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Innovation and recurring shifts in industrial leadership: Three phases of change and persistence in the camera industry☆

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ABSTRACT

This study examines factors underlying three phases of change or persistence in industrial leadership in the sector of interchangeable-lens cameras over the past century. During this period there were two major phases of leadership change, both associated with the emergence of innovations involving major discontinuities in the industry's core technologies. First, Japan won market leadership from Germany in the mid-1960s after commercializing the single-lens reflex (SLR) camera that replaced the previously dominant German rangefinder camera. Second, in the late-2000s, Japanese latecomer firms and a Korean firm developed Mirrorless cameras, which allowed them to capture the majority of market share from the incumbent Japanese leaders. We also examine the long period (about 60 years) between these two phases of change, during which leading Japanese firms were able to sustain their market leadership despite the digital revolution from the 1980s to 1990s. This paper explores the factors influencing these contrasting experiences of change and persistence in industry leadership. The analysis integrates several aspects of sectoral innovation systems – i.e., windows of opportunity associated with technology, demand, and institution – as well as the strategies of incumbents and latecomer firms. The conclusions highlight the complex and diverse combinations and importance of the factors that help explain the patterns of shifts in leadership.

1. Introduction

Latecomer firms may have considerable difficulty catching up with industry leaders. Consumers frequently choose leading firms with better products, superior resources, and proven capabilities. Incumbent leaders strengthen their dominant position by leveraging their market power and building barriers to entry. Valuable assets resulting from market dominance, such as secure branding, good reputation, network effects, access to high-level information, and slack resources further reinforce their superior position. In this sense, many researchers and practitioners have emphasized the importance of market leadership and incumbent advantage.

Interestingly, however, latecomers occasionally surpass incumbents and become new industry leaders. Furthermore, this catch-up tends to occur repeatedly in many industries; new leaders subsequently lose the dominant market position to other rising firms. Although leading firms must have learned from their own experiences when catching up, they lose their technological edge and market competitiveness to challengers, just as former incumbents did before them. Despite the elaborate strategies and actions of new market leaders to satisfy consumers, they often seem powerless to prevent this pattern from being repeated.

We investigate recurrent shifts in industrial leadership and the mechanisms behind them in the context of the interchangeable-lens camera industry. In doing so, we look at multiple levels in two important dimensions of the industry. First, we identify recurrent shifts in leadership at the firm level – that is, shifts between (a group of) individual firms, sometimes occurring within economies – and also at the national level. Second, we note that catching up is not limited to explanatory factors relevant at the firm level. Leadership shifts that happen at the national level imply that analyses at the firm level cannot be exhaustive, and that broader perspectives and multiple levels of analysis are necessary. We therefore examine a wide range of explanatory factors that contribute to leadership shift or catch-up and their interactions on different levels..

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In this study, we analyze successive shifts in industrial leadership between countries as well as firms. We examine the influence of technological advances, market demand, government policies, international conditions, and the interaction between strategies in latecomer firms and the responses of leaders. Our cases include firms in the camera industry, which has been the focus of several studies. For example, Wu et al. (2014) examined technological changes in several camera manufacturing companies from the perspective of firm heterogeneity and complementary assets. Their focus, however, was on the relationship between complementary assets and trajectory choices *within* a firm rather than inter-firm competition. The growth of Canon and Nikon has been examined, with a focus on Japan's support for the optical industry before and during World War II, by Alexander (2002) and Donze (2014), respectively. However, the *dynamics* of innovation and industrial leadership, especially between countries, have been overlooked. To the best of our knowledge, no study has investigated successive changes in industrial leadership in the camera industry within a comprehensive analytical framework. In particular, the recent proliferation of Mirrorless cameras pioneered by Japanese and Korean latecomers requires elucidation.

Our focus is on the interchangeable-lens camera industry, which provides us with invaluable opportunities to examine the mechanisms behind its recurrent leadership shifts. Three major phases can be identified in its 100-year history. The first notable historical event was the development of the 35-mm rangefinder camera developed by German firms in the early twentieth century. This was followed by three different technologies or product designs. The first was the single lens reflex (SLR) camera introduced by Japanese firms in the mid-1950s, which captured the major market share by the mid-1960s. In turn, this was followed by the development of the digital SLR (DSLR) camera in the 1980s–1990s by the (then) leading Japanese firms, which continued to dominate the camera market. Finally, the Mirrorless camera was developed by other latecomer Japanese and Korean firms in the late 2000s, achieving a large market share by the mid-2010s despite significant barriers to entry in this industry. These varied episodes in the interchangeable-lens camera market provide ample opportunities to study changes in industrial leadership that occur repeatedly not only between firms, but also between countries.

