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978-1-107-04268-1 - Schumpeterian Analysis of Economic Catch-up: Knowledge, Path-Creation, and the Middle-Income Trap

Keun Lee

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## *Schumpeterian Analysis of Economic Catch-up*

One of the puzzles about why some countries have stronger economic growth than others revolves around the so-called “middle-income trap,” the situation in which a country that has grown strongly gets stuck at a certain level. In this book, Keun Lee explores the reasons why examples of successful catching-up are limited and in particular, why the Asian economies, including China, have managed to move, or are moving, beyond middle-income status but economic growth has stalled in some Latin American countries. This is one of the first studies to demonstrate using patent analysis that the secret lies in innovative systems at the firm, sector, and country levels which promote investment in what the author calls “short-cycle” technologies and thereby create a new path different from that of forerunning countries. With its comprehensive policy framework for development as well as useful quantitative methods, this is essential reading for academic researchers and practitioners.

KEUN LEE is a Professor of Economics at the Seoul National University and Director of the Center for Economic Catch-up. He is a globally recognized expert on the economics of catch-up and Asian economies. Professor Lee is also a member of the UN’s Committee for Development Policy, a co-editor of the journal *Research Policy*, and a member of the governing board of Globelics, as well as the Asia-Pacific Innovation Network.

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“This book lays out a convincing new perspective on the conditions behind the remarkable development of manufacturing in South Korea and Taiwan. The well documented argument is that in several of the industries where firms in these countries were very successful, technology at the frontier was going through a transition, with the technology coming in requiring a different set of skills and capabilities than the technology becoming obsolete. This diminished the advantage of the old industrial leaders and provided a window of opportunity for effective entry in these two economies. The story Keun Lee tells is fascinating and thought provoking.”

Richard Nelson, Professor, Columbia University

“Based on convincing theoretical and empirical analyses, Professor Lee argues that Korea and Taiwan’s success hinges on their shift, after reaching middle-income status in the 1980s, to specialize on shorter cycle technology-based sectors, which rely less on existing technologies, allow their economies to leverage the greater opportunities that arise from the emergence of new technologies, and enable them to continue the catching up process. This book is original, makes important contributions to the development literature, and should be read by anyone concerned about how to help a country overcome the middle-income trap.”

Justin Yifu Lin, Peking University and  
Former Chief Economist, the World Bank

“The manuscript is original, relevant and impressive because Keun Lee consistently proves his argument with analyses conducted at three connected levels: countries, sectors and firm. Keun Lee inserts findings into a broader discussion of economic catch up, and on the role of public policy. The book encompasses other large emerging countries that were not (yet) as successful as Korea and Taiwan, such as India and Brazil, or that are on the road of sustained catch-up such as China.”

Franco Malerba, Editor, *Industrial & Corporate Change*

“This book is essential reading for any scholar interested in the economics of technological catch-up. While the core argument interestingly emphasizes the length of technological life cycles, Keun Lee here provides a fascinating treatment of the role of different types of firms and countries in the capacity for catch-up.”

John Cantwell, Editor-in-Chief, *Journal of  
International Business Studies*

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“Based on a profound theoretical understanding of the process of technological change and using careful and innovative empirical methodologies, the book provides a very sophisticated framework to understand the process of technological innovation and learning at the firm, sectoral, and national levels. It is a path-breaking work that should be read by everyone who is interested in understanding the process of economic development.”

Ha-Joon Chang, University of Cambridge  
and author of *Kicking Away the Ladder*

“The book presents an original analysis of the catch-up processes pursued by Korea and Taiwan (with a discussion extended to China and India) demonstrating (using patent data analysis) that successful catch-up involves strong attention to targeted knowledge capture and build-up of capabilities. The argument is that catch-up is always strategic, in that there must be smart choices made over which technologies to target, and the role of what are called high, middle and low roads. It is sure to become a classic in the field.”

John Mathews, author of *Tiger Technology*  
and Professor at Macquarie University

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## Foreword

JOHN A. MATHEWS

Macquarie University

One hundred years ago in 1912 a very young Joseph Schumpeter published an epochal book, *The Theory of Economic Development*, in which he laid bare the mechanisms through which capitalism expands and renews itself. In the intervening century, the system he described so well has expanded worldwide, and is now drawing in China, India et al. Yet while Schumpeter's emphasis on innovation and creative destruction was entirely correct, his dismissal of follow-up strategies as "mere imitation" has not stood the test of time. First Japan, then Korea and Taiwan, and now China are all pursuing highly sophisticated strategies of resource leverage and knowledge appropriation that have enabled them to catch up with the industrial leaders (in the cases of Korea and Taiwan) or to be well embarked on the process, in China's case.

