to explain the considerable and persistent interest in the NIS perspective. By improving access to appropriate networks, firms are able to identify relevant technology and information, and to adapt such knowledge, for their own needs. This is done because of a firm's need to upgrade their technical, managerial, and organisational capabilities or to invest in internal R&D, personnel training, and information technology. Ultimately, the purpose is to improve a firm's ability to acquire domestic or foreign information and technology and absorb it on a continual basis. In general, technology policies should not only seek to diffuse equipment and technology to firms but also to upgrade a firm's ability to find and adapt technology according to their needs.

The experience of Korea and other Asian countries that have successfully engaged in catching up draws attention to the role of government policies in supporting the absorptive capacities associated with the inward transfer and exploitation of technology developed in other countries. Their national absorptive capacity is attributed to successful ITT, strong public policies, and solid government support (Dahlman and Brimble, 1990). This capacity relies on investments in the scientific and technological knowledge and education in labour force, along with innovation and economic policies. A strong national absorptive capacity is related to the public sector components of NIS including public agencies and policy programmes that support local firms' ability to adapt and exploit foreign technology. Additional features that may be present include training of scientists, providing favourable institutional framework, and investing in relevant infrastructure. By doing this, domestic abilities to adapt and adsorb foreign technology are possible and national absorptive capacity can be enhanced (Roessner et al., 1992).

The concept of absorptive capacity was originally developed to apply to firm level activities. However, the national level of absorptive capacity is also discussed in relation to the concept of NIS (Hervas-Oliver et al., 2012). Firms' absorptive capacity may be enhanced by the external environment of the firm. It can be done by interactions within NIS. The definition of absorptive capacity, as offered by Mowery and Oxley (1995) is "a broad set of skills needed to deal with the tacit component of transferred knowledge and the need to modify this imported knowledge". They focus on a capacity that can be applied at a national or economic level and utilised to adopt and develop new technology. The concepts of NIS and of absorptive capacity share similarities with the concept of social capability used by Abramovitz (1986). Thus, it is a useful extension of the firm-based concept of absorptive capacity to propose the concept of national absorptive capacity, which is the enhancement of a country's ability to absorb and adapt foreign technology through public policies, and investments in education and infrastructure. The level of national absorptive capacity is not an aggregating of individual firms' absorptive capacities, but a nation's systemic capacity. This is because a nation's social and institutional norms, standards, and framework in conjunction with public policies and strategies help firms to create and increase their capacity to absorb external knowledge.

It is a reasonable conclusion that the development and enhancement of national absorptive capacity relies greatly on public policies and involvement. To make it effective, it requires two levels of approach. One is a general approach in which a well-established policy, educational, and infrastructural environment helps firms to enhance their absorptive capacity. The other is to help by providing specific and detailed assistance to a firm asking for assistance.

This conclusion is drawn based on cases of East Asian latecomers' successful exploitation of foreign technology. East Asian latecomers have created local absorptive capacity, allowing their economies to adapt and incorporate foreign technology (Dahlman and Brimble, 1990). National absorptive capacity requires a broad array of skills, including the ability to identify the value of and apply the tacit components of the transferred technology, as well as to modify foreign-sourced technology for domestic application. This capacity relies on investments in the scientific and production labour force, tax benefits for R&D expenditures, and an institutional framework assisting a firm's innovation activities (Alam and Bagchi, 2011).

In the past sections, I have discussed at length the concept of NIS to underscore the systemic character of technology transfer. Similarly to absorptive capacity, the NIS concept addresses the capacity of a firm or a national system, respectively, to identify and effectively adopt and implement a technology solution developed by others. However, the NIS concept emphasises the fact that the absorptive capacity of a firm can be greatly augmented by the integration of a set of institutions that aid firms in the specific stages and needs of a technology transfer project. As a consequence, even if a particular firm does not currently have the appropriate absorptive capacity for a given technology or partner, an effective NIS can intervene to expand the frontiers of possibility for this and other firms. Ultimately, a NIS can serve as an integrated network for technology transfer with distant partners.

3.4. BARRIERS TO ITT

Mansfield (1975) argued that it is important to distinguish between vertical technology transfer and horizontal technology transfer, where the former means transmission of knowledge from basic research to applied research, and from development to production and the latter the transfer of technology from one place, organisation, or context to another. The difficulties and costs of ITT are much greater than those for the case where only vertical or horizontal transfer is involved (Mansfield, 1975).

The nature of technology makes technology transfer difficult enough in domestic situations, and it is even more so in the international arena. In other words, the ability to utilise outside sources of knowledge is often difficult due to the organisational or individual context with which it is associated (Szulanski, 2000; Von Hippel, 1994).

Scholars such as Brown and Duguid (1991) and Kim (1999) have deeply examined the entire processes of learning and have concluded that learning requires numerous institutional arrangements. This is necessary because the innovation process needs systemic direction at multiple levels as well as a multitude of connections with local institutions and the local environment. There is no blueprint for the ideal institutional arrangements that will deliver effective technological transfer and adaptation, particularly with respect to the tacit knowledge elements of technology. Inevitably, institutions will be shaped by their technological conditions, socio-economic setting, and political regimes. Thus, attempting to transplant them from one country to another generally fails (Rodrik and Subramanian 2003).

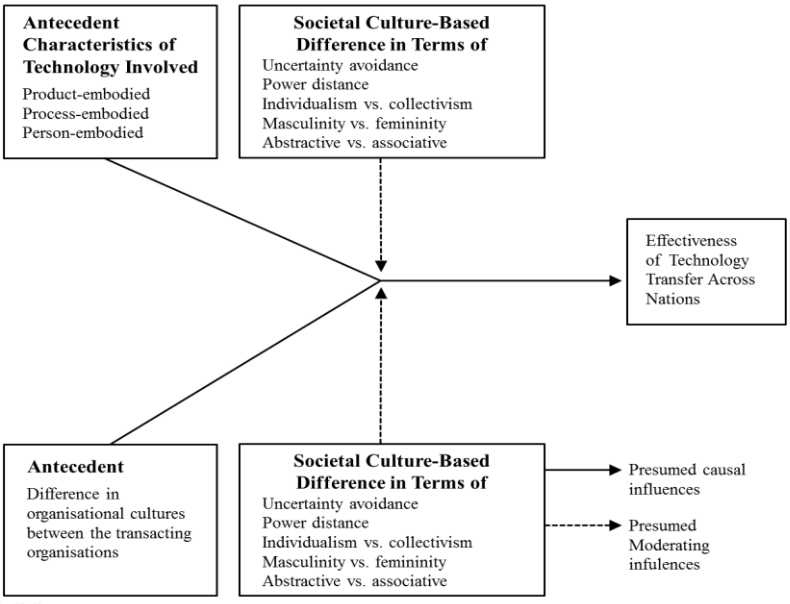
From the standpoint of the technology recipient, effective technological learning is very important for the success of an ITT project. The concept of absorptive capacity implies that there are likely to be gaps between a firm's absorptive capacity and the required level of absorptive capacity for successful absorption of the technological knowledge. These gaps result in difficulties or barriers to technology transfer. In the following sub-sections, three concepts related to those gaps that raise barriers to ITT are examined: 1) gaps arising from distance between the parties engaged in ITT, 2) gaps arising from different tacit knowledge of the parties, and 3) the potential role of intermediary organisations in overcoming these gaps.

3.4.1. Gaps from Distant Locations

Technological change is the outcome of local innovation systems, including socio-cultural, economic, political, and geographical dimensions (Kedia and Bhagat, 1988). In order to make technology transfer successful, it is very important to develop the capability to overcome the impediments caused by these diverse dimensions of differences. Because gaps or impediments arising from the socio-cultural dimension are embedded within a technology itself and transfer organisations, the performance of international technology transfer may vary due to differences in the underlying socio-cultural compatibility (Na-Allah and Muchie, 2012). Some examples of such socio-cultural dimension are attitudes to risk, distribution of power and rewards in the recipient organisation, location in the individualistic-collectivistic culture spectrum with regard to absorbing and diffusing imported technology, physical proximity, and ease of communication (Kedia and Bhagat, 1988; Gibson and Smilor, 1991).

Kedia and Bhagat (1988) proposed a conceptual model, as shown in Fig. 3.1, for understanding cultural constraints on technology transfers across nations. According to this model, there are two groups of factors which are causally related to the effectiveness of ITT: the characteristics of the technology involved and differences in organisational cultures between the transacting organisations. There are also factors presumed to be moderating influences on the causal relationship. These include societal culture-based differences and absorptive capacity or the existence of a sophisticated technical core in the recipient organisation. However, this model seems to be ambiguous. For example, there are some difficulties in distinguishing between impediments arising, on the one hand, from differences in the organisational cultures between the transacting organisations and, on the other hand, from societal culture-based differences. In terms of barriers or difficulties involved in ITT, the characteristics of the technology and differences in culture between different NIS could be a cause of barriers. In addition, however, the absorptive capacity of the recipient organisation, as defined by Cohen and Levinthal (1990), and not illustrated in Fig. 3.1, could provide a basis for effective technology transfer. In other words, Kedia and Bagat’s model, illustrated by Figure 3-1, argues for a deterministic model of effectiveness of technology transfer in which socio-cultural context matters more than individual differences between firms in their capacities to overcome barriers.

Figure 3-1: A conceptual model for understanding cultural constrains on internal technology transfer



Source: Kedia and Bhagat (1988)

Differences inhibiting ITT sometimes stem from factors related to political and legal factors such as laws, trade policies, tariffs, licensing regulations, and other economic, technological, and social factors (Munari, Sobrero and Malipiero, 201; Kedia and

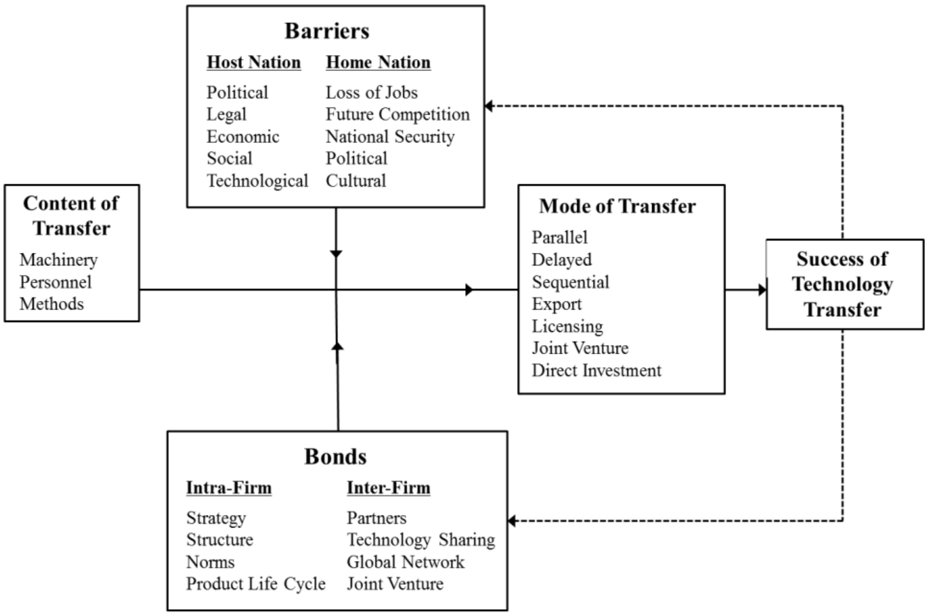
Bhagat, 1988; Perez and Soete, 1988). It seems reasonable to assume that technology transfer projects that span larger cultural differences at an organisational or national level will generally have a lower rate of success in comparison with projects with smaller differences. This is due mainly to the higher potential for misinterpretation of information by the recipient firm. Person or process-embodied technology is more difficult to transfer and diffuse than product-embodied technology in relation to cultural differences at organisational and societal levels (Kedia and Bhagat, 1988; Lin and Berg, 2001). For example, the cultural value system of Germany, which places values on assertiveness and achievement, is different from that of India, which places value on social relationships (Steenkamp, Hofstede and Wedel, 1999). Therefore, a transfer of technology may disturb one such cultural value systems and is more likely to be resisted (Keller and Chinta, 1990).

Keller and Chinta (1990) argued that examining both the barriers and impediments to technology transfer, and the bonds or bridges that can alleviate these blockages, help in understanding the context in which ITT occurs. They proposed an integrative framework of ITT as shown in Fig. 3.2. In this framework, there are four groups of factors influencing the success of technology transfer: content of transfer, barriers, bonds, and mode of transfer. The content of transfer includes machinery, personnel, and methods. For barriers, two categories of factors are suggested. The first category is political and legal factors such as laws, trade policies, tariffs, or licensing regulations, and the second category is economic/technological/social factors. Adopting the terms of Kedia and Baghat (1998) discussed above, the barriers may also include the differences in political, legal, economic, and social factors between the organisations or countries.

Further analysis of the implications of localised knowledge involves definitions of various types of “distance” between sellers and recipients – distances in terms of culture, practice, and experience can be defined and are often correlated with physical distance. That is, longer distances often involve larger changes in culture, practice and experience. This makes technology acquisition a localised and path-dependent learning process. This concept is drawn from the innovation system perspectives best summarised by Freeman (2002). He states that technological organisations are “embedded in a much wider socio-economic system in which political and cultural influence as well as economic policies helps to determine the scale and direction of all innovative activities” (Freeman, 2002: 195). Countries with similar socio-economic systems, including their industrial structure, share more common ground than those with dissimilar systems. In addition, it is commonly recognised that technological progress is a highly path-dependent process that evolves along specific trajectories that have become embedded in a country’s environment. Consequently, every country has a certain degree of technological context that is specific to that country. Those countries with similar technological context can communicate their technological knowledge move easily than those with different contexts (Bae, 2005; RAND, 2001).

Firms in a source country may attempt to exert control over technological resources by putting restrictions on the movement of technological information. A firm within such a source country may patent a large number of related products and market only a limited range of products in order to decrease potential competitive pressures. Furthermore, if a license is negotiated for a particular product, a firm in the source country may limit the conditions and fields of use for such a product.

Figure 3-2: An integrative framework of international technology transfer



Source: Keller and Chinta (1990)

There are also thousands of industrial standards that are required for a modern economy to function. Some recipient countries may lack the necessary compatible industrial standards that exist within a source country. Industrialised countries have standards for things such as electrical voltage, metrication of weights and measures, threading of fasteners, dimensions of roadways or railroads, radio and television frequencies, building codes, etc. (Keller and Chinta, 1990). In some cases, particularly in some of the electronics industries, these compatibility standards are also accompanied by intellectual property, which may create additional barriers. Assimilation and transformation costs must be taken into consideration if the recipient country does not meet such standards.

3.4.2. Gaps Stemming from the Tacit Nature of Knowledge

The effectiveness of technology transfer may depend on the characteristics of the technology being transferred. Successful technology transfer does not merely consist of transferring proprietary information and rights to the other party; it also includes both the transfer of technological information and the capability to master that technology (Rosenberg, 1982: 249). A significant part of technology is tacit and is embodied in individual and organisational routines. It is therefore inherently difficult to transfer a tacit component of knowledge without local investments in learning, which is how knowledge becomes re-embodied in the receiving organisation (Lawson and Lorenz, 1999).

For transfer to occur, this technological knowledge must be re-embodied in the receiving organisation. The term "re-embodiment" refers to the fact that the same knowledge does not exist in the two organisations, but that the knowledge of the receiving organisation is sufficient to modify, extend and improve the technology in ways that are, at least in principle, equivalent to those existing in originating organisations. Because the knowledge is not the same, it may in some cases prove more effective. This effectiveness depends more on the evolution of the technology and the uses to which it is applied than it does on pre-existing knowledge about the technology since, after transfer has occurred, the receiving organisation has its own base of knowledge for making applications and improvements. Whether, using this new knowledge base, these applications and improvements will be superior or inferior is uncertain and hence the re-embodiment of technology is not only difficult but also has uncertain outcomes. The re-embodiment problem makes technology difficult to reproduce and transfer (Radosevic, 1999b).

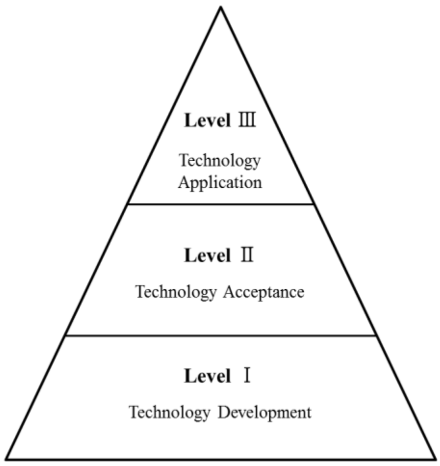
There are other aspects that contribute to the difficulty of technology transfer. In many cases, it is not economically rational to make technology readily transferable. If it were, then the ability to appropriate returns might be limited. Even in industries where knowledge is highly codified, the very understanding of this codification assumes continuous interpretive knowledge (Styhre, 2003). It may be more cost efficient to have successive generations of people learning on a person-to-person basis rather than codifying the interpretive knowledge (Cowan, David and Foray, 2000).

These basic observations about the difficulties of knowledge transfer have been considered by a number of authors, often using slightly different terminology or understandings of the re-embodiment problem. For example, Polanyi (1958) takes a slightly different approach to tacit knowledge. He views tacit knowledge as a personal form of knowledge that individuals may obtain only through direct experience rather than through a medium such as a manual book or blueprint. He further encapsulates the essence of tacit knowledge in the well-known phrase “we know more than we can tell.” According to his argument, tacit knowledge is held in a non-verbal form; therefore, the holder cannot provide a useful or verbal explanation to another individual. He contends that tacit knowledge is the elusive and subjective “awareness” of an individual that cannot be easily articulated into words. From Polanyi’s perspective the articulation of tacit knowledge into documents (what is later called codification) is either an impossible task or one that results in substantial destruction of the original knowledge (Polanyi, 1966). It is this difficulty of diffusing tacit knowledge into other forms of explicit knowledge that requires the recipient to have the capacity to adequately absorb this tacit knowledge. Grant and Gregory (1997) analyse this issue with cases studies dealing with manufacturing technology transfer. They conclude that the extent of the transfer of tacit knowledge often has a major impact on the effectiveness of technology transfer.

Another approach to the re-embodiment problem comes from the knowledge management field. Within this field, the common view that knowledge is a valuable organisational resource has become widely recognised and accepted (Empson, 2001). Consequently, there has been an increasing interest in the tacitness dimension of knowledge. Tacit knowledge is viewed as one of the hardest aspects to manage as it cannot be formally communicated. Thus, the issue of tacit knowledge has been dealt with in many disciplines by many authors. It is considered to be relatively unexplored and not fully understood (Zack, 1999) compared to that of the work on explicit knowledge (Leonard and Sensiper, 1998; Holtshouse, 1998).

Yet another approach to the "re-embodiment" problems is Gibson and Smilor (1991) who suggest a three-level involvement model of technology transfer (see Figure 3-3). At level I, the transfer process is largely passive through materials such as research reports or journal articles which contain technological information. At level II, efforts are made to make certain that the technology is made available to the recipients of the technology. At level III, technology is applied for the profitable use of the technology in the market place as well as in intra-firm processes. At this level III, which is closely related to the effective transfer of technology as described in Kedia and Baghat (1988) or success of technology transfer in Keller and Chinta (1990), interpersonal communication is emphasised (Gibson and Smilor, 1991), which again suggests that the transfer of codified knowledge is not enough and the transfer of tacit forms of knowledge is important for the success of ITT.

Figure 3-3: Technology transfer at three levels of involvement



Source: Gibson and Smilor (1991)

3.4.3. Role of Intermediaries Overcoming the Gaps

As noted at the outset of this thesis, a hypothesis concerning ITT is that it is influenced by differences arising from the unique context of socio-cultural systems and the distinctive qualities of technology. These differences may be defined as “gaps”. An important issue that must be considered in dealing with ITT involving distance and tacitness gaps and thus solving the “re-embodiment” problem is how these gaps may be bridged by intermediaries. Intermediaries promote a firm’s ITT activities by providing supportive services and information. If an intermediary is involved in public sector, it may have authority to make a favourable legal and institutional environment for ITT. In dealing with innovation, they fill structural holes between different groups and build a bridge for knowledge to be transferred more smoothly (Burt, 1992; Sarvary, 1999).

Knowledge which is tacit in the way suggested by Polanyi (1966) may immediately call for an intermediary who can help structure the experience of individuals in the receiving organisation to reproduce the tacit knowledge. Intermediaries may also serve as boundary spanners between technology sources and their recipients, taking knowledge from one domain and applying it in another (Polanyi, 1966). What they are “spanning” is the gaps between the two different organisations collective and individual knowledge. As the distance between the parties in terms of language and culture, and the physical distance, increases, the boundary to be spanned becomes more complex. This amplifies the importance of the intermediary (Kostova and Roth, 2003).

Another term used in the literature is that of the “middleman” (Kodama, 2008). Kodama views the role of the middleman as essential in the informal dissemination of knowledge that facilitated technical improvements in agriculture and textiles, and the processing of wool. Middlemen spent much time observing the best practices of each of these industries and then disseminating those practices to help raise the average or typical practice in firms with which they were more closely allied and thus benefitted from the resulting greater competitiveness of these firms. In both the past and present, successful intermediaries help both buyers and sellers by reducing their clients’ searching and bargaining costs, thus earning their fees within the pressures of the market. In addition, they mitigate market failures caused by imbalances in the information available to buyers and sellers.

The importance of intermediaries may have increased in recent decades due to the increased need for translating and transferring knowledge (Boon et al, 2011). The variety of intermediaries is growing, and now includes consulting service organisations, incubators, technology licensing offices, science parks, etc. (Van Lente et al, 2003). Intermediary functions grow to meet the needs of specific innovation systems. They now operate upstream in the innovation value chain, gathering intelligence on new developments. They also operate downstream in activities such as IP management and commercialisation (Ulset, 1996). The roles of intermediaries include: adapting specialised solutions to the needs of firms, connecting players within a technology system, identifying appropriate collaborative partnerships, and creating and maintaining relevant databases on technology, markets, competitors, etc. Intermediaries' clients on both sides of each transaction are discovering new needs for their services and demanding to have those needs filled (Boon et al, 2011). In all of these cases, the intermediary is acting in ways that will alleviate the "re-embodiment" problem by spanning or building bridges to traverse gaps in knowledge, understanding, and capabilities.

The roles that intermediaries perform in the technology transfer process between large and small firms are often organised in an entity known as a technology licensing office. These roles include: identifying partners in technology transfers; packaging the technology to be transferred; selecting suppliers to make components for the technology; providing support during the negotiation process; and advising on the terms of contracts and licensing agreements. It is noteworthy to observe that many universities and public research institutes have established internal technology licensing offices.[2] Ideally, such intermediaries help turn potential competitors into potential partners by

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[2]Technology licensing offices established by public sector organisations may perform rather differently, with some more interested in "rent seeking" for returns on public sector research while others play a more effective role industrial development, see Llerena et al. (2003).

building trust and preserving confidentiality. They may mitigate the risks of disclosing sensitive technological information by analysing and evaluating each partner objectively.

3.5. CHAPTER SUMMARY

This chapter has discussed key concepts of the conceptual framework employed in this study. This chapter draws upon the existing literature on absorptive capacity, problem solving, and socio-cultural differences. The concept of absorptive capacity is relevant to understanding the Korean use of Russian technology. This concept helps to explain the degree to which latecomers in both advanced and developing countries may succeed in augmenting their technological capacity with external knowledge. In addition, it is especially useful in understanding the successful transfer of technology between Russia and Korea.

The role of NIS in assisting local firms in absorbing external knowledge has also been discussed. A distinction is made between the role of the public and private sectors in providing optimal conditions for technology transfer. The public sector is seen to act through public R&D agencies and through law and regulation, while the private sector operates through R&D firms. As discussed, the NIS approach may shed light on the government’s role in the innovation process. In this thesis, the NIS concept is important in explaining the Korean government’s role in assisting ITT across gaps resulting from differences in context and experience, elements that are identified with tacit knowledge and the shortcomings of codification.

Finally, the relation between the barriers that arise as a result of the gaps between dissimilar NISs, such as gaps from the distant locations and different experiential backgrounds that create different tacit knowledge, have been discussed in terms of barriers. However, these barriers create opportunities for intermediaries to span or bridge these gaps. The gaps from dissimilarities between the NISs of Russia and Korea stem from both locational and tacit knowledge perspectives and this is why they are key concepts to be examined and tested in this thesis. In addition, the relative importance of gaps arising from location and tacitness is, *ex ante*, unknown and remains to be assessed in the empirical work of this thesis. The next chapter will discuss in more detail about how absorptive capacity, NIS, and barrier ITT comprise the conceptual framework of this thesis.

CHAPTER 4. EMPIRICAL BACKGROUND

4.1. INTRODUCTION

The purpose of this chapter is to present the empirical background characterising the Korean-Russian technology transfer process. It demonstrates the nature of ITT between Korea and Russia and how it differs from traditional ITT between developed and catching up economics. It also examines the nature of the gaps between the two countries. The Korean approach to the exploitation of Russian technology is illustrated in order to capture the macro level conditions and background shaping Korean firms involvement in such ITT. The ways in which Russia's unique S&T system leads to difficulties for Korean firms in the process of ITT are also considered. This chapter is organised in three sections, each of which presents an empirical facet of the Korean Russian technology transfer. These are: (1) the Korean absorptive capacity, (2) the nature of the Russian Innovation system, and (3) the evolution of Korean-Russian cooperation.

4.2. KOREAN ABSORPTIVE CAPACITY

This section addresses the empirical background of Korean absorptive capacity as part of the context that influences the success of Korean-Russian technology transfer. Specifically, this section addresses how Korea has built up the necessary infrastructure and policy framework leading to Korea's search for foreign sources of innovation. This section also reviews how Korea has accumulated technological capability throughout Korea's modern history. A large part of Korean success in the development of technological capability has relied upon foreign suppliers of fundamental technology. In the process of adapting foreign sources of fundamental knowledge, Korean firms have accumulated unique technological capabilities and knowhow in making effective and strategic technology adaptation. The Korean government also provides various policy measures to assist ITT activities and thereby strengthens national innovation capacities. The history of Korean firm experience in ITT and the role of the Korean government in assisting firms' efforts in the process of technology transfer are keys to understanding Korea's success in ITT.

4.2.1. Korean Achievements in Industrial Development

Modern industrialisation in Korea actually began during the colonial period, when the Japanese government managed the peninsula's economy as an integral part of its empire (OECD, 2009). However, the majority of Korean academic society and people believe that during the Japanese occupation period, the nation's autonomous introduction of industrial developments was limited by Japan's isolationist policies and increasing militarism (Hong, Yim and Seo, 2007).

After the colonial period had ended, Korea's economy had fallen to the point of collapse during the Korean War (1950-53). In the 1950s, Korea was a nation "with a shattered past and a bleak future" (Kim and Dahlman, 1992). Despite this, Korea managed to achieve a high and sustained rate of economic growth beginning in the 1960s. The annual growth rate of real GDP of Korea was around 8 percent from 1961 to 2000 (Shin and Chang, 2003). This achievement is often called the "Miracle on Han River". The phrase comes from the "Miracle on the Rhine", used to explain West German's rapid reconstruction after the Second World War (Lee and Yoo, 1987).

Korea's full-fledged industrialisation actually began in the early 1960s (Yi, 1999). At that time, Korea had neither the technological capacity nor locally accumulated capital and Korea's only abundant resource was labour. In order to initiate industrial development, utilising its labour with foreign technology and capital was a natural and perhaps the only available step. In order to pay for foreign technology and attract foreign investment, Korea adopted a strategy of export promotion that would accelerate growth though resource allocation in line with the comparative advantage of Korea in making effective use of well-trained labour (MOST, 1987). When Korea began to launch an export-oriented economy, the targeted imported technologies were mostly at a mature stage of development. Those mature technologies Korea needed for export-oriented industries could be acquired through direct foreign investment or foreign licensing. But in the early years of industrialisation, formal technology transfers such as foreign direct investment or licensing of foreign technologies were restricted and the Korean government promoted technology transfer through the procurement of turnkey plants and capital goods (Kim & Dahlman, 1992).

Most of the foreign licensing was related to technical assistance for training local engineers to operate the turnkey plants. The government emphasised import-substitution while giving tariff exemptions on the import of capital goods. Therefore, Korea acquired a large part of foreign technology through informal channels when the country exported basic natural resources and simple products (Shin and Chang, 2003). The acquisition of foreign capital equipment was accompanied by increasing capabilities in reverse-engineering to reduce technological dependence and reduce capital acquisition costs (Chung, 2006). Amsden (1989) and Kim (1999) described the Korean case as industrialising through technological learning.

