Characteristics of the Integrated Circuit Industries in the U.S. and China: A Primer

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This briefing provides an overview of U.S. and Chinese production, consumption, and trade patterns of integrated circuits (IC). [1] *It describes China's efforts to become more self-sufficient in the production of these goods, how advanced technologies are dependent upon ICs (in both intermediary and end-use products), and the controls the U.S. has in place on IC exports given sensitivities associated with their potential end-uses.*

U.S.-China IC trade and China's domestic support efforts

The U.S. integrated circuits industry maintains a competitive edge over China as well as other countries' IC industries in terms of global sales, technical capabilities (e.g., design, processing power), and associated R&D levels.[2] China has been the world's largest importer (since 2018) and largest consumer (since 2005) of ICs, primarily due to its firms' use of these products as intermediary inputs into consumer electronics, computers, and communication hardware that are ultimately domestically consumed or exported. Broad trades statistics, however, provide a conservative picture of the U.S. industry's competitiveness in this sector. This is explained by the fact that the vast majority of trade is conducted by foreign-invested enterprises (FIEs) in China who are conducting "related-party trade" along global supply chains.[3] FIEs in China are important producers, consumers, and traders of ICs. Despite their foreign affiliations, their activities are integrated into Chinese trade statistics and as such may appear as though they are part of Chinese business activities. With regard to U.S. data, the U.S. Department of Commerce (Commerce) attempts to differentiate the trade activities of such IC enterprises that are U.S.-owned but operating in China, by categorizing them explicitly as firms belonging to related party trade.

The OECD has recently summarized various countries' efforts to advance their domestic IC industries to become more globally competitive.[4] China is no exception and has recently set forth multiple plans to develop a closed-loop ecosystem pertaining to semiconductor manufacturing. Specifically, it has promoted self-sufficiency in the design, fabrication, and assembly of IC and semiconductor production, while simultaneously encouraging domestic consumption of these products.[5] In June 2014, the Chinese State Council announced the *Guidelines to Promote the National Integrated Circuit Industry* (National IC Plan and National IC Fund). These policies were designed to boost Chinese firms' manufacturing capabilities, by promoting FDI and domestic investment into that industry. In May 2015, moreover, the State Council released a draft of a new 'Made in China 2025' industrial policy, which more clearly aimed to develop information communication technologies and the IC industry upon which it depends. Some of these policies that China's State Council has introduced have not been fully implemented and play a role in influencing future IC-related investment, their supply chains, and trade patterns between the U.S. and China.

The role of ICs in advanced technology applications

ICs serve as one of the foundational inputs into artificial intelligence, aviation and aerospace engineering, high-tech manufacturing, and telecommunication technologies. Examples of ICs utilized in advanced technologies include complex programmable logic devices (CPLD), digital signal processors (DSP), field programmable gate

[1] Integrated circuits are broadly considered the most technically advanced semiconductor device.
[2] Semiconductor Industry Association (SIA), 2019. Factbook.
[3] Related-party trade refers to transactions involving trade between a USPPI (U.S. principal party of interest) and an ultimate consignee where either party owns directly or indirectly 6 percent or more of the other party, U.S. Census Bureau, Foreign Trade.
[4] OECD, 2019. "Measuring distortions in international markets: the semiconductor value chain."
[5] USTR, 2018. "Section 301 Report."

arrays (FPGA), microprocessor/microcontroller units (MPU/MCU), and monolithic microwave integrated circuits (MMIC). These ICs are incorporated into a variety of technologies including computers, mobile phones, communication hardware, radar systems, and satellite communications. ICs are also used in defense applications, including electronic warfare and weapon systems.[6] Moreover, ICs can be differentiated by their end-use, which in turn can be determined by specific variables used in production. For instance, certain variables of ICs include the operating temperatures, the number of digital inputs/outputs, and clocking/processing speeds. These variables help determine both the capabilities of the IC, as well as whether the IC is designed for a consumer, industrial, or specially designed for a military end-use.

Protecting sensitive IC technologies

Under existing U.S. export control regulations, ICs are principally under the jurisdiction of Commerce (dual-use technology) but are also referenced in the U.S. Department of State's regulations (defense/military technology). The commodity jurisdiction is an important component and purely determined by the parameters and technical specifications of the commodity in question, rendering its classification as crucial in terms of commercial viability. Technologies enabled by ICs are typically said to assist in maintaining the competitive posture of the U.S. microelectronics industry, especially at a time when technology policy incorporating ICs is becoming more controlled, sensitive, and critical. Further, ICs serve as a foundational input into the advancement of many technologies, whether they be consumer, industrial, or defense oriented. Identifying sensitive IC applications for the purposes of export controls remains a challenging task for regulators.[7] The evolving nature of technology in the industry, coupled with a regulatory environment that attempts to safeguard select technologies, requires continuous feedback between industry and regulators.

Only a small share (less than 2 percent in 2018, according to the Semiconductor Industry Association, or SIA) of ICs are designated for government or military end-uses in global markets. In the United States, this share was a bit larger but still small (approximately 3 percent) in 2018, according to the SIA.[8] Despite the small share of such uses, there are expansive export control regimes tied to ICs and electronics, which highlight the sensitivities applied to certain technologies. Furthermore, since ICs can be widely used in a multitude of technologies, applying export controls to a wider portfolio of goods may be difficult due to the potential ambiguity and sensitivity surrounding ICs' applications. Efforts to broaden the scope of such controls could have a significant impact on IC supply-chain configuration and trade globally, particularly between the U.S. and China.

Sources: Federal Register Notice. Review of Controls for Certain Emerging Technologies. November 19, 2018; Federal Register Notice. Implementation of Certain New Controls on Emerging Technologies Agreed at Wassenaar Arrangement 2018 Plenary. May 23, 2019; Fergusson, Ian F. Congressional Research Service. Export Controls: New Challenges. March 22, 2019; Max J. Zenglein, A. Max, Holzmann, Anna. Evolving Made in China 2025: China's industrial policy in the quest for global tech leadership. Mercator Institute of China Studies, July 2019; Semiconductor Industry Association. Beyond Borders Report. May 2016; U.S. Department of Commerce, U.S. Export Administration Regulations, Commerce Control List, Category 3. U.S. Department of State, International Traffic in Arms Regulations, USML, Category XI.

[6] Similar to the types of ICs identified above these same ICs can also be utilized in defense facets but may also contain additional parameters such as being radiation hardened and/or manufactured to precise military specifications (i.e. specially designed).

[7] Concerning exports of controlled commodities, along with the HTS/Schedule B, the commodity in question will be assigned an Export Control Classification Number (ECCN- Dept. of Commerce- dual-use articles) or United States Munitions List classification (USML- Dept. of State- defense/military articles, services, and/or related technical data) to assist in determining control parameters applied to the assigned classifications. Note that there are additional U.S. government agencies that have jurisdiction over specific export controls, but for the purposes of ICs, the above-mentioned serve as the principal agencies.

[8] SIA, 2018. End-use report.