One hundred years later, Keun Lee finally provides a clear account of just how they are doing it. His book draws from his own and colleagues' empirical investigations of Korea's catch-up strategies, and engages with the wider literature on industrial and competitive dynamics. The book presents a sustained and original analysis of the catch-up processes pursued by Korea and Taiwan (with a discussion extended to China) demonstrating – using patent data and analysis – that successful catch-up involves strong attention to targeted knowledge capture and build-up of broad capabilities. Keun Lee demonstrates that countries that catch up do so by targeting specific technologies that are characterized by what he calls short cycle times – meaning that they have a high rate of product and process turnover (as measured in terms of patenting rates). Using the examples of Korea and Taiwan, Keun Lee shows how the two countries acquired their initial technological capabilities for the decade 1975 to 1985 in technologies such as automobiles, steel, and chemicals (of lengthening cycle times) but passed their first transition, or turning point, in the

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mid 1980s when they started systematically targeting technologies with shorter cycle times (electronics, semiconductors, flat panel displays, IT) which required them to build broad capabilities in these fast-moving technologies. They then passed a second transition, or turning point, at around the year 2000 when they started concentrating on the most advanced technologies with longer cycle times, thereby approaching the technological frontier (as now achieved by companies such as Samsung, Hyundai and LG in Korea, and Acer, or AU Optronics in Taiwan). This is an instructive and very significant and original contribution (see Figure 6.1).

Keun Lee's contribution goes beyond arguments that emphasized how latecomers should target technologies that were standardized ("dominant technologies") – developed by scholars such as Alice Amsden, Sanjaya Lall, Linsu Kim, Richard Nelson, and myself. Keun Lee's new emphasis on technology cycle time clarifies why some technologies work better than others as vehicles for catch-up. He argues that countries like Korea and Taiwan go through a kind of "technological detour," pursuing the highest levels of technological capability only after mastering the medium levels associated with short-cycle technologies. By contrast, countries that go straight for the highest levels (as revealed in their patenting records) tend to burn out and fall behind (as he argues has been the case for some Latin American countries). By the same token, countries that go for only the lowest-level long-cycle technologies (like basic steel-making or automotive assembly) then get stuck at this technological level. In this sense his argument is the very opposite of the celebrated "product life cycle" approach associated with Ray Vernon of Harvard, where it is argued that countries emerge from poverty by focussing on the most mature parts of the product life cycle. Lee's argument is that this constrains countries' further development, and they end up caught in the "middle-income country trap."

Lee's argument also has something to say about countries that are at the earliest stage of development, where they need to focus on what he (and Justin Yifu Lin of the World Bank) call trade-based strategies, or what used to be called simply the pursuit of comparative advantage. These strategies can lift incomes in countries as they build industries in the simplest kinds of activities, exploiting their low labor costs – but need to be complemented, according to Lee, by promoting new industrial shoots where the focus is on successively shorter-cycle-time

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technologies. Otherwise countries again run the real risk of being stuck at a certain level of development and lacking the technological base for moving forward.

There are three points to make about this fresh argument from Keun Lee. The first is that it is firmly technology based – and thus leaves behind many of the less than helpful ideas associated with the Washington consensus, where the focus was exclusively on macro-economic variables at the expense of concern for development of technological capabilities. This makes it profoundly Schumpeterian in spirit. The second is that it is concerned with industrial development as a process of changing industry structure through targeted initiatives. In this sense it is profoundly Gerschenkronian, always being focussed on the latest technologies that offer opportunities for leapfrogging. Thus it places industrial policy firmly back on the development agenda. The third is that it views the role of the state in economic catch-up as essential, where strategies are driven by collective entrepreneurship exercised through ministries, state-funded R&D centres, and universities, all pursuing various levels of technological catch-up. Strategies that leave out this essential role for the state in catch-up are doomed to fail, according to Keun Lee – and he is right.

