



International technology transfer and the dynamics of complementarity: A new approach



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ABSTRACT

Latecomer firm's catch-up through indigenous R&D and cross-border technology transfer embeds various influencing factors that are present simultaneously – beyond the will or power of managers and policy makers – and that have to be recognised, analysed and taken into account. Despite the increase in literature on substitution/complementary relationship, some ambiguity remains in understanding the complexity of complementing between indigenous and overseas technology sources. Unlike the majority studies on complementarity, this paper suggests the dynamic approach by which scholars are able to reach a deeper understanding of the dynamics, challenges and difficulties of these relationships. This study builds a theoretical framework to being operationalized in the context of Iranian latecomer firm located in gas turbine industry. This paper shows that taking the dynamic approach is able to reveal the strategies by which the latecomer firm deals with the difficulties of acquiring advanced technologies. Although complementary relationship exists, it is a strategic vision to understand how a latecomer firm complements its indigenous efforts with overseas technology sources. Different kinds of insights will be provided in terms of national-, industry- and firm-level factors and the strategies by which a latecomer firm can deal with these factors.

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1. Introduction

Technological catch-up studies argue that both indigenous efforts and overseas technology transfer are the key elements of latecomer firms' catch-up. On one hand, the literature underlines the accessibility of foreign technology and international technology flows from leaders to followers as a significant part of the process. On the other, it emphasises indigenous innovation and learning systems and highlights the important role of institutions, organisations and interactions in enhancing domestic technological capabilities. In this view, a number of studies have tried to understand the relationship between indigenous and overseas technology sources. Some of them have shown that these two main technology channels are alternatives or substitutes, while others have argued that the channels are complementary. Regardless of the small number of such studies, especially in a developing country context, the majority of the existing literature has placed too much emphasis on the 'correctness' of one of these ideas. They have often examined the type of relationship and paid inadequate attention to its dynamics, challenges, and difficulties. Although some of the studies (Bell and Pavitt, 1993; Pack and Saggi, 1997; Radosevic, 1999) have criticised the static viewpoint of the existing literature and have posed interesting questions about the dynamics of technological development of latecomer firms, the issue has barely been touched upon. These studies have left unanswered the nature and the details of dynamics.

In this light, this paper, instead of examining only the type of relationship between indigenous technology development and overseas technology inflows, delves deeply into the dynamics. Based on a case study method and examining the Iranian Company – MAPNA, this research provides theoretical insights into the following questions: What have been the dynamics between indigenous technology development and overseas technology transfer for a latecomer firm intends to catch-up? How a latecomer firm can manage influencing factors in order to complement its indigenous technology development efforts with overseas technology inflows?

2. The conceptual framework

The first aspect of the technological catch-up concept is the important role of foreign technologies in enhancing domestic firms' technological capabilities. Radosevic (1999) argues that the catching-up literature builds upon the proposition that technology followers benefit from technology leaders (1999). Other important aspects which are highlighted in the literature on technological catch-up are the active role of domestic firms, the typology of their interactions, and the contributions of institutions, financial systems and infrastructure. Framed in this way, the technological catch-up process cannot be reduced to merely transferring technology from developed countries and imitating their routines among latecomers. Rather, indigenous capability building has become, and will continue to become, of ever greater value (Mazzoleni and Nelson, 2007).

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These kinds of discussions highlight an important theme in the literature. On one hand, the technological catch-up literature underlines the accessibility of foreign technology and international technology flows from leaders to followers. On the other hand, the literature highlights the important role of indigenous institutions, organisations and interactions in enhancing domestic technological capabilities.

Here, the question is how indigenous capabilities and foreign knowledge – as the two main sources of knowledge – interact with each other. What factors influence the dynamics of this process? And finally, the crucial question is whether these components are complementary or substitutes for one another. The extent of complementarity and substitution has become a focus for debate in the literature. Some researchers have argued that the two important technology sources work together in a substitutive way. In contrast, other researchers have argued that both means interact in a complementary way.

2.1. *Indigenous and overseas technology sources: substitute or complement?*

In the literature on technology transfer [Radosevic \(1999\)](#) states the definition of “mutual complementarity as the process where the rise in one variable raises the payoff of increasing the other” (p 115). In contrast, a substitutive relationship between two variables reflects the decrease of one if the other increases. For example [Braga and Willmore \(1991, p 421\)](#) argue that “increased imports of technology imply a decrease in local R&D”. Similarly, [Radosevic \(1999\)](#) defines substitution as “the more foreign technology was imported the less likely it was that domestic R&D would develop” (p 115). Complementary and substitutive relationships between indigenous technology development efforts and overseas technology transfers result in different policy implications, which have been highly controversial in the literature.

