Externalities in North-South technology transfer: the case of CNG engines in Iran

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Externalities in North-South technology transfer: the case of CNG engines in Iran

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Abstract: This contribution focuses on illuminating the challenges and difficulties of North-South technology transfer. The central message of this paper is that North-South technology transfer is not simply a contract between two transacting firms and does not depend only on intra-firm and inter-firm factors. The process may also be influenced by a number of external factors, beyond the control or power of project managers. However, understanding of these external factors greatly influences the success of firms' technological development. These externalities could arise from North-South contexts variances, international atmosphere and even by different levels of both sides' actors involved in the process. Using an in-depth case study analysis for collaboration between Iranian and German companies, this article develops a clearer understanding of external factors which affect the cross-border technology transfer process.

Keywords: external factors; North-South technology transfer; CNG; Iran.

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1 Introduction[1]

The new stage of globalisation associated with the changing relationship between finance, trade and production has entailed a changing context in North-South[2] technology transfer contracts (Radosevic, 1999). The interacting context is not only shaped by both sides' firms but by a wide range of external factors. On one hand, North companies are located in a well-established infrastructure, are advanced institutions and have a high-quality of manpower. In these circumstances, they are keen to shift to the global paradigms. On the other hand, South countries, despite the segmentation[3] (Freeman and Hagedoorn, 1994) may suffer much loss of advanced infrastructures, institutions, and perhaps well-trained manpower. These contrasts make the interacting context complex and challenging.

This study analyses the complexity of the interacting context in a North-South contract by focusing on the positive and negative externalities of the process. It studies the case of compressed natural gas (CNG) project between Iran-Khodro and its German partner. They collaborated to design and manufacture the first bi-fuel engine in the world 'optimised' for CNG operation as the primary fuel and petrol as the secondary fuel. The research is based on a case study method and, by going into great depth, enables the researcher to understand the dynamics present within single settings (Eisenhardt, 1989) and illuminate a particular situation (Yin, 2006). The author was the consultant of the project for three years enabling him to capture the important elements of the process as a participant observer. This opportunity gave the researcher access to documents and memos and interviews conducted with the Iranian project managers to obtain deep and rich data. All interviews were unstructured to allow the interviewee to give their observations and experiences about the external factors. The study shows how the interacting firms may stumble across unpredictable or uncontrollable externalities. It argues that international technology transfer projects do not occur in an isolated context, in which only two sides' firms are involved, but that the context is shaped by many political, cultural, social and macro economic factors. Technology transfer process frequently occurs in a complex and dynamic context and embeds an extensive range of influencing factors that are present simultaneously.

2 Theoretical framework

"Technology transfer is the process connecting two or more technological systems for the transfer of know-how, information, devices, etc." [Bugliarello, (1996), p.2]. Nowadays, the definition however has been contextualised within the concept of a knowledge-based economy. In the new perspective, technology transfer is perceived as a specific knowledge-transfer process between two or more economic agents in which the co-evolution of their absorptive capabilities and their knowledge-transmission strategies are the key elements of the process quality (Amesse and Cohendet, 2001). The firms of the developing countries typically look at the technology transfer from North countries as one of the mechanisms to stay abreast in rapid international competition and catch-up in specific fields of technologies. On the other hand, developed nations' companies look at technology transfer as a way to create and develop new markets in order to sell products and gain economic benefit. Meanwhile, a broad range of both sides' firms in terms of size, organisation and finance can be involved in the process. In some cases, even the governmental bodies are among the players and follow-up the issue due to political or economic reasons and hence the involved actors in the technology transfer process are at different levels.

