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Innovation and Upgrading pathways in the Chinese smartphone production GVC

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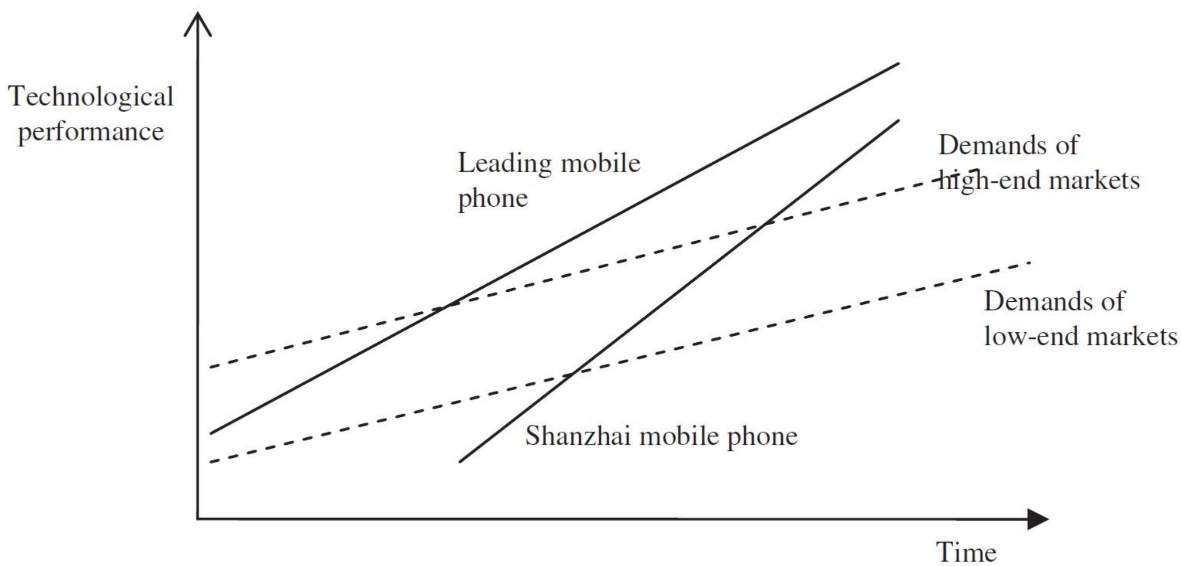
Abstract

This paper attends to the recent upgrading developments demonstrated by Chinese smartphone firms. Adopting a comparative approach of tearing down retail-accessible smartphones to their components, this paper traces the upgrading activities across global value chains (GVCs) that Chinese firms partake in during the production process. Upgrading is thus discovered to be diverse and complicated rather than a linear process, carrying significant implications for the production networks and supply chains in Chinese smartphone firms.

Introduction

China today is not only the world's largest exporter of labor-intensive goods but also remains as the largest producer of personal electronics devices, surpassing the output of the US (West & Lansang, 2018). Contrary to popular belief, Chinese smartphone producers do not merely mimic their competitors, instead, innovate to "catch-up" with international competitors by upgrading across Global Value Chains (GVCs). Utilizing Liu et al. 's (2015) illustration as a starting point, I open the dossier for both acknowledgement and critique.

Figure 1. Two different expectations, two sources of mobile phone manufacturing



Source: Liu et al. (2015, p. 273)