This book is well argued. The data are presented using country-level, sector-level, and firm-level analysis (e.g. Samsung and its knowledge trajectory tracked by patenting). The argument is that catch-up is always strategic, in that smart choices must be made about which technologies to target based on their characteristics (e.g. long-cycle technology vs. short-cycle technology), and the role of what are called the high, middle, and low roads in accomplishing the catch-up. It is sure to become a classic in the field.

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## *Preface*

This book originated with a research grant I received from the National Research Foundation of Korea (No. B00007). Given only to a selected number of “star” scholars, this Ministry of Education funded grant requires scholars to write a single-authored monograph over a five-year period. Before I received it, I had, like most economists, focussed my energies mainly on writing journal articles. Although I had published my doctoral thesis as a book some time ago, I felt that writing an article for a journal was a far more valuable contribution than writing a book. Needless to say, I did not like the idea of writing one, and without the grant, this book would not have existed.

I have since realized my folly. Writing a monograph became an opportunity to synthesize my work and to compile the ideas I have scattered across journals. In one sense, this book is an outcome of the Korean government’s “industrial policy” in the area of education. While the focus of Korean industrial policy during the catch-up period was to promote specific industries, the current priority of the Korean government is to boost the level of academic scholarship.

Given the background of the book, and its focus on economic catch-up, it is somewhat ironic that it devotes so little space to industrial policy itself. The reason for this is that several important works have already been written on industrial policy in East Asia, such as those by Ha-Joon Chang (1994) and Alice Amsden (1989). Adopting a Schumpeterian approach to innovation systems, this book provides a more theoretical and generalizable account of the divergent process of catch-up as it occurs in different countries or parts of the world. In addressing the important question of why some countries have been more successful than others, the book identifies several key innovation systems. The cycle time of technologies is one such variable. This refers to the speed with which technologies change or become obsolete over time, and the speed and frequency at which new technologies emerge.

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This book demonstrates that successful economies and firms have tended to specialize in, or gradually move into, sectors based on short-cycle technologies.

The argument that qualified latecomers can advantageously target such sectors and specialize in them is based on the fact that the dominance of the incumbent can be disrupted by the opportunities presented by ever-emerging new technologies. Latecomers do not have to rely too greatly on the existing technologies whose use is dominated by the incumbents. The new opportunities present new growth prospects, and a lower reliance on existing technologies may lead to the faster localization of a knowledge-creation mechanism. This property could also mean lower entry barriers and the possibility of greater profitability since there is less conflict with the technologies of advanced countries, fewer required royalty payments, and even a first-/fast-mover advantage or product differentiation. As an analogy, research by Jones and Weinberg (2001) on the age-achievement relationship in the natural sciences demonstrates that young scientists (who can be seen as being similar to late entrants attempting to play catch-up) tend to make more contributions at a younger age when they practice in the fields of abstract /deductive knowledge than when they attempt to make a mark in the more inductive fields that draw on accumulated knowledge, and in which existing knowledge is slow to reach obsolescence.

This book often uses Korean and Taiwanese firms and industries as examples of successful catch-up, leaving us with an intriguing question: did the policy makers in these countries have the criterion of short cycle time firmly in mind as they planned and conducted industrial policy? While the answer to this question is no, they were in fact always asking themselves, “what’s next?” They looked keenly at which industries and businesses were likely to emerge in the immediate future and thought carefully about how to enter the emerging ones. Without specifically planning to do so, in effect the policy makers were always pursuing the short-cycle industries as these were often the ones that relied the least on existing technologies.

The key strategies for economic development identified in the current study differ from those traditionally recommended. We maintain that trade-based specialization is more suitable for low-income countries than middle-income countries. This study then makes its biggest contribution to the literature by taking the first step to explicitly and

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theoretically addressing the specialization conditions for middle-income countries. We recommend that they specialize in technological sectors that rely the least on existing technologies, and that afford the greatest opportunities associated with new technologies. In this way, our findings complement the growth identification and facilitation framework of Justin Lin, in which policy makers are advised to target an industry that is new to a latecomer country but mature in a forerunning country. This allows the latecomer country to begin the process of moving into shorter-cycle sectors. This book argues that after a certain amount of technological capability has been built up in the latecomer economy, it can then target another industry that is new to both the latecomer and forerunning economies. This is an effort at leapfrogging, and China is already doing this in various industries. Thus the distinctive policy argument of this book is that sustained industrial catch-up requires not only an entrance into mature industries, but also an effort to leapfrog into emerging industries that are new to both advanced and developing countries.