There have been many studies in the literature about the types, methods and efficiency of cross-border technology transfer contracts. Autio and Laamanen (1995) classified and discussed technology transfer mechanisms and indicators. They identified three main indicators as input, output, and process indicators. These issues have been addressed inside the relationship between two interacting firms but external influences were not considered in the study. Other authors (Niosi and Hanel, 1995; Kim, 1998; Amesse and Cohendet, 2001; Kim and Inkpen, 2005) have focused on the success or failure of technology transfer processes particularly in the catch-up context and highlighted the importance of absorptive capacity, which was originally developed by

Cohen and Levinthal (1990). The modern perspective paid much attention to bringing to light the role of capability/knowledge transfer. It emphasis that the significant part of technology is tacit and embodied in people and organisational routines and thus the efficient transfer of technology not only embeds transferral of equipment and information but also capabilities (Radosevic, 1999; Amesse and Cohendet, 2001). The differentiating element lies in the fact that technology cannot be merely transferred by a sell/buy contract but also depends heavily upon the ways interacting firms manage knowledge.

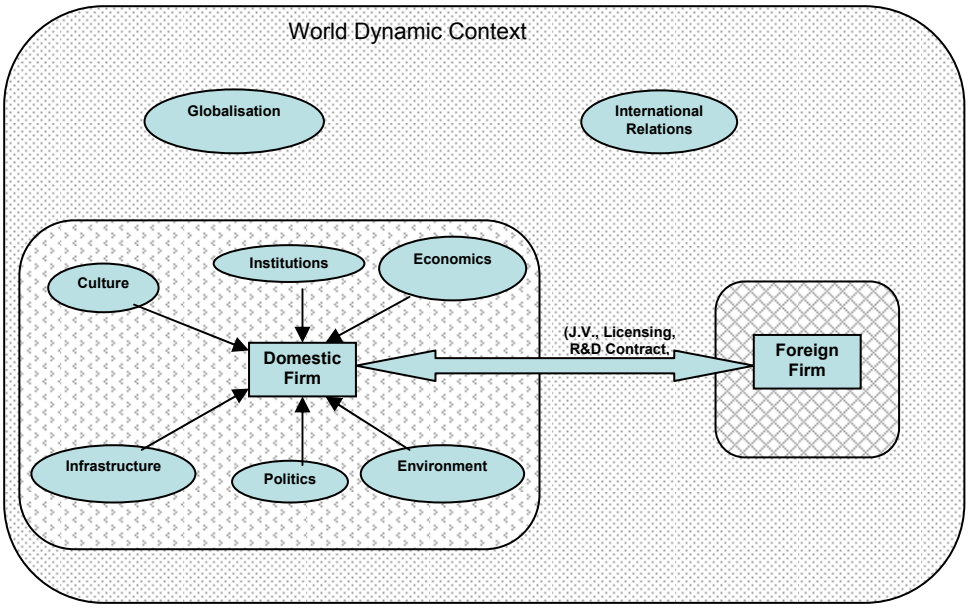
In spite of the importance of knowledge management issues in technology transfer processes, it is important to understand that both sides' firms are interacting within a complex context shaped by many social, cultural, political and other factors. Most of the studies on international technology transfer, especially on case studies, focus on micro level factors while other external meso/macro level influences are still seemingly missing from the literature. Niosi and Hanel (1995) highlight the important role of government of the host country in preparation of general and technical education and the legal, social and economic infrastructure which increases absorptive capacity of the transferor firm. Freeman and Hagedoorn (1994) showed that strategic technology partnerships or inter-firm technology transfer agreements do not necessarily entail catching-up by developing countries and even create a falling behind. Radosevic (1999) discussed technology transfer issues in the catch-up context. He argued that technology transfer policy options have changed in the period from the 1960s to the 1990s not only due to the change in the perception of knowledge elements of transfer but also due to globalisation which has been the dominant factor in changing the relationship between trade, finance, and production. Consequently, there is an increasing trend in technology transfer studies to highlight that the process is not implemented in an isolated context in which only two sides' firms play, but that the context is also shaped by many political, cultural, social and macro economic factors. With respect to this, there has been interest among scholars to embody national innovation system literature into technology transfer studies. The concept of national innovation system originated by Freeman (1987) was supported by theoretical contribution of Lundvall (1992), by empirical case studies of Nelson (1993), by sectoral perspective of Breschi and Malerba (1997) and Malerba (2002, 2004) and slightly contextualised in technology transfer literature by Bugliarello (1996) and Niosi (2002). Malerba and Nelson (2007, p.4), comment that "firms do not act alone. They must be understood as operating in the context of innovation systems that includes other kinds of economic actors that are involved in supporting and orienting the dynamics of economic activity and innovation: financial systems, primary and secondary education, universities, the public research system and government programs." Likewise, Bugliarello (1996) argue that the process of technology transfer, when occurs across national boundaries, is greatly influenced by the characteristics of two or more national systems of innovation. He also explains motivation and championship as the meta-factors which can affect technology transfer processes and illustrates how government's motivation in engaging in technology transfer may be economic development, political expediency, or the enhancement of military strength.