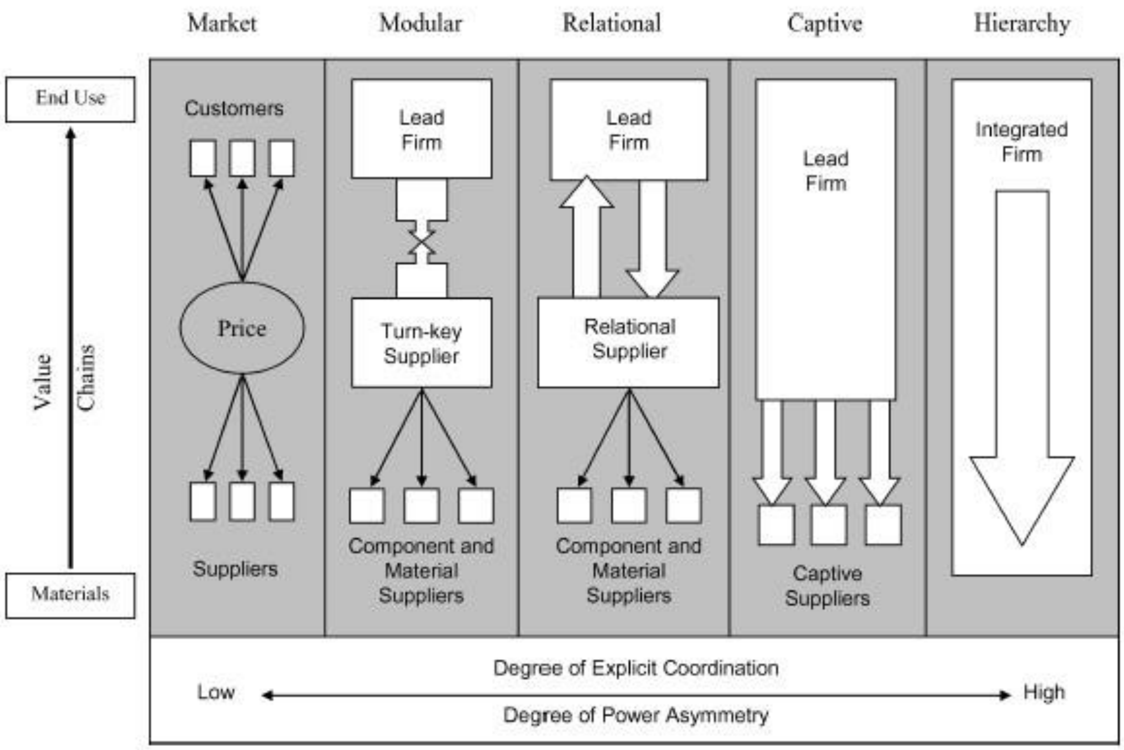
This paper primarily take issue with the linear depiction of technological improvements in leading smartphone firms in Figure 1 because upgrading is a complicated process involving different strategies and forms of innovation. Instead, it argues that leading Chinese smartphone firms subscribe to a non-linear upgrading process. Adopting a GVC approach, the paper first compares three leading Chinese firms' smartphone products to suggest a nonlinear growth trajectory. Subsequently, it traces Huawei's recent product innovation to pinpoint specific tactics taken to improve Chinese value capture.

Introducing Global Value Chains and Governance

A value chain consists the full spectrum of activities which firms undertake to bring a product from factory to customer. With globalization, value chains are effectively global in nature, due to the distribution of activities across transnational inter-firm networks

(Gereffi & FernandezStark, 2011, p.4). To study manufacturing, it is essential to focus on how the lead firm controls and coordinates its activities across GVCs through governance. According to Gereffi (1994, p.97), the governance of GVCs concerns "authority and power relationships that determine how financial, material and human resources are allocated and flow within a chain." The complexity of information and knowledge transfer, the codifiability of the knowledge for transmission, and the capabilities of suppliers influence what, where and how production is carried out (Gereffi et al., 2005). Specifically, in smartphone manufacturing, GVCs offer Chinese firms opportunities for catch-up and upgrading because of the reconfiguration in governance patterns within the consumer electronics GVC.