During the 1980s and 1990s, Korea developed an indigenous base for research and innovation in order to be competitive in global markets. Thus, the innovation policy focus shifted toward strengthening the national system of R&D (Bartzokas, 2007). In addition, a gradual opening of the domestic market forced Korean firms to improve their own R&D capabilities. During these decades, the Korean domestic market no longer served as a safety net for national firms and this increased the pressure on firms to compete internationally. In order to succeed in this international competition, Korea could no longer rely on a cheap and hardworking labour force.

As seen in the table below, Korea's top export items were iron ore, tungsten, and anthracite coal in 1960s. In 1980, they were textiles, electronics and shoes. In 2000, high technology and capital intensive products became top export items such as semiconductors and computers, petrochemicals and mobile telecom devices. To change its pattern of export from mineral resources to sophisticated manufactured goods, Korean firms were required to enhance their technological capabilities rapidly and they relied heavily on foreign sources of technological knowledge to do this.

Table 4-1: Changes in Korea's top-7 exported products

Ran	1960	1980	2000
1	Iron ore	Textile	Semiconductors
2	Tungsten	Consumer Electronics	Computers devices
3	Anthracite coal	Shoes	Petrochemical Products
4	Squid	Vessels	Mobile telecom handset
5	Live fish	Synthetic resin products	Vessels
6	Graphite	Metal products	Steel plates
7	Plywood	Plywood	Apparel

Source: STEPI (2005).

4.2.2. Korean Public R&D System

The establishment of a public R&D system is another important aspect of understanding Korea's successful achievement in innovation. The Ministry of Science and Technology (MOST), a government ministry responsible for promoting S&T, was launched in 1967. And it may be considered as a particularly important shift in Korea's post-war economic development (MOST, 1987). MOST placed the highest priority on the establishment of "the Long-Term Comprehensive Plan for S&T Development" which functioned to define and promote future directions for the development of S&T (MOST, 2008). The plan aimed at achieving the highest level of S&T among newly industrialising countries. This plan established policy measures to boost Korea's own R&D and the creative improvement of foreign technology. These measures included the nurturing of scientists, engineers, and the private sector's technology development activities, and the development of original technology (Kim 2002).

The fostering of government-funded research institutes (GRIs) was one of the most notable aspects of Korea's S&T development process (Lee, Kim, and Sohn, 2005). The nation's universities had focused on educating individuals for technical careers while firms were keen on developing productive rather than innovative capabilities during the 1960s and '70s. For each, R&D efforts were outside of their core activities. To respond to this, the Korean government adopted a strategy to set up research organisations in the form of GRIs. As the name suggests, these were not, strictly speaking, national institutes, but were semi-autonomous and largely privately funded. However, the private funding was often "directed" by the government which could exert control over firms due to its capacity to channel foreign investment, according to interviews with those responsible for policy making during this period (D. Lim, personal communication, December 1, 2011; S. Jang, personal communication, December 3, 2011). The centrality of private funding was preferred because the government believed national institutes were inappropriate for meeting industrial needs. National institutes inevitably have rigid operating systems with regard to promotion, salary, and other issues.

One of the important Korean GRIs that set a pattern for later GRIs was the direct result of the US-Korean political relationship. At a summit meeting in 1965, President Johnson of the United States and President Park of Korea reached an agreement related to the foundation of KIST (KIST, 2006). This was mostly because the US wanted to provide assistance for Korea in exchange for her participation for the Vietnam War. In their joint statement, it was announced that the United States had agreed to provide Korea with financial and technical assistance for the establishment of an industrial research institution (D. Hyun, personal communication, October 7, 2007). KIST persuaded Korean scientists and engineers working abroad to return home, incentivising them with high salaries, housing and sabbaticals to be used for research. KIST was equipped with modern facilities and researchers operating autonomously without direct control by the government (Choi, 2003). As Korean industry became more sophisticated, many GRIs were spun out from KIST or established separately for meeting industrial needs (Song, 2007).

As a system with features that are unique to Korea, the GRIs function as a major medium for implementing S&T policies and for creating a national capacity for innovation. Although they are public research institutes, their role in the 1960s and 70s was to assist the private sector as technological solution providers. While informally promoting technology transfer, Korea also tried to utilise international S&T cooperation to build technological absorptive capacity. In the 1960s and the early 1970s, these GRIs made great efforts to utilise foreign aid for S&T capability building (Kim, 2002). In the 1980s, the Korean government proactively launched national R&D programmes in response to the technology protectionism of advanced countries and market penetration by developing countries. Through the national R&D programmes, the government became more directly involved in facilitating the development of core technology (Kim, 2008). A series of national R&D programmes was launched from1982 onwards through MOST (MOST, 2007). This national R&D programme played a leading role in advancing the R&D system in Korea. It provided an opportunity for R&D projects to be promoted at the national level. Firms, universities, and GRIs participated in the projects of the programme. As a result, the country's R&D capability was significantly improved. The programme also had a significant effect on the later development of national R&D. With various ministries and agencies promoting national R&D programmes in the 1990s, a system for promoting national R&D programmes was developed in which each ministry and agency planned and promoted independent programmes (Lee, Hwang and Choi, 2012).

Table 4-2: Key strategy, activities, and players of Korean technological innovation by period

	1960~1970s	1980~1990s	2000s
Strategy	Importing and improving foreign advanced technology	Catching up with advanced countries	Shifting to a creative mode
Core activities	Supporting technology for industry	Developing technology for high	Developing basic & original technology
Key players	Government-funded research institutes (GRIs)	GRIs, private enterprises, universities	Private enterprises, universities, GRIs

Source: STEPI (2005).

4.2.3. From Catching-up to Post Catching-up

Korea's phenomenal economic growth since the beginning of 1960s was possible through the effective building and utilisation of technological capability. Korea's experience is different from that of industrially advanced countries. Because Korea's technological capability building made it possible for outside sources of knowledge to flow in rather than depending on indigenous efforts to generate new technology to the nation, Korea seems to be unique in terms of absorptive capacity – i.e. the ability to recognise the value of outside sources of knowledge, assimilate it, and apply it for economic use (Cohen & Levinthal, 1990).

To understand the process of Korea's technological capability building, the concept of the technological trajectory associated with the product life cycle discussed in Chapter 2 is useful. It explains the evolutionary path of technology development in industrialised economies in terms of three stages: emergence, consolidation, and maturity. In the emergence stage, product technology changes rapidly and the risks of technological and commercial failure are high. In the consolidation stage, process technology rather than product technology changes rapidly and production costs decrease following the rapid improvement of process technology. In the maturity stage, almost every aspect of technology is stabilized so that further improvement in critical parameters is difficult. But the sequence reverses for developing countries. It begins with the mature stage and then proceeds to the consolidation stage (Kim, 1980).

As Korean firms began to make products that involved sophisticated process technology, their former mode of technological learning seemed insufficient to allow competitive entry into foreign markets. Korean firms needed to change their technological learning strategy, which had been effective at the maturity stage, to one in which more "upstream" capabilities were present.

As mentioned in Chapter 2, Kim (1997b) explains that the normal pattern of early technological development in Korea and some of the other Asian countries was that of imitation and creative adaptation. In the imitator pattern, local firms started with small and rather primitive technology developed by them and gradually upgraded both processes and products through operating experience and using technical information and ideas that came from observing foreign technology.

During the industrialisation process, Korean industries were considered to take the "path-following mode"; thus, science, technology, and innovative activities were focused on development and applied research (Lee and Lim, 2001). This was achieved through effective adoption of foreign developed technology. Technological innovation attained through the catch up process involved imitating pre-existing technology. However, in order to promote a higher level of technological innovation, it was important to increase the autonomy of researchers. The same may be said for the promotion of creativity. These elements of the Korean NIS were achieved due to the pattern established by the GRIs which attempted to foster both individual researcher's autonomy and creativity (Amsden,1989; Kim, 1997a). In addition, this system created greater flexibility for meeting challenges arising from changing technology – e.g. the development of new technologies such as display technology and fibre optics.

The introduction of foreign technology contributed to increasing corporate facility investment and production capacities, and to developing industries. The preferred type of technology importation was the turnkey method, in which all the technology and equipment for constructing and operating factories were imported. The turnkey method was used in most of the chemical, fertiliser, cement, steel and paper-mill plants established in the 1960s and the early 1970s (Cheng and Lee, 2011). Because relatively large investments were poured into these factories, Korean firms lacking in technology capacity often relied completely on foreign firms. These firms were equipped with relevant experience and technology that allowed them to reduce risks and minimise the time required to enter into full operation. Even though turnkey operations had proven helpful, Korean firms still managed to absorb imported foreign technology very quickly, independent of foreign support. Adoption of technology through machinery importation has played a key role in Korea's rapid economic growth. The government not only allocated and supported these large-scale investments but also actively encouraged imports of foreign capital goods. The government also provided incentives, such as duty exemptions, to boost the international export businesses' competitiveness.

During that era, technological innovation was mainly oriented toward solving problems by leveraging foreign technology. Entering the 21st century, Korea started to successfully emerge as a leader in industries such as semiconductors, digital electronics, handsets, and ships. Unlike the innovations pursued in the time of catching-up, post catch-up innovation has involved the establishment of a new innovation path, which in turn requires a new approach. Creating new technology has also required a new social system in which new technology is being developed and utilised.

Table 4-3: Evolution of Korean innovation mode

	Path-Following Innovations	Path-Creating Innovations
Goals	To solve predefined issues in an existing trajectory (catch-up)	To solve new issues in a new trajectory (post catch-up)
Method of acquiring technology	Imported + self-developed	Self-developed + outsourced

Source: adapted from Choi (2003)

In order for a new technology to become established, a context for the emerging technology needs to be created. Therefore, post catch-up innovation requires technological innovation to occur in tandem with human resource development, standard setting, industrial development, and regional development. This implies that the development and execution of innovation policies in the post catch-up era requires an integrated approach, as well as the placing of technology in a broader framework. Since the late 1990s, Korea's innovation policy has shown these characteristics in various aspects. However, these new characteristics are not easily diffused or institutionalised due to the enduring legacy of ingrained practices acquired during the catch-up period. As a result, the post catch-up period that began in the late 1990s bears many of the hallmarks of the earlier catch-up period.

Lee and Lim (2001) argue that successful latecomers will ultimately confront the need for more expensive technology necessary for obtaining a higher level of technological capacity building. At later stages of development, successful latecomers become potential rivals of leading countries. As this occurs, incumbent firms may become reluctant to transfer their technology. Therefore, a competitive advantage based on cheap labour cannot be sustained when numerous latecomers are succeeding in the "catching up" process.

Korea has achieved a frontier position in many industrial areas; it faces the same problems and difficulties in advancing the frontier as the countries that are already at the frontier. Addressing these problems involves diversifying the sources of technological knowledge and enhancing its own knowledge base. Among East Asia's successful catch-up economies, Korea has been particularly aggressive in engaging in ITT with former communist economies as an extension of the search for alternative or supplementary source of external knowledge. Since the early 1990s, some of the large Korean firms indeed began to compete on the basis of their own leading-edge products and systems (Hobday et al., 2004). Korea was forced to seek new sources of innovation knowledge, complementing its traditional sources from the triad and enhancing its own knowledge base. In this situation, Russia appeared to be a very attractive partner and a possible source of scientific knowledge for Korean firms following the end of the Cold War era.

As Amsden (1989) and Kim (1997a, b) have argued, Korean achievements in successful and rapid industrialisation involved a high degree of the government involvement, learning and the creative improvement of borrowed technology. According to interviews with individuals involved in the early stage of Korean-Russian technology transfer, it was assumed this Korean legacy would make a positive contribution. In other words, it was initially assumed that Korean firms had already developed the SCTA capabilities needed to exploit Russian technology (Kim, 2000; Lee, 2001; Bae, 2005).

4.3. NATURE OF THE RUSSIAN INNOVATION SYSTEM

This section discusses the nature of Russian technology and Russia's innovation system in order to understand the nature of the gaps in respect of the Korean-Russian technology transfer. The aim is to provide a better understanding of the nature of Korean-Russian gaps stemming from tacitness and locality. Russian technology inherited the main characteristics and problems of Soviet science and technology. These characteristics are useful to recall in understanding the locality aspect of Russian technology and the resulting gaps between Russian and Korean technology.

Former communist economies have had to cope with a heritage that put science and research on a different footing from that of their Western neighbours. With weak civilian application, their research sector has suffered severe cutbacks in government funding since the fall of the Berlin Wall. Notwithstanding the collapse of many elements of its S&T system, Russia is still widely regarded as an S&T powerhouse. They possess a number of leading-edge product and process technologies, as well as a broad range of technological capabilities (Hong, Jeong and Kang, 1998). The high level of scientific knowledge with little commercial linkage and industrial application makes Russia a suitable partner for Korea.

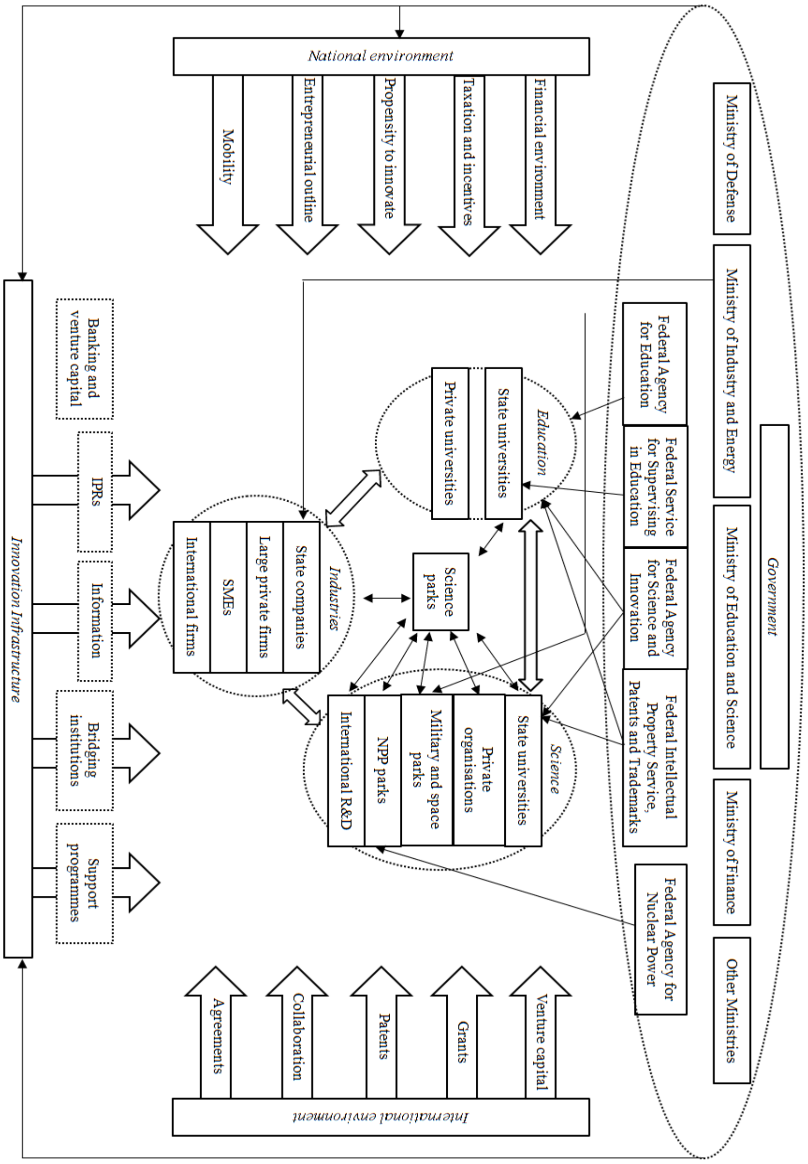
4.3.1. Characteristics of Russia's S&T System

The Soviet Union placed a high priority on S&T and built a huge assembly of research institutes, educational programmes, and production enterprises (Sandberg, 1992).The major goal of Soviet science was to create a powerful R&D sector appropriate for a socialist state. This created a particular S&T and innovativon system which is different from capitalist economies (Dezhina, 2006; Gokhberg, 2004). The objectives of R&D were, among others, supporting military and space programmes and technological self-reliance (Radosevic, 2003).

Figure 4-1 shows a diagram of the Russian Innovation system. The R&D actors include three main sectors: education, science, industry. The education sector includes public and private universities. The science sector includes state institutes, private organisations, military and space parks, and international R&D. The industrial sector includes state companies, large private firms, SMEs, and international firms. The government provides funds and policy directions through various departments and agencies.

Overall, Russia's R&D investment level has been lower than the average R&D investment level of OECD countries as shown in Figure 4-2. While GERD of the United States and Japan remained between 2.5 to 3.0% of GDP in 1990s, that of Russia stayed around 1% of GDP in the same period.

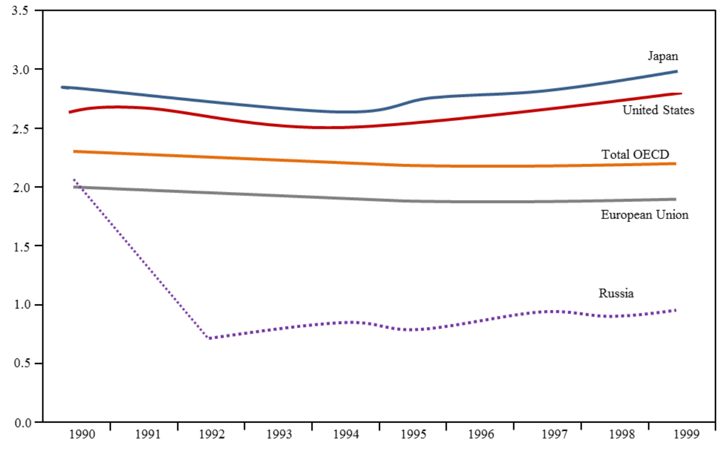
Figure 4-1: The Russian Innovation System



Source:

OECD (2005), Fostering Public-Private Partnership for Innovation in Russia

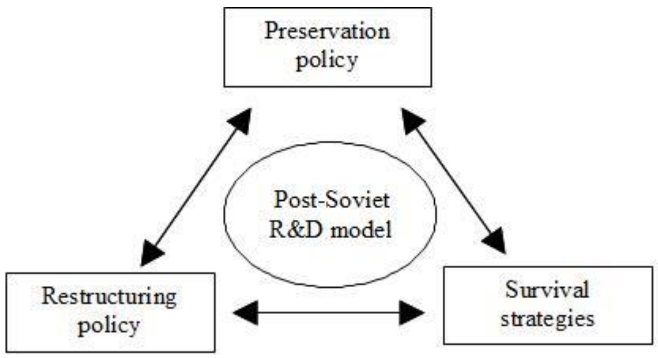
Figure 4-2: Gross R&D expenditures as a percentage of GDP



Source: OECD (2005)

This relatively lower level of R&D investment of Russia may be understood through the framework suggested by Radosevic (2003). As shown in Figure 4-3, the characteristics of post-Soviet R&D can be depicted as the interaction of survival strategies, restructuring policy, and preservation policy (Radosevic, 2003).

Figure4-3: Factors shaping post-Soviet R&D



Source: Radosevic (2003)

The preservation of science potential means efforts to solve the most acute problems of funding scientists without a major change to the role of the science establishment in the economy. An example of the policy attempts to preserve national science is the Russian Academy of Sciences and the branch academies, which still retain their traditional position regarding state R&D funding and operating as an association of institutes, without undergoing any major changes in their structure and organisation inherited from the Soviet era.

This element of science preservation is accompanied by a competing element of restructuring which is also needed in the long-term to successfully make the transition to a global market economy. Radosevic (2003) argues that restructuring elements of S&T policy include, among others, new criteria for public funding of R&D, privatisation of R&D, and new forms of institutional support for S&T. One of the most notable changes in the R&D system is the introduction of programme and project funding, in addition to the old institutional (per capita) funding. Restructuring policy needs to be balanced with preservation policy, so that the former does not overwhelm and destabilise the latter. A further and related element to restructuring, but one that is often undertaken directly by scientists and technologists consists of "survival strategies" such as promoting commercialisation through spin-offs which are expected to drive the R&D potential via economic payoff.

Table 4-4 shows a comparison of major economic indicators for Russia, China, Brazil, India and the USA in 2009. Russia's GDP per capita is 2,805 USD in 2009 which is a little higher than that of China but lower than Brazil. But in terms of the indicators related to S&T capabilities such as GERD, patent applications, and number of researchers per million population, Russia seems to have much higher level of potential than Brazil. And Russia has more researchers per million population than China, but the number of patent applications is much lower than that of China. These economic indicators suggest that Russia has a much higher potential in S&T, which is not fulfilled compared to other countries of similar income level.

Table 4-4: Comparison of major economic indicators in 2009

	Russia	China	Brazil	USA
GDP per capita (constant 200 USD)	2,805	2,206	4,419	37,106
GERD (as % of GDP)	1.24	1.44[b]	1.10[b]	2.82[a]
Patent Applications by residents	25,598	229,096	4,023[b]	224,912
Researchers per million population	2,602	1,071[b]	694[a]	4,663[c]

[a] Data available for 2008
[b] Data available for 2008
[c] Data available for 2008
Source: Adapted from Klochikin (2012)

Academic institutions responsible for basic sciences were founded and engaged at a world class level. Industry evolved in a favourable climate for labour and resource purposes, but not reflecting consumer needs (Seo, 1998). Soviet heavy industry was credible in steel and petrochemicals while less so in machinery and very weak in electronics (Seo, 1998). The results was an S&T complex that was suitable for some of the needs of a large industrial country with a broad spectrum of research and high quality scientific personnel but not suitable for other needs such as building mass production systems for mass consumption (Lee, Kim, and Sohn, 2005). The collapse of the Soviet economy, particularly the industrial and military complex to which most Russian R&D investment was directed in the early 1990s led to a considerable fall in R&D levels, and in the number of research workers (Kihlgren, 2003).

R&D spending decreased sharply in the period between 1990~1992. Gross domestic expenditure on R&D decreased in 1992 to 30% of the level in 1990. After 1992, relative expenditures on R&D stabilised at levels around 0.7 – 0.9% of GDP, the increased to more than 1% since 2000. After a sharp decline in the initial stage of the economic transformation, total R&D expenditures of Russia have grown steadily, but, in spite of a rebound and recovery in the R&D investment level, the bulk of R&D is still carried out within a large number of public organisations and financed through the government budget (Radosevic, 2003; OECD, 2005). Foreign firms invest in Russia according to their global strategies considering comparative advantage and risk/reward ratios for different types of investment, and except in a few areas including information and communication technology and oil explorations, this has generally not led to serious investments such as establishing R&D facilities in Russia.

Russian technology is developed in a specific context which is little linked to commerce (OECD, 1994). Some features of the Soviet legacy, in regards to technology transfer, remain important in present-day Russia. There is much "over-development" of specific skills that are not seen as necessary in the context of a Western viewpoint (Katkalo, 1993). The priorities and capabilities of the military-industrial complex have resulted in the development of a range of technological capabilities and specific high-tech products. The isolation of the Soviet Union resulted in the development of some technology which may have never been developed under the competitive pressures of markets (Dyker, 2001). However, this technology now has the potential to contribute crucial elements of technological diversity to the global technological system.

In centrally planned systems, the bulk of R&D had been paid for by the state and executed in laboratories and institutes that were geographically separated from production units. In the West, the growth of in-house R&D could be explained by the uncertainty of outcomes, the specific tacit nature of technological knowledge, the importance of such knowledge for competitive advantage, and acknowledgement of the need to link R&D with other specialised business functions as part of a process of continual organised learning.

For Russia, the main source of funding for basic research was the government. This was justified due to the impossibility of devising incentives that could reconcile the interests of private agents in appropriating the outputs of basic research with the general economic and social interest. The collapse of the Soviet economy brought down a system that was based largely on technological prestige and bureaucratic planning. Financial crises, deterioration of equipment, unemployment, and higher wages in other sectors drove large numbers of researchers away from S&T in Russia.

To summarise, the present Russian government is facing a difficult task: building a market-based national innovation system while preserving some parts of what remain of the Soviet S&T system (Klochikhin, 2012). Radosevic (2003) argued that Russia's R&D system is in a situation of low level equilibrium which is the outcome of balancing between restructuring and preservation policies coupled with the modest success of survival strategies. The efforts to preserve science potential play an important role in preventing a continuous decline in the real value of the R&D budget. It is reflected, for example, in Article 15 of the Law on Science and the State S&T Policy which mandates funds for scientific research and experimental developments to be allocated from the federal budget at a level of not less than 4% of the federal budget expenditures. Restructuring policy includes new criteria for public funding of R&D, the privatisation of R&D, and new forms of institutional support for S&T (Radosevic, 2003). Though some of the former strengths were lost in the turmoil of the 1990s, a large element of them seems to have been preserved. And the current stage of reform seems to be aiming at preserving the S&T potential of the country and providing adequate regulations for the results of innovation activity such as the legislation of the new Patent Law, part of the Civil Code on intellectual property, and others (Klochikhin, 2012).

4.3.2. Russian Gaps from a Western Perspective

There is an important contrast between Russia and other catching up economies. The Soviet Union had reached an advanced state of industrialisation and military technology. Many catching up economies have had to develop their technologies and industrial capabilities from a much lower technological level. There are advantages and disadvantages to the Russian situation. It is advantageous to have a base of technology, and, more importantly, trained scientists and engineers. On the other hand, the Soviet legacy of non-competitive practices, as well as obsolete equipment and facilities, is a liability (Sandberg, 1992). This disadvantage seems to be viewed as a major gap from a Western perspective.

Besides gaps from a technological perspective, several other issues remain between Russia and their Western partners, and these also might be considered as gaps for them. There is a widespread fear among the S&T establishment that the impact of globalisation on Russian S&T will result in the liquidation of their independent S&T base (Holden, 2011). Western partners perceive an unsatisfactory legal framework, political instability, and a unique technology culture as major problems in cooperating with Russia (Dyker, 2001). The transition to a market-based economy made no significant changes in the distorted patterns of financing inherited from the former Soviet Union. The government still finances the predominant share of R&D expenditure, with only one third of spending coming from industry (Hong, Yim and Seo, 2007). This is significantly lower than in advanced OECD countries where business is the main source of spending on R&D.

Institutional rigidities remain a major constraint on Russian R&D (Kim, 2000). There are few opportunities for their private sector to use R&D investments to increase economic performance. As a result, the bulk of R&D continues to be performed by academies of sciences (Song, 2005).

It is also noted that the Russian national innovation system is significantly unbalanced in that R&D units, enterprises and innovation infrastructures are isolated from each other, posing a need to pursue an innovation strategy promoting network links among the NIS components. One aspect of this weakness is the separation of teaching and research, which has been criticised as the major barrier to providing good training scientists and engineers (Lee, 2005). Another major aspect of this weakness is related to technology diffusion. Russian government continues to take measures to stimulate domestic demand for innovation goods and services as well as supply-side promotion by supporting a technology-push strategy (Klochikhin, 2012).

4.4. EVOLUTION OF THE COOPERATION

4.4.1. Introduction

Since the early 1990s, large Korean firms began to compete with their own leading-edge products and systems as a result of successful technological catching up (Hobday et al., 2004). Korean firms had been forced to seek new sources of innovative knowledge, complementing their traditional sources in the triad countries. Among East Asia's successful catching-up economies, Korea has been particularly aggressive in engaging in ITT with former communist economies. Since the collapse of the Berlin Wall, this has served as an extension to Korea's search for alternative sources for external knowledge. To Korean firms, Russia had appeared to be a very attractive source for scientific knowledge (Hong, Jeong and Kang, 1998; Kim, 2000, MOST, 2001, 2004).

With a greater openness to formerly socialist economies, a new pool of scientific knowledge and partners for ITT greatly expanded, and countries from transitional economies joined the world capitalistic markets and became part of the regional and global networks of innovation (Radosevic, 1999c). They became new potential business partners to the rest of the world. Even though Russia's overall standing in terms of its economic and industrial status had remained low, unlike other developing economies (such as in Asia, Africa, and South America) it had substantial scientific knowledge stocks in areas of basic science and applied technology.

Even though Korea and Russia shared a basis for technology transfer, they had difficulty implementing ITT (Hong, Jeong, and Kang, 1998). It was more difficult for Korean firms to exploit and absorb Russian technology than technology from other nations that shared a similar system and structure (Y. Kim, personal communication, October 6, 2008). Having had no interaction before or during the Cold War, Korean and Russian firms and government agencies shared little or no common ground. Korean firms had difficulty in absorbing Russian technology, due to their long period of separation. Despite its latecomer status, Korea nevertheless shared many aspects of compatibility and proximity with technology acquired from the triad countries.