Along the same lines, Mowery (1995, p.539) elucidates the importance of the alignment between government policies and technology transfer policies in the success of the process. He argues that technology transfer policies "when coupled with policies supporting exports and investment in human and physical capital may produce greater technological and economic spill-over from foreign to domestic entrepreneurs and firms."

However, despite insightfulness of the national innovation system concept in the technology transfer literature, it has some limitations in terms of perception and management of external influencing factors which are beyond the national boundaries. This might be the case, when a European firm interacts with a non-European firm where the atmosphere of interaction is conceivably shaped by European Union institutions.

This paper will present the case of CNG project as a technology transfer from a North firm to a South firm. It mainly focuses on external factors and the context in which both sides interact with each other and shows how the political, economic, and contextual factors (of transferor) shape the dynamism. Figure 1 schematically shows the contexts shaped by a range of factors in which both parties interact. However, the main focus of this paper is to analyse those external factors which arise from the context of domestic firm. This is because in the case analysed in this paper, the innovation system in the domestic country was at national level while it was at firm level in the foreign country (Section 6). The influences might be associated from the economics (e.g., domestic market demands, export markets, preservation of the current market), institutions (e.g., intellectual property rights, investment laws), politics (e.g., sanctions), infrastructure (e.g., information and communication technologies), culture (e.g., type of interaction, values, devalues, behaviours), and environment (e.g., air pollution). Moreover, the influencing factors on the domestic firm not only affect the strategy of the transferee firm but also the strategy of the foreign firm. For instance, the institution of the domestic firm, such as intellectual property rights, may influence the strategy of the foreign firm particularly in the case of high-technology transfer contracts.

Figure 1 Dynamic context of interaction in a North-South technology transfer contract (see online version for colours)



3 Project overview

Iran-Khodro, the largest car manufacturer in the Middle East, set out to develop new products with new types of engines to suit demands for both domestic and overseas markets. Historically, Iran-Khodro has produced a limited range of product models that were mostly behind contemporary global technology in the automobile industry, and it seemed unlikely that they would be able to retain their current domestic market. The future will include many new competitors offering a broad range of products once Iran joins the World Trade Organisation (WTO). Membership of the WTO will not only result in standardisation and strengthening of intellectual property rights' protection (discussed in the next section), but also realisation of an open door policy to the foreign products which incur removal of existing high tariffs in the car industry. Therefore, in order to maintain its current market, Iran-Khodro should develop a specific range of products that respond to domestic market demands which competitors will find difficult to match.

The strategy was to develop an engine family with advanced technology to cover a wide range of vehicle platforms. At the same time, the engine family must also meet the contemporary fuel consumption standards, emission standards and output power levels. The company decided to set out a project to design and manufacture such an engine in Iran, named EF7. The target of the standard emission was EURO4, which is placed among the strict standards of emission in the car industry. In addition, the engine is supposed to use CNG as the primary fuel instead of petrol. CNG is perceived as a cleaner fuel with less pollution than petrol. Furthermore, although Iran has several petrol refining plants, there is under-capacity in domestic petrol refining and a huge amount of petrol is imported to fill the domestic demands. This is why the government generally wrestles in vain with a rising rate of petrol imports each year. In contrast, Iran has plentiful natural gas resources, which will allow for a substantial reduction in petrol imports. Therefore, the promotion of CNG based engines is a strategy that is expected to reduce petrol imports and encourage economic growth.

