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# Rise of latecomers and catch-up cycles in the world steel industry<sup>☆</sup>

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## ABSTRACT

This study analyzes the sources of changes in industrial leadership and catch-up by latecomers in the world steel industry since World War II. The shift of leadership from the United States to Japan in 1980 and the subsequent rise of Korea, with POSCO's output surpassing that of Nippon Steel in 1998, is explained on the basis of a single theoretical framework. We rely on the neo-Schumpeterian concepts of sectoral innovation systems and windows of opportunity for latecomers in catching up with leading countries. These windows include changing generations of technologies, business cycles and demand shifts, and government regulations and other interventions. Japan realized a path-creating catch-up by taking advantage of the opportunity window associated with the emergence of new technologies. Entering as a state-owned enterprise, POSCO engaged in stage-skipping catch-up by utilizing the downturn as a window of opportunity to pay low prices for expanding its facilities and updating its technologies.

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## 1. Introduction

Mowery and Nelson (1999) examined changes in industrial leadership, considering not only technological factors but also market and institutional factors, including the government's role. They noted that leadership changes are affected not only by the firms' strength but also by their national environments. However, their study dealt mainly with leadership changes that involve advanced countries. Collected articles in Malerba and Nelson (2012) considered the cases of latecomer countries and their firms in terms of diverse factors. However, these contributions did not deal with two or more catch-up times by the latecomers, following the earlier tradition of Bell and Pavitt (1993) emphasizing capability building.

The more than the one-time incidence of the rise of latecomers or changes in leadership in the same sector is a different issue. Specifically, why does such a shake-up of an industry occur repeatedly, with the old incumbent faltering and the new leader rising and

then losing out to another later entrant? Accordingly, the present study deals with the question of what happens after latecomers build their technological capabilities, particularly in terms of leadership changes or the rise of latecomers. This question is interesting because capitalism has witnessed frequent changes in industrial leadership or rise of latecomers in various industries. For example, US firms dominated steel production in the 20th century, particularly during the first half of the century. The 1960s and 1970s witnessed the erosion of US leadership, and Japan eventually took over from the United States in steel production in 1980 (Yonekura, 1994). Moreover, as noted in D'Costa (1999), the rise of a Korean firm, namely, POSCO (Pohang Iron and Steel Company), occurred, and it eventually surpassed the top Japanese steel firm, Nippon Steel, in terms of crude steel output in 1998. We describe this frequently occurring phenomenon or change in industrial leadership in terms of "catch-up cycles," in which *catch-up* means a substantial closing of the gap in market shares between the incumbents/leaders and entrants/latecomers.

In the present study, a cycle means a period from the entry to the decline of a country in a particular industry. Therefore, if one refers to two instances of catch-up, the discussion includes three cycles. Each cycle refers to a specific country that is experiencing entry, gradual catch-up, forging ahead, and finally falling behind. A full and theoretical treatment of a catch-up cycle is suggested in Lee and Malerba (2016) and in the simulation analysis by Landini et al. (2016). The present study aims to explain the concrete mechanism of catch-up by latecomers in the steel industry, and adopts "appre-

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ciative theorizing” or the causal explanations of observed patterns of economic phenomena (Nelson and Winter, 1982: 46).

To explain the catch-up by latecomers in the industry, we combine the concept of windows of opportunity with the diverse catch-up strategies of late entrants and rely on a theoretical framework proposed by Lee and Malerba (2016). The concept of windows of opportunity was first used by Perez and Soete (1988) to refer to the role of new techno-economic paradigms in generating leapfrogging by latecomers that utilize a new paradigm and carry out preemptive investment in new technology, thereby surpassing the old incumbent. In addition to technological changes, the present study also considers other opportunity windows, such as those opened up by demand conditions, business cycles (Mathews, 2005), and the government’s industrial policy and regulations (Guennif and Ramani, 2012).

We explain the leadership change first from the US to Japan and then the catch-up by Korea. We may not consider the Korean case as a leadership shift because the Japanese firms did not undergo a radical decline. However, both cases constitute catch-ups in terms of the substantial rise of latecomer firms. This observation is related to the issue of the unit of analysis. Following Lee and Malerba (2016), the present study is concerned with catch-up at the industry level and interested in the position of a “country” in terms of the global market share in a specific industry. However, depending on the sectors and their characteristics, the focus of the analysis should be on a large or small number of firms in a sector; for instance, the wine sector consists of a large number of firms, whereas the steel sector in a relatively small country like Korea tends to involve only one firm. In other words, whereas our discussion on the catch-up by Japan involves several firms in the industry, the case of Korea is about a single firm, POSCO, compared with the single leading firm, Nippon Steel, in Japan, since POSCO was the only one integrated steel mill company in Korea for the period of analysis in this paper (up to 2000). The comparison of the two leading firms in Korea and Japan is also interesting and relevant because Nippon Steel was the key provider of the initial technologies and facilities of POSCO. Thus, how a “son” was able to catch up with the “father” is an interesting question.