Korea has not yet been able to develop the technology needed to fully respond to the rapidly changing world market. Russia, on the other hand, has an abundance of highly educated human resources in the field of science and technology, with a huge stock of scientific knowledge and research facilities, and world-class advanced technology in the aerospace and fundamental industries. However, Russia finds it difficult to make full use of such technology due to their lack of experience in technology commercialisation. Russia has the potential to act as a supplier of fundamental scientific knowledge to the rest of the world, but also needs to find a business model that will give them an economic return for doing so. Korea has the ability to integrate its outstanding manufacturing infrastructure and new technologies. They, however, lack novel advanced technology in many areas. Korea and Russia share contrasting, but complementary grounds. The realisation of mutual strategic ground in their S&T systems suggested the possibility of a successful symbiotic relationship. Doing so, however, involves both capacity and institutional development.

4.4.2. History of Korea-Russia S&T Cooperation

S&T cooperation between Korea and Russia was promoted by a complementary cooperation strategy that integrated Russian basic science with the industrial and commercial technology of Korea. Indeed, there were mutual benefits gained from this strategy, since Russia wished to commercialise their scientific potential and Korea wanted to add value to their industry by securing fundamental technology from Russia. Since the early stages of normalisation of diplomatic relations between Korea and Russia beginning in September 1990, the Korean government has promoted technological cooperation with Russia (D. Lim, personal communication, December 1, 2011). According to the agreement for Korea-Russian S&T cooperation (concluded on December 1990, and in effect as of December 1991), the Korea-Russia joint S&T commission was established at vice-minister level. In addition, in June 1992, Korea and Russia signed a protocol on S&T cooperation that allowed the Koreans to access Russia's plans to convert military industries into civilian ones. Through this agreement, various S&T cooperative projects were promoted at the highest governmental levels (Song, 2007)

Table 4-5: Major projects of Korea-Russia S&T cooperation

Year	Project	Description
1992	Exchange of science and technical manpower	A total of 512 professionals from Russia by the year 2000
1994	Joint coordination centre	6 centres are currently integrated into the Korea-Russia science and technical coordination centre.
1998	ISTC Programmes	Supports the CIS Research Centre with international aid. Invested US$ 3 million to 41 projects by July 2007,
1992	International joint research	Many projects are promoted as international cooperative projects with support from the Ministry of Education, S&T and also the MKE

Source: MOST (2004).

The major forms of scientific and technological cooperation have been:

- Joint research projects in high-priority fields of science and technology,
- Exchange of scientists and specialists,
- Establishment of joint R&D centres,
- Joint commercialisation of the results of R&D, and

- Information exchange on the two countries' status and development of their government policies concerning science and technology.

Public research institutes and universities in both countries are key participants in these cooperative projects. Joint research projects are launched by applying to the appropriate department of the Joint Committee with a mutually-chosen research subject. Applications are considered by the Joint Committee during its annual meetings and, if approved, included in the Programme of Scientific and Technological Cooperation between the countries, thereby qualifying for governmental sponsorship and financial support. Several dozen joint research projects have been completed since the inception of scientific and technological cooperation between Russia and Korea (Hong, Yim, and Seo, 2007). Another form of cooperation has been the creation of Russia-Korea joint research centres, with sponsorship from leading Russian research institutes (MOST, 2001, 2004). However, the actual collaboration between two countries was still at a preliminary exploratory stage, since both sides were still searching for potential joint R&D opportunities and scientific information that could be exchanged.

With the momentum generated by the Korea-Russia summit meeting in 1997, industrial and economic cooperative bodies were launched to expand the cooperative relationship between the two countries. Korea adopted a strategy of introducing and commercialising Russian technology in order to improve the global leadership of its firms, and to reduce its technological dependence on other developed countries. In order to expedite the transfer of Russian technology and effectively engage in more advanced forms of technological collaboration, a few important policy measures were implemented (S. Jang, personal communication, December 3, 2011). First, a special organisation or institute for collaboration in S&T between the two countries was established, named KRSTC (Korean-Russian Scientific and Technological Centre). Its mission was to first take an inventory of Russian technology and then effectively link that to Korea's commercialised technology. This centre is important because cooperation through a reputable organisation serves to better find and promote cooperative projects with a partner such as Russia, as opposed to depending on smaller domestic corporations that lack expertise in Russian business culture. Moreover, the Korean government provided various fiscal and financial incentives to promote the transfer and commercialisation of Russian science and technology. The Korea-Russia industrial cooperation committee was organised to expand scientific industrial technology exchange, with the goal of accelerating the global market penetration of Korean firms.

Meanwhile, non-government technical cooperation with Russia was also vigorously pushed forward. At the private sector level, a number of direct agreements between Korean firms and Russian science institutions or firms were successfully reached (MOST, 2004). Besides major corporations such as Samsung, LG and Daewoo, small businesses have also succeeded in technical development and commercialisation of technology developed in cooperation with Russia.

4.4.3. Cooperation Setbacks

Despite the promise of these efforts, most of Korea-Russia S&T cooperative projects were relatively short-term, small-scale projects (Hong, Yim, and Seo, 2007). Furthermore, interviews and survey results showed that many successful Korean-Russian technology transfer projects were generally not revealed publicly, as many firms wished to keep their business relationships private. In the opinion of the Korean Russian Industrial Technology Programme (KRITP) manager, the reason is that Korean firms prefer that consumers be familiar with the technology of domestically developed products (K. Kim, personal communication, April 1, 2010).

Korea promoted cooperation with Russia in both long-term and short-term horizons. In the short-term, the primary policy goal was to transfer needed Russian technology to Korea, taking full advantages of the opportunity provided by the transition period of Russia. Accordingly, manpower resources were exchanged and joint research projects were conducted in order to accelerate the technology transfer that private firms needed to meet the demands of domestic industries. The long-term policy goal was to establish a reciprocal coordination system and infrastructure that would enable constant cooperation in enhancing R&D and developing state-of-the-art technology for the next generation (D. Park, personal communication, May 3, 2012).

However, the Korean-Russian technology transfer projects simply imported technical know-how and researchers temporarily from Russia. As a result, the opportunity of progress toward the long-term goals of reinforcing research capability and innovating through the acquisition of advanced research development seemed to be limited (Hong, Yim, and Seo, 2007). In addition, the number of opportunities to develop useful technology through short-term projects decreased as the situation in Russia took a sudden change in 2000, which was when Western countries and China began to heavily promote a series of major projects. For example, China promoted the Techno Park project to receive advanced original technology from Russia. To effectively compete with these initiatives, Korea sought new policy initiatives (Bae, 2005)

Another problem is that Korea lacks experts who can adequately promote cooperation with Russia. So far, the Korean-Russian S&T cooperation has been promoted by government departments, local-government affiliated organisations, and other institutions of various types (MOST, 2004). The level of cooperation has been on the rise, but projects are not going smoothly and sometimes are not successful because of differences in language, culture, and scientific and technical systems between Korea and Russia. Small corporations promoting cooperative projects often fail to deliver results, primarily because they lack expertise in Russian culture (Hong, Yim, and Seo, 2007). Furthermore, when an institution lacks expertise in technical cooperation with Russia, it tends to attach too much importance to simple, short-term technical research projects, due to a lack of pilot surveys or other background information.

It is a fact that Korea has only had established diplomatic relations with Russia for 20 years, and therefore a shortage exists of professionals who can promote Korean-Russian S&T cooperation. A solution would be to reinforce the government organised Korea-Russia S&T centres that promote technology exchange.

4.4.4. Public Agency Programmes for Overcoming the Gaps

As a way to overcome the difficulties and barriers in technology transfer from Russia, the Korean government has taken a slightly different approach since the late 1990s (M. Kim, personal communication, December 7, 2011). The Korean government launched a number of public agency programmes to support Korean firms who are attempting to exploit Russian technology. Some government ministries and local governments launched programmes. Each of these programmes has its own purpose, target, and procedures with the goal of smoothly facilitating the transfer of technology between Korea and Russia. These programmes aim to systematize the transfer of technology by coordinating interactions between government agencies, public research institutes, and private firms under the umbrella of a governmental agreement of both countries and public policy direction.

They provide relevant S&T information, technological support, and infrastructure for testing for domestic firms to use to seek, acquire, transform, and exploit Russian knowledge by engaging in the public agency programmes (Bae, 2005). The programmes are specifically designed to bridge wide gaps where there are multiple differences between countries, as is the case with Korea and Russia. A vast amount of Russia's scientific knowledge stock appears attractive to Korean firms, but unfamiliarity and the dissimilarity of both Russia, the country itself, and Russian technology made Korean firms hesitate in approaching them (Bae, 2005). These programmes are not designed to function at the level of individual firms or at the national level, but to provide a new, systematic framework for the absorption of foreign technology. The design of this framework is a natural outgrowth of an examination of the processes, patterns, and mechanisms of technology transfer between Korea and Russia.

4.4.5. Evolution of Korean-Russian Technology Transfer

In the early 1990s, MOST was very actively engaged in Russian technology transfer in respect of acquiring national strategic technology. But now in the 2000s, the Ministry of the Knowledge Economy (MKE) also participates in assisting Korean firms (H. Park, personal communication, November 17, 2011).

In the early 1990s, important benefit that Russian partners had received from their Korean counterparts had been related to funding, but in the 2000s Russian partners learned from Korean firms how to use their technology in the industrial sector (MOST, 2001). There now appear to be some joint ventures between Russian scientists and Korean firms, which suggests that a two-way knowledge exchange is involved. The patterns of complementarity and the structuring of ITT between the two countries have been evolving for the past twenty years (S. Jang, personal communication, December 3, 2011).

After the advent of the Putin administration in 2000, the number of Russian scientists or engineers going abroad in order to maintain their employment in some type of scientific or technical activity has fallen (Bae, 2005). Now that Russia has a semi-market economy, Russians have begun to prioritize the commercialization and industrialization of new technology. This can be explained in terms of institutional and attitudinal changes between the two countries. The social, political, economic, and innovation environments of the two countries have changed. The Russian side no longer hungers for funds with the same degree of urgency, and Korean large firms no longer rely solely on external technology. Several of those interviewed for this thesis observed that in the early 1990s, the Russian side did not benefit from Korean side except by receiving funds, but by the 2000s Russian partners were learning from their Korean partners how to employ their technology in the industrial sector.

In the early 1990s, large firms such as Samsung and LG were the main actors in acquiring Russian technology, but in the 2000s, Korean small and medium sized enterprises have become more involved in technology acquisition, often through being the main participants in programmes sponsored by public agencies (Kim, 2000). Korean small and medium sized enterprises try to develop new technology or solve technological problems. However, large firms still actively implement Russian S&T by establishing R&D centres in Russia. In the 1990s, transferring Russian technology was done entirely through person-to-person communication and interaction. Even though collaborations have been implemented as contracted projects, inviting Russian scientists to come to Korea was a core part of the contracts negotiated in this period. The Korean government and Korean firms invited or hired Russian scientists and engineers. In the 2000s, Russian technology transfer is still very much dependent upon human social interactions, but hiring Russian scientists is now very rare (MOST, 2001). Short-term visits or distance collaboration are increasing rapidly. This suggests Russian technology has become a more codified form of knowledge and that Korean firms have increased their absorptive capacity so that the reliance on human interactions is less necessary.

4.5. CHAPTER SUMMARY

To summarise this chapter, Korea's industrial and technological achievement has relied heavily on imported technology from advanced countries. This is not a simple purchasing process, but involves learning and absorbing through indigenous efforts. From the beginning of the Korean catching up period in the early 1960s, Korea acquired and assimilated foreign technology in mature, packaged, and codified forms through technical assistance, turnkey industrial plants, and licensing. Korea repeated this process with higher-level technologies and sophisticated industrial products. Ultimately, Korea arrived at such a highly competitive position in the global market that technology transfer with advanced countries became more difficult. Korea was forced to seek new sources of innovation knowledge, and Russia appeared to be one of the best sources of fundamental knowledge for supporting such innovation.

Even though Russia and Korea are different in almost every imaginable aspect including socio-economic system as well as political system, they share some complementary strengths and resources. Russian has strength in upstream scientific knowledge, but Korea is strong in downstream industrial application. This complementarity suggests that Russian partners may also have the opportunity to increase their own absorptive capacity through S&T cooperation between Russia and Korea. The existence of the joint ventures is an example of such opportunity. Therefore, this raises an important question: what are the effects of S&T cooperation on the innovation capabilities of Russia? This question, however, is beyond the scope of this thesis, due to both observational limits (limited access to Russian partners in the project's described) and to time and resource constraints in conducting this research. It is an important avenue for studies in the future.

A finding from this research (discussed in more detail in the empirical results chapters, Chapters 7 and 8) is that Korea-Russia S&T cooperation has proven to be rather limited to relatively short-term, small scale projects. Because of the potential value of Russian technology, methods for improving ITT were seriously considered by government policy makers. In order to further improve the results of technology transfer, the Korean government launched a series of public agency programmes, acting as an intermediary to assist Korean firms in acquiring Russian technology. Through programmes, government agencies, and public R&D institutes, firms interacted and collaborated in a systemic way that provided local Korean firms with information, technological know-how, and infrastructure. Local firms were enabled to seek, access, acquire, and transform external knowledge from Russia, even though there were major differences between these countries.

CHAPTER 5. CONCEPTUAL FRAMEWORK: The Systemic Capacity for Technological Absorption (SCTA)

5.1. INTRODUCTION

The purpose of this chapter is to introduce and discuss the conceptual framework that is employed to examine the construction of absorptive capacities in the Korean context, and which will be referred to as the Systemic Capacity for Technological Absorption (SCTA). This conceptual framework draws upon the assembly of the literature and empirical background discussed in Chapter 3 and 4, particularly the role of Korean NIS actors in facilitating ITT from Russia. These include the role of intermediary organisations used to bridge the gaps arising from the dissimilarities in the NIS of the two countries and the complexities of adopting and utilising the knowledge produced in the Russian context which are influenced by the existence of gaps stemming from locality and tacitness.

As mentioned Chapter 1, this thesis examines the processes of ITT by extending the concept of absorptive capacity. The existing literature on absorptive capacity is primarily concerned with firm-level processes. This thesis adds to the understanding of firm-level absorptive capacity by drawing on the significance of institutions identified in the NIS approach, examining the existence of these institutions and the roles that they may play in complementing and reinforcing firm-level absorptive capacities. Consideration of the role of intermediaries plays a complementary role to examination of firm-level absorptive capacities. The SCTA has been developed to deepen the analysis of the transfer of Russian technology into Korean context. It focuses on how this has been facilitated and, in particular, how this capacity plays a role in filling knowledge gaps, bridging differences, and overcoming difficulties in this process.

Before discussing the SCTA, a number of research questions and hypotheses are introduced based on the discussions of previous literature and empirical review chapters. Doing so here is a way to make clear the relation between the conceptual framework and the analysis of the empirical results.

5.2 RESEARCH QUESTIONS

The discussion of previous chapters suggests certain research questions to be pursued in this thesis:

RQ 1. Given that gaps exist between the knowledge developed in Russia and the absorptive capacity of the recipient Korean firms (reflecting Korean firms' prior knowledge base which was developed and accumulated in a different market context), do the nature of gaps between technology donor and recipient influence the success of technology transfer? More specifically, in the context of ITT, do very large gaps serve as a barrier to technology transfer?

RQ 1 takes forward the premise drawn from the literature that there are gaps arising from locality and tacitness that impede technology transfer. However, the literature is vague about the nature of these gaps and their extent. Hence, answering RQ 1 will involve gathering and evaluating evidence on the nature and extent of gaps that, in practice, have influenced technology transfer from Russia to Korea.

RQ 2. Unlike the triad countries from which technological knowledge has been transferred to Korea, the Russian S&T and innovation system was different from that of capitalistic economies. To what extent were Korean firms' motivated to attempt to meet this new challenge?

RQ 2 begins with the premise that the transfer of applicable Russian technology to Korea might be difficult and asks why Korean firms might seek such transfers. This question is grounded in the empirical background of Chapter 4 which demonstrated that Korean firms have historically most often relied on triad countries but that in the recent period have sought to diversify their technology sourcing. However, this background is insufficient to establish the extent of effort devoted to this technology sourcing diversification by private firms.

This empirical background is also insufficient to rule out the possibility that observed cases of Russian technology transfers are solely due to government programmes seeking to demonstrate such activity. Hence, answering RQ 2 will involve examining the nature of these technology transfers to identify the efforts made by firms and the outcomes of transfer projects.

RQ 3. For the Korean firms that succeeded in technology transfer, how did they overcome the gaps faced?

RQ 3 takes up the examination of successful transfer projects to ask how the transfer was achieved. In particular, it draws upon the concept of SCTA developed in this chapter to examine how systemic capabilities for absorption might play a role in the achievement of transfer. A central issue to be examined in answering this question is whether intermediaries, particularly those organised by the Korean government, have played a useful or even essential role in successful cases of technological transfer. The alternative is that transfers would have occurred without the existence of intermediaries or the larger systemic capabilities for absorption which are part of the SCTA concept. Thus, the answer to RQ 3 involves both an examination of the factors underlying successful technology transfer of Russian technology to Korean firms and a test of the usefulness and validity of the SCTA concept.

5.3. RESEARCH HYPOTHESES

Based on the discussions from the literature review and empirical background, four hypotheses are proposed by way of pursuing answers to the research questions. Each hypothesis is related to the SCTA framework. In this thesis, the term hypothesis means a broader statement that provides key concepts relating to the SCTA, and formulating a specific statement of the argument intended for empirical test.

Hypothesis 1. The success of technology transfer is a function of gaps between the transferred technology and the absorptive capacity of the recipient firm which reflect gaps of tacitness and locality. Thus, it is hypothesised that larger gaps in tacitness and locality of technological knowledge will prevent ITT.

In discussing ITT, it is important to capture the nature of technology and its relationship with technology transfer. Exploiting technology from foreign countries often involves overcoming wide technological and socio-cultural differences. The differences are huge when countries share little common ground in terms of culture and production experience. The nature of these differences is characterised in this study as involving "locality" and "tacitness" gaps.

The concept of locality and tacitness gaps as used in this thesis arises from the idea that there are barriers and difficulties in ITT process arising from the dissimilar conditions and context of ITT partners. Specifically the "locality gap" involves socio-cultural, geographical, and political distance that creates a difference between the source and recipient of ITT. In other words, it is a non-technological barrier arising from different culture, language, and socio-economic systems. Ideas and knowledge circulate more easily between two parties when they have close geographical and social proximity (Saxenian, 1994; Audretsch and Feldman, 1996; Fosfuri et al., 2001).

The "tacitness gap" involves the difference in technological knowledge that comes from different legacies and contexts of the respective innovation systems between the source and recipient countries. In other word, it is technological barrier caused by the different context of technology from dissimilar NIS.

As discussed in Chapter 4, some features of the Soviet legacy remain unique with regard to the context and quality of Russian technology. These include difficulties in valuing, understanding, and modifying transferred technologies. The two concepts of locality and tacitness gaps cover both technological and non-technological matters in the ITT process, and these gaps are likely to be more critical when dealing with partners with dramatically contrasting innovation systems. It is for this reason that these specific gaps are identified and characterised among the many other differences that might have been chosen as needing to be bridged in order for effective ITT to occur.

In addition, it is hypothesised that the capabilities and methods for overcoming these two types of gaps should be different. This leads to an investigation of the different roles that intermediaries may play in assisting the ITT process.

Hypothesis 1 focusses on the potential to prevent ITT. As discussed in Chapter 4, there are major differences between Soviet and Korean technologies, institutions (including the NIS) and market orientation which are taken to create the potential for major gaps of both types: locality and tacitness. As discussed in the next chapter, the ideal situation would be to compare the performance of ITT more generally and specifically to conduct a comparative study of successes and failures to isolate the effects and assess the balance between these two types of gaps In practice, however, a sample of such cases is unavailable so the focus is on those projects which are undertaken and have had outcomes that are observable, i.e. the cases where the gaps have been overcome.

Hypothesis 2. The combination of the absorptive capacity of a recipient firm and the capabilities of an intermediary, which is described in this thesis using the concept of the SCTA (defined and described below in Section 5.4), is more effective in bridging the gaps than the absorptive capacity of the firm acting alone in the process of ITT.

Learning incentives within a firm will have a direct effect on its R&D spending. Factors affecting a firm's incentives to learn or its incentives to invest in absorptive capacity via its R&D expenditures include the quantity of knowledge to be assimilated and exploited and the difficulty of learning. The difficulty of learning will depend on the characteristics of underlying scientific and technological knowledge, but it is difficult to specify *a priori* such characteristics of knowledge affecting the difficulty of learning

(Cohen and Levinthal, 1990). The gaps or barriers with regard to ITT discussed in Chapter 2.6 may exemplify the factors affecting the difficulty of learning, given the current level of absorptive capacity of a firm.

But in the Korean-Russian case, Russia's unique socio-economic system and technological knowledge generate large gaps. Recipient of this technology must have very high absorptive capacities. The recipient's ability to learn, absorb, and assimilate is the decisive factor that makes a difference in the successful execution of ITT (Cohen and Levinthal 1999). Overcoming these technological and socio-cultural gaps requires the recipient firms to develop the extra-ordinary absorptive capacity needed to understand and master the transferred technology.

In this context, the fact that a firm seeks help from innovation intermediaries in the process of ITT implies that it has incentives to utilise the capabilities of the intermediaries in addition to its own absorptive capacity. And the availability of intermediaries that can help firms to effectively recognise, assimilate, and exploit external knowledge or transferred technology will reflect the characteristics of the national innovation system of the recipient county.

As discussed in chapter 2, intermediaries may promote a firm's ITT activities by providing supportive services and information, and if an intermediary is involved in the public sector, it may have authority to create a favourable legal and institutional environment for ITT. Such services can be thought to function as boundary spanning roles between technology sources and their recipients, taking knowledge from one domain and applying it in another. This can be one of the many dimensions by which a firm's absorptive capacity may be enhanced with the addition of the capability of the intermediaries according to the needs and purpose of the firm.

Thus, the synergistic effect from firm-specific knowledge and the complementary knowledge co-produced by the intermediary and the firm will give rise to a higher and broader level of absorptive capacity that should lead to more effective bridging of the gaps or difficulties involved in the process of ITT.

It is assumed that although impressive internal capabilities for absorptive capacity were built in the context of transfers from triad economies, Korean firms were unable to use these specific capabilities successfully to meet the challenge of importing Russian technology largely due to the substantial locality and tacitness gaps. Prior knowledge and experience are one of the primary means of enhancing a firm's absorptive capacity and success in technology transfer (Cohen and Levinthal, 1990). It is hypothesised that firms with prior knowledge and experience in technology transfer from a specific country will report and experience narrower gaps in tacitness and locality as compared to those firms without such knowledge and experience. These firms would have more success in bridging the gaps.

Hypothesis 3. The bigger the gaps, the more important the role of intermediaries is. Innovation intermediaries provide an extension to the absorptive capacity of firms to help to reduce the gap in tacitness and locality involved in the process of internal technology transfer.

Tacitness and locality gaps require the construction of relationship-specific complementary capital and that the costs and feasibility of doing this are affected by the existence of an intermediary.

The recipient's ability to learn, absorb, and assimilate determine the difference in performance of ITT (Cohen and Levinthal 1999). Overcoming these technological and socio-cultural gaps requires the recipient firms to develop an extra-ordinary absorptive capacity in understanding and mastering the transferred technology. In this context, it is inferred that the basis for successful technological transfer is influenced by tacitness and locality gaps.

But in the case of the Korean-Russian technology transfer, the tacitness and locality gaps are very large. Russia's socio-economic system and the technological knowledge stemming from the centrality of the military industrial complex led to important gaps in terms of the suitability of the technology for commercial use. These differences compared with market based economies are examined in terms of tacitness and locality gaps. The recipient of this technology must have a very high absorptive capacity. However, it is hypothesised that if the gaps in tacitness and locality are too big, even a high level of absorptive capacity may be insufficient to overcome the impediments created by tacitness and locality gaps.

As discussed in Chapter 3, intermediaries may promote a firm's ITT activities by providing supportive services and information. If an intermediary is involved in the public sector, it may have the authority to create a favourable legal and institutional environment for ITT. Such services are believed to function as boundary spanning roles between technology sources and their recipients, taking knowledge from one domain and applying it in another.

Considering that a firm's absorptive capacity depends on the individuals who stand at the interface of the firm and the external environment (Cohen and Levinthal, 1990), and an intermediary may extend a firm's absorptive capacity by enhancing this boundary spanning or gatekeeping function. As the distance between the parties in terms of language and culture and the physical distance both increases the boundary of supportive service to be spanned becomes more complex and firm specific. This amplifies the importance of the intermediary role which may help extends the absorptive capacity of the recipient firm. High levels of tacitness and locality gap may require higher and greater firm-specific knowledge and complementary knowledge co-produced by the intermediary and the firm.

Hypothesis 4. Absorptive capacity consists of the stages of recognition, acquisition, assimilation and transformation, and exploitation. Each stage requires different types of support from intermediaries. This hypothesis helps provide a more detailed explanation to the question "what do intermediaries do?" which is an elaboration and reinforcement of the claim that intermediaries are essential.

The variety of intermediaries such as consulting service organisations, incubators, technology licensing offices, science parks is growing (Van Lente et al, 2003) to meet the needs of specific innovation systems, both upstream and downstream in the value chain (Ulset, 1996). Howells has proposed a typology of intermediation in the innovation process. The types include foresight and diagnostics; scanning and information processing; knowledge processing, generation, and combination; gatekeeping and brokering; testing, validation, and training; accreditation and standards; regulation and arbitration; intellectual property protection and management; commercialisation; and assessment and evaluation (Howells, 2006). Moreover, these types are covered by various organisations, which suggests that different forms of intermediaries are needed to support the innovation process and some form of intermediaries are more suited to supporting a specific aspect of absorptive capacity. For example, an intermediary conducting assessment and evaluation would be able to support a firm in “recognising the value” aspect of absorptive capacity, while another intermediary operating in commercialisation may be able to extend a firm’s exploitation aspect of absorptive capacity.

Cohen and Levinthal (1990) suggested three elements involved in absorptive capacity: recognizing the value of new information, assimilating, and commercial application. Zahra and George (2002) proposed four dimensions/capabilities of absorptive capacity: acquisition, assimilation, transformation, and exploitation. Todorova and Durisin’s model of absorptive capacity (2007) is based on Cohen and Levinthal (1990). All of these models include assimilation and commercial exploitation. Todrova and Duris’s model (2007) is useful to explain internal transfer of technology in that input and output stages are provided. And formal activities like contracting involved in the process of internal technology transfer seem to be distinct from the recognition of the value. In Zahra and George’s conceptualization (2002), assimilation and transformation are presented as separate dimensions; the roles included in the assimilation dimension (interpretation, comprehension, and learning) seem to overlap with those in the transformation (recodification) dimension in the process of internal technology transfer.

In applying these models of absorptive capacity to external technology transfer such as Korean-Russian technology transfer, the process of internal technology transfer may be described as a sequential process that involves the stages of recognition, acquisition, assimilation or transformation, and exploitation. At each stage, the degree of knowledge gaps and needs for intermediary support may be different from one firm to another. Due to the nature of knowledge, the gap in the stage of recognising the value of knowledge, for example, will be more easily bridged by an intermediary performing the function of scanning and information processing than are conducting the role pf intellectual property protection and management. Gaps arising from tacitness are more technological in nature and may require very sophisticated technological knowledge to overcome. The different technological capability of the intermediary may be needed in bridging this type of gap.

5.4. THE SCTA CONCEPT

As discussed in Chapter 1, the thesis examines the process of ITT by developing and extending the concept of absorptive capacity. The existing literature on absorptive capacity is primarily concerned with firm-level processes. This thesis adds a firm-level understanding to ideas derived from the NIS approach, addressing institutions and policies that are able to enhance local firms' absorptive capacities. These institutions and policies may complement and reinforce firms' own absorptive capacities. Intermediaries may also play a complementary role to firm-level absorptive capacities. The SCTA framework has been developed in order to explain how the transfer of Russian technology into the Korean context was facilitated by intermediaries (primarily public sector organisations with an intermediary mission) and, in particular, how this capacity plays a role in filling knowledge gaps, bridging differences, and overcoming difficulties in this process.

The framework is created based on four hypotheses discussed above. These hypotheses, to the extent that they may be validated, lead to the conclusion that in order to overcome the contrasting nature of the socio-economic and technological systems in the Korean and Russian technology transfer, (1) the role of the intermediary (third party assistance) is critically important, and (2) such an intermediary role is closely linked with Korean NIS and public policies.

As discussed in Chapter 4, these technologies from Russia have not been developed with an aim of optimising price and performance in relation to competitive market conditions. They also have not been integrated in large-scale production and distribution systems aiming to address global markets. Such a country-specific technological feature makes technology transfer difficult enough in domestic situations, and even more so in the international arena (Kedia and Bhagat, 1988; Keller and Chinta, 1990).