The EF7 project began in 2004 and was a collaborative research and development (R&D) project between Iran-Khodro and one of Germany's leading companies in engine design technology. Iran-Khodro has a supplier network comprising of many local and foreign suppliers. One of the targets of the EF7 project was the technological growth of local suppliers, in terms of designing knowledge, as well as production capability and hence the priority of the project was to supply engine parts locally as much as possible (this is discussed further in the next section). This procurement policy meant that during EF7, local suppliers began to retrofit their production lines to survive in the competition otherwise the required parts and components would be provided by foreign suppliers. Iran-Khodro's supplier handling department has had relationships with engaged suppliers and is well aware of their organisations and manufacturing capabilities. The project managers provided an opportunity for their most reliable suppliers to implement technical changes and to adapt their products to meet required quality standards. Indeed, at the early stages of the project, Iran-Khodro defined a deadline for the suppliers to upgrade their production lines and build the capabilities to produce the engine parts. In these circumstances, the domestic suppliers should not only deliver the parts according to the project time-plan but they should also, inevitably, upgrade their manufacturing capabilities as well as their production equipment. Accordingly, the suppliers initiated to acquire technological knowledge from foreign (mostly European) suppliers through collaboration agreements. Therefore, both the main car manufacturing company and

related suppliers were involved in the technology acquisition processes. Such a broad technology transfer can initiate severe economic debates such as capital equipment and knowledge creation among domestic parties. However, there were many factors influencing this process at macro, meso and micro levels. This study will focus on the important external factors which shaped the interacting context.

4 Political factors

4.1 Political sanctions

From 1996, when the D'Amato Act legislated against Iran, the country faced increasing challenges in international interactions and, in particular, in technology transfer projects. The D'Amato Act purports to limit access to Iran and the transfer of advanced technologies by limiting the development of Iran's ability to explore for, extract, refine, or transport by pipeline petroleum resources. This sanction not only limits US firms' business scopes but also allows the US Government to withhold US financing and contracts from foreign companies that trade with Iran. Sanction circumstances were initiated by forbidding the transfer of strategic high technologies. Such an embargo gradually affected domestic industrial companies when they procure high-technology embedded goods internationally. Iran-Khodro as a state-owned car company was among those striving to cope with this hardship. The company procures its parts from a network of its own suppliers including domestic and foreign suppliers. The relationship between the company and its foreign suppliers was based on economic benefit, technology requirements and trust. However, the crisis caused some foreign suppliers to become reluctant to sell the products due to international credibility. For a long time the company was able to procure parts from abroad but foreign companies, due to existing high political risk, began to supply the parts at higher costs. The negotiation process between domestic firms and foreign companies was much more difficult when the local company interested in transferring know-how and technological capabilities. One of the interviewees in this research comments that:

> "It is really difficult to enter into the negotiation process with foreign companies when they are aware that your country is under embargo. Our company must clarify to the foreign company that such a technology will be used only for peaceful purposes. This weakens your bargaining power particularly when you want to acquire the knowledge. It will be much more difficult when you are aware about the challenges of your suppliers in transferring equipment/technology from foreign suppliers".

International sanctions have also influenced the decisions of policy makers. Parliament tried to push local firms into acquiring technological knowledge as fast as possible by legislating deadlines to reduce/eliminate import tariffs for local firms. Furthermore, Iranian parliament has gradually discouraged high levels of state intervention and encouraged an open door policy for the import of cars manufactured abroad. It is believed that this new policy orientation can bring about greater competition in the domestic car market, leading to the production of higher quality cars domestically (Amoli and Shamsavari, 2006). This crisis seems to be similar to the case of the Korean car companies, not in inter-organisational forms, but in government level intervention. In the

1970s and 1980s the Korean government imposed a crisis by asking the domestic car companies "to shift from assembly production of foreign cars on a CKD basis to the development of locally designed 'Korean' cars" [Kim, (1998), p.511], then to increase production capacity and finally, acquiring technological capabilities (Kim, 1998). The established principles in Korea have many similar aspects to the Iranian government policies in the protection of the local market from new entrants and from new foreign knock-down imports and also a significant tax reduction. Nevertheless, in recent years, the parliament as well as the government seems to be unhappy with the trend of the technological capability growth by domestic firms and hence they have initiated an open door policy to make a crisis for the domestic firms to hasten the catching-up process. The state's carrot and stick approach, forced IKCO Company to firstly enhance its technological capabilities by technology transfer from North companies and secondly, to help its domestic suppliers to upgrade their production lines as well as technological knowledge through setting up of new international R&D contracts. It also developed new products for its current market. However, in this study we do not evaluate technology transfer projects but the influences of external factors.

