Economics & Business Management
ISSN Print: 3079-5214
ISSN Online: 3079-5222
https://doi.org/10.63313/EBM.9150

Analysis of the Dependence of China's Integrated Circuit Related Industries on United States Technologies under the Context of United States Chip Export Controls

ShanMin Zhou
School of Economics and Trade, FoShan University, Foshan, 538000, China
Email: zhoushanmin0618@163.com

How to cite this paper: Zhou, S. M. (2026). Analysis of the Dependence of China's Integrated Circuit Related Industries on United States Technologies under the Context of United States Chip Export Controls. Economics & Business Management, 4(3), 42-56. ISSN Print: 3079-5214; ISSN Online: 3079-5222.
https://doi.org/10.63313/EBM.9150
Published: 2026-02-20

Copyright © 2026 by author(s) and Erytis Publishing Limited.
This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).
http://creativecommons.org/licenses/by/4.0/

Abstract

This study examines how United States chip export controls propagate through the semiconductor sector and reshape China's integrated circuit value chain. Using the 2020 national input–output table, it constructs a complete allocation coefficient matrix to quantify supply-driven transmission effects on downstream industries. The analysis shows that regulatory revisions to the Export Administration Regulations, expansion of the Entity List, and implementation of the Foreign Direct Product Rule together create a multilayer restriction system covering equipment, software, and materials, which generates structural dependence in critical technological nodes. Empirical results indicate that communication equipment, computer manufacturing, and automotive electronics exhibit the highest exposure to chip supply constraints, while modern service sectors also demonstrate strong sensitivity due to their reliance on digital infrastructure. Chips therefore function not only as essential manufacturing inputs but also as foundational components of the digital economy. The findings highlight the systemic vulnerability of high-technology manufacturing and advanced services to external supply shocks and suggest that strengthening domestic innovation capacity and substitution capability is central to improving industrial resilience.

Keywords

Chip Export Controls; Transmission Mechanisms; Input-output Analysis

1. Introduction

As global technological competition intensifies, the integrated circuit industry becomes a central domain of national security and industrial rivalry. As a critical segment of the high technology value chain, chips provide the fundamental infrastructure of the digital economy and serve as an important indicator of a country's technological autonomy and industrial security. The United States maintains long standing technological advantages in advanced chip design tools, manufacturing equipment, and key materials. Since 2018, it strengthens export controls toward China through revisions to the Export Administration Regulations (EAR), expansion of the Entity List, implementation of the Foreign Direct Product Rule (FDPR), and coordinated restrictions with the Netherlands and Japan on lithography equipment exports. These policies significantly weaken China's capacity to advance in leading process technologies and critical manufacturing stages, while imposing constraints on upstream domains such as EDA software, IP licensing, and photoresist materials. The result reveals a structural dependence on externally controlled technological bottlenecks.

In October 2022, the United States issues additional regulations targeting high performance computing and semiconductor manufacturing, extending export restrictions to artificial intelligence training systems, advanced logic devices, and cutting edge fabrication equipment. This shift transforms chip controls from isolated measures into a systematic blockade that integrates technological restrictions, market limitations, and investment constraints into a multilayered regulatory framework. The implementation of the CHIPS and Science Act of 2022 further strengthens domestic subsidies and industrial support policies in the United States, while national security guardrail provisions restrict subsidized firms from expanding investment and technology cooperation in China. These institutional arrangements intensify the external technological pressure faced by China's integrated circuit sector. As strategic competition between China and the United States deepens, chips no longer function merely as tradable goods but emerge as key strategic assets in global political and economic competition. Multidimensional export controls suppress domestic progress in chip design, manufacturing, and materials, and propagate through supply chain transmission channels to downstream industries including communication equipment, electronic manufacturing, and information services. This propagation generates systemic chain reactions across interconnected sectors[1][2].