As mentioned in the empirical background chapter, the context of Russian technology development suggests that there are likely to be greater uncertainties and a greater need for adaptation when acquiring these technologies than when acquiring technology from other contexts where market processes dominate. At the same time, because the context of their development has been less constrained by the need to satisfy market demands, these technologies may have features or characteristics that have not been adequately explored or developed in market-dominated contexts.

For this reason, when technology is transferred, implementation may fail due to the underlying socio-cultural and technological mismatch. Russian technology may be viewed as having great or even unique difficulties when technology transfers are attempted. This is true when it takes place between Russia and other countries with capitalist economies. Technologies developed in those capitalist economies are mostly private-led, civilian-purposed, and market-oriented. The SCTA explains how with Russian technology such characteristics is successfully transferred and absorbed by Korean firms through the creation of a particular systemic capacity. This systemic capacity is created through the interaction between a firm's capability and external assistance provided by government policy.

This framework explains how the Korean-Russian divides in "locality" and "tacitness" may be bridged. The SCTA may be defined as a mechanism and process of public agency involvement in order to enhance local firms' abilities to absorb external knowledge when adapting from countries whose culture and language differ substantially in terms of "locality" gaps. The SCTA also plays a key role in accessing, acquiring, nurturing, and integrating external technology within a firm's existing capability, which is related to the problems of knowledge transfer more generally where the "tacitness" gap is important. The SCTA highlights the role of public R&D agencies and institutes as intermediaries for bridging these gaps.

It is important to stress that the SCTA framework is based on a particular level of analysis. It is not on the macro level of the NIS, nor is it on the micro level of a firm's absorptive capacity. Rather, it is on a meso-level that the absorptive capacity created by a public and private partnership is built with the aim of leveraging various and not "pre-selected" private firms" capacity to bridge the gaps involved in adapting Russian technology. This approach facilitates ITT, which is done by enhancing the local systemic capability for exploiting external technology.

How can the role of the SCTA be differentiated from the roles of NIS and government policy? The governments of nearly all developing countries have been involved, in a major or minor way, in promoting inward transfer of technology from advanced countries and in supporting the private sector's technological development through the implementation of various policy measures (Narula and Dunning, 1998). This is slightly different from the specific capabilities considered within the SCTA framework. Although the existence of the SCTA becomes apparent in examining and attempting to explain the unique circumstances of Korean-Russian technology transfer, it is an idea that might be generalised with further research to consider other processes of ITT, particularly where the resources of individual firms are not adequate to bridge differences between the source and destination of the technology transfer.

As discussed in Chapter 4, through a range of public agency programmes, the Korean government provides information and technical assistance to Korean firms in order to find the right partners (overcoming the locality gap) and interpret scientific knowledge (bridging any tacitness gap) in establishing ITT from Russia. The evidence presented in the empirical chapters suggests that the Korean-Russian gap would not have been bridged without the existence of public agency programmes. The SCTA provides a framework for thus direct public involvement in technology transfer projects that fill and close gaps between local firms and foreign technology suppliers. However, the NIS contributes a critical indirect input to the SCTA in the form of fostering well-trained scientists and engineers (Mowery and Oxley, 1995).

The constituents, boundaries, and functions of the SCTA are clearly limited as they are based on the public agency programmes discussed in Chapter 4. The SCTA is also involved in targeting the creation of system or programme level absorptive capacities, integrating capabilities from government agencies, public research institutes, and firms. The SCTA is especially necessary when transferring external technology from foreign countries whose technologies reflect the tacitness and locality gaps that arise from contrasting systems of innovation. In summary, the SCTA is a framework used to create unique ITT capability which is implemented in the Korean case by a specifically designed public assistance package. This package bridges the gaps of socio-economic and technological systems in the process of transferring foreign technology from countries that have contrasting, rather than common, characteristics.

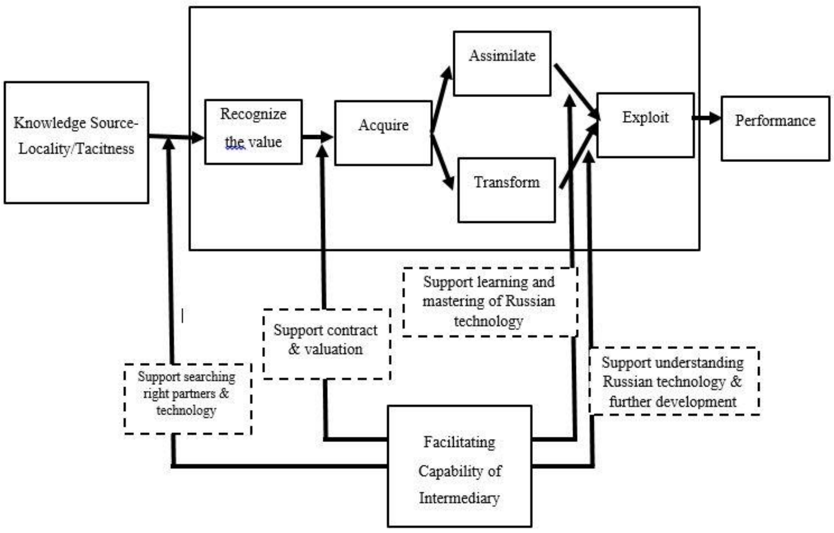
5.5. KEY FEATURES OF THE SCTA

5.5.1. The SCTA as a Sequential Process

The SCTA concept is developed based on observations and features that extend the existing absorptive capacity perspective. The SCTA involves linear routines stemming from the time-based process activities involved with ITT. Technology transfer is not an instantaneous event, but a time-based process involving several stages. These range from the initial recognition of technological value and opportunity, to application of the transferred technology to a product or service. Absorptive capacity is also a time-based process that consists of knowledge recognition, assimilation and commercial exploitation (Cohen and Levinthal, 1990). Recognition, assimilation, and application of transferred technology take place in linear sequence as shown in Figure 5-1. The knowledge source and prior knowledge act as a pre-condition, stimulating the external knowledge adoption.

In outline, the SCTA is a process similar to that of absorptive capacity. However, the nature of Russian technology requires an additional alternative stage of "transformation". The SCTA is therefore a process-based framework that may be divided into (1) recognition, (2) acquisition, (3) assimilation or transformation, and (4) exploitation. Each of these stages is worth considering in a little more detail in the context of Korea's ITT from Russia.

Figure 5-1: Process nature of the SCTA



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Recognition describes the stage in which a firm searches and discovers which technology is best to adopt. Experience with knowledge search is a key antecedent in absorptive capacity. The recognition stage has important implications for the accumulation of absorptive capacity. There is a strong path-dependent component in such a process. Firms that have been involved in R&D related activities have shown higher rates of accumulation of this ability (Fosfuri and Tribo, 2008). The technologies developed in Russia are marked by their "origin of socialist economy" (Michailova, 2011; Michailova and Jormanainen, 2011; Vlachoutsicos, 2011). This signals the possibility of substantial locality and tacitness gaps. These gaps reflect Russia's unique socio-political and cultural context. In this stage, it is important to evaluate the quality of the Russian technology and to recognise the potential value in solving technological problems.

Acquisition describes the stage in which recipient firms contact and negotiate with their counterparts to make formal or informal arrangements for technology transfer and adoption. During the Cold War period, there were wide differences between Korea and Russia. Various systems including legal, administrative, and business environments were largely affected. The heritage of this period is that Russia's local context presents differences that required Korean firms to seek external assistance in understanding and dealing with these differences. Individual firms did not have the incentive to learn and negotiate institutional and administrative arrangements for acquisition in the post-Cold War period and therefore benefitted from the existence of a public agency willing to help build the relevant expertise.

Assimilation describes the stage in which recipient firms learn and master the scientific and technological knowledge from their counterparts. This may be done through technology licensing, personnel exchange, and joint research projects. Russian technology is not ready-made and packaged, so the capability of Korean firms to master and understand the technology is highly important. The strongly tacit nature of Russian technology requires innovative approaches to transferring technology. Specifically, means to facilitate human-to-human technology transfer appear to be more effective in these conditions than non-human channels such as manuals, tools or blueprints (Howells, 1996).

Transformation is an alternative stage to assimilation. Transformation is necessary when the transferred technology needs further development before application may take place. Firms inevitably transform their transferred knowledge when it cannot be assimilated or directly applied. In transferring Russian technology, transformation is the nurturing, modifying, and appropriating process that makes the raw ingredients (scientific knowledge) useful. Some applied Russian technologies do not need significant nurturing or modification. In this case, assimilation is the more appropriate term for describing them.

Lastly, exploitation describes the stages in which a firm creates genuine business opportunities or applies technology within products or processes for a competitive advantage.

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5.5.2. The SCTA as a Multi-Dimensional Activity

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The SCTA is a multi-dimensional construct. The construct is made up of a complex set of activities involving multiple actors and interactions. The actors include the government, public organisations as intermediaries, private firms, and Russian organisations. This suggests that that the SCTA is a broader concept than absorptive capacity, having multi-actor and systemic features which are all internalised in the case of absorptive capacity but which raise coordination issues when considered from an inter-institutional perspective. The SCTA is comprised of a set of multi-organisational structures, routines and processes, and their interactions, mechanisms, and consequences. The SCTA also affects many actors within the NIS. The process of technological absorption is realised in the long run by not only by the firm's individual learning processes, but also by interaction and communication between actors. Although this view is implicit in Cohen and Levinthal and has been developed further in subsequent literature, e.g. Zahra and George (2002), it is particularly relevant for considering the alignment between Korean and Russian NISs, including technology, research organisations, and technology transfer transaction.

In this chapter, the SCTA is described as a multi-dimensional and sequential process, representing multiple actors' involvement. Figure 5-1 explains the SCTA by extending the absorptive capacity framework. The intermediary helps to leverage a firm's absorptive capacity to overcome locality and tacitness gaps. These gaps form due to contrasting knowledge sources within the process of technology transfer.

Figure 5-1 identifies how each stage of the process of ITT provides an opportunity for interaction with the intermediary, with the entirety of these processes and interactions being the scope of analysis of the SCTA.

5.5.3. The SCTA as Path-Dependent Activity

The SCTA is understood here to be path dependent. This is an implication of the two ideas of sequential and multi-actor processes. If the SCTA is developed over time and has multiple features or dimensions, some may develop at different rates. Because these dimensions or features are inter-connected and mutually influential, the overall performance of the SCTA will differ depending on the order and extent to which its various components have developed in the past. This is not simply a case of “history matters” but one in which the actual nature of the SCTA may be different as the result of the particular path of its development. Hence “locking in” the development of the SCTA according to its past course of development is a key feature defining its path dependence. In this respect, the specific experience of Korean firms in developing high levels of capabilities for identifying and absorbing foreign technology from the triad economies created significant forms of “lock in”, which government policy measures and programmes may play a vitally important role in overcoming.

5.6. CHAPTER SUMMARY

Despite Korean firms’ capability for absorbing foreign technology, simply duplicating ITT implementation processes utilised with Korea’s traditional counterparts, the triad countries, seems not to guarantee successful ITT (Kim, 2007). Instead, greater capability and more complex processes seem to be required in overcoming barriers between countries with contrasting systems and environments.

The intermediaries' role in the SCTA is developed to explain how greater capacity and improved processes are created in order to overcome barriers. Specifically, Korean firms' internal efforts alone were insufficient. To address this shortcoming, extraordinary capability was created with assistance from the public sector, including government agencies and public R&D institutes as intermediaries. The intermediary role is closely linked with NIS and public policies. The SCTA concept provides a framework for identifying how this intermediary intervention serves to overcome gaps.

The SCTA concept is useful when technological and socio-cultural conditions between two countries with ITT implementation are dissimilar. In this thesis, such contrasting conditions and strengths are designated as gaps.
The detailed consideration of the role of intermediaries should be analysed on the basis of several specific extensions of absorptive capacity theory. First, there is a multiplicity of actors addressing the multi-dimensional and sequential processes involved in technology transfer. Second, the SCTA may serve as a mechanism for overcoming "lock in" to established processes of absorption shaped by prior experience, specifically the historical reliance of Korea on inward technology transfer from the triad economies.

In this chapter, research questions and hypotheses are discussed with regard to the concept and key features of the SCTA. The SCTA is described as a multi-dimensional, and path-dependent, sequential process representing multiple actors' involvement. As a framework it directs research attention to the following issues: 1) barriers arising from dissimilar conditions surrounding innovations that have the potential to block successful ITT, 2) the empirical question of whether existing firm capabilities are sufficient to overcome these blocks, 3) the need to assess whether intermediaries play an essential role in overcoming these blocks, and 4) how the intermediary is able to overcome these blocks. The first three of these numbered items constitute answers to the three research questions and conclusions regarding the first three hypotheses. The fourth numbered item involves a more detailed analysis of Hypothesis 4 and its implications for the design and conduct of SCTA activities.

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CHAPTER 6. RESEARCH METHODOLOGY

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6.1. INTRODUCTION

This chapter sets out the research design and overall methodological approach for the thesis. Furthermore, it presents the details of data sources and methods for collecting and analysing data in this research. The primary aims of this study are twofold. First, to identify and understand the underlying processes and mechanisms that have led to successful instances of ITT between countries which share little "common ground", specifically the contextual conditions identified in Chapter 4. Second, to assess whether the extension to the absorptive capacity literature represented by the SCTA is useful in explaining these instances of success or not. Because the second of these aims involves specific hypotheses about blockages to ITT processes and means of overcoming them, it is essential to find appropriate cases to elaborate and evaluate my hypotheses. In order to focus on the central theme and make my research more feasible, I limited the scope of my research to a single exchange context: Korean firms' exploitation of Russian technology since the 1990s. The reasons for doing this are explained in the next section.

6.2. CHOICE OF COUNTRIES

For several reasons, it is concluded that the case of Korean firms' exploitation of Russian technology properly meets the conditions that this study intends to examine. First, Russia and Korea are different in almost every imaginable aspect geographically, socio-economically, culturally, politically, and technologically. Korea and Russia officially agreed to end their past hostile relations in the early 1990s, mutually restarting scientific and technological exchanges in various fields. However, as a result of having had no interaction before and during forty years of the Cold War period, they seemed to have little or no common ground for ITT to successfully occur. It seems to be the case that Korean firms have experienced more difficulty in exploiting and absorbing Russian technology than technology from other countries that have shared similar cultural and political systems and structures. Despite Korea's successful experience and capability in exploiting and absorbing foreign technology, adapting and exploiting technology from Russia has proven to be very different in both context and nature. However, it is interesting and relevant to observe that while Korean firms face challenges in exploiting Russian technology, some of them, though not many, have succeeded in exploiting and commercialising Russian technology after agreeing to cooperate scientifically and technologically.

In particular, it seems that Korean firms have experienced more difficulty in exploiting and absorbing Russian technology than technology from other countries that share similar cultural and political systems and structures. Despite Korea's successful experience and capability in exploiting and absorbing foreign technology, adapting and exploiting technology from Russia has proven to be qualitatively different from prior Korean ITT experience in ways that will be examined through the cases presented in subsequent chapters.

While the hypotheses concerning ITT would suggest a severe blockage to such transfers in the case of Korean and Russia, it is, nonetheless observable that some of the firms, though not many, have succeeded in exploiting and commercialising Russian technology after agreeing to cooperate scientifically and technologically. How the predictions following from a straightforward application of the problems of technology transfer are falsified in these cases is of inherent interest.

Finally, as a researcher at KIST, I can access the relevant information to the cases. For all of the above reasons, I chose Korean-Russian technology transfer as my main target of investigation.

6.3. CHOICE OF METHODOLOGICAL APPROACH

The thesis is based on a mixed approach including a survey (with a modest quantitative analysis) and case studies. In order to explore factors that can explain successful transfer of technology from Russia to Korea, an in-depth case study is necessary. At first, my methodology did not include a survey. However, during the course of analysis for the literature review and empirical chapter, it was realised that relying on interviews and case studies would raise concerns regarding the potential for generalisation of my case study findings. Thus, analysis of a survey is included. In addition, the survey provides a more comprehensive view to complement the micro view of case studies and interviews. It has been developed to test the hypotheses developed from the SCTA.

These case studies have been used to understand the mechanisms by which the gaps have been overcome. Specifically, these case studies provide an in-depth analysis of successful ITT projects, with respect to the SCTA. Case studies have been selected of two intermediaries and four of the successful firm-level Russian technology transfer projects. The public agency programmes implemented by the Korean government to assist domestic firms turned out to be a key feature in successful ITT from Russia to Korea in interviews as well as empirical investigation. From the empirical investigation, it is found that these public agency programmes provided the intermediation functions needed by domestic firms to bridge the gaps that would otherwise have prevented their acquisition of Russian technology. An examination of these public agency programmes is a necessary step toward developing an understanding of the context in which Korean firms acquired Russian technology and testing whether the SCTA is useful in representing the nature of Korean-Russian technology transfer.

The project level case study has been designed to: (1) develop a deeper understanding of motivation, gaps, and processes of Russian technology transfer, (2) test the SCTA framework from a different perspective than the survey and (3) identify in greater detail the role of intermediary mechanisms in enhancing absorptive capacity. Only successful projects have been chosen as a target of analysis because of the rarity of such success. However, if time, resources, and the availability of cases would have supported it, it would have been desirable to consider cases in which one or more of the “success” factors were present but success was not achieved. In this sense, further exploration of unsuccessful projects should be considered in order to more clearly identify what makes the difference between successful and unsuccessful projects. It is extremely difficult, however, to identify the extent of failure or to recover the details of failed projects. From my interviews with industry participants and government officials, it is observed that many projects had been stopped in the very early stages when Korean firms were searching for right partners. These interviews also revealed many examples of projects that were stopped in the process of negotiation. In some cases, Russian technology itself was transferred and mastered perfectly, but failed to be commercialised. In other cases, Russian technology was commercialised, but the products with Russian technology content failed to attract consumers or win the market competition. Gathering information on all of these outcomes was beyond the feasibility of this research, given the difficulty of identifying the relatively few cases in which success has occurred. In short, only a very small proportion of attempts could overcome the many hurdles in achieving their expected goals or satisfaction so that it is concluded that direct comparison between successful and unsuccessful cases of the Korean Russian technology transfer would be less informative than a more in-depth investigation of those few cases that were successful. Interviews had also been implemented to better understand the background of the Korean-Russian technology transfer projects and to make a survey questionnaire.

6.4. CHOICE OF SURVEYED FIRMS

The survey collected information from survey responses to a series of questions that have been scored on a seven-point Likert scale. The survey has been implemented twice, using the same questionnaire each time. The first, questionnaire was sent to about 30,157 Korean firms, through an online emailing system, registered with the Bank of Korea, which provides the largest and most accurate database of firms in Korea. Of the 30,157 registered firms, 1,554 firms replied. Of these, only 31 firms have experiences with technology transfer from Russian partners. It is assumed that many Korean firms using adapted Russian technology are reluctant to reveal the fact of their Russian technology acquisition. Some of them want to hide the fact that they did not develop core technology themselves. Some of them exploited military-related technology and are prohibited from revealing the information by contracts.

I realised that a sample of 31 is too small. Consulting with my supervisors, I tried to extend the sample in order to improve the accuracy of the results. I sent out the same questionnaire again, with a more detailed explanation of the research purpose, omitting the 1,554 firms that had already answered. In order to increase the response rate, I randomly chose about twenty percent of firms from the same database and sent out the questionnaire again via postal mail. As a result, 1,196 answered surveys were received, including 63 firms with Russian technology transfer experience. With one response discarded as incomplete, a total of 93 completed surveys out of 2,750 replies have been analysed. The scarcity of such examples is itself evidence of the contribution of the intermediary in this technology transfer process.

The sample size was still smaller than what was expected, but it represents a large enough sample to examine the range of experience of Korean firms in attempting to import Russian technology. As a way to obtain more samples, the alternative strategy of pursuing intermediaries, such as government programmes or industrial associations with an interest in promoting such exchanges, was considered. However, one of my important research goals is to find out how the intermediary role is necessary and important in the process of Korean-Russian technology transfer. Though these organisations are motivated to demonstrate their success, they are of less value in providing information. The randomly selected firms from the database would provide more objective results, even with a smaller sample size.

One important question is whether the number of survey responses has yielded a selectivity bias. To assess this possibility, I compared the sampled firms by size and industry in relation to the size and industry of Korean firms more generally in order to obtain an assessment of the sample's representativeness in the larger context of Korean industry. The result of this comparison is that the choice of the sample of surveyed firm is representative, an important goal of the survey. Thus, through successive administrations of the questionnaire it was possible to achieve a significant sample while preserving the representativeness of the sample for the entire population of Korean firms.

6.5. SURVEY QUESTIONAIRE DESIGN

In the process of finalising the questionnaire, focus group interviews were implemented twice with five managers or engineers from Korean firms with Russian technology transfer experience; twice with two administrative managers from government agencies undertaking the role of the intermediary, and twice with two experts from academia. These structured interviews were used to review all of the questionnaires, while taking into account existing gaps and motives. None of the interviewees were the same people who answered the questionnaire.

6.6. CHOICE OF THE PARTICULAR CASE STUDIES

In selecting the cases of successful ITT from Russia, the group of 93 firms or those participating in the focus group interview include were not part of the case studies that I conducted. These projects have been selected through the following process. Twenty years of articles from the press data base on the web were searched for successful Russian technology transfers. About two hundreds articles were selected. I tried to establish e-mail contacts with relevant staff including managers, engineers, and sales persons who had participated in the technology transfer projects. About 47 firms responded, providing further information for this study.

I decided that with limited time and resources, four successful cases would be a practical maximum number. In selecting these four successful projects out of 47, the first important criterion was that they should have support from intermediaries. Based on the survey results, it is interesting to observe that out of the 93 Korean firms with Russian technology transfer experience, 75 firms were supported by intermediaries in their technology transfer process. Also, in order to test the conceptual framework of the SCTA, one important purpose of case studies is to identify how firms' absorptive capacity is enhanced by the intermediaries' managerial and technological support. Of the 47 firms contacted by e-mail, 12 firms confirmed that they were supported by intermediaries. The remaining did not confirm me whether they get help from an intermediary or not. Among the 12 firms, the 4 successful projects were selected on the basis of diversity of industry, size of firms and type of intermediaries.

Case studies were implemented according to interviews conducted with key personnel and document analysis provided by the Korean firms and their intermediary agencies. Frequent follow-up interviews, telephone conversations and emails were also undertaken in order to fill in the blanks and give structure to the case study. In order to avoid subjective judgment, information gathered from intermediaries was used solely for the purpose of cross-checking facts. A very limited amount of information from intermediaries was used, due to the concerns mentioned earlier about whether the intermediaries would have an incentive to bias the findings in a positive way with regard to their role. Case studies were then implemented on the basis of interviews conducted with key personnel (see appendix 2). Analysis of documents provided by the Korean firms and their intermediary agencies was also carried out.

6.7. INFORMATION GATHERING ABOUT PUBLIC AGENCY PROGRAMMES

Eleven public agency programmes have been developed to promote Russian to Korean ITT. These public agency programmes were developed and operated by central government agencies and local governments. Most of the public agency programmes focus on collection and distribution of Russian S&T information and data by implementing document search and analysis as well as dispatching groups of experts. Only two programmes, the Core Technology Transfer Programme (hereafter CTTP) and Korean Russian Industrial Technology Programme (hereafter KRITP) involve more detailed ITT procedures.

Table 6-1: Korean public agency programmes designed to promote Korean-Russian technology transfer (2005)

Ministries	Programmes (Starting Date)	Budget (1,000£)
MOST	Operating office in Moscow (1994)	500
	Assisting Korean- Russian joint R&D, investigating Russia's relevant technology (1998)	420
	Core Technology Tranter Programme (1994)	1200
MKE	Creating the Russian industrial technology information system (2000)	175
	KRITP (1998)	1000
Small & Medium Business Administration	Organising seminars and forum relating to Russian technology and market (2003)	150
	Russian technology information gathering (2003)	50
	Assisting SMBs' access to the Russian market (2001)	100
Seoul Metropolitan Government	Assisting local firms' entering Russian market and adapting Russian technology (2002)	75

Kyunggi Provincial Government	Investigating Russian technology, recruiting Russian scientists, Joint R&D (2004)	500
Daejeon Metropolitan Government	Assisting local firms' entering the Novosibirsk technology cluster (2004)	50

Source: Hong et al. (2007)

As a result, CTTP, designed by MOST and KRITP, designed by MKE, have been chosen to be the main targets of this analysis. In addition, these two programmes have been selected because they have been operating for the longest period of time with the largest budget among the eleven public agency programmes. The two programmes have been role models that have motivated other central and local governments to launch similar programmes to perform their missions (Kim, Y, 2007). Furthermore, these two programmes represent the government ministries of MOST and MKE, the two main bodies for science and industrial policies. Hence, it is possible to compare how ministerial science and industrial policies reflect the intermediary role of supporting technology transfer from outside the country.

Two of the public agency programmes are analysed mainly by examining documents provided by commissioned agencies as well as by interviews both inside and outside the agencies. During the interview process, SPRU alumni, working on MOST and MKE, assisted in retrieving specific information from those intermediaries and ministerial policies regarding the intermediary.

CHAPTER 7. SURVEY

7.1. INTRODUCTION

This chapter examines the utility of the SCTA based on the experience of individual firms' ITT activity with Russia, testing the hypotheses developed in Chapter 5. The identification of gaps is examined for Hypothesis 1 using information drawn from various questionnaire items that refer to the difficulties that firms encounter in the process of ITT. The term 'gaps' in this thesis represent difficulties and barriers in the ITT process, as defined in Chapter 5, and the questions referring to these gaps are highlighted in the Annex version of the questionnaire with the label "Gaps_". Since the role of intermediaries is important for Hypotheses 2 and 3, an examination of the intermediaries' role and a classification of their organisational forms are required for better analysis. And throughout the four stages of the ITT process in the SCTA framework, different types of support from intermediaries are addressed in the survey.

7.2. SURVEY DESIGN

This section introduces a brief overview of the survey design. Table 7-1 shows the variables, definitions, and measurement scales adopted in the questionnaire. Demographic variables include size, age, and industrial classification of the surveyed firms. Prior experience in ITT from Russia (Question 12 of the questionnaire coded as variable Exp_foreign) involves a binary response and is related to prior knowledge of the firms regarding ITT with Russia.

For the purpose of adopting Russian technology (Obj_Coop), Question 9 of the questionnaire presents four choices, which are given with a multiple response option. The purposes can be developing a new product with transferred technology, combining the transferred technology with existing products, improving the cost effectiveness for an existing product, and solving current technological problems.

For the motivations of adopting Russian technology, the importance of each variable is measured on a 7-point Likert scale. Motivation variables focus on why firms try to adopt Russian technology. Care needs to be taken in interpreting the response because what is measured is the level of importance of each variable. Also, it is noted that the motivation variables are specific to the context of the Korean-Russian ITT.

Awareness variables are related to prior knowledge of the firms, especially the capacity for defining the internal needs in the problem-solving process, which is a dimension of absorptive capacity. Each of three variables in this category (Aware_problem, Aware_Rustech, Needs_outsource) is measured by a 7-point Likert scale.

Variables regarding perceived gaps in the process of technology transfer are related to barriers and difficulties involved in the process of ITT. As described in Chapter 5, locality gaps and tacitness gaps are acknowledged in the hypotheses. The former means non-technological barriers arising from different culture, language, and socio-economic systems. The latter relates to differences in technological knowledge.

After reviewing an extensive amount of field interviews, empirical data, government reports, and literature reviews on technology transfer, I defined the gap variables in the process of Korean-Russian technology transfer. As mentioned early in the previous methodology chapter, the validity of these gap factors was confirmed through focus group interviews, with all of the interviewees agreeing that these factors represent common difficulties in implementing ITT with Russia. These gap factors are presented in the survey questionnaire.

These variables are measured using a 7-point Likert scale. Gaps related to socio-cultural matters such as information, network, language, administration, cultural differences, and contract seems to be associated with locality concepts. They are not directly linked with technological matters, and are more barriers arising from the donor's locational characteristics. Other gaps seem to be more closely linked with technological barriers arising from the different nature of Russian technology, which are referred to as tacitness gaps. This survey adopted the pre-defined-stages in the sequential model of absorption based on the SCTA, and asked about support by external entities including government agencies and R&D institutions, universities and private consulting firms.