Figure 2. Five Global Value Chain Governance Typologies



Source: Gereffi et al. (2005)

Referencing Figure 2, I suggest that Chinese smartphone production has moved away from hierarchical and captive governance typologies, shifting towards more modular and relational forms, because of increasingly complex information that demands codification, and rising demands on supplier capabilities. In relational governance, transactions are difficult to codify; instead, depend on substantial inter-firm interactions and mutual reliance on suppliers for knowledge exchange (Gereffi & Fernandez-Stark, 2011, p.9). Built on long-term relationships and trust, relational governance thus creates difficulties when switching suppliers. When transactions and knowledge are easily codified, modular governance is achieved through a complex network of specialized suppliers, each dedicated to performing a single specialized task (Gereffi & Fernandez-Stark, 2011, p.9). Collectively, relational and modular GVCs enable leading Chinese firms to coordinate production of increasingly complex smartphones by disaggregating and dispersing production.

Modularity

Historically, electronics production was associated with vertical integration. When civilian electronics acquired popularity, production became reorganized along GVCs. Lead firms defined production parameters while non-lead firms manufactured according to their designs. Production became highly standardized to increase outsourcing, hence shifting towards horizontal integration. This shift is achieved by modularization, which reduces barriers to entry for non-lead firms to enter knowledge and technology-intensive activities.

Modularity is a design strategy which enables interchangeability of (multi)components (Brusoni & Prencipe, 2001). Ulrich (1995) regards modular architecture as a system that directly matches component production with module function. By extension, Sanchez and Mahoney (1997) suggest modular products could enable modular (re)organization, where each module could be specifically delegated to an organizational unit. They argue that modularity is effective because it allows for easy (de)coupling and independent production. Modularization proves powerful because it enables firms in developing countries to specialize in activities where they possess a comparative advantage to partake in the GVC.

The Limits to Modularity

However, there remains a fundamental difference between what these firms ultimately produce and what they actually know. As Brusoni et al (2001) argue, in aircraft production, the division of labor does not necessarily yield the same distribution pattern of knowledge access. Therefore, knowledge and organizational coordination remain critical despite the adoption of modular architectures in a GVC. Modularity alone does not suffice in explaining the upgrading of activities conducted by Chinese suppliers to “catch-up”. That many of these former OEM (Original Equipment Manufacturers) transformed themselves into “module specialists” or ODM (Original Design Manufacturing) firms imply additional capabilities are acquired, over the years, to produce components that were once too complicated to handle with more efficient processes.

Upgrading as Prerequisite

Participation in GVC is the critical first step for firms to achieve upgrading, but what matters more is how firms continue climbing up the learning (value) curve. According to

Humphrey and Schmitz (2002), there are four specific ways that upgrading could be pursued:

(1) product upgrading by improving product sophistication
(2) process upgrading through deployment of new technologies and improved coordination
(3) functional upgrading by entering new (higher value-added) functions
(4) inter-sectoral upgrading by moving into higher value sector by acquiring new competencies

Crucial to this is the concept of innovation, defined as the selective implementation of new ideas to reinvigorate products and processes and improve their value-add. Through GVCs, Chinese smartphone firms seek out incremental product upgrading through innovative hardware and software improvements to catch-up with competitors. They also strive to improve manufacturing processes by optimizing the production chain, while their suppliers are compelled to upgrade technological capabilities. If successful, some suppliers may even move into new functions or sectors, hence rise-up the value chain. For this paper, I suggest that Chinese upgrading is measurable (1) at the firm level from competitive product specifications, and, at the industrial scale, from (2) supplier's technological competencies and their value capture (from the factory to consumer).

Case Study 1: Comparison of 3 flagship Chinese Smartphones

Xiaomi, Oppo are leading Chinese smartphone firms known to offer value-for-money products with specifications that rival pricier competitor offerings. It is important first to recognize that each smartphone hardware configuration remains strongly predicated on compatibility with Google's Android OS, which is *de rigueur* implementation across most smartphones in the last decade. Essentially, software has replaced hardware as the new "turnkey solution", hence allowing firms to differentiate themselves through (compatible) hardware and branding. Therefore, modularization proves convincing, as these Chinese firms can mix-and-match compatible components and suppliers. They stay in business so long they continue delivering Android-supported devices with competitive component upgrades. Product innovation, therefore, occurs first from improved specifications of components sourced from the modular network of suppliers.