Existing studies primarily examine China-United States technological rivalry from perspectives of international politics or strategic competition, while paying limited attention to the economic transmission mechanisms and structural industrial effects of export controls[3][4]. Conventional analyses based on trade elasticity or sectoral dependence are insufficient to reveal supply constraints under conditions of external technological blockade. In contrast to the demand driven Leontief framework, Ghosh (1958) proposes a supply oriented model that more effectively characterizes how upstream industries stimulate downstream production. Its core full allocation coefficient matrix quantifies the structural pattern through which a unit of upstream supply is absorbed by downstream sectors, thereby revealing transmission effects and systemic dependence within the national economy when key industries become constrained[5]. Under an environment of external regulatory pressure, supply driven input-output analysis therefore provides an effective tool for identifying critical nodes, evaluating the scope of blockade shocks, and designing substitution strategies.

Against this background, the present study uses China's 2020 national input–output table to construct a full allocation coefficient matrix. From a supply-side perspective, it measures the driving effects of chips on downstream integrated circuit sectors and treats this linkage as the intermediate transmission channel through which external policy shocks operate, thereby quantifying the structural dependence of China's semiconductor industry on United States technologies.

This study contributes in three dimensions. Methodologically, it integrates export control analysis with input–output modeling and applies full allocation coefficients to identify key sectors and dependence pathways under chip supply constraints, extending the application of the Ghosh framework to the analysis of non-tariff technological barriers. Theoretically, it develops an analytical framework linking external supply restrictions, industrial chain dependence, and systemic vulnerability, offering a quantitative perspective on how technological blockades affect industrial security. Empirically, scenario simulations of chip export restrictions identify the most exposed downstream sectors within China's semiconductor value chain and quantify the direction and intensity of cross-industry transmission, providing measurable evidence for evaluating industrial resilience and systemic risk.

2. Related Work

2.1. U.S. Export Controls and Industrial Implications

Since the early twenty first century, China's rapid economic expansion and manufacturing growth reposition it as a central actor in global trade. At the same time, China-United States relations increasingly shift toward strategic competition. In response, the United States gradually restructures its China policy, moving from the Asia Pacific rebalancing initiative during the Obama administration to tariff sanctions under the Trump administration and the explicit designation of China as a strategic competitor under the Biden administration[6]. Accelerated domestic demand and relatively open industrial policies promote the upgrading of China's semiconductor sector toward higher value segments of the global value chain. This progress intensifies strategic concerns in the United States and triggers successive rounds of technological restrictions aimed at limiting China's industrial advancement[7]. Lv et al. (2020) document that heightened trade frictions coincide with tighter controls on high technology exports, reinforced by extraterritorial jurisdiction and stricter foreign investment review[8]. Zhang and Tang (2023) further argue that the Biden administration's chip strategy carries long term implications for global technological governance and industrial security[9].

While existing research explains the institutional logic and macroeconomic consequences of United States export controls, quantitative investigation of how these policies propagate through industrial networks remains limited. Most studies emphasize institutional interpretation and short term effects, whereas systematic measurement of supply driven transmission and structural dependence is still underdeveloped.

2.2. Structural Dependence in China's Semiconductor Industry

China's integrated circuit industry expands rapidly under sustained policy support and gradually forms a production system spanning design, manufacturing, packaging, testing, and materials. Despite this progress, substantial external dependence remains in critical segments such as advanced equipment, EDA software, and key materials. Zhang et al. (2021) propose a dual helix iterative framework and argue that coordinated innovation between design and manufacturing is essential for overcoming technological bottlenecks[10]. Using patent network analysis, Yang et al. (2023) find that China's innovation system is characterized by concentrated core firms and dependent peripheral actors, suggesting that collaborative innovation networks remain incomplete[11]. Although external policy pressure accelerates domestic substitution, the resilience and coordination of the industrial chain remain limited.

These studies provide important insights into innovation patterns and structural constraints in China's semiconductor sector. However, quantitative measurement of structural dependence and transmission mechanisms under technological blockade conditions is still scarce. Existing research largely concentrates on policy discussion or firm level case analysis and rarely offers a systematic characterization of intersectoral supply dependence or its macroeconomic consequences.