The following Table 7-1 shows all of the variables employed in the analysis:

Table 7-1: Variables: explanations

Variable	Definition	Values
	Firm Characteristic (categorical variable)	
Size_emp	Firm size in terms of number of employees	
Size_sales	Firm size in terms of sales	
Age	Age of the firm (years)	
Industry	SIC 2 digit industry classification	

Exp_foreign	Prior experience with ITT	1=yes; 0=no
Obj_Coop	Purpose (categorical variable) 1-Introducing 'the new' to the world of products 2 Integrating it with already developed products 3-Improving already h already developed products 4-Solving current technological problems	
	Motive (opinion variables)	
Motive_cost	Relatively Cheaper to import	7 pt. Likert scale
Motive_excel	Technological excellence in in certain fields	7 pt. Likert scale
Motive_originality	Unique strength of Russian technology	7 pt. Likert scale
Motive_Ipstr	Easier to avoid IP disputes	7 pt. Likert scale
Motive_time	Shorter procedures in implementing technology transfer	7 pt. Likert scale
Motive_comple	Capability and resource complimentary to Korean firms	7 pt. Likert scale
Motive_active	Russia’s proactive attitude on technology transfer	7 pt. Likert scale
Aware_problem	Clear awareness of weaknesses and how to improve	7 pt. Likert scale
Aware_Rustech	Prior knowledge of Russian technology due to previous importation experiences	7 pt. Likert scale
Needs_outsource	Clear awareness on what technology can be outsourced	7 pt. Likert scale
	Gaps	
Gap_info	Information relating Russian S&T, in general	7 pt. Likert scale
Gap_network	Human network introducing Russian institutions and researchers	7 pt. Likert scale
Gap_admin	Administrative difficulty in implementing technology transfer (residence, VISA, insurance etc.)	7 pt. Likert scale
Gap_lang	Language barrier	7 pt. Likert scale
Gap_culture	Cultural differences	7 pt. Likert scale
Gap_transfer	Differences in understanding of ITT and research collaboration	7 pt. Likert scale
Gap_contract	Difficulty in contract or negotiation	7 pt. Likert scale
Gap_eval	Difficulty in understanding and evaluating Russian technology	7 pt. Likert scale
Gap_modify	Difficulty in modifying or transforming Russian technology	7 pt. Likert scale
Gap_cost	Uncertainty in unexpected additional cost	7 pt. Likert scale
Gap_time	Uncertainty about time needed for technology development	7 pt. Likert scale
Gap_reliability	Level of unreliability of Russian technology	7 pt. Likert scale
Gap_codification	Degree of codification of technological knowledge	7 pt. Likert scale
dummy_int	The gap is bridged with support from intermediaries	1=yes; 0=no
Type_int	The types of intermediaries 1 - Central government agency 2 - Local government agency 3 - Public R&D institution 4 - University 5 - Private consulting firm	
Support_Info	Receiving information-related support	7 pt. Likert scale
Support_Fund	Receiving fund-related support	7 pt. Likert scale

Support_Tech	Receiving technological support	7 pt. Likert scale
Support_Cont	Receiving contract or negotiation-related support	7 pt. Likert scale
Support_Admin	Receiving administrative services support	7 pt. Likert scale
Per_support	Level of satisfaction of intermediary support	7 pt. Likert scale
Per_Rus	Level of satisfaction of Russian technology transfer project	7 pt. Likert scale
Proc_recog	Active in support of the ‘recognizing the value’ stage	1=yes; 0=no
Proc_acq	Active in support of the ‘acquisition’ stage	1=yes; 0=no
Proc_assim_trans	Active in support of the ‘assimilation or transformation’ stage	1=yes; 0=no
Proc_exploit	Active in support of the ‘exploitation’ stage	1=yes; 0=no

7.3. ANALYSING THE DATA PROFILE

It is important to define the characteristics of our sample and to draw some implications regarding the differences between two groups of Korean firms. One consists of Korean firms with ITT experience with Russia and the other group without. As shown in Table 7-2, among 2,750 Korean firms that replied to the questionnaire, only 93 firms have ITT experience with Russia. The size (number of employees) and age in years were investigated in an effort to understand the general profile of the surveyed firms. The table below provides demographic data on the firms which have pursued technology transfer from Russia.

Table 7-2: Firms’ characteristics – age and size

	N	Min	Max	Mean	std dev
Firms Type A	2,657				
Age	-	2	98	19.623	9.983
Size emp	-	3	18,000	50.176	54.145
Firms Type B	93				

Age	-	4	71	15.555	10.093
Size_emp	-	50	12500	82.485	92.567

Type A Firms: Those not acknowledging ITT experience with Russia
Type B Firms: Those acknowledging ITT experience with Russia

Table 7-3 describes the characteristics of the surveyed firms in terms of the industry distribution (SIC 2-digit code) of firms that had ITT experience with Russia. It shows that the sample covers almost every industry except the beverage and coke industries. It is quite similar to the industrial distribution of Korea, the data of which were obtained from National R&D Activity Survey in 2009, nearly contemporaneous with the timing of conducting this survey. Table 7-3 further shows that some of the more technology-intensive industries, like chemicals, electronic computers, and medical and electrical equipment, as well as other machinery and computer programming, have a slightly greater representation in the sample than in Korean industry as a whole. This, however, seems to add to the argument that the more technologically-intensive industries are more likely to be interested and ultimately to engage in ITT.

Table 7-3: Firms' characteristics – industry distribution

SIC2	Frequency	Sample (%)	Korea (%)
Food	2	2.15	5.12
Beverages	0	0.00	1.06
Textile	1	1.08	2.76
Apparel	1	1.08	1.56
Leather	1	1.08	1.5
Wood	1	1.08	1.32
Pulp	1	1.08	2.82
Printing	3	3.23	2.44
Coke	0	0.00	0.85
Chemicals	8	8.60	5.82
Pharmaceuticals	2	2.15	1.85
Rubber	2	2.15	6.35
Non-metallic	3	3.23	2.88
Basic Metal	3	3.23	3.23

Metal	6	6.45	6.12
Electronic_Computer	9	9.68	6.00
Medical instrument	7	7.53	5.67
Electrical equipment	9	9.68	6.00
Other Machinery	8	8.60	6.56
Vehicles	4	4.30	5.56
Other Transport Equipment	3	3.23	2.29
Furniture	1	1.08	2.26
Other manufacturing	3	3.23	2.5
Waste Collection	1	1.08	0.91
Publishing	3	3.23	5.73
Computer programming	4	4.30	2.62
Information service	2	2.15	1.06
RnD	2	2.15	2.47
Architecture_etc	3	3.23	4.65
Total	93	100	100

7.4. IDENTIFYING THE GAPS

It is very important to identify what kind of barriers or difficulties may hinder a successful technology transfer between Korea and Russia, Thus, identifying the gaps in the Korean-Russian technology transfer is one of the important research questions in this study.

These gaps are presented as difficulties of technology transfer from the point of view of the technology recipient. Based upon the review of literature, focus group studies and interviews, the conclusion was that these gaps may be identified with the concepts of tacitness and locality, each of which might be candidates for assistance from intermediaries. Using these gaps as the basis for questionnaire questions, I sought to gather several pieces of evidence. First, which gaps were most strongly identified as being encountered in their transfer experiences? Second, was there a closer relationship within the tacitness and locality variables than between them? Third, which, if any of the variables were significantly correlated, whether within or between the two groups? Some correlation between variables was found to be significant, and this helped to understand the overall pattern and characteristics of the transfer.

The confidence of Korean firms may be reflected in the relatively lower values associated with time and cost variables (tacit components). Although they are important, concerns about the "reliability" of Russian technology were the least strongly emphasized of these issues. These observations are impressionistic because the standard deviations of the answers are broad, preventing us from ascertaining the statistical significance of the differences between the answers.

Table 7-4: Descriptive statistics of gaps that hinder technology transfer

Descriptive Statistics

	Mean	Std. Deviation	N
Gap_lang	6.01	0.699	93
Gap_culture	5.58	0.742	93
Gap_modify	5.44	1.005	93
Gap_admin	5.39	0.847	93
Gap_info	5.38	0.859	93
Gap_eval	5.33	1.087	93
Gap_transfer	5.33	0.838	93
Gap_network	5.32	0.969	93
Gap_codification	5.20	0.951	93
Gap_contract	5.16	0.912	93

Gap_time	4.77	0.979	93
Gap_cost	4.70	0.942	93
Gap_reliability	4.37	0.953	93

Note: All thirteen gap-measuring variables shown are higher than 4 (the average on the 7-point Likert scale), showing perceptions of the difficulty of Russian technology transfer.

The values of all thirteen gap-measuring variables are higher than 4 on average, which means that the firms perceived there to be difficulties related to all the gap variables provided.

The mean value for the difficulty of communicating with Russian partners because of language barriers (Gap_lang) was the highest among the difficulty variables. As shown in Table 7-5, other variables with relatively high correlation coefficients with Gap_lang are Gap_info (0.57), Gap_contract (0.54), Gap_network (0.43), Gap_transfer (0.38), Gap_admin (0.38), and Gap_culture (0.37). Difficulty variables with relatively low correlation coefficients with Gap_lang are Gap_eval (-0.12), Gap_modifiy(-0.04), Gap_cost (0.04), Gap_time (0.02), Gap_reliability (-0.01), and Gap_codification (-0.04). There was no difficulty variable with a highly negative correlation coefficient. Basic observation based on correlation with the language barrier (Gap_lang) appears to reveal two groups of difficulties related to ITT. The first group of variables is generally related to non-technological factors and the second to technological ones. But the distinction is not very clear. For example, difficulty in collecting S&T related information (Gap_info) may be related to both technological and non-technological aspects. Therefore, this can be interpreted as being mainly related to non-technological or locality aspects.

Difficulty variables with relatively high correlation coefficients generally, though not entirely, have higher mean values than the rest of the difficulty variables. This is the perception of firms actually involved in ITT. This observation prompts certain questions. First, is this result peculiar to Russian-Korean ITT or can it be generalised to ITT between other countries? Second, are non-technological or culturally related difficulties more important or harder to overcome than difficulties related to technological matters? Third, what should be the focus of support from intermediaries, the technological side or the non-technological side, or should it vary according to the nature of specific company's absorptive capacity?

Research by Lin and Berg (2001) provides an interesting comparison. They studied empirically the effects of cultural differences on technology-transfer projects using a sample of 180 Taiwanese manufacturing companies. Their empirical evidence suggested that cultural differences might not only impose barriers to technical communication but also have an interaction effect with the nature of the technology, interpreting the results of the regression analysis of their data (Lin and Berg, 2001:291). However, reviewing the models they tested, the model including cultural differences as an independent variable was slightly better than the one without, and another model composed of the interaction between technological maturity and tacitness instead of cultural difference was better still(see Table 3, Lin and Berg, 2001: 291). Therefore, in interpreting Table 7-4 and Table 7-5 of this study, the interaction between non-technological, culture-related difficulties and technology-related difficulties may be an important point to be considered before attempting to identify implications for S&T policy and the role of intermediaries.

Table 7-5: Correlation matrix: analysis result

Correlation Matrix

	Gap_ info	Gap_ network	Gap_ admin	Gap_ lang	Gap_ culture	Gap_ transfer	Gap_ contract	Gap_ eval	Gap_ modify	Gap_ cost	Gap_ time	Gap_ reliability	Gap_ codification
Gap_info	1.000												
Gap_network	.610	1.000											
Gap_admin	.619	.349	1.000										
Gap_lang	.572	.428	.378	1.000									
Gap_culture	.558	.372	.451	.365	1.000								
Gap_transfer	.624	.361	.367	.383	.349	1.000							
Gap_contract	.574	.519	.439	.542	.454	.441	1.000						
Gap_eval	-.101	-.062	-.059	-.119	-.229	-.015	-.099	1.000					
Gap_modify	-.068	.031	--.062	-.038	-.114	.146	-.019	.730	1.000				
Gap_cost	.128	.096	.039	.038	.051	.129	.044	.375	.601	1.000			
Gap_time	.128	.123	.041	.019	-.012	.199	.090	.378	.599	.538	1.000		
Gap_reliability	-.037	.000	.025	-.006	-.058	-.032	.006	.553	.499	.451	.439	1.000	
Gap_codification	-.055	-.013	-.032	-.036	-.155	.118	-.001	.470	.599	.507	.354	.349	1.000

Source: Author

Factor analysis was conducted in order to confirm whether the thirteen gap-measuring variables actually divide themselves into the two main underlying factors of locality and tacitness gaps, as predicted by the correlation analysis. Accordingly, I adopted a specific criterion to determine the main variation patterns of the thirteen gap-measuring variables: namely, the component Eigenvalue had to be greater than 1. As shown in Table 7-6 below, up to two factors have Eigenvalues that are greater than 1 with the cumulative variance explained about 57%. Although this is a bit less than 60% (the ideal percentage to aim for in social science studies), the marginal increase of variance (about 6.2%) of introducing a third underlying dimension does not significantly improve the predictive power. Thus, introducing a third underlying dimension was not necessary. Therefore I confirmed that only two groups were needed to represent the 13 gap-measuring variables in Korean-Russian technology transfer.

Table 7-6: Total variance explained

Total Variance Explained

Component	Initial Eigenvalues Total	% of Variance	Cumulative %	Extraction Sums of Squared Loadings Total	% of Variance	Cumulative %	Rotation Sums of Squared Loadings Total	% of Variance	Cumulative %
1	3.874	29.797	29.797	3.874	29.797	29.797	3.874	29.796	29.796
2	3.539	27.219	57.016	3.539	27.219	57.016	3.539	27.220	57.016
3	.803	6.177	63.193						
4	.749	5.759	68.952						
5	.707	5.439	74.391						
6	.624	4.799	79.189						
7	.571	4.391	83.581						
8	.523	4.022	87.603						
9	.464	3.572	91.175						
10	.430	3.311	94.486						
11	.344	2.648	97.134						
12	.243	1.871	99.005						
13	.129	.995	100.000						

Extraction Method: Principal Component Analysis

Source: Author

We determined which of the thirteen gap-measuring variables belonged to which of the two groups (denoted as Component). As Table 7-7 shows, the factor loading scores after rotation of the variables.

Table 7-7: Rotated component matrix

Rotated Component Matrix

	Component 1	Component 2
Gap_info	.895	.001
Gap_network	.707	.047
Gap_admin	.692	-.019
Gap_lang	.708	-.035
Gap_culture	.687	-.137
Gap_transfer	.681	.148
Gap_contract	.770	.005
Gap_eval	-.161	.774
Gap_modify	-.034	.894
Gap_cost	.124	.753
Gap_time	.140	.722
Gap_reliability	-.027	.702
Gap_codification	-.043	.717

Source: Author

Based on this result, the Korean-Russian technology transfer gaps are grouped accordingly:

- Component 1 – Locality gap in technology transfer
- Component 2 – Tacitness gap in technology transfer

Descriptive statistics for the rotated factor scores are summarised below in Table 7-8.

Table 7-8: Descriptive statistics: rotated factor scores

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std Deviation
LOCAL	93	-2.367	2.102	.00	1.000
TACIT	93	-2.801	1.816	.00	1.000
Valid N (listwise)	93				

Source: Author

Note: After rotation, the mean and standard deviation of the two factors were adjusted to 0 and 1, respectively.

As a result, these two factors are employed as latent constructs, representing a firm's perceived gaps in technology transfer, so that two groups of main hindrances to Korean-Russian technology transfer can be conceptualised in terms of locality and tacitness gaps.

Motives and Purpose

Korean firms understand that the basic nature of Russian technology has been largely based upon R&D conducted for their military and mission-focused purposes. As such, Korean firms mostly had not expected Russian technology to be in a mature and packaged form that could be directly applicable to the commercial market. What, then, motivated Korean firms to attempt adoption of Russian technology? This is related to the second research question in this thesis.

According to the empirical research and the interviews, the most frequently mentioned motives can be divided into seven main categories: (1) relatively cheaper to import; (2) technological excellence in various fields; (3) unique strength in Russian technology; (4) easer to avoid IP disputes; (5) shorter procedures in implementing technology transfer; (6) complementary strengths lacking in Korean firms; and (7) Russia's proactive attitude to technology transfer.

Table 7-9 presents a correlation analysis between these motive variables and the gap factors derived above by factor analysis, i.e, the locality and tacitness gap factors. Correlation coefficients between the motive variables were not found to be significant except for the motives for seeking capabilities and resources that are complementary to Korea's (Motive_comple). The variable Motive_comple has a relatively high correlation with three of the seven motive variables: cutting edge R&D capability in certain fields (Motive_excel), Russia's unique strength compared to western technology (Motive_originality) and shorter time to adopt the necessary technology (Motive_time). This result suggests that Russia's cutting edge R&D capability in certain fields and Russia's unique strength against western technology were part of the complementary strengths Korea was seeking.

However, how can one interpret the fact that the motive for capabilities and resources that are complementary to Korea's is highly correlated with the motive for shorter time to adopt the necessary technology? Given that Russia's cutting edge R&D capability in certain fields was one area of Korea's search for complementary capabilities, this may mean that the cutting-edge technology Korea needed in certain fields was relatively easier to transfer and adopt from Russia than from other technologically advanced countries.

Table 7-9: Correlation coefficient: an analysis between motivations and gaps.

	Motive_ cost	Motive_ excel	Motive_ originality	Motive_ Ipstr	Motive_ time	Motive_ comple	Motive_ active
Motive_ cost	1						
Motive_ excel	.15	1					
Motive_ originality	-.14	.12	1				
Motive_ Ipstr	-.03	.19	.01	1			
Motive_ time	.04	-.02	.09	-.17	1		
Motive_ comple	.04	**-.37****	**-.34****	.18	**-.29****	1	
Motive_ active	.05	-.04	.11	-.01	.07	-.06	1
Locality gap	**-.57****	**-.36****	**-.31****	-.08	.02	.18	-.18
Tacitness gap	-.09	-.02	.03	-.17	.05	-.19	**-.41****

** Correlation is significant at the 0.01 level (2-tailed). Source: Author

As discussed in Chapter 2, a major pattern of industrialisation of latecomer economies has been the adoption and application of technology developed by Western advanced countries. But successful latecomers will ultimately confront the need for higher levels of technology, and at later stages of development, successful latecomers become potential rivals of leading countries. Therefore leading firms of Western countries which had previsouly been the primary source of technology for the technological follower may become reluctant to transfer more of their technology. The survey result shown by the correlation analysis of the motives for participation in Russian-Korean ITT suggests that Korea may have reached such a competitive position as explained above for latecomer firms.

And it is observed that there are negative correlations which are significant at the 1% level between the two factors locality gap and three of the motive variables. These variables are relatively lower cost of technology import (Motive_cost), cutting edge R&D capability in certain fields (Motive_excel), and Russia's unique strength against western technology (Motive_originality). All of the correlation coefficients between these variables and the factor locality gaps are negative, with that between the relatively lower cost of technology import and locality gap being the highest of the three correlation coefficients (-0.57).

The factor locality gap stands for locality barriers to ITT. The highly negative correlation coefficient between locality gap and Motive_cost means the greater the perception about the cost advantage of Russian technology import, the lower the perception about the locality barriers to ITT. And regarding the other two negative correlations coefficients, they can be interpreted to mean that the higher the perception about cutting-edge R&D capabilities in certain fields (Motive_excel) and Russia's unique strength compared to western technology (Motive_originality), the lower the perception about the locality barriers. And only one variable, a proactive attitude from the Russian R&D community (Motive_active) has a correlation coefficient that is significant at the 1% level with the factor tacitness gap. This means that the more proactive the attitude from the Russian R&D community about the technology transfer project, the less the project is perceived as difficult with respect to tacitness barriers. In addition, Korean firms are motivated by Russia's proactive attitude, as it helps to reduce the tacitness gaps in the process of technology transfer. This can be interpreted as Russian partners with a proactive attitude can make the technology more adaptable to the needs of Korean firms.

In some sense, the motive variables are related to the relative advantages of Russian-Korean ITT compared to technology transfer from advanced Western countries. Thus, negative correlation coefficients are expected between motive variables and the two barrier factors. Four of the seven motive variables have a relatively high correlation with the barrier factors, locality gap or tacitness gap, and the other three do not show any meaningful correlation with the barrier factors. These three variables are avoiding IP disputes (Motive_Ipstr), shorter time to adopt the necessary technology (Motive_time), and capabilities and resources that are complementary to Korea's (Motive_comple). All three variables seem to represent important advantages in the Russian-Korean ITT context. So why do these variables related to important advantages show little or no correlation with the barrier factors? A clue to the answer of this question may be that these variables are relatively indirect and complex in the specific context of importing Russian technology. For example, though shorter time to adopt the necessary technology is important, the uncertainty for Korean firms about commercialising knowledge that is principally in the form of scientific findings may well be much higher than that for adopting commercialised Western technology.

In addition, from the survey analysis (see table 7-14), about 80% (75 out of 93 cases) of Russian technology adopted by Korean firms were utilised to solve technological problems in improving a process or product rather than making a new process or product. This shows a different aspect of Korean firms' motivation to adapt Russian technologies. It may be inferred that Russian technology is relatively science-oriented and developed mainly for military or special mission purposes. This less market-oriented technology seems more easily applicable to improving already existing Korean products or technologies rather than to introducing entirely new products or technologies.

Table 7-10: Case summary: comparison analysis with regard to type of innovations

Case Summary

Per_Rus

Obj_Coop	N	Mean	SD
new products	12	3.67	.778
existing products	51	4.29	1.045
new process	6	4.17	.753
existing process	24	4.21	1.021
Total	93	4.18	.999

Source: Author

This table clearly shows that the pattern and nature of the Korean-Russian technology transfer is very different from that of Korean firms with advanced Western technology. We have found that the main purpose and motivation of Korean firms adapting Russian technology is not the transfer of technology that will lead to a new product entering the market. Instead, Korean firms use Russian technology to supplement their research efforts in order to improve a process or the specification of an already developed product.

According to the absorptive capacity concept (Cohen and Levinthal, 1990), recognising the potential value is the initial step of technological absorption from outside. However, recognising one`s own needs and problems are a prior condition for identifying the value of external knowledge. Table 7-11 indicates that the relationship between awareness of technological needs and perception of gaps. As shown in the table, the degree of a firm’s awareness of its technological needs (or problems) (AWARE_PROBLEM) is negatively correlated with the tacitness-related gaps. This result can be interpreted as meaning that when a firm is clearly aware of its technological needs, the hurdles to understanding the transferred technology is not such a significant matter.

Table7-11: Correlation analysis for tacitness, locality and technological needs (Aware_Problem)

		Locality gap	Tacitness gap
Aware_problem	Corr. Coeff.	.180	**-.493****
	Sig. (2-tailed)	.084	.000

Source: Author

The survey results (see table 7-12) also show that firms with a greater understanding of their technological needs tend to be more satisfied with the adopted Russian technology. In addition, when firms have a clear awareness of the technology that needs to be outsourced, the solutions (NEEDS_OUTSOURCE) are perceived to be of higher quality. This results in higher satisfaction ratings of the technology transfer process (PER_RUS) (the correlation coefficient is significant and positive 0.34).

Table 7-12: Correlations: analysis for problem awareness and performances

		Aware_ problem	Needs_ outsource	Aware_ Rustech	Per_ support	Per_Rus
Aware_ problem	Corr. Coeff.	1				
	Sig. (2-tailed)					
	N	93				
Needs_ outsource	Corr. Coeff.	.438**	1			
	Sig. (2-tailed)	.000				
	N	93	93			
Aware_ Rustech	Corr. Coeff.	-.278**	-.035	1		
	Sig. (2-tailed)	.007	.737			
	N	93	93	93		
Per_ support	Corr. Coeff.	.194	-.046	-.215	1	
	Sig. (2-tailed)	.096	.697	.064		
	N	75	75	75	75	
Per_Rus	Corr. Coeff.	.226*	.342**	-.077	.231*	1
	Sig. (2-tailed)	.030	.001	.463	.047	

	N	93	93	93	75	93

Source: Author

In summary, seven motives were identified from the empirical literature review and from interviews. Korean firms' locality gaps as less difficult to overcome. A large portion of Korean firms that adapted Russian technology utilised problem solving to adapt the existing processes or products, rather than creating an entirely new process or product. Also, when a firm is clearly aware of its technological needs, the hurdles to understanding the transferred technology is not such a significant issue. Such Korean firms tend to be more satisfied with technological transfer projects.

Prior Knowledge and Experience

Prior knowledge and experience with Russian entities are one of the gap-bridging instruments discussed in Hypothesis 2 in the previous chapter. Once Korean firms obtain experience in Korean-Russian technology transfer, do they gain the perception that it will be easier to overcome locality-related gaps next time? In regards to the concept of absorptive capacity, prior knowledge certainly plays an important role in assimilating external technology and knowledge. From the interviews, it would seem that having prior experience of Russian technology transfer helps to overcome these locality-related gaps. For example, firms become accustomed to Russia's business culture, gain access to their scientific community, and understand Russia's business administration procedures. Therefore, it is necessary to confirm whether or not this is a common tendency for Korean firms.

Table 7-13: Case summary: differences in the perception of gaps depending on prior experience

Case Summary

Exp_foreign		TACIT	LOCAL	Per_support	Per_Rus
0	N	39	39	27	39
	Mean	-.16	.35	5.67	3.87
	Std Deviation	.811	1.064	.679	1.005
1	N	54	54	48	54
	Mean	.11	-.25	4.62	4.41
	Std Deviation	1.109	.876	.866	.942
Total	N	93	93	75	93
	Mean	.00	.00	5.00	4.18
	Std Deviation	1.000	1.000	.944	.999

Source: Author
Note: Out of the 93 firms that replied, 54 have prior experience while 39 do not. The value 0 for the variable Exp_foreign denotes Korean firms with no previous contractual types of work with Russian scientists or institutes.

Indeed, Table 7-13 shows that firms with a lack of Russian technology-transfer experience face difficulties with locality gaps compared to firms with significant experience. Though I was not able to statistically show that there was a significant difference in these perceptions as I was not able to collect a large enough sample (as noted earlier, the sample size is affected by reasons including the secretive and competitive nature of Korean firms.) to create a reliable confidence interval of the difference between the means, my main objective was to follow up on the views of my interviewees and discover whether this was a common perception prevalent among Korean firms participating in Korean-Russian technology transfer.

I employed non-parametric statistical tests on the same data set. According to the data displayed in Table 7-11, the null hypothesis, that both groups are equally distributed, is rejected. Thus we may infer that locality, perceived satisfaction with the support from intermediaries and perceived satisfaction with the technology transfer from Russia were all significantly different depending on prior experience.

Table 7-14: Non-parametric tests: differences in the perception of gaps depending on prior experience

	Locality gap	Tacitness gap	Per_support	Per_Rus
Mann-Whitney U	710.000	851.000	252.000	731.500
Wilcoxon W	2195.000	1631.000	1428.000	1511.500
Z	**-2.670**	**-1.573**	**-4.583**	**-2.614**
Significance	.008	.116	.000	.009

Group variable: Exp_foreign

The picture that emerges from this analysis is that, once firms find a way to access the Russian scientific community, or to overcome Russia's locational and sociocultural differences, these no longer represent barriers. However, such prior experience does not make a significant difference in bridging gaps relating to tacitness. Moreover, prior experience seems to have an impact on the success of technology transfer projects (PER_RUS), as measured by Korean firms' satisfaction ratings. Prior knowledge of socio-cultural and geographical issues greatly enhances a firm's absorptive capacity. In this respect, Hypothesis 2 is also supported.

7.5. ROLE OF THE INTERMEDIARIES

One important goal of this study was to find out how some of Korean firms managed to overcome the gaps encountered in transferring Russia's contrasting technology. It was hypothesised that the role of an intermediary might facilitate the technology transfer. Analysis was therefore conducted to identify the role and contribution of intermediaries. Out of the 93 Korean firms with Russian technology-transfer experience, 75 firms were supported by intermediaries. Their satisfaction with the assistance on technology transfer is rather high (a mean of 4.35) compared to that of the comparison group (with a mean of 3.50) with no such support (see table 7-15).

Table 7-15: Case Summary: comparison analysis with regard to involvement of intermediaries

Case Summary

Per_Rus

dummy_int	N	Mean	SD
not supported	18	3.50	.707
supported	75	4.35	.993
total	93	4.18	.999

Source: Author

Since our sample, especially firms' experienced in Russian technology transfer with the involvement of intermediaries, is not large enough to draw any parametric statistical inferences, we employed the non-parametric test again. Based on data displayed in Table 7-16, we may conclude that differences between groups with intermediaries and those without intermediaries are significant (p-value = 0.001).

Table 7-16: Non-parametric test: comparison analysis with regard to involvement of intermediaries

	Per_Rus
Mann-Whitney U	343.500
Wilcoxon W	514.500
Z	-3.366
Significance	.001

Group variable: dummy_int

Source: Author

Through the interviews, we found that firms without support had other linkages with Russia in terms of human networks, established relationships between partners, etc. This seems to indicate that these firms had succeeded in overcoming locality gaps without assistance from intermediaries.

Table 7-17 shows that public sector intermediaries such as central government agencies, local government agencies, and public research institutes offer a relatively higher quality of support. This is especially noticeable with regard to the intermediary role of public research institutes. It is assumed that a public research institute provides not only administrative support but also technological assistance. As a result, both locality and tacitness can be bridged in a balanced way.