Therefore, with the emergence of new political circumstances, in the government and local companies, the self-reliance type of doctrines dominated. The term 'self-reliance' refers to the policy of supplying the parts locally as much as possible with the minimum dependency on foreign sources. This self-reliance policy has some aspects which are worth discussing here. The positive elements are: the degree of enthusiasm and energy devoted to nation building and acquiring technology as much as possible with the great motivation of local parties. In contrast, the negative effects are: the insularity and potential for waste in not making use of experience from abroad or in over-protecting domestic elements (and thus causing them to be parochial and local monopolies). However, Iran-Khodro managers and state authorities perceive the EF7 project as an opportunity to compensate for the negative side of the self-reliance doctrine in the automotive industry.

The politicised context has also affected the North companies. Interacting with a South company, which is under international sanctions, incurs taking a high risk in terms of financial issues and international credibility. Furthermore, since the host country's state-level authorities follow-up the technology transfer project, some intervention by politicians in the decisions of the host country's firm is inevitable. Such an intervention makes the decision making process unstable and difficult to manage for the North companies' managers.

Hence, the particular political situation affected the technology transfer process. On the one hand the host firm was determined to acquire engine design technology especially design capabilities and upgrade its local supplier by connecting them to European suppliers. On the other hand, the state organisations, which we will discuss in the next section, chase the project issues and progress. The finding confirms Seddiqi (1990) who argues that the status of political relations between countries plays a significant role to an extent to which high technology is likely to be transferred between them.

4.2 Political economic factors

Iran possesses 11.2% of all the oil reserves in the world and ranks as the second biggest country among oil reserves countries, while the figure for oil production is 5.4% of the

oil market (BP Statistical Review, 2008). Despite such oil production and export, that is vital for the country's economy, there is an under-capacity in domestic petrol refining and a huge amount of petrol is imported to fill domestic demands. Iran imported more than 20 million litres of petrol each day in the fiscal year (21 March 2006–20 March 2007) which was worth more than five billion dollars (Sanati, 2007). The budget law, legislated by the Iranian parliament, for the last fiscal year (21 March 2007–20 March 2008) allows the government to import only 2.5 billion dollars worth of petrol. There was, however, a petrol import budget deficiency of 2.5 billion dollars for the last fiscal year (Sanati, 2008) which is why the government generally wrestles in vain with a rising rate of petrol imports each year.

In contrast, Iran has plentiful natural gas resources, which will allow for a substantial reduction in petrol imports. Iran has 15.7% of all the natural gas reserves in the world and ranks as the second biggest country among natural gas reserves countries while the figure for production is 3.8% of the natural gas market which ranks the country fourth in the world (BP Statistical Review, 2008). Compared to petrol, CNG does not need to establish massive and capital-intensive refinery plants as infrastructure. Despite the shortage of CNG stations in Iran, the local firms are able to invest and supply the local market.

Another comparison between petrol and CNG relates to the customer choice in terms of the price of both fuels. Table 1 compares the fuel costs (petrol and CNG) for a typical vehicle in Iran. The prices are the subsidised prices ratified by the parliament and government. A typical vehicle in Iran, with its 90 km/h speed-limit on its highways, consumed 13.8 litres of petrol consumption over 200 km. Under the same conditions, only 12.3 kg of CNG would be consumed. The price of petrol in Iran in 2008 was \$0.1 per litre, while the price of CNG was about \$0.0215 per kg (data valid in 2008). Accordingly, the cost of fuel for over 20,000 km would be less than one-fifth the cost of petrol. The importance of CNG-based engines in Iran is further clarified when we note the recent fuel rationing policy. The government began rationing fuel in July 2008, allowing each vehicle to consume only 100 litres of petrol per month using the subsidised prices. Further consumption requires petrol to be bought using unsubsidised prices, which are four to seven times the subsidised ones. In Iran, the petrol price is a fixed price and does not vary with the fluctuation of global oil prices. Each fiscal year the government examines its budget and expenses and accordingly ratifies the price of petrol. However, the subsidised prices lead to some economic hardships for the government. In 2006, more than a quarter of the government subsidies in the energy sector went to petrol consumed by vehicles. Hence, the state strongly supports, both in moral and financial terms, any projects in the automotive industry that will remove these high subsidies and corresponding budget deficiencies.

