Interconnected Worlds: Global Electronics and Production Networks in East Asia

Henry Wai-chung YEUNG

In press, April-May 2022
Innovation and Technology in the World Economy Series
Stanford University Press, Stanford, CA

(For Backcover: *Henry Wai-chung Yeung is Distinguished Professor and co-director of Global Production Networks Centre at the National University of Singapore. He is author of* Strategic Coupling: East Asian Industrial Transformation in the New Global Economy *and co-author of* Global Production Networks: Theorizing Economic Development in an Interconnected World)

Contents

Detail Chapter contents

Preface

The global electronics industry – "global electronics" in short – is certainly one of the most innovation-driven and technology-intensive sectors in the contemporary world economy. The Covid-19 pandemic in 2020 and 2021 made us all deeply aware of the critical importance of various electronic devices in supporting our remote work, learning, and daily life, and their intricate production across the world. Indeed, global electronics is characterized by organizationally fragmented and geographically dispersed production networks. Many devices and products in today's information and communications technology (ICT) sector are developed and manufactured in several macro-regions and yet sold worldwide in all end markets. From semiconductor chips powering these devices to end products such as personal computers, smartphones, and televisions, complex transnational production and value-generating activities – coordinated by lead firms through their in-house facilities and/or outsourced partners around the world – have integrated diverse macro-regions and national economies worldwide into what might be termed the "interconnected worlds" of global electronics.

Using the motif of "worlds" to describe the predominant model(s) of organizing electronics production, I argue that the current era of interconnected worlds started in the early 1990s when electronics production moved from the multi-national worlds of innovation and production systems dominated by domestic lead firms in the United States, Western Europe, and Japan towards increasingly globalized and cross-macro-regional worlds of electronics manufacturing centered in East Asia – a large region comprising Northeast Asia (e.g. China, Japan, South Korea, and Taiwan) and Southeast Asia (e.g. Indonesia, Malaysia, Singapore, and Vietnam). Over time and as more electronics manufacturing shifted towards key locations in East Asia, lead firms in the US, Western Europe, and Japan remained dominant in technological innovation and product development. By the 2010s – the book's main focus, this co-evolution of production network complexity and interconnectedness led to a transformative shift in global electronics through which lead firms from South Korea, Taiwan, and China emerged as key players by integrating their home macro-region – East Asia – into these interconnected worlds of global electronics production comprising predominantly the US, East Asia, and Europe.

This monograph describes and explains this co-evolution of globalized electronics production centered in East Asia during the 2010s. To date, a significant body of literature has been written about the historical development of the electronics industry in specific national economies. But very few of these scholarly studies have extended their analytical coverage to the 2010s, the decade in which East Asian economies and lead firms became dominant in electronics manufacturing. In theoretical terms, this work also differs substantively from most earlier academic studies of the electronics industry, as I do not focus on individual national economies and industrial transformation *within* them – I have previously published a monograph taking this inter-national political economy approach to industrial transformation in East Asia (*Strategic Coupling*, Cornell University Press, 2016). Contributing to cutting-edge social science debates on global production networks and global value chains, my theoretical framing in this book is premised on a *network* approach that examines intra-firm and inter-firm production activities across different national economies and sub-national regions. Understanding the innovative organization of these firm-specific activities in the form of global production networks, in turn, allows us to appreciate better the evolving complexity of the interconnected worlds of global electronics. This conceptual approach extends my earlier theoretical work in *Global Production Networks* (with Neil Coe, Oxford University Press, 2015).

In a nutshell then, this work is meant to be a theory-driven analysis of electronics global production networks. My main goal is to develop the idea of global production networks as innovative organizational platforms that connect different and yet interdependent "worlds" of production (e.g. from technological innovation in Silicon Valley to innovation and production in East Asia) and to demonstrate how the theory of global production networks, known as "GPN 2.0" in Coe and Yeung (2015), can be productively applied to explain these organizational dynamics in global electronics. The book thus offers an industrial-organizational analysis of *where*, *how*, and *why* electronics global production networks operate from a social science perspective. It is neither a detailed history of the development of any of its four major industry segments (semiconductors, personal computers, mobile handsets, and consumer electronics/TVs), nor a country-level study of these segments and national competitiveness *per se*. In this sense, it certainly goes beyond an industry analysis or a country study.