Hypothesis 3 is conclusively supported in that about 80 percent of Korean firms with Russian technology transfer have been supported by intermediaries and their perceived level of satisfaction with regard to technology transfer projects was higher than that for those without intermediary support.

Table 7-17: Case summary: types of intermediaries

Case Summary

Type of intermedieries		Tacitness	Locality	Per_support	Per_Rus
Central agency	N	21	21	21	21
	Mean	.46	.17	4.86	4.24
	SD	.921	1.035	.854	.995
Local autonomous entity	N	21	21	21	21
	Mean	-.21	.17	5.14	4.57
	SD	.734	1.015	.854	.811
Public institutes	N	9	9	9	9
	Mean	.46	-.24	6.00	5.67
	SD	1.056	1.149	.866	.500
Universities	N	12	12	12	12
	Mean	.08	-.04	4.75	3.67
	SD	.917	.804	.452	.651
Private consultant	N	12	12	12	12
	Mean	-.10	-.22	4.50	3.83
	SD	1.297	1.066	1.168	.835
Total	N	75	75	75	75
	Mean	.12	.02	5.00	4.35
	SD	.978	1.003	.944	.993

Source: Author

Intermediary Support at the stage of ITT

Table 7-18 shows the correlation analysis results between provision of intermediary support and gap-related items. The statistical significance between pairs such as GAP_INFO & SUPPORT_ADMIN and GAP_NETWORK & SUPPORT_ADMIN indicates that firms facing locality-related issues receive administrative support from their corresponding intermediaries. It is notable that the overall satisfaction with private consultants was much lower (3.83) than that for public intermediaries (5.67), and also that local government agencies (4.57) and even central agencies (4.24) in table 7-17. These patterns remain valid when the perceived level of satisfaction with the support provided by the specific intermediary is examined (designated Per_support).

On the other hand, difficulties in tacitness (GAP_MODIFY, GAP_CODIFICATION) were highly correlated with intermediaries' support with regard to technological aspects (SUPPORT_TECH). Interestingly, firms facing barriers in networking and contracts have a tendency to rescure support for securing funds (SUPPORT_FUND). We can infer that funding support from intermediaries can help firms to overcome certain types of locality issues.

Table 7-18: Correlation coefficient

Correlation Coefficient

		Support_Info	Support_Fund	Support_Tech	Support_Cont	Support_ Admin
Gap_info_L	Correlation Coeff	.196	.208	-.025	.319**	.286*
	Sig (2-tailed)	.092	.073	.830	.005	.013
Gap_network_L	Correlation Coeff	.191	.274*	.078	.228*	.144
	Sig (2-tailed)	.100	.017	.504	.050	.217
Gap_admin_L	Correlation Coeff	.024	.196	.058	.212	.348**
	Sig (2-tailed)	.841	.092	.622	.068	.002
Gap_lang_L	Correlation Coeff	.192	.240*	.033	.400**	.116
	Sig (2-tailed)	.099	.038	.781	.000	.321
Gap_culture_L	Correlation Coeff	.252*	.045	.073	.173	.059
	Sig (2-tailed)	.029	.702	.531	.139	.617
Gap_transfer_L	Correlation Coeff	.173	.038	.213	.128	.290*
	Sig (2-tailed)	.138	.744	.067	.275	.012
Gap_contract_L	Correlation Coeff	.176	.286*	.057	.249*	.249*
	Sig (2-tailed)	.130	.013	.627	.031	.031
Gap_eval_T	Correlation Coeff	-.067	.030	.147	-.151	-.228*
	Sig (2-tailed)	.567	.797	.207	.195	.049
Gap_modify_T	Correlation Coeff	.036	.022	.327**	-.264*	-.155
	Sig (2-tailed)	.756	.854	.004	.022	.184
Gap_cost_T	Correlation Coeff	.069	-.077	.256*	-.266*	-.206
	Sig (2-tailed)	.559	.511	.027	.021	.077
Gap_time_T	Correlation Coeff	-.027	.011	.326**	-.250*	-.222
	Sig (2-tailed)	.819	.924	.004	.030	.056
Gap_reliability_T	Correlation Coeff	-.102	.045	.206	-.297**	-.212
	Sig (2-tailed)	.384	.701	.077	.010	.068
Gap_codification_T	Correlation Coeff	-.109	.059	.395**	-.313**	.044
	Sig (2-tailed)	.353	.617	.000	.006	.711

**. Correlation is significant at the 1% level

*. Correlation is significant at the 5% level

Source: Author

In the SCTA framework, ITT is viewed as a sequential process involving several stages. It is assumed that each stage needs different types of support from intermediaries. As we saw in previous chapters, the four stages used to describe the SCTA as a process are: recognition, acquisition, assimilation/transformation, and exploitation.

Table 7-19 shows that Korean firms supported in the recognition stage have a relatively higher value of locality (0.497) compared to that of the other firms not supported (-0.546).

Table 7-19: Comparison analysis of the recognition stage

Case Summary

Proc_recog		Tacitness	Locality	Per_support	Per_Rus
0	N	34	34	34	34
	Mean	-.06	-.55	4.68	4.53
	SD	1.036	.899	.976	.961
1	N	41	41	41	41
	Mean	.27	.50	5.27	4.20
	SD	.914	.830	.837	1.005
Total	N	75	75	75	75
	Mean	.12	.02	5.00	4.35
	SD	.978	1.003	.944	.993

Source: Author

Table 7-20 shows that Korean firms supported in the acquisition stage have a relatively higher value of locality (0.874) compared to that of the other firms not supported (-0.957).

Table 7-21 shows the assimilation and transformation stage differs with respect to the tacitness dimension. It would seem that the locality gap is more critical when searching for the right partners and technology, but that technological matters are more important during the on-going transfer process.

Table 7-20: Case summary: comparison analysis of the acquisition stage

Case Summary

Proc_acq		Tacitness	Locality	Per_support	Per_Rus
0	N	26	26	26	26
	Mean	-.34	-.10	4.96	4.15
	SD	1.158	.969	.958	1.008
1	N	49	49	49	49
	Mean	.36	.09	5.02	4.45
	SD	.781	1.024	.946	.980
Total	N	75	75	75	75
	Mean	.12	.02	5.00	4.35
	SD	.978	1.003	.944	.993

Source: Author

Table 7-21: Comparison analysis of the assimilation and transformation stage

Case Summary

Proc_assim_trans		Tacitness	Locality	Per_support	Per_Rus
0	N	16	16	16	16
	Mean	-.97	.29	4.75	4.38
	SD	.573	.876	1.000	.957
1	N	59	59	59	59
	Mean	.42	-.05	5.07	4.34
	SD	.845	1.029	.926	1.010
Total	N	75	75	75	75
	Mean	.12	.02	5.00	4.35
	SD	.978	1.003	.944	.993

Source: Author

Table 7-22 shows that the role of intermediaries during the exploitation stage is rather limited compared with other stages. The difference in the satisfaction levels between firms with an intermediary and firms without is not present in the exploitation stage. Indeed, the not-supported group (5.06) expressed a higher overall satisfaction than the supported group (4.88).

Table 7-22: Comparison analysis of the exploitation stage

Case Summary

Proc_exploit		TACIT	LOCAL	Per_support	Per_Rus
0	N	55	55	55	55
	Mean	.04	.15	5.06	4.24
	SD	.769	1.143	.966	1.091
1	N	20	20	20	20
	Mean	.04	-.19	4.88	4.38
	SD	1.406	.964	.991	1.408
Total	N	75	75	75	75
	Mean	.04	.04	5.00	4.28
	SD	.985	1.081	.957	1.173

Source: Author

These results indicate that there might be an important selection effect operating among those firms that seek out intermediary services. While it is important to note that the majority of firms have been involved with intermediaries, those that have not often perceive locality gaps and sometimes tacitness gaps as to be of lesser significance. In effect, this is a measure of the confidence of firms.

In summary, the role and contribution of intermediaries seem quite notable with a major share of firms (75 out of 93 firms) having been supported by intermediaries and expressing higher satisfaction with the assistance. Public agencies including R&D institutes and local entities make better performance on assistance. There are differences in intermediaries' roles and their level of contribution in each stage of technology transfer.

7.6. SUMMARY

As mentioned in the Introduction, the survey was designed to understand the macro view of ITT between Korea and Russia, in such a way as to complement the micro view supplied by case studies and interviews. Additionally, the survey was developed to test certain hypotheses underlying the SCTA framework, and to verify some of the findings from interviews. The survey specifically focused on identifying the connection between the gap that Korean firms face when transferring Russian technology and on exploring the concepts of locality and tacitness. It also focused on identifying the connections between the gaps Korean firms perceive in the ITT process from the locality and tacitness perspectives. Finally, it focused on examining the role of intermediaries, and whether they made a positive difference at the different stages of transferring Russian technology. Four hypotheses are supported by the survey, and some of the key findings from the survey can be summarised as follows:

- The survey results show that thirteen different gaps uncovered in the interviews and empirical findings represent, as a group, the details of the concepts of tacitness and locality, and that these are sufficiently problematic to require assistance from intermediaries.
- About 80 percent of Korean firms were supported by one or more intermediaries in the process of ITT with Russia. At each stage, a different type of intermediary support is required in order to bridge the gaps faced by each firm. Those Korean firms assisted by intermediaries manifest a higher level of satisfaction with ITT projects than those without intermediary support.
- A large portion of Korean firms utilised Russian technology for problem solving connected with their existing processes or products rather than creating a new process or product. This is due to the fact that Russian technology, as a general rule, has not been "market tested". Russian technology becomes more practical when it is combined with technologies developed in Korea.
- Prior knowledge of socio-cultural and geographical (locality) differences

between countries greatly enhances a firm’s absorptive capacity. Once firms find a way to access the Russian community of scientists and research organisations, locality gaps diminish. This change is leveraged by the firms in future interactions with Russian scientists. However, such prior experience does not make a significant difference in bridging gaps relating to tacitness.

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CHAPTER 8. CASE STUDY PART ONE: PUBPIC AGENCY PROGRAMMES

CHAPTER 8. CASE STUDY PART ONE: PUBLIC AGENCY PROGRAMMES

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8.1. INTRODUCTION

This chapter examines case studies concerning the transfer of technology between Korea and Russia. These include two case studies from the intermediary's point of view and four case studies from the firm's point of view. The case studies selected are those that provide important insights into the impact that key players have on the technology transfer process.

The two intermediaries are public agency programmes designed by the Korean government, MOST and MKE. These two programmes have been models for other central and local governments launching similar programmes (Kim, 2007). The public agency programmes implemented by the Korean government to assist domestic firms turned out to be a key feature in successful ITT from Russia to Korea in both the interviews and the survey results. According to my results, the transfer of Russian technology to Korean firms is tightly linked and associated with the role of an intermediary in the form of public agency programmes.

A major share of Korean firms responding to the survey reported having benefitted from the public agency programmes in various ways in the process of technology transfer. These government-designed public agency programmes directly reflect the nature of Korean innovation systems and the government's policy position of supporting domestic firms in their acquisition of Russian technology. An examination of these public agency programmes is a necessary step toward developing an understanding of the context in which Korean firms are acquiring Russian technology and testing whether the SCTA is useful in representing the nature of the Korean-Russian technology transfer. The more general aim is to ask whether the Korean experience can then be used to advance a more general understanding of the public role in leveraging the private sector's absorptive capacity for outside technology absorption. The public agency programmes that my study analyses include: (1) CTTP, designed by MOST, and (2) KRITP, designed by MKE. These two public agency programmes have been analysed mainly by reviews of documents provided by the agencies, as well as interviews inside and outside those agencies

8.2. THE CORE TECHNOLOGY TRANSFER PROGRAMME (CTTP)

The CTTP, developed by MOST and implemented by KIST which served as the commissioning agent, has played a pivotal role in technology transfer since the inception of the Korean-Russian agreement to build a collaborative relationship in science and technology. The CTTP was developed to coordinate Korea's competencies in engineering-based research with Russia's strength in basic science and special-purpose technology. Following the dismantling of the Soviet system, the Korean government developed the expectation that Russia could be an important source of knowledge, a sort of “Treasure Island” of strategically valuable technology both for civilian and military purposes. Russia was also enthusiastic about cooperating with Korea at the time (MOST, 2004), and their enthusiasm has served as a growth engine for CTTP’s efforts.

After the sudden collapse of the Soviet system, Russian scientists were anxious to find means for continuing their research. KIST’s scientific knowledge seems to have provided an important foundation for recognising the value of Russian technology (Kim, 2008). Because KIST`s research activities have focused on fundamental technology, it has developed a stronger understanding and a wider spectrum of S&T knowledge than private firms in Korea (KIST, 2011). The CTTP has taken on the supporting role by formulating a framework for supporting Korean firms, as well as by building strategic partnerships with important Russian research institutes (Kim, 2008).

Based on documents provided by KIST and interviews with programme managers and researchers, a typical *modus operandi* of CTTP can be described as follows. First, the overall process and framework of the CTTP is designed by MOST, including a budget for activities. MOST then contracts for KIST implementation services. One part of this activity involves infrastructural activities provided by the KIST subdivision, the Korean-Russian Scientific and Technological Centre (hereafter KRSTC), located in Moscow. KRSTC monitors S&T activities along with the output of the Russian scientific community. This is followed by interactions between members of KRSTC and KIST’s domestic Korean research community. As a by-product of this process, material for Korean seminars and presentations, available to the public and to the private Korean research community, is generated.

Another part of KRSTC's activity involves following up on general monitoring with a more specific process —that of KRSTC recruiting "Technology Search Groups" from Korean firms. As useful Russian technologies are identified, and a number of firms show interest, the KRSTC and KIST organise "Technology Search Groups" from the Korean private sector to visit the Russian research institutes and universities where those technologies originate. The purpose of these visits is both to confirm the value of identified technologies and help to build a network between the research communities of the two countries. The CTTP underwrites a portion of the expenses for the visits. This visit guided by KRSTC provides Korean firms with an opportunity to understand the network of the Russian scientific community and the nature of Russian technology.

If the visiting Korean firms show an interest in further exploring the identified Russian technology, the KRSTC and KIST provide consultation on specific strategies and processes to be used based on the firm's request including language, legal assistance, and administrative support. This can extend as far as launching private-public projects to develop and transform Russian technology that cannot yet be absorbed solely by Korean firms. Once the acquired technologies have been absorbed by the Korean firms, KIST stands aside, allowing the private sector to have autonomy in applying the acquired technology. This allows firms to do what they do best, using technology to bring new products into the market or to improve their existing process or products. This division of responsibilities is what is taken to be appropriate for attaining competitive market conditions in the Korean context. However, some Korean firms requested KIST to work together to further develop and transform the newly acquired Russian technology. In these cases, the firm and KIST concluded separate contracts for specific research projects. Some technology has been developed in Russia for a long time without having a specific civilian application. KIST, which is able to understand both scientific knowledge and industrial application, aids in maturing and developing this technology.

CTTP not only waits for Korean firms to request help in adapting Russian technology. Through its operator, KIST, it is also continually scouting for strategic Russian technology (D. Hyun, personal communication, October 7, 2008). KIST researchers have access to primary Russian scientific sources through KRSTC. Upon locating potentially valuable technology, KRSTC staff contact the in Russian counterparts and negotiate to acquire the technology. During its twenty years in operation, more than three hundred technology acquisition projects have been implemented by KIST under the CTTP budget.

CTTP also invites Russian scientists to visit Korean firms. Russian scientists have an approach to research that is unique from a Korean perspective. Combining their unique research approaches with a Korean firm's knowledge, they have been able to solve several stubborn research problems with many publications of papers and patents (D. Hyun, personal communication, October 7, 2008). This form of collaboration is not necessarily directly involved with the formation of specific projects but instead offers Korean firms the opportunity to absorb research knowhow that Russian scientists have accumulated over their entire professional life. According to David Dyker, one of the peculiar features of Russian S&T is that scientific knowledge created in Russia, in general, is more often held tacitly than codified, meaning that knowledge transfer requires human interaction (Dyker, 2001). CTTP assists Korean firms in overcoming locality and tacitness gaps.

8.3. THE KOREAN-RUSSIAN INDUSTRIAL TECHNOLOGY PROGRAMME (KRITP)

8.3. THE KOREAN-RUSSIAN INDUSTRIAL TECHNOLOGY PROGRAMME (KRITP)

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The second public agency programme selected for closer investigation is KRITP, sponsored by MKE, which is responsible for industrial policy in Korea. MKE began to implement policies for the transfer of Russian technology in the early 2000s, about a decade after MOST. In the early stages of cooperating with Russia in the 1990s, Korea's policy approach was more focused on acquiring Russia's strategic and military technology rather than industrial technology (Kim, 2007). Some Russian technologies can be used for dual application —i.e. military and commercial purposes. MOST is in charge of implementing a national strategy for both purposes. In the early 1990s, only the largest Korean firms showed any interest in using Russian technology.

In 2000s, many large Korean firms accumulated prior knowledge and know-how for approaching Russian technology so that MKE focused on small and medium-sized firms without such Russia-related knowledge and experience. MKE has established KRITP at the state-run Korea Polytechnic University located in Ansan, about one hour away from Seoul. MKE funds Korea Polytechnic University to operate KRITP in a similar way as MOST funds KIST to run CTTP. MKE evaluates KRITP's performance annually in terms of the quantity of assistance it supplies to Korean firms as a way to maintain the quality of the programme. If the performance of KRITP is below expectations, MKE has the option to change to other universities or public research institutes for the KRITP operating contract.

In order to reduce the accessibility gap, KRITP's main role is follow-up (D. Oh, personal communication, November 19, 2010). First, KRITP provides relevant information about Russian technology. This information is more focused on industrially applicable technology rather than on basic science. The information is provided by e-mail mailing lists, monthly magazines, and seminars. Based on this routine, KRITP arranges a technology investigation delegation six times a year. The delegation includes both Korean firms and experts in the fields of management consulting, engineering, legal counsel, and industrial associations, as well as government officials. These experts help Korean firms to quickly understand the Russian context of targeted technology, as well as the socio-economic system related to technology transfer. This support makes it easy for Korean firms to identify areas of interest in the Russian R&D complex. These delegations are sometimes organised by areas of technological interest, and sometimes by geographical regions. Korean firms can therefore choose the type of delegation that suits their needs. KRITP also support some part of travel fees for the delegation (J. Kwon, personal communication, November 17, 2010).

Second, KRITP also invites scientists and engineers from Russian universities or public research institutes to Korea on a regular basis, to participate in technology information sessions with Korean firms. These sessions allow for both the transfer of information and the formation of networks. It also allows groups of Russian scientists to visit Korean firms to discuss technological problems and possible solutions. In some cases, Russian scientists have stayed with the Korean firms for several months to provide technical consultancy. KRITP also provides technology consulting services to Korean firms, focusing in particular on those firms that have participated in technology delegations. There is even an on-line technology consulting service for simple issues. However, KRITP's technology consulting services are difficult to extend to complex issues. KRITP may refer more complex issues to other organisations with the specific expertise required.

There are two major types of supporting programmes that KRITP provides specifically to Korean firms undertaking Russian technology transfer (J. Kwon, personal communication, November 17, 2010). When Korean firms initiate technology transfer projects and ask for assistance, KRITP provides a variety of various managerial, legal, and language assistance with the contract. Because KRITP is sponsored by the government, it results in a lower cost when compared to private consulting firms. KRITP also operates the "Russian technology development programme" that funds Korean firms' adaptation and the further development of Russian technology. KRITP releases the request for proposals, inviting Korean firms to invest in the cost of importing the technology. KRITP carefully selects the firms' projects with technological and financial credibility in mind. There is a great strategic importance in targeting Russian technology. Every year, about US$ 500 million are spent on these projects (Bang, 2010).

KRITP is a type of intermediary that aids in bridging mostly locality gaps, since it is operated by a university as a contract-based programme. Its orientation is more focused on small firms that lack the capability to absorb Russian technology. KRITP bridges locality gaps with simple technical support. This intermediary role is greatly influenced by the government agency since it is regarded as the implementing measure for government policies (C. Bang, personal communication, November 18, 2010).

8.4. DISCUSSION

Both CTTP and KRITP are organised as ministry-sponsored mission-oriented agencies. CTTP operates mainly on the basis of utilising KIST's technological and managerial capabilities. KIST finds Russian technology that is seen as appropriate from a Korean national perspective by using its accumulated scientific knowledge base and links to the Korean scientific research community. CTTP targets sophisticated technology that requires a high level of technological absorptive capacity. KRITP is operated by Korea Polytechnic University under a contract from MKE and aims to support small and medium-sized enterprises that lack both information and technical capability. KRITP provides financial and managerial assistance, targeting Russian technologies that are readily applicable. This suggests that the intermediary role in public agency programmes is very closely associated with the sponsoring of ministries' missions. In other words, the Korean NIS has established an ITT support structure which is aligned with existing ministries, and that attempts to improve the performance of Korean firms' in adopting and adapting Russian technology. In both cases, the intermediaries provide services that leverage the assets of private firms by providing infrastructural and complementary capabilities in the absorptive process. The following are project-level cases that could explain how firms' absorptive capacity is enhanced by this leveraging of the intermediary role.

CHAPTER 9. CASE STUDY PART TWO: KOREAN-RUSSIAN TECHNOLOGY TRANSFER PROJECTS

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9.1. INTRODUCTION

The project-level case study has been designed : (1) to develop a deeper understanding of motivation, gaps, and processes of Russian technology transfer, (2) to examine whether the SCTA framework's focus on the sequential stages of the absorption process can be traced to the experience of individual projects and thereby provide some validation of this element of the framework, and (3) to confirm the role of intermediary mechanisms in enhancing absorptive capacity, the larger aspect of the SCTA framework.

In presenting the case studies, the sequential activities that the SCTA framework uses, are employed, namely 1) recognition of value, 2) acquisition, 3) transformation (adaptation) and 4) exploitation.

Case studies were then implemented according to interviews conducted with key personnel (see appendix 2). Document analysis provided by the Korean firms and their intermediary agencies took place. Even though all four cases were supported with information from intermediaries, in order to minimize subjective judgment, information gathered from intermediaries was used solely for the purpose of cross-checking facts.

9.2. LG ELECTRONICS AIR-CONDITIONER

The case of LG Electronics' Whisen air-conditioner is thought to be one of the most successful examples of Korean-Russian technology transfer. LG Electronics was a late entrant in the air-conditioner market, introducing their first air-conditioner in the early 1990s. From the time of their entry into the market, they continued to have quality-related difficulties in keeping the heat exchanger surface dry. Dampness collects on the exchanger, causing serious problems in cooling efficiency. LG Electronics' solutions for these problems were less effective than their competitors' solutions, including those of Samsung Electronics, Daewoo Electronics, and Mando Whinia. At the time, LG Electronics was the third-ranked player in the Korean air-conditioner market in terms of market share, and they had not adopted a strategy for actively attempting to penetrate the global market. LG Electronics' "Technology Team" exerted their best efforts to solve this problem, but their efforts met with continuous failure. In order to address this persistent problem, the firm adopted a strategy of searching overseas for possible solutions (J. Suh, personal communication, June 18, 2007). However, they had difficulty in finding decent partners in Western countries because they did not want to expose their technical problem to rival firms. Also, existing foreign technology involved approaches that were similar to what LG Electronics had already tried. As a result, their efforts at collaboration with the triad countries produced dismal results (T. Jung, personal communication, July 15, 2007).

9.2.1 Recognise the Value

KIST researchers were aware of Russia's plasma technology from an internal report provided by KRSTC and believed that they could apply this plasma technology to metal coating processes. Since KIST is not a private firm, it did not know where to apply this plasma technology specifically. KIST researchers believed that this Russian plasma technology could have a potentially huge number of applications in various industrial areas, but would need to go through additional nurturing stages of R&D. In particular, the KIST research team acknowledged that this Russian technical capability was a unique result developed under Russia's special circumstances. Such an approach had not even been published in academic journals. As noted earlier, KIST is a government research institute that has quite a large scope of research which includes physics, materials science and mechanical engineering. The KIST research team had the capability not only to nurture the development of plasma technology but also to apply it in everyday production as a metal surface coating. The Russian research team had the best knowledge of the underlying scientific principles, but did not know how to apply it.

9.2.2 Acquire

KIST contacted the Russian institute through KRSTC, KIST's Russian-based office. As noted earlier, KRSTC has established a network with the Russian S&T community, especially the public sector. The collaborative agreement between Korea and Russia empowers KRSTC to officially contact Russian citizens and to collect information. The negotiation was very simple, as KIST decided to invite several key scientists, and also provided some research funds for remaining scientists. This was because there was not much in the way of concrete results such as patents, and the scientists were willing to continue their research in a more stable environment. The research institute paid no particular heed to the negotiation. KIST launched a two-year project using funds from

CTTP, sponsored by MOST, and introduced a prototype of a plasma process for very thin coating of metal surfaces.

KIST introduced the prototype at a MOST-sponsored technology fair in Seoul during May 1996. It was mandatory that technologies developed under CTTP had to reveal their research results after the completion of a project. MOST's intention and mission were to disseminate Russian technology more widely into Korean business society. The LG Electronics Technology Team, struggling with their heat-exchanger drying issue, discovered the plasma coating technology at the fair, and recognised that it could possibly solve their long-standing technological problem. LG Electronics approached KIST, and KIST explained the general details of the plasma technology, including information regarding the situation of the Russian research community and the quality of their science and technology. As a result, LG tried to apply this plasma technology to their air-conditioner's heat-exchanger surface by licensing this technology from KIST.

9.2.3 Transform

LG Electronics signed a licensing contract with KIST, and with help from KRSTC, also approached the Russian research institutes in order to obtain a detailed, deeper understanding of plasma technology. Many Russian scientists visited the LG Electronics research centre located in Seoul to give advice on the scientific principles of plasma technology. However, LG Electronics realised that it was almost impossible for their researchers to understand the basic principles of plasma physics completely. This was so because most LG Electronics researchers had electronic or mechanical engineering backgrounds. The nature of the research work to be undertaken was also very different from Korean experience, since Russian scientists were not familiar with performing research work that had many constraints such as weight, price, design, and schedule . The gaps between LG Electronics researchers and Russian scientists were too big. As a result, LG Electronics and KIST launched a three-year joint research project, asking participants to establish links between Russian scientists and LG Electronics engineers. They also asked that KIST make Russian knowledge of plasma physics more tangible and concrete, with an orientation toward electronics and material engineering. KIST has many researchers with physics backgrounds, and holds patents in the core technology for plasma coating. KIST also had a clear understanding of what technological problems LG Electronics needed to solve.

9.2.4 Exploit

The results were very positive. LG Electronics developed the technology that could coat the surface of the air-conditioner heat-exchanger. Plasma gas is inserted inside the coating layer in a way that allows complete control of the surface condition by manipulating the character of the plasma. As a by-product of the research project, LG Electronics also achieved additional research goals that improved the device’s energy saving performance. With this new technology, LG Electronics introduced a new brand of air-conditioner product called “Whisen”, which was launched in 2000. It became the world’s bestselling air-conditioner in 2001, taking 11.6% of the world market for air-conditioners (J. Min, personal communication, July 1, 2007). It is important to bear in mind, again, that before adopting and applying plasma technology, LG Electronics was only the third biggest player in the Korean air-conditioner market. However, since then it has been the global leader in the air-conditioner market for eight consecutive years. By 2007, its worldwide market share for air-conditioners reached 19.6%. Plasma technology is not the only factor in the success of Whisen -- LG Electronics also introduced a new design and employed aggressive marketing campaigns in the global market (T. Jung, personal communication, July 15, 2007). However, the main driver of revenue growth was a dramatic improvement in cooling efficacy, the core function of the air-conditioner, using transferred Russian technology.

9.2.5 Summary and Discussion

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As outlined in the SCTA, locality, tacitness gaps, and the role of intermediaries affect the process of technology transfer. KRSTP, a subdivision of KIST, an intermediary agency specialising in bridging locality gaps, first recognised the value of Russian-developed plasma technology. KIST nurtured and partly transformed it to meet specific application needs. It is very rare for intermediary agencies to provide relevant information or services to Korean firms when they are asked, as a matter of course. CTTP is designed to provide Russian S&T information that is highly valuable in satisfying military and industrial purposes. The Korean government wished to obtain Russian technology to support the more strategic aspects of their national plan. In the early 1990s, most Korean firms were not able to see past the condition of the original form of Russian technology and recognizing its true value. Russian technologies were too unique, and Korean firms possessed almost no prior knowledge about of them. It is necessary to nurture technology so that its more refined form emerges, allowing Korean firms to more easily understand how the technology could meet their own needs. In the early stages, intermediaries helped Korean firms' recognize of the value of transferred technology.