Table 1 Comparison of petrol and CNG costs in Iran as alternative fuels for vehicles (2008)

Fuel type	*Cost*	*Fuel consumption in 200 km*	*Cost of 200 km traversal*	*Cost of 20,000 km traversal*
Petrol	\$0.1 per litre	13.8 litre	\$1.38	\$1,380
CNG	\$0.0215 per Kg CNG	12.3 Kg	\$0.2625	\$262.5

5 Environmental determinants

Vehicles are the main source of air pollutants in Tehran and hence Iran's Department of Environment has been trying to regulate the rules to diminish air pollution as much as possible. As one of the top organisations in Iran, the Department is responsive to the car industry and has set up many programmes to improve quality of life which is an urgent issue in Tehran. In these circumstances, the Department encourages (or at least does not punish) car companies to develop engine vehicles with other alternative clean fuels. Since CNG is a cleaner fuel than petrol and it is easy to reach the standard levels by a CNG-based engine, the EF7 project had the sympathy of environmentalists in Iran. Similarly, the Iranian fuel Conservation Company was assigned to make and monitor fuel policies. This company has prioritised the development of CNG-based engines in the country and gives incentives to the private sector to build CNG stations. Although many big cities are equipped with CNG stations, there is a considerable gap in CNG stations compared to petrol. Furthermore, this company offers financial support for domestic car companies in order to develop and manufacture CNG-based engines.

Therefore, EF7, as a technology transfer project, was influenced by environmentalists. Although the influence was positive and had moral support of other state-level authorities, the managers were concerned over the future trend of regulations. One of the interviewees believes that:

> "Although we were quite sure that the project will successfully pass the current environmental regulations, we are still concerned over the growing strict environmental laws as the future uncertainties. We have to predict the upcoming environmental laws and regulations as they are vital in the future competition".

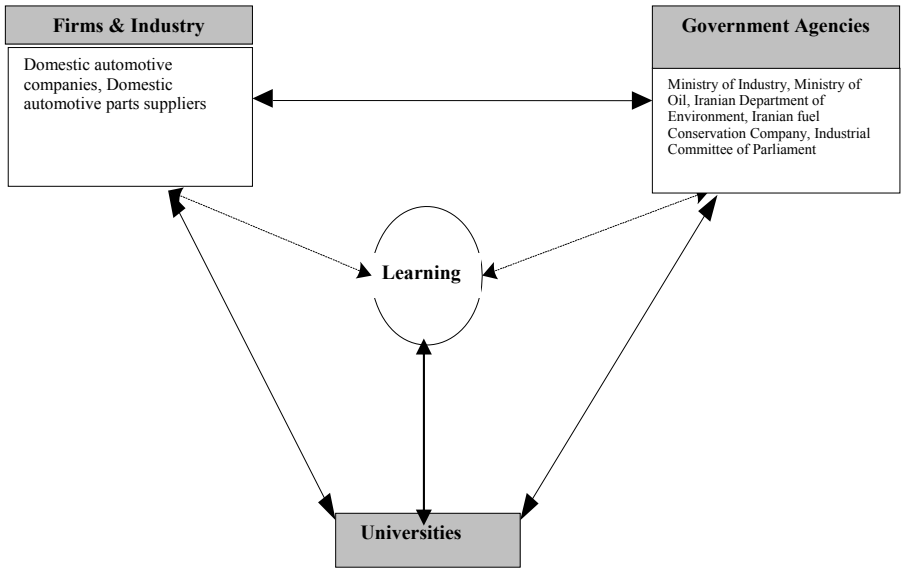
6 Innovation system in the case study: North-South contrasts