I would also like to contrast this book's emphasis on innovative systems with that on inclusive systems in the book *Why Nations Fail* by Acemoglu and Robinson (2012). First of all, their book does not explain how a country can move toward more inclusive institutions, which is also pointed out in a book review by Bill Gates. Furthermore, I observe that the inclusive or extractive dimension may be relevant more for low-income countries or pre-modern economies existing before the world became interdependent and globalized, and that contemporary middle-income nations fail not so much because of extractive institutions but more because of weak innovation systems, since these also affect their international competitiveness. This contrasts with differences in the degree of inclusiveness among them, which are not that substantial.

This study also provides a yardstick with which one can assess whether a middle-income country is stuck in the middle-income trap, or whether it is in fact moving beyond the middle-income stage to achieve high-income status. We label this phenomenon the technological turning point, or the point at which cycle time, as measured by the patent portfolio of a country, reaches a peak and turns to technologies with shorter cycle times. Korea and Taiwan passed this turning point in the mid 1980s, and China seems to have reached this point in the mid 1990s. The Indian graph also shows a peak in its cycle

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time in the late 1990s, but a downward trend is not yet clear enough for us to declare that India has passed its technological turning point.

While this book defines economic catch-up as a narrowing of a firm or country's gap *vis-à-vis* a leading country or firm, the concept has a long history, going back to the famous work of Gerschenkron (1962) and, Abramowitz's (1986) influential article ("Catching up, Forging ahead, and Falling behind"), which popularized the concept of catch-up and made it part of the standard vocabulary of development economists. While the article examines the relative performance of European economies after World War II, this book is about non-Western latecomer countries. It conducts a multinational, quantitative analysis of economic catch-up across three dimensions (i.e. firms, sectors, and countries) based on a single consistent framework focussed on the innovation system. This multi-level analysis identifies a consistent set of catch-up determinants and operationalizes them using patent data, with technological cycle time (short cycles) serving as the transition variable, and the localization of knowledge creation and technological diversification serving as end-point variables.

This book offers both new and refined methodologies for quantifying the conceptual elements of innovation systems and Schumpeterian economics, which can be used to conduct econometric analyses across country, sector, and firm levels. While these methods are useful for researchers, the book also contains important insights for practitioners and policy makers. In particular, Chapter 7 offers suggestions on building up the technological capability required for the journey toward economic catch-up. It focusses on the role of the government, of public research institutes, and of public-private partnerships. We consider capability building to be one of the most binding elements in catching up growth.

This book owes a lot to an intellectual tradition that may be called neo-Schumpeterian or evolutionary economics, and in particular to the works of Richard Nelson, beginning with the book he co-authored with Sidney Winter (1982) called *An Evolutionary Theory of Economic Change*. I am a latecomer in this school and I came to study the book only in the early 1990s – a full decade after it was first published. My intellectual journey started in that period, and I evolved from being a student of the economics of transitioning former socialist economies, to being a student of the economics of innovation in latecomer economies. Interestingly, both areas can be subsumed

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under the heading “economics of catch-up”. While the former is about the catch-up of economic systems, both focus on reducing the performance gap between latecomers and the forerunning economies. This book argues that you cannot catch up by trying to directly emulate or replicate the economic practices of the forerunning economies. Catch-up comes only if you take a different path.

My personal encounter with Nelson came another ten years after my encounter with his book, at the 2004 Globelics Conference held in Beijing. After the conference, I became a key participant of the research group on catch-up that he initiated, as well as of the Globelics conferences led by another mentor of mine, Bengt-Ake Lundvall. The catch-up group held its first meeting at the campus of the Columbia University in May 2005. The meeting resulted in several books on multiple subjects, specifically sectoral innovation systems and catch-up (Malerba and Nelson 2012), intellectual property rights (IPR) and catch-up (Odagiri et al. 2010), and innovative firms and catch-up (Amann and Cantwell 2012). It also spawned another forthcoming book on university–industry linkages and catch-up. I have contributed a chapter to each of the four books and have learnt tremendously from the community which meets annually at the Globelics meeting. Earlier sections of the book have been presented at these meetings, and they have provided me with a great opportunity to pursue my own intellectual catch-up through exposure to the leading ideas of eminent scholars in the field, such as John Cantwell, Giovanni Dosi, and Franco Malerba. It has been my good fortune to receive both direct and indirect feedback on my research from these scholars.