LG Electronics would not have found out that Russia's plasma technology even existed at all, without the facilitating role of the intermediaries, including KRSTC and KIST. In an interview with the chief of the LG Electronics Technology Team (air-conditioner division), he said that "I can't speak for the possibility of LG on a general level – which covers various product portfolios – having had experiences cooperating with Russian scientists, but the air-conditioner division never even imagined incorporating Russian technology. It was hugely fortunate we ended up participating in the technology fair. KIST's prior experiences with Russian plasma scientists reduced trial and error greatly. The project could utilise Russian knowledge to align with LG resources and capabilities. More importantly, working together with KIST gives the technology team powers of persuasion over the firm's top management."

In the process of applying Russian technology licensed from KIST to their technological problem, LG Electronics encountered serious problems in understanding and absorbing Russian knowledge. They understood that Russian knowledge is highly tacit and embodied in humans, so they invited many Russian scientists along with technology licensors from KIST. However, there are large differences in the nature of research between the two groups. Russian scientists, in general, do not believe that the goal of their work is to achieve specific, desired and targeted results by using their knowledge. Instead, their intention is to continuously make new discoveries in plasma physics. This is an important difference between applied research and basic research. To overcome this cultural difference among scientists and engineers, LG Electronics utilised KIST as an intermediary to leverage Russian knowledge, and to concentrate on their desired research outcome.

It is important to note that many of the good ideas in organisations may not be implemented because of conflicts between new insights and initiatives on the one hand, and established mental models on the other. Mental models can dominate business decisions, and these models are often tacit and contradictory with regard to openly stated points of view (Senge, 1990). In this case, LG Electronics and KRSTC might have had different mental models, and the latter could see what the former could not.

Therefore, intermediaries also expand the range of mental models that private firms can access, in order to recognise the true value of external knowledge.

Through a combination of LG Electronics' internal absorptive capacity and the facilitating capabilities of the intermediaries, LG Electronics was able to recognise the value of Russia's plasma technology and transform it into a coating technology that could be applied to their products. But it must be emphasised that in order for them to successfully apply this scientific knowledge of plasma physics to their air-conditioners, LG participated in a joint research project with KIST and Russian scientists. KIST had a better understanding of plasma physics. In addition, some of the locality gap was bridged by CTTP (described in section 2.1), which assisted Korean firms in accessing and acquiring Russian technology.

9.3. SCAN-TYPE DIGITAL X-RAY DETECTOR

Advanced Digital Technology is a medium-sized firm with annual revenues of US$ 25 million that was looking for a new business opportunity. This firm found that digital radiography is a fast growing business and it already had some degree of technological capability in a related area. It began considering the possibility of branching out into the digital X-ray business, carefully analysing all the existing and emerging technologies in that field. Afterwards, it concluded that it would be very difficult to compete, even in the local market, without advancing their original core technology.

Digital radiography involves a sophisticated system that consists of a detector, X-ray tube, generator, software, and mechanical system, along with auxiliary equipment. Most digital radiography system makers in Korea had depended on outsourcing to obtain detectors, X-ray tubes, and generator technology. The market was considered very competitive, and the profit potential quite low. About 45 to 55% of a digital radiography system's cost was due to the cost of the detector (Y. Choi, personal communication, February 1, 2011). Because it was too risky to develop all the relevant technologies, the firm became interested in importing the technologies from other countries. After several months of investigation, they considered Russia to be one of the most advanced countries in this field. Also, the cost of technology cooperation with Russia was expected to be relatively low.

9.3.1. Recognise the Value

Advanced Digital Technology's next step was to try to reach out to research institutes in Russia. In this process, the firm contacted KRITP for assistance. After acquiring the necessary information from KRITP to contact prospective partners in Russia, they visited two candidate organisations in Moscow and two in Novosibirsk. They decided on one in Novosibirsk, called the Budker Institute of Nuclear Physics, as a preferred partner. At the time, the Budker Institute employed about 3,000 scientists and engineers, having been established in 1959. It concentrates on high-energy physics, particularly plasma and particle physics. As part of its basic science capability in physics, it developed various X-ray technologies. KRITP highly recommended the Budker Institute's core and applied X-ray technologies as suitable for Advanced Digital Technology. In doing this, KRITP and Advanced Digital Technology utilised several Korean experts in this area to narrow down the technological and contractual matters (H. Lee, personal communication, January 28, 2007).

Advanced Digital Technology applied to KRITP projects for support funds for adapting and further developing Russian technology. KRITP deemed that X-ray technology could also be used in several other industries and accepted the proposal for research funding.

9.3.2. Acquire

The Budker Institute initially showed little interest in facilitating a technology transfer with Advanced Digital Technology because it is a small-sized firm in Korea. Russian institutes were sceptical of the firm's ability to conduct the necessary technology development and commercialisation. KRITP explained to the Budker Institute that Advanced Digital Technology had been preparing for this business and had the potential to make it successful. KRITP as a government agency could provide the necessary confidence to the Budker Institute.

The Budker Institute was willing to transfer a low-resolution detector (1024, 400μm) technology that had already been commercialised and introduced in the market. However, Advanced Digital Technology was seeking to be the first mover in the market, and requested the transfer of technology for a higher-resolution detector (2048, 200μm) from Budker. There were three main points that the firm used to persuade Budker to make the transfer: 1) intense competition in the low-resolution market reduced the possible gain from a transfer, 2) the firm's technological capability and standard was high enough to catch up with the more advanced technology, and 3) the market prospect data for the high-resolution market was very promising. Budker concluded the technology transfer agreement, which included giving Advanced Digital Technology exclusive rights to the more high-resolution technology.

9.3.3. Transform

Since Advanced Digital Technology's role was to adapt Russian technology in the technology transfer, they could shorten their time and cost in taking the first step in developing X-ray technology by availing themselves of KRITP's assistance. The firm tried to internalise products with their own skills when they were receiving technology from Budker. Moreover, they collaborated with Yonsei University in Korea for further aid in developing applied technology such as digital signal processor software and hardware, image processing, and control systems.

The transfer process started with the Budker Institute. They transferred the detector development technology, system design know-how, and system manufacturing know-how to the firm. With those source technologies, combined with the industry-university cooperation, Advanced Digital Technology was able to successfully develop the X-ray detector. Their new X-ray detector, Scan Detector Radiography, provided a high quality image at a low radiation dose, which offered a competitive selling point. Attributes such as direct transformation detection and the absence of a dead zone in the imaging field contributed to a high quality image. This resulted in no scattering, no practical limitation in the length of picture taking, and low distortion of the image (H. Song, personal communication, March 4, 2011).

In creating a closed relationship among Advanced Digital Technology, the Budker Institute, and Yonsei University, KRITP mainly took the role of the connector and supporter in this joint project. KRITP was positioned as the moderator of negotiations between the firm and the Institute, and encouraged the university to join in the project.

9.3.4. Exploit

After four years of attempting to enter the high-resolution market, Advanced Digital Technology succeeded in developing its own technology. According to documents provided by the firm, and interviews with two managers from product development divisions, the firm has now successfully entered this market. They applied their Scan Detector Radiography technology to a range of products. They developed Detector Radiography for Chest, Multipurpose Detector Radiography, Detector Radiography for Emergency, and Detector Radiography for Long Bone/Full Spine. These products were presented to potential customers at the Korea International Medical and Hospital Equipment Show in 2005 and in 2006, and at the Radiological Society of North America 2006 exhibition in Chicago. The firm also completed product concept designs for Detector Radiography for Animals and Detector Radiography for Security. They are currently developing Mammography, Panorama for Dental and Dental CT by applying this same Scan Detector Radiography technology.

9.3.5. Summary and Discussion

This case is representative of the critical role of an intermediary in adapting foreign technology. As mentioned above, the intermediary helped to successfully complete the transfer process. The intermediary’s main activities during this case can be summarised as: 1) helping to persuade the Russian partner to trust a small-sized Korean firm’s ability to develop the technology, 2) funding Advanced Digital Technology during the transfer of technology, 3) encouraging universities to collaborate on research projects with the firm, and 4) reducing cultural difficulties, moderating negotiations, and developing domestic technology.

9.4. BIOGAS PRODUCTION AND PROCESSING FROM LIVESTOCK WASTE

Since its establishment in 2001, the Korean Trade Commission Co., Ltd. has engaged in the production of solvent-free paint and adhesion materials using Low Density Polyethylene. Despite the Korean Trade Commission’s total sales in 2010 being estimated at US$10 billion, the uniqueness of their product was cause for a limited growth potential (K. Lee, personal communication, April 3, 2010).

In 2007, Korea’s newly elected President Myung Bak Lee focused on the development of eco-friendly, or green, energy as a part of the national agenda. The new “Low-Carbon Green Growth” policy concentrated on expansion of green energy and reduction of carbon emission levels. With active government support for green energy and the firm’s confidence in the successful adaptation of new technology, the Korean Trade Commission made an attempt to utilise their own green approach in new areas of industry. However, the lack of enthusiastic business partners delayed their expansion of the new technology. In the 1970s, Korea had started to research the activation of methane bacteria in processing livestock waste by means of anaerobic fermentation. Simultaneous research was carried out on facilities emitting methane gas. In 1995, Korea imported 49 anaerobic fermentation facilities for livestock farms and 35 industrial plants that were similar to the regulation-compliant European Biogas Induced Mixing Arrangement method, a principal process for treating livestock wastewater. However, most of these facilities had not been worked continuously due to a lack of core technological capability.

The conditions for this technology changed in 2007 when Korea launched its policy on green energy. The new policy resulted in the direct importation of products from advanced countries and efforts to repair and upgrade older systems.

Biogas is the term used to refer to the mixture of gasses produced from the breakdown of organic matter through process anaerobic digestion or fermentation. It is typically composed of 50-80% methane, 20-50% carbon dioxide, and minute amounts of other gases, including hydrogen, carbon monoxide, and nitrogen (Y. Ha, personal communication, March 15, 2010).

Biogas can be used for cooking, lighting, heat and steam and electrical generation, chemical production, etc. The purity level of biogas can be set to a certain level through compression or liquefaction of the gas. Such processes can also be used as delivery methods e.g. Compressed Natural Gas or Liquefied Natural Gas, which are green alternatives for vehicle fuel.

By 2008, the livestock waste produced in Korea is estimated at 47 million tons (Ministry of Agriculture, Food and Rural Affairs, 2010). The waste is discharged at sea. This includes areas that are only 60 to 200 km away from some of Korea's major cities. When no processing of the waste is done, the discharge is "raw". In most Western countries some degree of processing of livestock waste is generally required before discharge. If the waste were to be processed to form biogas, it is estimated that about 430 MW (megawatts) of electricity could be produced annually (Y. Ha, personal communication, March 15, 2010).

In addition, the reduction of methane gas would contribute to the Clean Development Mechanism business sector by increasing its expected income by about US$ 5.5 billion.(Rural Development Administration of Korea, 2010)

9.4.1. Recognise the Value

To support the government's policy and to obtain nationally needed advanced technology, KRITP was given a mission by their sponsor ministry, MKE, to find a firm or institution in Russia that could transfer more advanced technology. Before that time, Korea was still using old systems that processed using low temperatures, having high risk for creating viruses. For this reason, KRITP actively tried to find organisations within their networks and database system for the adaption of advanced green technology. KRITP sought a partner firm that possessed technology using a high-temperature system, resulting in better sterilizing action. After about a year of search, KRITP found the Russian State Agricultural University had an original technology with a high temperature system.

The University was founded in 1930 around a core of seven PhDs who worked alongside selected students and other experts in its green technology department (Russian State Agricultural University, personal communication, April 26, 2010). These researchers utilised a high-temperature processing system for livestock wastewater that contained 100-ton scale facilities. In 1993, the Physics-Sun Academy of Sciences in Uzbekistan developed a new technology for heat treatment based on research from the Russian university's core technology. In 2009, KRSTC judged that this newly advanced technology would have positive effects on Korea's economy, and would strongly support their green energy policy.

9.4.2. Acquire

KRSTC contracted with two foreign organisations in April, 2010 to acquire their already advanced technology and their abilities to assist Korea in creating new technology. KRSTC contacted Physics-Sun Academy for core target technology adaption, but regarded the Russian university as the technical advisor. KRSTC sent their experts to the Uzbekistan institute to learn the basic heating system of Dry Ceramic Technology. During this time, a group of Korean experts including research scientists in a public research institute learned from Uzbekistani experts that information on the high temperature processing of livestock wastewater had been shared with experts from KRSTC. KIST used this information to their advantage, after the delegation's return, to draft a technology cooperation agreement with the Uzbekistan researchers. KRSTC published an advertisement seeking a firm eager to join the project. At that time, the Korean Trade Commission was actively looking for future business partners to develop new technology, and decided to join the project. In turn, they invited five Uzbekistani scientists to travel to Korea to assist KRSTC in the design and development of a pilot system. (M. Seong, personal communication, April 1, 2010).

From the outset, the firms faced difficulties in technology transfer from Russia and Uzbekistan. Due to environmental and conditional differences, the Russian technology could not be applied to Korea's terrain. The firms made the decision to develop a more advanced system based on their existing domestic technology.

9.4.3. Transform

Since the Korean Trade Commission was not knowledgeable on green technology, KRSTC sought an additional research institute that could help in developing and transferring the needed new technology. The Korean Institute of Energy Research, a government research institute under MKE, responded to the KRSTC's request and joined the project. KRSTC, the Korean Institute of Energy Research, and the Korean Trade Commission jointly funded the project. KRSTC has some funds to assist firms when additional research is necessary to improve transferred technology. The Korean Institute of Energy Research has research funds for assisting small- and medium-sized firms. During this process, the Korean Trade Commission focused on absorbing the transferred technology, while the Korean Institute of Energy Research concentrated more on adapting Russian technology to the Korean environment. Uzbekistani scientists participated as main partners, and Russians as technical advisors. The four organisations combined their efforts to successfully transfer the technology

9.4.4. Exploitation

At first, the pilot system was able to process approximately 0.5 tons of livestock waste per day. Four months later, with the next step in place, the system was able to process 50 tons of livestock waste per day (Y. Ha, personal communication, March 15, 2010). During this time, Korean researchers visited Russia and Uzbekistan for detailed technological information on biogas production and wastewater processing to be transferred to scientists in Korea.

With the new technology in hand, the Korean Trade Commission succeeded in processing livestock waste. This was an important contribution toward fulfilling the London Convention and Kyoto Protocol agreements, and provided a solution to serious economic and environmental problems. The higher temperature system could compost materials and treat livestock waste three to four times more quickly than the old system.

As the market continued to have positive reactions to the new technology, continued financial investments were made (K. Kim, personal communication, April 3, 2010).

9.4.5. Summary and Discussion

As mentioned above, the role of the government intermediary had a decisive effect on this project. The new "Green Energy" policy encouraged domestic firms to start new businesses. It led to the transfer of advanced foreign technology and the exploitation of Korea's own technology. The main governmental roles were in supporting green technology industries with policies and funds, in appointing KRITP to assist and organise the technology transfer project, and in troubleshooting the international agreement between countries.

This case serves as an example showing how technology collaboration must be targeted, depending on the nature of the technology. Despite their initial lack of skills, Korea's industrial collaboration in the transformation to green technology now allows for self-reliant energy production. With hard work and a passionate interest in green energy, the Korean government was able to provide abundant funding for this project and to adopt supportive policies.

9.5. LASER SURFACE CLEANING TECHNOLOGY

Seepel, founded in 2000, had mainly been engaged in the manufacture of electronic materials and components related to thermo-electric energy conversion technology. Its measurement systems and remote control systems had used radio data communication technology since their establishment. Seepel is the "typical" small-to medium-sized firm. In 2010, they averaged US$ 15 billion per year in total sales. Seepel decided to expand their focus on laser technology linked to existing technology for environmental and economic benefits through business partnerships with Samsung and Hyundai (M. Jung, personal communication, May 6, 2012).

However, much of the laser industry, and in particular high-power lasers, has not yet been developed in Korea. There are several reasons for the delayed Korean absorption of laser technology, including that it had been classified as a defence technology. The development of laser technology had been actively researched by Korea’s military, but never for commercialisation. Within the relationship established between the United States and Korea, military-use laser products were imported from the United States. While Korea continued to import laser products, the basis for a domestic laser market could not develop.

The industrial application of laser technology, such as industrial surface cleaning, developed beyond simple cutting and welding. Laser technology provided for more cost effective and environmentally responsive solutions in comparison to conventional cleaning technology. Research on flexible and reliable laser systems for cleaning operations began in the late 1980s, but the results (modified welding and cutting lasers) did not meet the requirements for surface preparation. After years of research and experimentation, laser systems have only now been adapted by various industries for a range of surface preparation tasks, from automated mould cleaning to oxide removal.

The manufacturing of semiconductor devices is one of the most important areas in which efficient and environmentally responsive surface-cleaning technology is needed. It is extremely important to reduce particle, metallic, organic, and inorganic contamination in the semiconductor manufacturing process, since these are the principal source of device defects. The cleaning methods used in the semiconductor industry demand costly chemicals that burden the environment with pollution. Since many of the chemicals used are solvents (which disperse very efficiently), they can have a major impact on groundwater quality. An example of a conventional cleaning method adopted in semiconductor manufacturing lines is a “wafer cleaning method” that uses large scale multi-tank immersion units. Twenty-five to fifty wafers are immersed into two mixtures: one consists of ammonium hydroxide, hydrogen peroxide and water, and the other consists of hydrochloric acid, hydrogen peroxide and water. These are then heated in dilute hydrofluoric acid to remove particles, metallic contamination, and organic contamination from the wafer surface. Since this process uses an abundance of chemicals and pure water, there is a strong need for more environmentally responsible technology (such as laser surface cleaning), for the removal of contaminants during the manufacturing of semiconductors. By 2011, the market share of Korean semiconductors in the *global semiconductor market* reached about 70% (D. Park, personal communication, May 3, 2012). For this reason, Korea now needs to develop micro-cleaning technology for the reduction of pollution from semiconductor manufacturing lines.

9.5.1. Recognise the Value

To initiate the development of laser technology, Seepel organised its own advisory committee to develop a future business plan. Upon consideration, the committee concluded that Seepel needed to collaborate with Russian firms, due to its limited technological capability. Seepel found that firms with a laser technological capability in Russia would be the best partners to aid their situation since Russia possessed advanced laser technology. In addition, the related technology fee was cheaper in Russia than in the United States. Russia had also developed their laser technology in the defence industry. It was, however, hard to find the right Russian firm. Seepel decided to seek help from KRSTP.

Since Seepel requested help in locating a Russian laser firm, KRSTC assisted in the task. Their first role was in finding a firm that could work with Seepel's technology. Among the firms considered, Volo Ltd., established by Russian scientists in close relation with the Russian Science Academy, had an interest in Seepel. KRSTC played a pivotal role in setting up the technology transfer process. They connected Seepel to Volo, serving as a moderator and a supporter.

9.5.2 Acquire

To create a close relationship between Seepel and Volo, KRSTC provided the firms with each other's approved key technical information and with the appropriate level of technology. Furthermore, KRSTC acted as a liaison in dealing with the firms' administrative and cultural differences. Both firms approved their collaboration in transferring laser technology. Professors at Korea Polytechnic University also joined the partnership.

Before their collaboration, Volo had not recognised the necessity for cooperation with Seepel. After much debate, Volo visited Korea at Seepel's request. Despite having superior laser technology, the operating profit of Volo had not been sufficient. Upon visiting, Volo recognised that the firm in Korea had a superior ability to commercialise and expand the business. Seepel's persuasiveness, expressed in "Commercialisation and

Synergy Effect" changed Volo's attitude (K. Hwang, personal communication, September 16, 2011).

With the assistance of KRSTC, Seepel and Volo agreed to create the Seepel-Volo Joint Venture. Through the Joint Venture, Seepel would have a stable, long-term contract with opportunity to import technology packages from Volo. They also built a consortium consisting of ten domestic firms (including Hyundai Motor) to ensure financial support. Beginning with the Seepel-Volo Joint Venture, the business relationship between Russia and Korea has grown increasingly stronger.

9.5.3 Exploit

Seepel is currently working on three main laser projects in the medical and industrial fields. They could be commercialised within the next one to two years (M. Park, personal communication, September 25, 2012). As seen in previous cases, a positive global response to their projects results in ongoing financial investment.

9.5.4 Summary and Discussion

As mentioned above, the role of the Korean government and KRITP has had a decisive effect in cementing collaboration between two countries and their firms. The government of Korea built the basic infrastructure for the laser industry where the firms began. To have active communication at the diplomatic level, they founded KRITP. KRITP's main roles were in connecting Korean and Russian business concurrently, resulting in saved time and costs. They also led the negotiation process between the two countries, taking care of legal and administrative issues, which eased the establishment of incorporation. They arranged capital, taxation, and investment support for the promotion of domestic firms in starting new business.

This case is different from other Korean-Russian Technology Transfer models in several ways. Both firms focused on the process of technology transfer, not on the technology itself, which would require continuous skill development. Despite use of an unrefined method, Seepel-Volo mutually achieved their goals by balancing out each other's weaknesses. Each organisation put forward their best efforts, resulting in great success.

9.6. CROSS CUTTING DISCUSSION

The case studies presented above reveal important aspects of the SCTA function in the process of technology transfer. Korean firms could utilise Russian technology to enhance their technological capability, and to develop new products and processes. Firms' absorptive capacity is enhanced by the combination of their own technological capability and by the intermediaries' managerial and technological support.

The intermediary's role is identified and understood through the project-level case studies within the sequence of the SCTA. Among the types of assistance provided by intermediaries, four can be highlighted. The intermediaries provided technology vision to the firms during the process of technology transfer. The intermediaries enhanced absorptive and transformative capacity to overcome bottlenecks. The intermediaries built increased trust between Russian technology sources and Korean firms, so that the projects could continue. Finally, the intermediaries reduced the transaction costs involved in the technology transfer process. These four aspects of the intermediary role may explain some of the mechanisms through which Korea's systemic absorptive capacity was raised, so that Korean firms might be able to overcome the locality and tacitness barriers.

9.6.1 Recognise the Value - Technology Vision

In the case of LG Electronics' Whisen Air Conditioner, KIST found the information about the plasma technology and believed that it might be applied to coating. KIST contacted the technology source in Russia through KRSTC and also introduced the prototype at a MOST-sponsored technology fair in Seoul, where the LG Electronics' technology team discovered the plasma coating technology. Then LG Electronics started making efforts to industrialise the technology by contacting KIST. LG Electronics' absorptive capacity became operative only after KIST provided leadership in the transfer of the plasma technology.

9.6.2 Assimilate or Transformation - Bottleneck Breaking

Absorptive capacity can be viewed as a process consisting of recognising value, acquiring, transforming, and exploiting foreign technology. Though LG Electronics recognised the potential for industrial application of Russian plasma technology, it was very hard for them to proceed to the transforming stage of the process.

LG Electronics signed a licensing contract with KIST and the Russian scientists joined the LG Electronics research centre to help the firm gain a deeper understanding of the technology. But it turned out that LG Electronics lacked sufficient technological capability to absorb Russian scientists' advice, because most of LG Electronics' scientists had electronic or mechanical engineering backgrounds. The absorption process was blocked due to a lack of capability. This hurdle could be overcame by

KIST's technological capability, because many of KIST's scientists had physics backgrounds and the institution had patents for the core technology of plasma coating technology. In this way, the systemic absorptive capacity could streamline the absorptive capacity by removing a bottleneck in the process of technology transfer.

9.6.3 Acquire - Trust Bridging

In the case of Advanced Digital Technology, the Russian counterpart, the Budker Institute, showed little interest because the firm was just a medium-sized firm in Korea. Budker was established in 1959 and is a major research institution in Nuclear Physics. The Institute could not trust Advanced Digital Technology as a partner that could commercialise its technology in the areas of funding and of technological capability. KRITC, a Korean government agency, and Yonsei University provided the missing capacities for a successful partnership in this technology transfer. Though Advanced Digital Technology had the necessary capability for the commercialisation of laser technology, it could not utilise the Russian technology because it did not inspire the necessary confidence for technological cooperation. Without confidence, technological capability and commercialisation of foreign technology was not possible. For small- and medium-sized firms, this problem might always undermine ITT process. Trust is a necessary part of absorptive capacity and the intermediary role will be especially important in nurturing growth of technology.

9.6.4 Overall Process - Reduction of Transaction Cost

In the case of Biogas Production and Processing from Livestock Waste, KRSTP tried to find organisations that could provide advanced green technology. It contacted candidates and sent experts to Russian institutions. Russian scientists visited Korea, invited by KRSTP. Then, KRSTP published information about the technology absorption project. If the Korean Trade Commission and other Korean organisations had not invested in this kind of search process, the transaction costs would have been tremendous. But the intermediary performed these costly activities for all the organisations that had an interest in technology transfer from foreign technology sources with advanced green technology, reducing the transaction cost involved in the transfer process. Systemic absorptive capacity reduced Korea's social cost for the utilization of foreign technology through the role of intermediaries.

CHAPTER 10. FINDINGS AND DISCUSSIONS

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10.1. SUMMARY OF RESEARCH FRAMEWORK

In an era of open innovation and globalisation, exploiting external knowledge and cooperating with complementary partners should never be limited to domestic boundaries or to familiar regions with traditional counterparts. This argument is not only important for latecomer firms, but also front-runner firms in advanced countries in sustaining their technological competitiveness. In the context of global competition, my work focuses on how to exploit external knowledge from foreign partners, overcoming the gaps that could make technological adaptation difficult.

This thesis aims to explain how some Korean firms have successfully exploited Russian technology, overcoming the wide gaps between the two countries, something that is thought to be very difficult to do. Despite Korean firms' past successful experience, legacy, and capability in exploiting foreign technology, adapting technology from Russia is considered a more difficult task, because of the different contexts and the nature of the divides between the two countries. Those technologies Korea had been successfully exploiting earlier in its industrial development phase were relatively more packaged and more mature, acquired from the triad countries that have many commonalities with Korea. Moreover, Russia is a country with fifty years of a hostile relationship with Korea, and its research capability is largely scientifically oriented and developed for military purposes.

In the more than two decades since the Russian scientific community opened up to the Western world, many entities, both countries and firms, have tried, with varying success, to import Russian technological knowledge and adapt it to commercial use. This military and mission-focused body of technological knowledge does not come ready-made to be exploited in the market-place, yet there are several advantages it offers to those who are able to make use of it. Korean firms quickly recognised and discovered that Russian technology could be successfully used to improve their products and services already on the market, by nurturing, transforming, and combining those Russian technologies with Korea's technological capability. Furthermore, it is often cheaper to import technology from Russia than from the West, and it comes with fewer legal entanglements, for example, intellectual property restrictions.

Not many Korean firms have tried to import Russian technologies, and of those only a small portion seems to have succeeded. It is important to know what makes the difference between success and failure in this effort. Firms that are successful in importing and adapting Russian technology might overcome gaps arising from the Russian context. If the reasons why some firms fail and others succeed in this effort can be identified, it may be possible to expand the scope of this technology transfer, thereby benefitting not only some of Korean society, but also other latecomer countries that lack fundamental knowledge of S&T or have complementary capability with Russia. Also, it will help to suggest to those countries with strong legacy of basic science a way to utilise their S&T knowledge that is more commercially useful.

Exploiting technology from Russia involves overcoming wide technological and socio-cultural differences. The nature of these differences is characterised in this study in terms of tacitness and locality gaps. As discussed earlier, tacitness represents the human-embedded nature of technological compatibility and proximity based on a country's innovation system, and locality represents country-specific features of Russia: socio-cultural and geographical proximity including language, business practice, and information access issues. This method of characterisation helps to systematise an examination of the nature of gaps and the ability to overcome them.

The conceptual framework named the SCTA has been developed to explain how the Korean- Russian divide is bridged regardless of gaps. It rests on the hypotheses that (1) the success of technology transfer is a function of tacitness and locality, with large gaps in these constituting hindrances to successful technology transfer; (2) higher levels of collective prior knowledge and experience support more effective bridging of tacitness and locality gaps during the ITT process; (3) the bigger the gaps, the more important the role of intermediaries; and (4) from the perspective of absorptive capacity consisting of the stages of Recognition, Acquisition, Assimilation & Transformation, and Exploitation, each stage requires different types of support from intermediaries in bridging the gaps in the process of internal technology transfer. The SCTA also covers the sequential process of technology transfer projects, the gaps existing in this process, the firms' capabilities and the role of the intermediary in leveraging these capabilities. Based on my investigation, the Korean public sector (programmes or agencies) commonly plays an intermediary role, by implementing supportive public policies. I define such a public involvement as a key component in the SCTA. Because exploiting Russian technology is relatively market driven and it is linked with governmental agreement, the role of private consulting firms is smaller than that of public ones.

The SCTA suggests that the extra capacity generated by the interaction process between private sector firms and the public sector intermediary enhances a local firm's abilities to overcome barriers and difficulties in absorbing external knowledge from a source where tacitness and locality gaps are large. And to be specific, this process, guided by public policies, includes the systematic linkage and dynamic interplay between public and private sectors during the process of technology acquisition and absorption. This study has been achieved through a survey and case studies. Interviews were implemented with experts from government, academia, and private firms in order to understand the background to the Korean Russia technology transfer and to supplement some parts of the survey and case studies.