As described previously, due to political, economical and environmental reasons, the actors in the Iranian side were not just the Iran-Khodro Company but also other meso and macro level actors. Automotive industry promotion is one of the state's priorities particularly those which accord with the state fuel consumption policy. In line with this strategy, the state has provided some incentives as well as some crises for domestic car companies. It is argued that the CNG-based engine technology is at national level in Iran and the state level organisations including: the Ministry of Industry, Ministry of Oil, Iranian Department of Environment, Iranian fuel Conservation Company, and the industry committee of the parliament are the major actors in the technology transfer project. If the technology innovation system of this project is mapped in accordance with the agent-based model[4] (Nelson, 1993), it will be shown that the system is at a national level in Iran. Figure 2 illustrates the innovation system CNG engine technology in Iran.

In contrast, the figure is not the same for Germany. In German national innovation system (where the export performance of its economy makes it a special case) research oriented universities combine their educational function with the advancement of scientific knowledge (Keck, 1993). Also within German universities, mechanical engineering is the largest discipline with a research budget of DM 652 mio (Krahmer and Schmoch, 1998). This discipline is very much close to the car industry both in production and R&D. According to a survey study at German universities by Krahmer and Schmoch

(1998), the central linking element in the cooperation between universities and industrial firms (for all fields) is the exchange of knowledge in both directions. Although the institutional orientation of academic and industrial researchers is different, the exchange of knowledge can be considered a common denominator where both interests meet. In the case of Iran's CNG project, the transferor company has a very close relationship with the local university on one side, and the industry companies on the other. The observed company not only actively implemented research for German industry demands, but also actively expanded its technological knowledge as an export. In this technology transfer project, the German company designed and developed CNG-based technology for an Iranian context and although the knowledge of the firm grew through this project, such a technology is not workable in a German context. Germany prefers to have diesel-based engine vehicles instead of CNG, because of the economic issues of imports, refinery, and infrastructure of distribution of both fuels. The German state also has no interest in diffusing CNG-based engine technology. The only actor of this innovation was the German firm and, hence such an innovation system is at firm level in Germany. This paper does not focus on this issue but would suggest for future research to study how the innovation system levels might differ within cross-borders.

Figure 2 Agent-based model of innovation system for CNG engine technology in Iran



7 Intellectual property issues: a North-South debate?

North companies often question the strength or weakness of Intellectual Property Rights (IPR) regimes in the South before transferring technology. Mansfield (1994) argues that for US firms the strength or weakness of a country's system of intellectual property protection not only plays a significant role but also this factor

influences the composition and extent of US direct investment in that country, although the size of the effects seems to differ greatly from industry to industry. There has been a wide range of perspectives about the effect of the host country's IPR regimes in transferring technology from the North. Positive views perceived the strength of IPR regimes as an incentive for North countries to invest in the South (Phillips and Firth, 1990; Bhat, 1996). Skeptical views point to insufficient and contradictory empirical evidence on linkages between IPR and investment and technology flows (UNCTC, 1990), while the opposing views believe that strong IPR protection will be too costly and that the costs are unlikely to be justified by inward technology flows (Ringo, 1994).