2.3. Input-Output Approaches to Supply Side Policy Shocks

Input-output analysis provides a standard framework for examining industrial linkages and structural dependence. Leontief (1936) introduces a demand driven model to describe intersectoral relationships[12], while Ghosh (1958) develops a supply oriented formulation based on full allocation coefficients that captures upstream transmission effects[5]. Zhao and Ni (2020) employ the World Input-Output Database to evaluate the industrial consequences of China-United States trade frictions and show that high technology manufacturing exhibits concentrated dependence under supply constraints[13]. Tu (2023) uses scenario simulations to analyze technological decoupling and identifies the information and communication technology and semiconductor sectors as the most exposed[14]. Recent work integrates input-output models with social network analysis, hypothetical extraction, and multiregional frameworks to assess policy shocks and industrial resilience[15][16]. Shi et al. (2024) further quantify the effects of semiconductor supply disruptions in China and simulate extreme embargo scenarios coordinated by the United States and its allies[17].

Although input-output analysis effectively reveals intersectoral transmission under policy shocks, systematic supply side modeling of chip export controls and industrial dependence remains limited. Empirical applications of full allocation coefficients are largely confined to energy and trade studies and rarely extend to high technology supply chain blockades. This study therefore adopts a supply driven input-output framework to quantify systemic dependence and transmission pathways in China's integrated circuit sector, addressing an important gap in the existing literature.

3. Analytical Background

3.1. Evolution of United States Chip Export Control Policies

Export control measures targeting China's integrated circuit sector intensify progressively under the backdrop of escalating technological competition and trade frictions between China and the United States. Rather than emerging as isolated interventions, these policies evolve through a structured trajectory that reflects a transition from firm specific sanctions to institutionalized regulatory frameworks and eventually to a comprehensive system of strategic control instruments. As summarized in Table 1, this evolution can be broadly divided into three stages, each characterized by increasing policy coordination, legal formalization, and scope expansion. The trajectory indicates a shift from reactive measures toward a systematic architecture designed to constrain.

Table 1. Evolution of United States Export Control Policies Toward China.

Year	Policy Framework	Key Measures
2018	Trade Act of 1974; Export Control Reform Act (ECRA); Foreign Investment Risk Review Modernization Act	Strengthened semiconductor export restrictions, leading to a sharp decline in China-related imports
2019	Executive Order on Securing the Information and Communications Technology and Services Supply Chain; establishment of the Entity List	Prohibited transactions involving foreign ICT products deemed national security risks; Huawei added to the Entity List, restricting procurement of U.S. components and technologies
2020	Revision of Export Administration Regulations by the Bureau of Industry and Security (BIS)	Tighter thresholds for high-performance computing and advanced manufacturing equipment; SMIC placed under export control coverage, limiting access to advanced process tools
2021	Initiative to establish the Chip 4 Alliance	Coordination with Japan, South Korea, and Taiwan to address potential supply chain disruptions related to China
2022	CHIPS and Science Act; restrictions on AMD and Nvidia exports	$52.7 billion allocated for domestic semiconductor production and research; advanced AI chips restricted from export to China
2023	Expansion of Export Administration Regulations to the Hong Kong and Macao Special Administrative Regions	New coordinated controls with the Netherlands and Japan; tightened restrictions on AI chips and advanced equipment; continued expansion of the Entity List
2024	New BIS regulatory measures	Further strengthened controls on China's access to AI chips and semiconductor manufacturing tools

Source: Official website of the Bureau of Industry and Security, US Department of Commerce

The first stage from 2018 to 2020 marks a transition from case specific restrictions to targeted sanctions on key firms. Following the Export Control Reform Act and revisions to Section 301 of the Trade Act of 1974, semiconductors become formally incorporated into a strategic control framework directed at China, accompanied by higher export licensing thresholds. The 2019 executive order on information and communications technology supply chain security establishes the Entity List and restricts transactions with designated firms on national security grounds, with major Chinese technology companies becoming primary targets. Subsequent regulatory revisions place high performance computing and advanced manufacturing equipment under stricter controls and expand the list of sanctioned firms. This period signals a shift from isolated interventions toward a structured and institutionalized control regime.