Figure 3. Comparison of Mi and Oppo Flagship device components

Oppo R11		Mi Mix 2	
Launch: June 2017		Launch: September 2017	
CPU - Snapdragon 600	Qualcomm (US)	CPU - Snapdragon 835	Qualcomm (US)

Flash Memory 6GB	Samsung (Korea)	Flash Memory 6GB	SK Hynix (Korea)
Display	Samsung (Korea)	Display	JDI (Japan)
Dual Camera	Sony (Japan)	Camera	Sony (Japan)
RAM 64GB	Samsung (Korea)	RAM 64GB	Samsung (Korea)

Source: Xing & He (2018)

A close examination of Oppo and Mi smartphones from 2017 reveal that most core components are produced overseas. Korean and Japanese firms dominate core components production for smartphones, resulting in significant foreign value capture. In contrast, only a few Chinese firms are involved in the provision of cheaper non-core parts e.g. fingerprint sensors produced by Goodix. Therefore, the lack of Chinese suppliers for advanced components cultivates heavy foreign supplier dependence, exposing the limits of modularity in enabling local upgrading. This heavy reliance on foreign technology signifies room for reduction in manufacturing costs and highlights Chinese firms' inability to assume manufacturing of more critical, by extension, more profitable core components. However, comparing cross-country distribution of value generated from retail and after-sales service support, China secures the largest share, with Oppo and Mi capturing 45.3% and 41.7% of their respective retail prices (Xing, 2019). Hence, brand building, ownership, marketing, and service are an essential means to capture more significant share of value.

Case Study 2: Huawei Flagship Lineup Teardown

Although innovation is challenging, the commitment that Chinese firms demonstrate to cultivate product niches and develop proprietary technology production capabilities is remarkable. Examining the evolution of Huawei's flagship devices across three years, I illustrate how a Chinese firm and its suppliers demonstrate upgrading across the GVC, revealing shifting trends in Chinese smartphone manufacturing processes.

Figure 4. Comparison of Huawei Flagship device components

Huawei P9	Huawei Mate 10	Huawei P30 Pro	Product Upgrading Outcomes
Launch: April 2016	Launch: November 2017	Launch: March 2019	

CPU - HiSilicon Kirin 955	China	CPU - HiSilicon Kirin 970	China	CPU - HiSilicon Kirin 980	China	• Improved local supplier competence • In-house Innovation
RAM 3GB	SK Hynix (Korea)	RAM 4/6GB	Samsung (Korea)	RAM 6/8GB	Samsung (Korea)	Continued foreign dominance
Display	Multiple sources	Display	Multiple sources	Display	BOE Technology (China)	• Improved local value capture • Improved local supplier competence
Dual Camera	Samsung (Korea) + Leica (Germany) R&D + Huawei (China)	Dual Camera	Samsung (Korea) + Leica (Germany) R&D + Huawei (China)	Quad Camera	Samsung (Korea) + Leica (Germany) R&D + Huawei (China)	• Successful cross organizational learning • Knowledge transfer • (Re)branding exercise to capitalize on Leica's reputation
Flash Memory 32GB	Samsung (Korea)	Flash memory 128/64GB	Toshiba (Japan)	Flash memory 128/256/ 512GB	Micron Technology (US)	Continued foreign dominance

Source: Dempsey (2016, 2018) and Tanaka (2019)