A number of other scholars have kindly provided me with comments on the manuscript version of this book. Specifically, Nelson led me to explore more literature on the Schumpeterian theory of the firm, and to further revise a chapter on firm-level analysis. He introduced me also to Tushman’s works, which offered the insight that competence-destroying discontinuity may lead to the rise of new entrants. As one of the pioneers in the subject of technological catch-up, John Mathews read several versions of the manuscript and suggested a number of important changes to the overall structure of the book. He led me to reevaluate the priority given to key concepts of the book, and I benefitted from his encouragement and feedback at various stages of writing this manuscript.

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Among his feedback, Adam Szirmai's remarks on the generalizability of the technological turning points led me to think more deeply about this issue and I added a separate chapter on the subject (Chapter 9). I recently found out that postwar Japan also specialized in much shorter-cycle technologies than European countries, although by then it was too late to add this. Kangkook Lee and Kyoocho Park have also commented on early versions of this book. I have to thank Park in particular because we first identified the importance of technology cycle time during our collaboration.

The econometric analysis conducted in this book would not have been possible without a data set of US patents. This was compiled by the NBER research group, in particular Bronwyn Hall, who also provided comments on Chapter 4 after I presented my findings at a conference in Hitotsubashi University. Some variables used in the book were directly retrieved from the data set, with my research team reclassifying them at the firm, sector, and country level. I would like to thank my students for managing the data set and conducting the statistical analysis, particularly Junki Park, Buru Im, Raeyoon Kang, and Hochul Shin.

Earlier versions of sections of this book have been presented at various academic meetings and the final versions have benefitted greatly from participant feedback. I would like to thank Eduardo Albuquerque, Hyunbai Chun, Susan Cozzens, John Foster, Xudong Gao, Shulin Gu, Mei-Chih Hu, K. J. Joseph, Taehyun Jung, Byung-Yeon Kim, Chulhee Lee, Xibao Li, Maureen McKelvey, Justin Lin, Xielin Liu, Mehdi Majidpour, Mammo Muchi, Rajeshwari S. Raina, Sadao Nagaoka, Barry Naughton, Hiro Odagiri, Walter Park, Rajah Rasiah, Bhaven Samphat, Elias Sanidas, Daniel Schiller, Jung C. Shin, Lakhwinder Singh, Joseph Stiglitz, Bart Verspagen, Yi Wang, Brian Wright, Guisheng Wu, Xiaobo Wu, Yao Yang, Gabriel Yoguel, and Jiang Yu. Notable occasions on which feedback was received include the 2012 International Schumpeter Society held in Brisbane, several Globelics conferences (Beijing, Kuala Lumpur, Mexico City, Buenos Aires, Dakar), the IEA–World Bank Conference on New Thinking in Industrial Policy, the EPIP conference in Tokyo, the Atlanta Conference on Science, Technology, and Innovation Policy, the Cicalics Workshops (Hangzhou and Beijing), the Africalics Academy (Nairobi, Kenya), the Asia-Pacific Innovation Conferences (Singapore and Seoul), the Gordon Research Conference (New Hampshire), and the

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*Preface*

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EBES Conference (Istanbul). The book benefitted also from presentation at many seminars held at Tsinghua University, the China Academy of Sciences, the University of Gothenburg, UNU-MERIT, the American University, the Amirkabir University of Technology (Teheran), Punjabi University, Kyoto University, CCER and the School of Economics of Peking University, UFMG (Belo Horizonte), Korea University, Lund University, Hanover University, Seoul National University, and NIS-TADS (New Delhi).

I would also like to thank the staff at Cambridge University Press, whose valuable work has made this book available to the world, including Chris Harrison, Claire Poole, and Tom O'Reilly. A couple of editors have helped me by lending professional English-editing services to this work. In particular, I thank Amrit Kaur for this service. The last acknowledgement (but certainly not the least) goes to my lovely wife, So-yeon, who always stands by me with her prayers.

Keun Lee,  
On the hills of Gwan-ak Mountain, Seoul, Spring 2013