The second stage from 2021 to 2022 represents institutional consolidation. The United States promotes coordination with Japan, South Korea, and Taiwan through the Chip 4 framework to reorganize semiconductor supply chains and reduce China's integration within global production networks. Simultaneously, the Entity List expands and export licensing procedures tighten, embedding restrictions within a stable regulatory structure. The CHIPS and Science Act reinforces domestic industrial support while limiting subsidized firms' advanced expansion in China. Additional regulatory revisions institutionalize controls over high performance computing and advanced manufacturing equipment, strengthening constraints on China's artificial intelligence and frontier process sectors.

The third stage from 2023 onward reflects the emergence of a coordinated systemic regime. Regulatory coverage expands geographically and export controls increasingly align with allied economies. Advanced AI chips and semiconductor manufacturing tools become priority control categories, while scrutiny over China's technological access intensifies. Export controls thus evolve from unilateral measures into a multilateral strategic framework integrating legislation, executive authority, entity lists, and technical thresholds, with a clear long term orientation.

Overall, the policy trajectory progresses from firm specific sanctions to institutional embedding and finally to systemic integration. The increasing complexity of regulatory instruments incorporates semiconductors into the core of United States national security strategy and generates structural constraints on China's upstream equipment, materials, and advanced manufacturing capabilities.

3.2. Structure and Industrial Organization of China's Integrated Circuit Sector

The integrated circuit value chain consists of three interrelated segments: upstream support activities, midstream manufacturing, and downstream applications. The upstream segment includes semiconductor materials, EDA software, and core IP architectures that provide the technological foundation of the industry. The midstream segment comprises chip design, wafer fabrication, and packaging and testing, which jointly determine performance and supply capacity. Downstream applications extend across communication equipment, consumer electronics, and automotive systems. By product classification, integrated circuits are typically grouped into processors, memory devices, analog components, and logic chips, each serving distinct functional roles within the industrial structure, as illustrated in Figure 1.

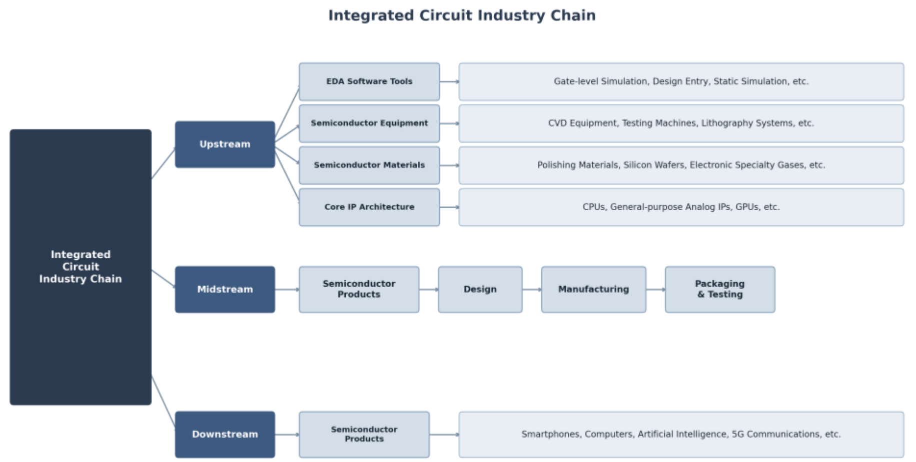

Figure 1. Schematic diagram of integrated circuit industry chain.