The substitutive view originates from import substitution policies, which were part of the mainstream development position of the 1960s and 1970s and were practised by the majority of developing countries such as India and Latin America ([Radosevic, 1999, 2009](#)). This view has been mainly articulated by [Stewart \(1977\)](#) and [Mytelka \(1978\)](#) in the literature. [Stewart \(1977, 1987\)](#) believed that developing countries should not copy advanced technologies developed in industrialised countries but rather should cooperate with each other to develop appropriate technologies and build a so-called South-to-South cooperation. [Mytelka \(1978\)](#) also studied two industries – metalworking and chemical firms – in the Andean Group of Latin American countries, and contends that by reducing the need to create indigenous technology, technology imports curtail domestic technological development and create a reliance on foreign technology. Both [Mytelka \(1978\)](#) and [Pillai \(1979\)](#) believe that imports reduce developing countries' need (or incentive) to undertake their own technological efforts: the developing country enterprises become ‘dependent’ on the imports.

The dependency idea has been criticised by [Pack and Saggi \(1997\)](#). They believe such policy thinking was the harmful long-term impact of technology capability building in Latin America. Despite these critiques, at that time Mytelka argued based on the circumstances of the 1960s and 1970s. She had observed unsuccessful technology transfer projects in Latin America and she was concerned with the traditional approach of technology flows from North to South, in which technology transfer regimes sufficed to import machines and equipment. These regimes often neglected the transfer of tacit elements of knowledge and did not include the engagement of indigenous people in learning-by-doing processes. [Perez \(2001\)](#) also interprets Latin American cases in a similar way. She argues that these countries, in contrast to the newly industrialised Asian countries, have passively engaged in technology transfer processes. Nevertheless, the substitutive idea, or the idea of import substitution, is no longer valid in the literature and the trade circumstances have been largely altered over the last three decades: this matter has also been argued by [Perez \(2008\)](#) in terms of changing conditions, changing strategies.

After [Mytelka \(1978\)](#) and [Pillai \(1979\)](#); [Lall \(1985\)](#) studied the interaction of both domestic and foreign technology sources. [Lall \(1985\)](#) argues that the relationship between technology transfer and domestic technological efforts is changeable, and at certain stages the two are substitutes while at others they are complementary. However, [Lall \(1985\)](#) believes that when the strategy of low technology import lasts so long, it may lead to technological stultification due to limited capabilities of developing country enterprises. The concept of the complementary relationship has been somewhat raised accordingly. [Lall \(1989\)](#), in his next piece of research, interpreted importing technology as a “building block” for domestic capabilities. His studies cast light upon the crucial role of foreign knowledge and interaction with domestic technology sources in building domestic capabilities. However, in Lall's studies this question remains unanswered: why does the relationship between these two technology sources change, and what factors influence this?

[Bell and Pavitt \(1993\)](#) and then [Freeman and Hagedoorn \(1994\)](#) had influential studies in which they show catching-up firms choose and use both of indigenous and overseas technology sources. Their studies also emphasise technology partnership with foreign technology owners, if not complemented with indigenous efforts, may even lead to falling behind. Although these studies confirm the complementary relationship, the details of this complementarity, its dynamics and influencing factors are still shrouded in mystery.

The studies discussed above are based in the general context of developing countries. Within the literature, scholars have identified the need to be more specific, and hence studies have begun to examine complementarity/substitutive ideas in specific contexts.

[Braga and Willmore \(1991\)](#) investigated the relationship between technological imports and technological efforts in Brazilian firms. [Lee \(1996\)](#) studied the relationship between technology imports and R&D efforts in the context of Korean manufacturing firms. [Katrak \(1997\)](#) implemented a similar study in the electrical and electronic industry in India. [Kim \(1998\)](#) studied Hyundai, the Korean automotive company, to interpret how both indigenous and foreign technology sources are coupled to upgrade the level of organisational knowledge. In the context of developed countries, [Caloghirou et al. \(2004\)](#) and recently [Hagedoorn and Wang \(2012\)](#) examined the type of relationship between firms' internal and external knowledge sources.

The abovementioned studies confirm the complementary relationship between indigenous and foreign technology sources. Furthermore, these studies showed that the complementary relationship exists apart from the size of firms.

Moreover, although a number of these studies operationalized in the context of developed countries, their scope overlaps with those conducted in developing countries. All these studies are built upon the strategic management of firms' knowledge sources (internal or external to firms). In fact, the complementary relationship, indeed, originates from the accepted concept of ‘absorptive capacity’ in cross-border technology transfer. [Cohen and Levinthal \(1989\)](#) coined the term ‘absorptive capacity’ and argue that the main function of R&D is to develop the firm's ability to identify, assimilate, and exploit knowledge from the environment. Subsequently, [Cohen and Levinthal \(1990\)](#) developed the concept of absorptive capacity, arguing that “the ease of learning, and thus technology adoption, is affected by the degree to which an innovation is related to the pre-existing knowledge base of prospective users” (pp 148–149). They divide the concept into two important elements, namely the “prior knowledge base” and “intensity of effort”. The corollary of this argument is that foreign knowledge absorption needs prior indigenous capability building efforts as well as the extent to which latecomer firms makes the effort to acquire knowledge from leader companies.

Buildings on the notion of absorptive capacity, make-or-buy discussions (or substitution perspective) were cast aside in favour of complementarity between indigenous and overseas technology sources. The corollary of this position is that catching-up firms should not trap in the dichotomy of making or buying technologies; rather they should

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