

# *China's Innovative Enterprises at the Frontiers: Lessons from Indigenous Innovation in Telecom-Equipment and Semiconductor Industries\**

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## *Abstract*

Advanced semiconductors and telecommunication technologies are both critical high-tech industries for China's success in indigenous innovation, defined as the process of improving upon technologies learned abroad and generating sophisticated technologies indigenously. Leading Chinese companies in both industries, including Huawei in telecom equipment and Semiconductor Manufacturing International Corporation (SMIC) in semiconductor fabrication, have been thrust into geopolitics because of their success as innovative enterprises. Examining Huawei and SMIC's processes of indigenous innovation in the historical context of government policies and industry development paths, this article argues that strategic innovation investment and sustained organizational learning in innovative enterprise, enabled by autonomy in decision making, are the key to successes in indigenous

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\* The project has been supported by the National Natural Science Foundation of China (Grant No. 71904029, 71673012). The author would like to thank William Lazonick and two anonymous reviewers for their helpful suggestions.

innovation. This industry study may have implications for the developing countries in rethinking and adjusting their policy practices and theories of innovation transition.

Competition for advanced semiconductor and next-generation telecommunication technologies has emerged as a contested battlefield in the U.S.-China high-tech rivalry. In recent years, the U.S. government has targeted leading Chinese high-tech companies, including Huawei Technologies and the ZTE Corporation in telecom equipment and Semiconductor Manufacturing International Corporation (SMIC) in semiconductors, with sanctions and export bans. While current U.S. trade policy will certainly create obstacles for China's further progress, this targeting nevertheless confirms that these Chinese firms have achieved a level of technological capabilities. Indeed, Huawei is the world's largest telecom equipment provider by revenue, with industry-leading 5G wireless technologies, while SMIC is the world's fifth largest pure-play semiconductor foundry,<sup>1</sup> although it severely lags behind Taiwan Semiconductor Manufacturing Corporation (TSMC), the top foundry, for at least 5 to 7 years in technology nodes.<sup>2</sup> Since both modern telecom-equipment and semiconductor industries barely existed in China forty years ago, Huawei and SMIC are remarkable achievements for China's indigenous innovation.

Indigenous innovation occurs when industry within a developing nation improves the quality and lowers the cost of technologies transferred from abroad and ultimately develops sophisticated technologies to enter global competition.<sup>3</sup> For developing nations, indigenous innovation is central to the transition from recipients of foreign technology transfers to novel innovators. While a developmental state can provide the necessary conditions for indigenous innovation by investing in physical infrastructure and human capabilities and facilitating technology transfers, it depends on business enterprises to carry out the indigenous innovation process and utilize resources and capabilities created by the state. Because innovation is uncertain, collective, and cumulative, it requires a set of organizational and institutional conditions for innovation to occur in innovating firms. William Lazonick calls this "social conditions of innovative enterprise," including "strategic control," "organizational integration," and "financial commitment."<sup>4</sup> *Strategic control* occurs when business executives who exercise corporate resource allocation have the capabilities and incentives to make strategic investments in innovation.