Huawei's entire lineup deviates from Oppo and Mi in that the most expensive Kirin Processor is domestically produced by local supplier HiSilicon. Incremental hardware upgrades in Kirin chipsets are visible from improved models implemented in every production cycle, which is achieved through in-house R&D instead of outsourcing. The latest P30 also differs from its Huawei predecessors because the high-cost OLED screen, formerly procured through multiple sourcing strategies, is now locally produced by BOE Technology. Therefore, local sourcing of core components (processing chips and displays) significantly increased Chinese value capture in P30 Pro production, hitting 38.1% of total manufacturing costs, significantly higher than aforementioned Mi and Oppo devices (Xing, 2019). It is worth noting that HiSilicon is a Huawei-owned semiconductor company with dedicated research capabilities that enabled internal innovation for chipsets, hence minimizing Huawei's foreign value capture and dependence. BOE Technology, was a struggling Chinese display supplier initially founded for military/defense purposes that eventually upgraded its capabilities with government subsidies and backward integration. BOE leadership established strategic alliances with leading Japanese and Korean LCD firms, and aggressively acquired Korea's Hynix and Hong Kong's TPV Technology Ltd to rapidly obtain foreign technology, human capital, and networks (Liu & Buck, 2009). Currently, they are capable of competing with Samsung in the rapidly expanding high-end OLED market, which is valued at $30billion (Chen et al., 2019). Therefore, Huawei is distinct in that local innovation and improvements in technological competence are pursued at an unparalleled intensity to achieve local substitution of core modules, alongside establishment of relationships with promising domestic suppliers demonstrating high technological competencies. In the process, local suppliers HiSilicon and BOE Technology therefore succeed in "catch-up" through functional and inter-sectoral upgrading with GVC participation. The upgrading pathways for Chinese smartphone firms are, therefore, numerous and diverse, far from linear, serving as evidence that different styles of innovation are appropriate for different organizations (Henderson & Clark, 1990).

While Oppo and Mi attained incremental product upgrades through modularity and improved Chinese value capture through brand building, Huawei invested heavily to develop production competencies for core components, achieving supplier substitution through in-house innovation. However, as Brusnoni et al. (2001) assert, multi-technology firms require knowledge that exceeds what they aim to produce due to unpredictable product requirements and differentiated rates of technological improvement. Hence, access to new networks of knowledge is envisaged as a necessity for Huawei to operationalize further growth (Low, 2007).

The expansion of knowledge networks to enable continued product and process upgrading is best illustrated by the cameras used by Huawei. This component must be historicized to 2016 when Leica announced their strategic collaboration with Huawei through the establishment of Max Berek Innovation Lab for joint research in digital optics and computational imaging, leading to the P9's groundbreaking dual-camera. By collaborating with specialized firms to ride on their expertise, the Leica partnership assisted Huawei in developing a product niche by revolutionizing their camera technology. While this proves to be an immediate R&D expense, it offers Huawei newfound credibility and an opportunity to (re)build the brand's public image according to its new expertise. Building on Leica's knowledge on camera optics over three years, Huawei's P30 Pro, equipped with a quad-camera setup demonstrates intensive camera improvement through R&D and the potential inter-firm transfer of knowledge, revealing (1) successful cross-organizational learning for upgrading, (2) in-house innovation of core components and (3) a successful branding exercise to capitalize on Leica's reputation for photography.

Conclusion

The nonlinear upgrading evinced in the Chinese smartphone GVCs is likely to continue in years to come. Therefore, I resist the simplistic argument that upgrading emerges in a linear trajectory. As Storper (1995) and David (1995) have importantly argued, innovation and technological change may "restart the clock" for codification, disrupting the functioning of modular architectures. Furthermore, supplier competence is likely to change over time, and new suppliers could challenge the durability of previously established relationships.

As Zhang and Vialle (2014) also argued, the development of the Chinese University system fostered close relationships between research and industry, thereby establishing the possibility to acquire and diffuse knowledge instead of codifying it. This local knowledge pool is augmented by sending students and scientist on scholarships overseas. Therefore, the future for upgrading across the GVC in Chinese electronics production seems promising with continued institutional support. I am confident that Chinese production may eventually break free from the stereotype of being low quality and lacking in innovation.

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