As a central pillar of modern information infrastructure and advanced manufacturing, integrated circuits underpin performance upgrading and functional innovation in downstream equipment that frequently depends on externally supplied high end chips. From communication systems and computing hardware to automotive electronics and industrial control platforms, advanced chips operate as the computational core of critical terminal products. United States export controls therefore affect the industry primarily through intermediate supply constraints. Restrictions on chips propagate across successive production layers and generate cascading effects throughout the value chain.

Based on this industrial structure, the analysis treats chips as the central transmission variable and focuses on the three critical stages of design, fabrication, and packaging and testing. By incorporating the development trajectory of logic devices, the study examines how United States export controls constrain chip supply and thereby influence the evolution of China's integrated circuit value chain.

3.3. External Dependence in China's Integrated Circuit Supply Chain

While China's integrated circuit industry expands rapidly, critical segments continue to exhibit strong external dependence, particularly in advanced equipment, foundational software tools, and essential materials. The most pronounced vulnerability lies in chip fabrication. Lithography systems constitute the technological core of wafer manufacturing, and extreme ultraviolet lithography remains almost entirely supplied by ASML, with no comparable domestic alternative. Coordinated export restrictions by the United States and allied economies therefore impose significant constraints on process upgrading and capacity expansion of Chinese foundries.

Dependence is equally visible in chip design infrastructure. EDA software and IP licensing remain indispensable yet highly concentrated among overseas suppliers, primarily Synopsys, Cadence, and Siemens EDA. In logic chip design and verification, EDA platforms are functionally irreplaceable, while domestic substitutes remain in early development stages. Core IP architectures, including processor cores and memory controllers, continue to rely on foreign licensing, exposing the design segment to persistent technological bottlenecks.

Material inputs follow a similar pattern. High purity silicon wafers and advanced photoresists are largely imported from Japan, Germany, and South Korea. Although domestic production improves in mid range markets, high end material capabilities still lag behind international standards. Taken together, reliance on external supply chains in equipment, design infrastructure, and materials creates structural vulnerabilities. Once export controls are activated, disruptions at these critical nodes propagate quickly and transmit shocks across the broader value chain.

3.4. Transmission Effects of United States Export Controls on China

United States export controls generate direct and far reaching impacts on both the manufacturing and design segments of China’s integrated circuit industry. In fabrication, core equipment such as lithography systems and ion implantation tools is supplied by a small group of firms in the United States, Japan, and the Netherlands, with extreme ultraviolet lithography almost entirely controlled by ASML. Since 2022 coordinated regulatory revisions prohibit the export of advanced lithography machines and several categories of critical equipment to China. These restrictions constrain process upgrading below advanced technology nodes, increase capital intensity, and slow capacity expansion of domestic foundries.

In chip design, export controls operate through the Entity List and the Foreign Direct Product Rule to limit access to EDA platforms and core IP architectures. Licensing uncertainty lengthens verification cycles and raises research costs, while continued reliance on foreign IP frameworks exposes advanced processor and logic chip development to persistent risk. Material supply constraints reinforce these pressures. High end photoresists and high purity silicon wafers remain largely import dependent, and domestic substitution is limited in the short term. Performance based restrictions on advanced GPUs and AI chips further constrain data center expansion and artificial intelligence infrastructure, delaying downstream technological applications.

Taken together, export controls function as an institutionalized strategic instrument that disrupts equipment supply, design infrastructure, materials access, and application development. To examine how these constraints propagate through the industrial system, the following chapter treats chips as the intermediate transmission channel and applies the full allocation coefficient framework to quantify China's structural dependence on United States technologies. This measurement establishes the empirical basis for subsequent policy shock analysis.

4. Quantifying China's Dependence on United States Technologies

4.1. Input-Output Framework

The input-output model is an economic analytical framework constructed on the basis of an input -output table and is designed to examine intersectoral relationships and production linkages across industries. It represents the economy as a structured system of mutual exchanges in which each sector both supplies outputs to and receives inputs from other sectors. This modeling approach provides a formal mechanism for tracing how changes in one industry propagate through the broader production network.