In summary, this study attempts to elaborate, in the case of the steel industry, the proposition by Lee and Malerba (2016) that changes in industrial leadership or catch-up by latecomers occur when a combination of newly opened windows of opportunity and appropriate catch-up strategies is taken by latecomers. Section 2 presents our theoretical framework to analyze the catching-up phenomenon. Section 3 provides an overview of changes in industrial leadership in the world steel industry since the 20th century. Sections 4 and 5 elaborate the process of how Japan and Korea, respectively, successfully caught up. Finally, Section 6 summarizes our findings.

## 2. Theoretical framework and the argument

The product life cycle theory of Vernon (1966) can be considered the most closely related theory to the catch-up cycle. However, Vernon did not consider the possibility that latecomer firms could take control of not only the production but also the R&D and brands of these goods, with firms from advanced countries losing out in the competition. Lee and Malerba (2016) proposed an alternative framework that considers the diverse factors at the industry level and even those at the national institution level. Their framework and this study rely on the Schumpeterian concepts of innovation systems, such as national systems of innovation (Lundvall, 1992; Nelson, 1993) and sectoral systems of innovation (SSI) (Malerba, 2004). Malerba (2004) defines a sector as a set of activities that are

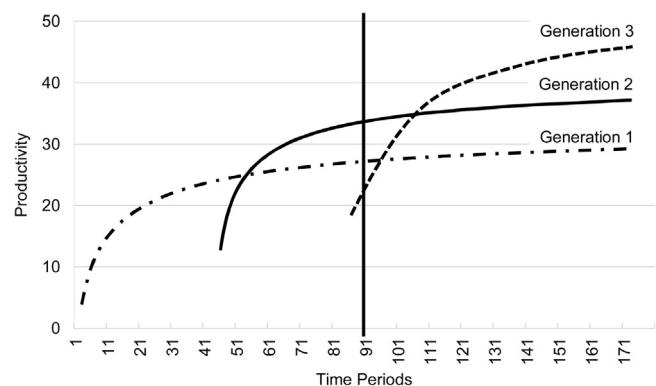
unified by some linked product groups for a given demand and that share some common knowledge.

To explain the successive changes in industrial leadership, we match each component of the SSI to diverse windows of opportunity. Several types of windows can be opened up for late entrants. One is the rise of a new techno-economic paradigm (Perez and Soete, 1988) that tends to threaten the advantage of incumbents rooted in investment in the existing vantage of technologies. When a new paradigm emerges, both latecomers and incumbents stand on the same starting line with the new technology; the incumbent may fall behind by clinging to old technology in which they hold a dominant position. In the current study, instead of dealing with the techno-economic paradigm shift, we deal with a mini paradigm, a new generation of technologies.

Another type of window of opportunity is derived from a second component of SSIs (demand conditions), that is, a business cycle and/or abrupt changes in market demand. Mathews (2005) indicated that business cycles create opportunities for challengers to stir up the industry as downturns play the cleansing role; thus, weak players are forced into bankruptcy, and resources are released at low prices to be picked up by challenger firms that aim to enter the industry. Finally, a third window of opportunity can be opened by the government generating an asymmetric environment for incumbents and entrants through a range of regulations. Such asymmetries can be utilized by latecomers to offset the initial cost differences associated with the late entry.

Although the three types of windows of opportunity are assumed to be events that are exogenous to latecomer firms, firms should recognize the open windows and take advantage of them to realize their potential. In other words, the strategies of firms themselves interact with the windows of opportunity and the technological and market environments that affect their performance. Accordingly, our model is not deterministic but emphasizes the role of actors, particularly firms and governments.

According to Lee and Lim (2001), several choices are available for possible entry or catch-up strategies by latecomers, such as path following, stage skipping and path creating, in which *path* means the trajectory of technologies and *stage* means the stages in the trajectories. These three strategies can be explained in Fig. 1, which shows the different trends of the productivities (shown at the vertical axis) of technologies of different generations (with the horizontal axis representing time). The idea of generations of technologies is consistent with the theory of technology life cycles (Abernathy and Utterback, 1978). However, we focus on the implications of generation changes for the entries by latecomers, not for the types of innovation (product vs. process innovation). Let



**Fig. 1.** Three Strategies of Latecomer Firms.  
Notes: Path-following strategy = To adopt the oldest (generation 1) technology.  
Stage-skipping strategy = To adopt the latest (generation 2) technology.  
Path creation (leapfrogging) strategy = To adopt emerging (generation 3) technology.  
Source: Adapted from Lee et al. (2016).

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