In terms of research methodology, we rely mainly on secondary sources of information when scrutinizing the three phases of leadership in the interchangeable-lens camera market. We look at global or national market shares either at the individual firm level or at the level of technological standards. Other, less explicit dimensions, such as superiority of new technologies, their rapid diffusion/adoption, and industry experts' opinion, are considered as well.

Our baseline research question is as follows: what are the factors that make changes in industrial leadership possible (or impossible)? Subsequent questions that naturally arise include: why did the catch-up in this industry occur successively? Finally, what are the commonalities and peculiarities across multiple catch-up cases?

This paper is organized as follows. In Section 2, we provide the theoretical framework for our analyses on multiple leadership shifts across firms and nations. We also outline important concepts related to technological change and catch-up. In Section 3, we describe the specific product that claims our attention: the interchangeable-lens camera. In Sections 4–6, we analyze the three phases of industry leadership in chronological order. In each section, we begin with a brief narration of the catch-up story and then discuss three windows of opportunity and strategic actions of both latecomer and leader firms. Section 7 then summarizes our main findings and concludes the study.

2. Theoretical framework

In scrutinizing successive changes in industrial leadership that happened at the firm or country levels, we comprehensively identify explanatory factors at various levels. Several fine theories and frameworks have been developed, such as product cycle theory (Posner, 1961; Vernon, 1966), sectoral systems of innovation (Malerba, 2002), patterns of technological catch-up (Lee and Lim, 2001), and national innovation systems (Freeman, 1987; Lundvall, 1992; Nelson, 1993). However, given that our study entails both temporal variation (successive leadership shifts) and level-of-analysis variation (firm, industry, national, and international factors), no single theory may be adequate to explain the phenomena of interest.

Recognizing a need for a more integrative approach, Lee and Malerba (2016) devised a new theoretical framework that captures the various features of dynamic shifts in industrial leadership. Their framework consists of two main components: windows of opportunity and strategies of firms. First, they further developed the concept of windows of opportunity, building on Perez and Soete (1988), as follows. As an industry evolves, one or more of the fundamental components of the sectoral system may change. This change paves the way for latecomers to catch up. Three windows of opportunity are proposed in that study: (1) changes in knowledge/technology, (2) changes in demand, and (3) changes in institutions and public policy. The second component that completes the framework is firm capabilities and strategies. In dynamic industrial environments, firms are actors that compete in the market. In this study, we distinguish the strategies of incumbent leaders from those of challengers, and discuss strategic interactions between them. Windows of opportunity and firm strategies are intimately connected to each other and to the cycle of leadership shift (or catch-up) in industries.

To facilitate analysis of these two important components of Lee and Malerba (2016), we highlight several important concepts about technological change. First, to assess the effects of new technologies, we make use of Tushman and Anderson's (1986) insightful work; they classified technological discontinuity in terms of a firm's existing competence. A *competence-enhancing discontinuity* represents "an order-of-magnitude improvement over prior products [that] build[s] on existing know-how", whereas a *competence-destroying discontinuity* is a "mastery of the new technology which fundamentally alters the set of relevant competences within a product class" (Tushman and Anderson, 1986: p. 442). Incumbent firms in an industry are in a superior position to exploit competence-enhancing discontinuities, whereas a competence-destroying discontinuity, which disrupts the established industry structure, favors new entrants or latecomers.

Second, Lee and Lim (2001) developed a similar concept from the perspective of firm strategies. Building on Perez and Soete's (1988) "leapfrogging" concept, they drew a contrast between path-creating catch-up (in which a new technological trajectory is pioneered) and path-following catch-up (in which latecomers pursue the same technological path as the existing leaders). Path-skipping catch-up, in which the existing technological trajectory is followed but several steps are skipped, lies in between.

Along with challenging firms' capabilities and strategies, incumbents' responses also play an important role in the catch-up process. Incumbent leaders generally have superior resources and capabilities compared to latecomers and thus are inclined to build on their current technological assets or trajectories. This path dependency makes industrial leaders inattentive to changing demands or disruptive technologies. This is often called the "incumbent trap" (Chandy and Tellis, 2000) or "success trap" (Levinthal and March, 1993). We discuss how the competitive assets or strategies

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