An input-output table serves as the foundational accounting instrument that records flows of intermediate goods and final demand among economic sectors. Organized in matrix form, where rows and columns correspond to product based sectors, the table captures the structural interdependence embedded in production processes. Row entries describe how a sector's output is distributed across intermediate and final uses, while column entries represent the composition of inputs required for production. The framework operates as a bidirectional accounting system that simultaneously tracks interindustry inputs and output destinations. By revealing upstream and downstream linkages within the production chain, the input -output table is particularly well suited for evaluating how sector specific shocks influence the broader national economic structure.

Table 2. Input-output Table.

Input \ Output			Intermediate Use (Intermediate Products)					Final Use (Final Products)	Total Output
			1	2	…	n	Total		
Intermediate Input	1		x_{11}	x_{12}	…	x_{1n}	$\sum x_{1j}$	Y_1	X_1
	2		x_{21}	x_{22}	…	x_{2n}	$\sum x_{2j}$	Y_2	X_2
	⋮		⋮	⋮	⋮	⋮	⋮	⋮	⋮
	n		x_{n1}	x_{n2}	…	x_{nn}	$\sum x_{nj}$	Y_n	X_n
	Total		$\sum x_{i1}$	$\sum x_{i2}$	…	$\sum x_{in}$	$\sum\sum x_{ij}$	$\sum Y_i$	$\sum X_i$
Primary Input	Depreciation		C_1	C_2	…	c_n	$\sum C_j$		
	Value Added	V_j	V_1	V_2	…	V_n	$\sum C_j$		
		m_1	m_1	m_2	…	m_n	$\sum m_j$		
		Total	…	…	…	…	…		
	Total		…	…	…	…	…		
Total Input			X_1	X_2	…	X_n	$\sum X_j$		

An input-output table is typically expressed as a square matrix, as illustrated in Table 2. Each row describes how the output of a given sector is distributed across other sectors and final demand, while each column records the origin of inputs required for that sector's production. The matrix structure forms three analytical blocks that correspond to intermediate exchanges, final demand allocation, and primary factor inputs. The first block captures intersectoral flows of intermediate goods. The second block records how sectoral outputs are allocated to final uses such as consumption, investment, and exports. The third block represents the allocation of primary inputs, including labor and capital, into sectoral production.

Suppose the economy consists of n production sectors. Any intermediate transaction can be denoted by x_{ij}, which represents the output of sector i used as intermediate input by sector j. The total output of sector j, denoted by X_j, is divided into the portion absorbed as intermediate inputs by other sectors $\sum_{i=1}^{n} x_{ij}$ and the portion directed to final demand Y_j. The accounting identity is written as

$$X_j = \sum_{i=1}^{n} x_{ij} + Y_j$$

4.2. Allocation Coefficients and Model Applicability

Within a supply side analytical framework, the output change of one sector generates propagation effects on other sectors, which can be captured by direct allocation coefficients and full allocation coefficients. The direct allocation coefficient reflects the proportion of total output supplied by sector i, including imports, that is directly absorbed by sector j as productive input. It is defined as

$$h_{ij} = x_{ij} / X_i (i, j = 1, 2, \ldots, n)$$

Here h_{ij} denotes the direct allocation coefficient, and the corresponding matrix form is written as **H**. The term X_i represents the total output of sector i. A larger coefficient indicates that sector exerts a stronger direct supply influence on sector. The full allocation coefficient corresponds to the direct allocation coefficient and measures how each unit of primary input from sector i is distributed to sector j through both direct and indirect linkages. It describes the extent to which the output of a given industry is fully absorbed by the demand of other industries. Based on the matrix of direct allocation coefficients, the full allocation matrix is expressed as

$$\mathbf{D} = \begin{bmatrix} d_{11} & d_{12} & \cdots & d_{1n} \\ d_{21} & d_{22} & \cdots & d_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ d_{n1} & d_{n2} & \cdots & d_{nn} \end{bmatrix} = (\mathbf{I} - \mathbf{H})^{-1} - I$$