10.2. MAJOR FINDINGS

10.2.1. Nature of the Gaps

In a very short period of time, Korea has had outstanding success in catching up with technologically front-running countries. This suggests that Korea has been particularly good both at learning new technology and in absorbing and adapting technologies that were originally invented elsewhere. What is notable about the Korean process of acquiring and utilising Russian technology is that it has not involved technologies that have been "market tested". These technologies from Russian were not originally developed with the aim of optimising price and performance relative to competitive market conditions, nor have they been integrated into a large scale production and distribution system aiming to address global markets.

The context of Russian technology development means that there are likely to be greater uncertainties and a greater need for adaptation than for technology acquired from other contexts where market processes dominate. At the same time, because the context of their development has been less constrained by the need to satisfy market demands, these technologies may have features or characteristics that have not been adequately explored or developed. In other words, if other factors such as technological originality are given priority in the development, the resulting technology may be quite “inventive”. This inventiveness or novelty might be a basis for differentiated or superior development of technology. The ability of firms to filter novelty (winnowing out novelties that are commercially unpromising) is a different challenge than that of adapting technologies which have already demonstrated commercial potential.

According to the empirical literature, there are also practical difficulties in the Korean-Russian technology transfer process. First, the language barrier presents problems in the process of technology transfer projects. Russian scientists normally do not speak English, so the communication gap negatively affects the process of building mutual trust between collaborative partners. Second, the Russian S&T community is a relatively closed society in comparison to the corresponding communities in Western capitalistic societies. Even though the Korean government has made several bilateral agreements with its Russian counterparts, collecting information about the Russian S&T community is still a difficult task. As a result, the progress of technology transfer projects depends not only on managerial and technological skill, but also on luck or political connections, resulting in relatively longer periods required to develop the projects. Third, Korean partners perceive an unsatisfactory legal framework, political instability, and a unique technology culture as major perceived difficulties in cooperating with Russian partners. Russian scientific and industrial leaders still tend to view Korean firms with some suspicion. They fear having their valuable intellectual property stolen. Fourth, Russian technology is mostly embedded in Russian scientists' understanding and memories and is less codified, so opportunities for cooperation are naturally limited by the number and extent of personal contacts in which the Russian scientists are able to engage.

10.2.2. Korean Firms' Motivation to Meet the Challenges

From a broader perspective, since the early 1990s, some of the largest Korean firms began to compete on the basis of their own leading-edge products and systems (Hobday et al., 2004). Korea was forced to seek new sources of innovation knowledge, complementing its traditional sources from the triad countries. Even though Russia and Korea are two sharply contrasting countries, they fortunately share some complementary strengths and resources. This seems to have motivated Korean firms to adopt Russian technology as a supplemental or alternative source of external knowledge. Russia has a high level of advanced scientific knowledge, but little of it is commercially linked (Dyker, 2001; Michailova, 2011). Korea has extensive capabilities in advanced industrial applications, but possesses a weak scientific knowledge base.

Korean firms basically understood that the nature of Russian technology was largely based upon basic scientific research that was military or mission-oriented. As such, Korean firms did not expect mature or packaged technology that could immediately lead to commercialisation and marketable products. Thus, what then motivated them to attempt to adopt Russian technology? Evidence from the survey analysis provides some answers to this question. Korean firms are motivated by the relatively lower cost of importing some of Russia's unique, complementary, excellent technology, along with flexible and simple technology transfer procedures, including intellectual property concerns. The motivation of Korean firms is strong enough to counteract their concern over the gaps.

In addition, according to the survey analysis, a large portion of Korean firms utilised Russian technology as problem-solving tools on their existing processes or products product rather than creating new processes or products. This shows that the nature of Russian technology is that it has not involved technologies that have been "market tested". Russian technology becomes more useful, from a consumer point of view, when it is combined with technologies already developed in Korea. Korean firms are motivated by the advantages of using Russian technologies to improve their already existing technologies or to solve technological problems.

10.2.3. Korean Strengths in Overcoming the Gaps

Throughout the study, we have sought to find the key capability that enables Korean firms to utilise Russian technology. In the process of transferring Russian technology, Korean firms' behaviours and strategies are heavily influenced by their past patterns and experience in the Korean NIS. Russian technology that was transferred to Korea reflects the characteristics of Russia's former Communist system. The Korean use of Russian technology followed a different pattern and process than those which usually occur in technology transfers between developing and developed countries. Technology transfer normally depends upon numerous complex processes, upon having favourable conditions, and upon the recipient's capability. Korean firms have a demonstrated capability to absorb Russian technology, which seems largely determined by a history of depending on the "catching-up" mode to grow in technological and industrial capacity.

Within this legacy, Korean firms have a particularly strong organisational culture and a capability for grasping ideas from outside. They are not accustomed to creating something from nothing, even though some of the large Korean conglomerates lead the global market in some industries. As discussed in Chapter 4, the Korean innovation pattern has had a path-following or catching up style. Korean firms excel at linking external knowledge to their internal needs, focusing on upgrading this knowledge to achieve competitive products. They have accumulated a strong capacity not only to identify value from the outside, but also to link externally acquired technology to their needs for improving own technologies.

For Linsu Kim and Richard Nelson (2000), creative imitation is the second stage of industrial learning, and it is defined as the production of imitative products with new performance features. The first stage of industrial learning, duplicative imitation, sustains the competitiveness of a country fundamentally on the imitator's low wage cost. On the other hand, creative imitation is meant to give the imitator a tangible advantage based on strictly technological enhancements and not only cheap labour. This is why, in a sense, creative imitation can have similar characteristics with the third and final stage of industrial learning, innovation, and its meant to challenge (and not only catch-up) advanced industrial countries. This is so because, as Kim and Nelson point out, most innovations do not take the form of breakthrough inventions, but instead are deeply rooted in existing ones.

Before 1990, Korean firms focused on simply adapting external knowledge. In recent years, they have accumulated their own capability and knowledge stock, and now focus on complementing their internal weaknesses. For example, it was Korean firms that found useful high power laser technology in Russia, since Russia had world-class laser technology capability, developed mainly for military applications. Korean firms lacked fundamental knowledge of this technology, but have utilised it in many business areas by adding more research and combining it with existing knowledge of other technologies. Russian laser technology is used by Korean firms to carve sculptures, to medically remove discolorations from the human face, in fibre optics, in surgery, etc. When Russian scientists saw how their fundamental knowledge of lasers was modified and applied for value-added business purposes, they said they never had imagined that their technology could be used and applied in such a way.

I found from the Korean experience with Russian technology exploitation that key tasks in Russian technology acquisition are: to find appropriate technology and partners, and then to successfully integrate and transform those technologies so that they are integrated as well as native technology. The primary focus in external technology acquisition is not in finding and acquiring the technology, but in successfully nurturing and exploiting it after it has been acquired. The bridging and integrating role of public R&D institutes is more effective when firms have strong internal problem-solving capabilities, which must be present in order to properly "fine-tune" the transferred technology. The ability to absorb external knowledge effectively depends to a great extent on the ability to properly evaluate the new external knowledge.

Because of these past successes, the technology transfer pattern of Korean firms has changed. Now they know how to start by clarifying the problem, identifying possible technology to apply, and always maintain their hunger for solving problems. These are the critical success factors in the Korean-Russian technology transfer. First, Korean firms with a clear market focus have the ability to identify appropriate technology from Russia. This is not about the technology in general, but about the specific technology which can provide solutions to their needs. Second, Korean firms have the capacity to find and utilise Russian scientific knowledge that is applicable to their specific problems. This capacity is largely based on Korean path dependency – following the path of adopting and exploiting externally acquired technology -- because Korean firms might lack the necessary foundations to create entirely new scientific knowledge. However, they are optimised to modify, transform, and nurture knowledge which will be useful in providing solutions to already identified problems. Korean firms are characterised as "fast followers". Once they have sufficient experience in building technical capacity through reverse engineering, they then concentrate on improving the transferred technology. This capability is called creative imitation. This works quite effectively for adapting Russian technology, and also reduces unneeded functionality.

10.2.4. Intermediary Role

Direct foreign investment, joint ventures, licensing agreements, original equipment manufacturer and similar arrangements have been instrumental to the industrial successes of developing countries. However, lacking local capability to absorb and assimilate foreign technology, most of the developing countries could not duplicate the process of building technological capability internally, and only some of them benefited from foreign supplies of technology. This local capability, often described as "absorptive capacity", is the ability to exploit and utilise external knowledge (Cohen and Levinthal, 1990). Many previous discussions of the technology transfer process have emphasised that creation of a local "absorptive capacity" is essential to an economy's exploitation of technology transferred from abroad. The stage of development of an economy affects the role of its NIS and of its innovation policy in technology transfer and absorption (Mowery and Oxley, 1995). Absorptive capacity alone is not sufficient to smoothly adapt technology developed in different common contexts. This is reason I have extended the absorptive capacity framework to recognise the systemic elements and intermediary functions that area employed the SCTA.

Based on the survey results, it is interesting to observe that out of the 93 Korean firms with Russian technology transfer experience, 75 firms were supported by intermediaries in their technology transfer process. According to interviews with managers (both from CTTP and KRITP), the primary reason for firms to seek intermediary assistance is that they have a lack of basic information of how to start, who to contact, where to visit. Access to the Russian S&T community is an urgent issue. Within the two countries' governmental agreements, the public sector has more information and a better position to approach the Russian S&T community. Public agency programmes are designed to provide such information and assistance in a more systemic way.

Traditionally, the role of the government in ITT is to provide a proper institutional and infrastructural environment. The significance of the role of government policy and the public sector is more visible when Korean firms are dealing with ITT from Russia than from developed countries. The private sector relies more heavily on the public sector when Korean firms are dealing with ITT from Russia than developed countries. They rely on government agencies and public agency programmes in seeking out the right partners and technology in Russia. These public agency programmes, including the MOST and the MKE, were designed to provide technical assistance to help bridge the gaps between Russian scientists and Korean firms, by means of Korean government agencies. And it is important to note that these programmes were initiated because of the long period of separation between the two countries, which meant that Korean firms had no prior information or channels of exchange with the Russian S&T community. Also, the private sector expects the public sector to play a role in helping to interpret and transform Russia's scientific knowledge into something that can be used for commercial applications. The active role of Korea's public research institutes in this is one of the factors responsible for Korea's success in catching up.

Russian technology is very effective when used in solving technological problems. Technological knowledge by itself is very hard to sell directly, because, in the case of Russia, it has often been developed without any consideration for markets. However, the uniqueness of Russian technology provides complementary or unexpected dimensions of knowledge, so that it helps to solve problems that could not have been answered with an ordinary approach. Intermediaries like public research institutes, having a broader spectrum of scientific knowledge, play a significant role in bridging the gaps between the science-based knowledge of the Russian scientific community and the market-based knowledge of Korean firms.

The intermediary's role is identified and understood through the project-level case studies with a focus on how it contributed to the success of ITT. First, intermediaries provided a technology vision to firms during the process of technology transfer. Second, intermediaries enhanced the absorptive and transformative capacity to overcome bottlenecks. Third, intermediaries built increased trust between Russian technology sources and Korean firms to continue the project. Finally, intermediaries reduced the transaction costs involved in the technology transfer process. In this respect, it is interesting to notice that, despite the survey research and the extensive interviews with key stakeholders, no instance of technology transfer from Korea to Russia was identified. Although this certainly does not provide conclusive evidence, it is indeed suggestive of the contribution of intermediaries in transfer processes with partners of contrasting backgrounds.

10.2.5. The Differences between Two Types of ITTs

Through my empirical investigation, several interesting results were found by comparing the technology transfer from Russia with that from the triad countries. In the early stages of industrialisation, Korea acquired mature foreign technologies from advanced countries, which in their packaged form included assembly processes and product specifications. The Korean firms mostly exploited S&T knowledge from Russia in the form of scientific knowledge or military-based technology. Understanding and mastering knowledge of the technology was very important when Korea adapted it from the triad countries. However, the more decisive issue in the case of succeeding in the Korean-Russian technology transfer was to understand how to access, nurture, and integrate those aspects with a firm's existing technology, in order to improve product quality or solve a technological problem.

In the Korean-Russian technology transfer, the external knowledge Korean firms wanted to exploit was mainly scientifically based. Small and medium sized enterprises naturally lacked a deep understanding of how exactly the firms could apply scientific knowledge to their innovation processes. Technology from developed countries could be transferred through channels such as patent licensing, turnkey plants, and technical assistance. However, Russian technology is mostly transferred through human channels because it is more scientifically based. Russian scientists were invited to work with Korean R&D teams when Korean firms launched technology transfer projects with Russian partners. Russian scientific knowledge has a greater tacitness in the sense that transferring the knowledge relies more on the human channel. As a result, a recipient's capability to absorb knowledge is most important.

Table 10-1: Comparison between advanced countries and Russia

Advanced countries	Russia
Large part of technologies are available for transfer	Small part of technologies are available for transfer
Systemised technology information	Fragmented technology information
Easy access to available technology	Difficult to search in a systematic way
Predictable cost of technology transfer	Unpredictable cost of technology transfer when contacting researchers directly
Technology often embedded in patents (explicit)	Technology generally embedded in human capital and organisations (tacit)
Horizontal cooperation between private sector firms	Vertical cooperation between the public and private sector

Source: Author

Korea has been quite actively implementing S&T cooperation with Russia since the early nineties, with a clear goal of obtaining Russia's state-of-the-art technology from both the military and private sectors. The two countries initiated S&T cooperation in 1990, when Korea and Russia signed their agreement on S&T cooperation. Even though the actual outcome from the cooperative agreement has not been comprehensively and systematically monitored or traced, nevertheless it is widely believed that the agreement has produced some meaningful outcomes, although not very many. There have been several public agency programmes developed to promote Korean-Russian ITT which have played a critical role in ITT successes. Such public agency programmes are developed and operated by central government agencies and local governments. Most of the public agency programmes focus on collecting and distributing Russian S&T information and data through document search and analysis, as well as by sending groups of experts abroad. A few programmes, such as CTTP and KRITP, involve more extensive procedures to support ITT initiatives.

10.3. DISCUSSION

10.3.1. Contribution

As mentioned in Chapter 1, the primary aim of this study is to identify and understand the underlying processes and mechanisms that make ITT successful under such difficult and differing circumstances. This challenge would create an opportunity to draw meaningful implications which would further aid in exploiting and extending S&T knowledge stock from countries with dissimilar innovation systems.

The concept of the SCTA can be useful as a conceptual framework to examine the technological transfers between dissimilar innovation systems such as Korea and Russia. The Korean government contributed by bridging tacitness and locality gaps through helping firms to identify appropriate partners and technology, and assisting firms to master, deepen, and transform Russia's unfamiliar knowledge for commercialisation. This concept is based on the following conceptual elements: (1) the absorptive capacity related to ITT; (2) the role of the NIS in assisting domestic firms in absorbing external knowledge; and (3) the tacit and localised character of technology and technology transfer process.

The SCTA enhances a clear understanding of the ideas of absorptive capacity drawn from the NIS approach, while addressing institutional and public policies. It complements and reinforces the firm-level absorptive capacity concept and emphasises the role of intermediaries which may also play a complementary role to firm-level absorptive capacity. As a result, the SCTA is defined as a mechanism and process of public involvement combined with the absorptive capacity of firms in order to enhance local firms' abilities to absorb external knowledge. It is guided by public policy on the process of technology acquisition and absorption.

In this study, I explained that the SCTA can be distinguished from firm-level and national-level absorptive capacity. It is "meso-level" absorptive capacity, where direct public involvement can create absorptive capacity that encourages and enables firms in adapting unfamiliar foreign technology. From an open innovation perspective, the supply of external knowledge is largely determined by a well-equipped and functioning NIS. Even for firms trying to adopt external knowledge from other countries, a well-functioning NIS plays an important role in providing various indirect policy measures, as has been noted in some latecomer countries. The Korean approach to Russian technologies that includes governmental assistance to domestic firms that are exploiting Russian technology can be considered to be a process of national-level open innovation. This concept of the SCTA and the Korean approach to Russian technology naturally leads to the concept of national absorptive capacity, which is the enhancement of a country's ability to absorb and adapt foreign technology through public policies, and investments in education and infrastructure. The level of national absorptive capacity is not an aggregate of firms' absorptive capacity, but rather a nation's systemic capacity. This is because a nation's social and institutional norms, standards, and framework in conjunction with public policies and strategies help firms to create and increase the capacity to absorb external knowledge. The development and enhancement of national absorptive capacity still relies greatly on public policies and involvement.

The SCTA is rooted in a latecomer firm's technological capability, combined with the intermediary role of government and the public sector. The thesis extends existing latecomer innovation research by exploring the effects of different partners, wide variances in the nature of technological knowledge, and differing channels of adaptation. The SCTA may provide a useful framework by which policy implications can be drawn for other latecomers, who are coping with adapting technology from new partner countries who are not their traditional counterparts.

10.3.2. Boundaries and Limitations of the Study

Regardless of my extensive work, there needs to be further study on this issue. One of the important goals of my study was to uncover the factors and mechanisms that allow Korean firms to acquire and adapt Russian technology successfully, regardless of the gaps that would impede success. However, it is extremely difficult to define success exactly. Public agency programme managers, government officials, research scientists, and company executives all have different definitions and concepts of success and perceptions of to what degree it has been attained. There are many cases where it is much harder to judge whether or not there has been success than in projects such as LG Whisen air-conditioner. In some cases, Russian technology itself was transferred and mastered perfectly by Korean firms, but failed to be commercialised. In other cases, Russian technology was commercialised, but products with Russian technology content failed to attract consumers or to win the market competition. In still other cases, it is hard to measure how much transferred Russian technology contributed to market success of the products. Some products might have succeeded anyway, without any Russian technologies. According to my interview results, it is even the case that personnel within a single firm may have differing opinions from division to division. Marketing, production, and distribution capabilities of firms vary greatly, further adding to the difficulty of comparison. In this thesis, a technology transfer project is regarded as a success if the firms had a high level of satisfaction with the results of the technology transfer. In the survey, the degree of satisfaction was used as a proxy variable for success in ITT.

Complementarities between Korean and Russian technologies were among the motives of S&T cooperation between the two countries. And the cooperation from the Russian side was important in overcoming the barriers of tacitness and locality, whether it was provided to Korean firms or intermediaries. Russian S&T organisations involved in this process are expected to have improved technological capacity through this process. Therefore, one of the limitations on this study concerns the effects of ITT on national absorptive capacity on the Russian side, which needs to be studied in the future. It is necessary to study how the interaction with Korean firms with a strong explicit and horizontal collaboration in the private sector scheme has altered the Russian technology and innovation system. In addition, a more extensive study of projects with partial success or that fail despite exhibiting some of the features of successful projects would provide a complete and robust picture of the nature of the technology process and the role of intermediaries in facilitating technology transfer.

Finally, in such a study, an international comparison is necessary to determine how crucial Korean government policies and public programs are necessary for Korean firms to adapt Russian technologies. With limited time and resources, I confined my analysis to only Korean firms. Industry or technology-level comparison would also be a useful addition to this work if a sufficiently large sample can be obtained.

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Appendix 1. Survey Questionnaire

1. Name of your company?

2. Field of industry that your company belongs to? (SIC 2 digit classifications) (Industry)

3. How many employees does your company have in total? (Size_emp)

4. Your company's total sales? (KRW, using the year of Korea-Russian cooperation as the base year) (Size_sales)

5. How many among your company's total number of human resources are engaged in research development (R&D)?

6. What is your company's research and development expense? (KRW, using the year of Korea-Russian cooperation as the base year)

7. Does your company have an attached research institute or an exclusive department for R&D? (yes / no)

8. When does your company established?

II. Purpose of and Reasons for Cooperation with Russia

9. What is your company's purpose of adapting Russian technology? (Multiple choice) (Obj_Coop)

- Introducing "the new" to the world of products
- Exploring the possibility of integrating it with already "developed products" to produce niche products or services
- Improving specifications and cost effectiveness for already "developed products".
- Solving current technological problems

10. What are the motivations for adapting Russia technology?

Rank the following reasons in order of importance. (1: most important – 7: least important)

(1) Relatively cheaper to import (   ) (Motive_cost)

(2) Cutting edge R&D capability in certain fields (   ) (Motive_excel)

(3) Russia’s unique strength against western technology ( ) (Motive_originality)

(4) Easier to avoid IP disputes ( ) (Motive_Ipstr)

(5) Shorter time to adapt necessary technology ( ) (Motive_time)

(6) Capabilities and resources that are complementary to Korea’s ( ) (Motive_comple)

(7) Proactive attitude from Russian R&D community ( ) (Motive_active)

11. Does your company have experience of adopting technology from domestically? (yes / no)

12. Does your company have experience of adopting technology from overseas (besides Russia)? (yes / no)

13. Does your company have experience of adopting technology from Russia? (yes / no) (Exp_foreign)

14. How clearly were you aware of technological weakness and the way to improve? (7 point scale) (Aware_problem)

15. What is the level of your company's prior knowledge on the Russian technology? (7 point scale) (Aware_Rustech)

16. How clearly were you aware of what technology can be outsourced? (7 point scale) (Needs_outsource)

17. What is your company’s success rate of development of all projects compared to its number of technology development projects? (%)

18. What is your company’s success rate of commercialisation of all projects compared to its number of technology development projects? (%)

19. It is difficult to collect S&T related information (7 point scale) (Gap_info)

20. It is difficult to connect with Russian institutes and researchers (7 point scale) (Gap_network)

21. It is difficult to implement ITT with Russia due to administrative matters such as residence, VISA, insurance etc.(7 point scale) (Gap_admin)

22. It is difficult to communicate with Russian partners (language barrier). (7 point scale) (Gap_lang)

23. It is difficult work with Russian partners because of cultural difference. (7 point scale) (Gap_culture)

24. It is difficult to share understanding of ITT and research collaboration (7 point scale) (Gap_transfer)

25. It is difficult to make contracting or negotiation. (7 point scale) (Gap_contract)

26. It is difficult to understand and evaluate Russian technology. (7 point scale) (Gap_eval)

27. It is difficult to modify and transform imported Russian technology. (7 point scale) (Gap_modify)

28. There is a big uncertainty of unexpected costs. (7 point scale) (Gap_cost)

29. There is a big uncertainty of duration for technology development. (7 point scale) (Gap_time)

30. Low level of reliability of Russian technology (7 point scale) (Gap_reliability)

31. Technology exists as human embodied know-how (7 point scale) (Gap_codification)

32. Did your company get external assistance in the process of Russian technology transfer? (Multiple choice) (dummy_int)

- No support
- Support from private entities
- Support from public entities

33. What support did your company get? (Overlapping multiple choice)

- Information (Support_Info)
- Funds (Support_Fund)
- Technology (Support_Tech)
- Contract or Negotiation (Support_Cont)
- Administrative support such as exchange or transfer of human resources (Support_Admin)

34. What is the type of intermediary that your company is supported? (Overlapping multiple choice) (Type_int)

- Central government agency
- Local government agency
- Public R&D institution
- University
- Private consulting firm

35. At what stage did your company receive the support? (Overlapping multiple choice)

- Recognising the value (Proc_recog)

- Acquisition (Proc_acq)
- Assimilating or transforming (Proc_assim_trans)
- Exploiting (Proc_exploit)

36. How satisfied are you with support from intermediary? (7 point scale) (Per_support)

37. How satisfied are you with the results of Russian technology transfer? (7 point scale) (Per_Rus)

VII. Questions on the Russian Technology and Institute

38. What is the technology that your company transferred?
(Name of technology)

39. What is the nature of technology that your company transferred? (Multiple choice)

- Basic Science
- Applied technology
- Development (Production) Technology

40. What is the type of the Russian organisation your company cooperated with? (Multiple choice)

- Private enterprise
- Government research institute
- College
- Other

Appendix 2. List of Interviewees

1. Interview for Empirical Background and Case Studies

Number	Organisation	Position	Name	Date
1	ADT	Director	Younghee Choi	1st February 2011
2	ADT	Executive Manager	Minju Lee	10th February 2011
3	ADT	Junior Researcher	Hyungwook Song	4th March 2011
4	Korean Institute of Energy Research	Senior Researcher	Yeonho Choi	3rd May 2006
5	Korean Institute of Energy Research	General Manager	Soyoung Kim	10th May 2006
6	Korean Institute of Energy Research	Junior Researcher	Sungyong Kim	13th May 2006
7	KIET	Senior Researcher	Woori Kim	24th July 2006
8	KIET	Junior Researcher	Jangbum Park	26th July 2006
9	KIET	Junior Researcher	Hansol Lee	1st August 2006
10	KISTEP	Senior Researcher	Minki Kim	26th January 2007
11	KISTEP	Senior Researcher	Hongmin Lee	28th January 2007
12	KISTEP	Associate Researcher	Sunjin Lee	2nd February2007
13	KIST (CTTP)	Program Manager	Yonghwan Kim	6th October 2008
14	KIST (CTTP)	Principal Researcher	Dobin Hyun	7th October2008
15	KISTI	Senior Researcher	Hojin Kim	19th April 2009
16	KISTI	Senior Researcher	Junghee Yoon	20th April 2009
17	KISTI	Junior Researcher	Yoonjung Bae	28th April2009
18	Korea Univ.	Professor	Youngrak Choi	9th August 2009
19	KORUSTEC	Director General	Sanghyun Lim	14th September 2009
20	Korea Polytechnic University (KRITP)	Executive CTO	Junghee Kwon	17th November 2010
21	Korea Polytechnic University (KRITP)	Senior Administrator	Changyong Bang	18th November 2010

22	Korea Polytechnic University (KRITP)	Leader in Operation	Dongjin Oh	19th November 2010
23	Korea Ship Safety Technology Authority	Division Director	Kwangmin Lee	6th May 2011
24	Korea Ship Safety Technology Authority	General Manager	Yejin Kim	24th May 2011
25	Korea Ship Safety Technology Authority	Manager	Hanna Lee	2nd June 2011
26	Korean Trade Commission	Technical Director	Youngjoon Ha	15th March 2010
27	Korean Trade Commission	General Manager	Minha Lee	18th March 2010
28	Korean Trade Commission	Manager	Dongil Seong	1st April 2010
29	Korean Trade Commission	Manager	Kangmin Kim	3rd April 2010
30	LG Electronics	Technical Director	Jinwook Suh	18th June 2007
31	LG Electronics	General Manager	Junghyun Min	1st July 2007
32	LG Electronics	Manager	Taekwoon Jung	15th July 2007
33	MKE	Deputy Director General	Hongchul Park	17th November 2011
34	MKE	General Manager	Kinam Jeong	18th November 2011
35	MOST	General Manager	Dongju Lim	1st December 2011
36	MOST	Manager	Sanghee Jang	3rd December 2011
37	NSTC	General Manager	Minkwan Kim	7th December 2011
38	NSTC	Manager	Minho Lee	8th December 2011
39	Seepel	Executive Director	Dongyoung Park	3rd May 2012
40	Seepel	Technical Director	Minhye Jung	6th May 2012
41	STEPI	Senior Researcher	Jiyoon Park	7th July 2012
42	STEPI	Junior Researcher	Donghoon Seo	8th July 2012
43	STEPI	Junior Researcher	Inhwan Min	10th August 2012
44	Volo	Assistant Manager	Kyungsin Hwang	16th September 2011
45	Volo	Assistant Manager	Minhyung Park	25th September 2011
46	KIST	Visited Scientists	Anton Brodovich	4th September 2012
47	ETRI	Visited Scientists	Alexi Kogan	16th September 2012

48	KIMM	Visited Scientists	Ivan Barilov	24th October 2012
49	University of Sussex	Professor	Dyker, D.A	3rd August 2007
50	Former Samsung Electronics	Managing Director	Sunkyu Hwang	15th April 2010
51	RSAU	Administer staff	Unidentified	26th April 2010

* Interviewed by Author

2. Interview for Survey (Focused Group Interview)

Number	Organisation	Position	Name	Date
1	LG Electronics	Director	Jeewon Jung	26th June 2012
2	Goldstar Central Institution	Former researcher	Wonkyu Park	26th June 2012
3	OCI	Managing director	Kihong Kim	26th June 2012
4	Millinet Solar	General manager	Dongwoo Shin	26th June 2012
5	Lucky Materials and Siltron	Former researcher	Jean Cho	26th June 2012
6	MKE	Former assistant director	Jaehong Lee	26th June 2012
7	MOST	Assistant director	Ilyoung Oh	26th June 2012
8	Korea Univ.	Professor	Sanosoon Bae	26th June 2012
9	Yonsei Univ.	Professor	Dongsup Kim	26th June 2012

* Interviewed by Author