The Iranian national engine project was aimed at designing an engine for Iran with Iran-Khodro ownership in which the whole intellectual property rights of the engine belonged to Iran-Khodro. It meant that no company was allowed to copy any design feature in detail or any design detail of this engine without the permission of the Iran-Khodro Company. The prominent feature of this engine was that it was the first bi-fuel engine in the world 'optimised' for CNG operation as the primary fuel and petrol as the secondary fuel. The question and concern of Iranian managers relates to the protection of intellectual property rights of this engine. Despite the Iranian government's recent challenges, the country has not yet joined the WTO and consequently, it is not a member of the TRIPS agreement yet. This circumstance may threaten the engine in terms of copy or reproduction in the international market and it will be very difficult for the international judiciary office to support the engine patent rights in the case of infringement or copying in design. The concern of the domestic firm seems slightly unusual in the existing technology transfer literature. In most technology transfer studies, the protection of the IPR of the technology is a serious concern of transferor rather than transferee. However, in the case of Iran's national engine project the issue was totally different due to the special type of technology transfer contract in which the intellectual property right of the product belonged to the domestic firm. Hence, the foreign firm had not the apprehension of copying, reproducing or infringement of the new product in the domestic or even in the international markets. Nevertheless, on the other side of the coin, such concern was the case for involved European suppliers of the engine parts particularly for those who developed/designed the new parts. There were a few parts in the engine as the patents of European suppliers, and neither German firm nor Iran-Khodro was allowed to change the design. Although Iran-Khodro had the right to use the alternative parts in the engine, the intellectual property rights of a few parts, belonged to the suppliers who had firstly designed and developed them. In the EF7 project, those European suppliers insisted on establishing clear and strict contractual terms in their collaboration with the domestic suppliers. In fact, due to the IPR status in Iran, those suppliers requested having legal guarantees to protect their technology against any infringement and copying. These circumstances sometimes postponed parts procurement in the project and the managers perceived it as a negative factor. One of the interviewees commented that:

> "The oil pump of EF7 engine is a high-tech and patented part. We had some difficulties in its procurement. The German supplier was reluctant to work with our domestic supplier due to low technological capital equipment of our domestic supplier as well as lack of clear IPR institutions in the contracts. These two factors shifted the project timelines several times."

8 Research limitations

Cultural proximity is one of the significant influencing factors in shaping the interaction context between transferee and transferor. "The greater the cultural proximity between technology developer and users, the more likely there will be successful product/process application" [Gibson and Smilor, (1991), p.304]. Expanding the number and diversity of people interacting in technology transfer process is occasionally suggested in order to increase mutual understanding of values, attitudes and to minimise the cultural differences. Despite the cultural distance between transferee and transferor in the EF7 project, this study did not consider the influence of this factor. We would suggest to future researchers to study the influence of cultural factors with the approach of North and South differences. We favour case studies that enable the researcher to achieve an in-depth understanding of the dynamics of the interactions between indigenous and overseas capabilities. We also encourage researchers from many disciplines to investigate the role of the influencing factors in the technological catching-up of a latecomer firm.

9 Conclusions

International technology transfer projects frequently occur in a complex and dynamic context and embed an extensive range of influencing factors that are present simultaneously – they might be beyond the will or power of both transferor and transferee management – and that has to be recognised and managed. There is an increasing trend in technology transfer studies to highlight that the process does not occur in an isolated context, in which only two sides' firms are involved, but that the context is shaped by many political, cultural, social and macro economic factors.

Recent evidence, as an in-depth case study analysis, would argue that the North-South technology transfer process is substantially influenced by various external institutions, international rules, and political factors. This study showed that those externalities may hamper or hasten technological acquisition of a latecomer firm. It also showed how the engaged actors of both sides may come from different levels of state, industry and firms. Lack of awareness of these influencing factors not only jeopardises the project's progress, but also incurs negative consequences in the knowledge acquisition of the host country's firm. Although out of control, the managers of both sides should be well aware of the dynamics of interacting context in order to manage the influences of external factors in the process effectively.

This study reveals, on one hand, major differences in the North-South contextual contrasts, and on the other the special context of Iran in the process that might be the case for other developing countries. While some questions remain, the study suggests a dynamic perspective approach for helping to understand the interacting context of North-South companies. The article outlines some new research directions and by analysing external factors in North-South technology transfer projects, the study suggests for future studies to focus on the interaction processes between local capabilities and foreign technology sources.

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Notes

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2 In the technology transfer literature, the term 'North' means developed countries and 'South' means developing or less developed countries.

3 They differentiate among developing countries in terms of stage of development, size of economy, resource endowment, and so forth.

4 In this model, the key interaction involved between component and system producers, upstream and downstream firms, universities and industry, and government agencies and universities and industries are considered.