where D is the full allocation coefficient matrix and each element represents a complete allocation coefficient. The matrix I denotes the identity matrix, and $\mathbf{G} = (\mathbf{I} - \mathbf{H})^{-1}$ is the Ghosh inverse matrix, also referred to as the complete supply coefficient matrix. It captures the total propagation effect of a sector's output change on the rest of the system, including direct impacts and multiple rounds of indirect feedback. In empirical analysis, the diagonal elements are often removed in order to isolate cross sectoral transmission and highlight the degree to which other industries are driven by a given sector.

Within a supply side framework, sectoral output changes are represented through direct and full allocation coefficients. This study treats the chip industry as the origin of a supply constraint and constructs an allocation coefficient matrix from the input–output table. The Ghosh framework is then applied to identify how chip supply restrictions propagate through intersectoral linkages and influence downstream production.

The Ghosh model captures a top down transmission mechanism in which supply shocks diffuse across the industrial network. Full allocation coefficients measure how one unit of sectoral output is absorbed by other industries as intermediate input and thus indicate systemic driving capacity. Unlike the Leontief formulation, which emphasizes demand constraints, the Ghosh framework highlights the spread of supply disturbances and reveals both direct supply relationships and indirect multilayer transmission paths. This structure makes the model particularly suitable for analyzing the system wide consequences of chip supply restrictions.

4.3. Data Sources and Sector Classification

The empirical analysis uses the 2020 national input–output table released by the National Bureau of Statistics. The table contains 153 sectors measured at basic prices and records interindustry input–output relationships under a competitive framework. It provides the statistical basis for constructing allocation coefficient and full allocation coefficient matrices, which are used to estimate how chip supply constraints propagate through the industrial network.

Sector classification follows the official industrial taxonomy. Chip fabrication and packaging activities are assigned to electronic components manufacturing, while chip design, EDA development, and related information services are grouped under software and information technology services. These categories are merged to represent the chip sector as an integrated analytical unit, and the combined output structure serves as the foundation for subsequent measurement.

To identify industries most exposed to chip supply constraints, the analysis selects sectors that exhibit strong structural linkage with integrated circuit production. These include downstream manufacturing industries such as electrical equipment, household appliances, computers, communication equipment, and electronic components, as well as embedded application domains including automotive manufacturing and instrumentation. Professional and technical services are also incorporated to capture supporting linkages. Together, these sectors define the principal transmission channels through which chip supply shocks affect the broader economy and provide the quantitative basis for subsequent policy shock analysis.

4.4. Dependence of China’s Integrated Circuit Sector on Chip Supply

4.4.1. Measurement of Full Allocation Coefficients

To evaluate how chip supply constraints influence China's integrated circuit sector, the study implements data processing, coefficient matrix construction, and result visualization using Python and scientific computing libraries. This computational framework enables a direct representation of how the chip industry propagates supply effects to downstream sectors.

Following the official industrial classification standard, the sectors corresponding to electronic components manufacturing, software services, and information technology services are merged to represent the chip industry. The aggregated intermediate matrix is then standardized by column to obtain the direct allocation coefficient matrix H. Based on the Ghosh formulation, the inverse matrix is constructed as $\mathbf{G}=(\mathbf{I}-\mathbf{H})^{-1}$ and the full allocation coefficient matrix is derived as $\mathbf{D}=\mathbf{G}-\mathbf{I}$. This matrix reflects the systemic driving effect generated by one unit of chip sector output as it diffuses through multiple rounds of interindustry transmission. It serves as the core quantitative indicator for measuring structural dependence across sectors.

The row of D corresponding to the chip sector is extracted to represent the systemic driving strength imposed on all other industries. These values are sorted in descending order, and the top twelve sectors are selected for visualization and structural interpretation. Table 3 reports the ranked full allocation coefficients for these leading sectors.

Table 3. Share of Total Allocation Coefficients Across Industries.