The book's main contribution should ideally be read as one that illustrates empirically the geographical configurations ("where"), organizational strategies ("how"), and causal drivers ("why") of electronics global production networks throughout the 2010s. This most contemporary decade can be characterized by much more complex worlds of electronics production – coordinated by lead firms from the US, East Asia, and Western Europe, underpinned by significant US-origin technologies and knowhow, and yet co-constituted by East Asia-based manufacturing facilities and firm-specific capabilities. This main focus on unpacking and explaining the organizational dynamics of electronics production networks in East Asia also means that the book has much less to say about broader economic development issues, such as labor, industrial upgrading, environment, and the state (politics and policies). But my focus on the "network box" and its underlying causal dynamics will be relevant for those development scholars interested in the unequal and contentious consequences for localities and sub-national regions that are "plugged" into or strategically coupled with these production networks.

While adopting the global production networks theory, this book primarily takes on an *empirical focus* through its wide-ranging analysis of global electronics throughout the 2010s. This analysis is underpinned by substantial new empirical material based on a custom dataset and personal interviews. First, I have acquired from IHS Markit/Informa Tech comprehensive proprietary data at the firm- and component-levels in the four major segments of global electronics (covering up to 2019 Q3): semiconductors, personal computers, mobile handsets, and consumer electronics (TVs). This custom material also includes highly detailed quantitative data on key electronics production networks in 2015 and 2018. Acknowledging semiconductors' distinctiveness as critical intermediate goods for ICT end products and their capital-intensive production networks, my empirical discussion in all chapters will follow the same logical order – starting with semiconductors before going into such end products as personal computers, mobile handsets, and TVs. Second, my qualitative dataset is derived from 64 interviews with 44 lead firms in these four segments. All interviews were conducted between 2017 and 2018 in various locations in East Asia – Singapore, Taiwan, South Korea, and China. Through the in depth analysis of this new and complementary material, the book's empirical chapters demonstrate where these electronics production networks operated throughout the 2010s, how they were organized in innovative ways, and why their pivot towards East Asia could be explained by several causal drivers and risk mitigation conceptualized in the GPN 2.0 theory.

The incredible and unexpected world events during the late 2019 to 2021 period, however, have added a major twist to my book's empirical analysis and potential use for future research, education, and policy. While I originally had the ongoing US-China trade conflicts in mind during the manuscript preparation starting in the second half of 2019, empirical events linked to the devastating Covid-19 pandemic since early 2020 have now clearly upended the world's expectations on the future of economic globalization and cross-border production networks in *all* industries and economic sectors. I believe there are very challenging policy implications and academic research agendas arising from these massive disruptions on a global scale during and after the pandemic. Where appropriate, I bring some of these current events and issues to the fore throughout the book and address them more fully in the concluding chapter. To some skeptical readers though, it might be tempting to dismiss this book's empirical observations on the interconnected worlds of global electronics up to the late 2010s and their relevance for the post-pandemic world economy in the 2020s. My sense is that much of the current discussion of global supply chain restructuring and national economic resilience in the public domain remains rather speculative and cursory due to the highly uncertain nature of these latest developments associated with the pandemic and ongoing geopolitical tensions (e.g. the US-China trade war since March 2018 and its likely refashioning in the post-Trump era under the Biden administration). Solid and complete up-to-date empirical data are rare in these media reports and business analyses – they are simply very hard to collect due to the widespread travel and social restrictions in 2020 and 2021!

While I am able to update some empirical material to 2020/2021 based on data releases up to July 2021 (finalization of manuscript), I believe the book's comprehensive analysis of global electronics production networks up to the late 2010s can serve as a definitive benchmark for future academic and policy research into the dynamic transformations in global electronics and, perhaps, other manufacturing industries. My book can also be a standard baseline reference for post-2020 empirical studies of global economic change. Some of these studies can be found in the current research on "Covid-19: what's next in the world economy?" and the "deglobalization/decoupling" literature focusing on the reshoring of manufacturing back to advanced countries and the disintegration of China-centered production networks. Future empirical research in different academic disciplines can certainly take advantage of this book's novel empirical material on intra- and inter-firm networks in all major segments of global electronics that "ends" at a relatively high point in the globalization of electronics production in 2018/2019 – an all-time high in both shipment and markets of semiconductors and mobile handsets, and near peak in personal computers and televisions. I believe these future comparative studies will very likely appreciate how the interconnected worlds of global electronics in the technology, production, and market domains are rather enduring and cannot be easily replaced by the politically motivated decoupling and reshoring initiatives that might seem fashionable in today's highly contentious world.

Tables and Figures

Tables

Figures