Rank	Industry	Total Allocation Coefficient
1	Communication Equipment	0.200596
2	Computers	0.197850
3	Business Services	0.053377
4	Professional Technical Services	0.044334
5	Power Distribution and Control Equipment	0.042622
6	Residential Building Construction	0.040272
7	Audio-Visual Equipment	0.039268
8	Internet and Related Services	0.038067
9	Instruments and Meters	0.033791
10	Electricity and Heat Production and Supply	0.033294
11	Automotive Parts and Accessories	0.030693
12	Other Electronic Equipment	0.029401

Note: The results exclude diagonal elements, meaning the self-impact of the chip industry is not included, in order to focus on its external driving structure within the national economic system.

4.4.2. Comparison of Sectoral Exposure

Based on the computed coefficients, Figure 2 visualizes the twelve sectors that exhibit the highest full allocation coefficients with respect to the chip industry.

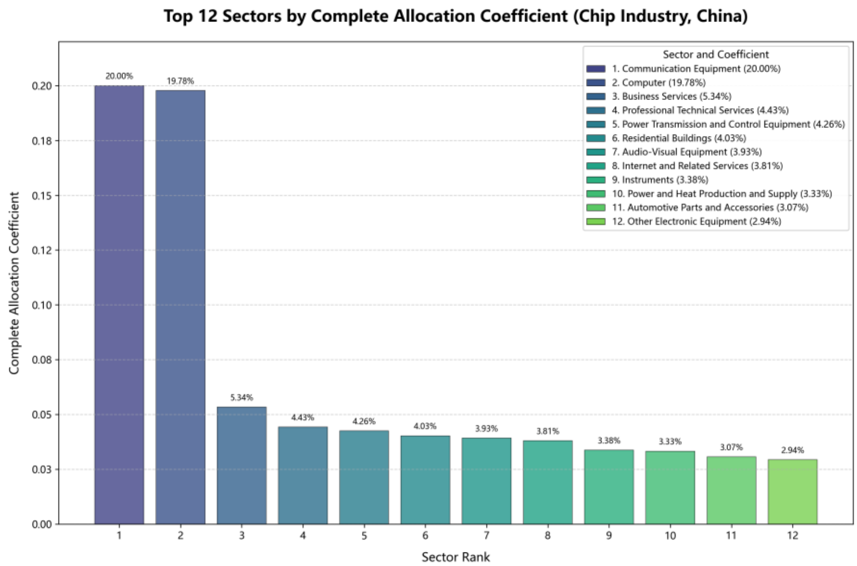

Figure 2. proportion of complete distribution coefficient in China's chip industry.

The results indicate that under the environment of United States export controls, chip supply shocks generate pronounced downstream effects within China's integrated circuit value chain, and the magnitude of these effects is positively associated with the full allocation coefficients. Excluding the chip sector itself, the twelve most affected industries can be grouped into three structural categories.

The first category consists of terminal equipment manufacturing sectors in which integrated circuits function as core production components. This group includes communication equipment and computer manufacturing, with full allocation coefficients of 0.2006 and 0.1979, respectively, the highest across all sectors. These industries are highly sensitive to processing capability, control precision, and energy efficiency. Chips serve both as central control units and as drivers of product upgrading. When advanced chip supply is constrained, production capacity in high technology manufacturing sectors such as communication equipment, computers, and automotive electronics is directly restricted. Information intensive services, including software and information technology services, are simultaneously affected, indicating substantial vulnerability under global technological restrictions.

The second category includes embedded control and equipment manufacturing industries, such as instrumentation, power transmission equipment, and automotive components, with coefficients ranging from 0.03 to 0.04. These sectors rely on chips as essential embedded components in precision control systems. Supply disruptions create cascading effects through reduced system performance, substitution difficulty, and weakened operational stability. Unlike terminal equipment manufacturing, the impact appears as a latent constraint that undermines long term system reliability and technological capability.

The third category comprises modern service and information platform industries, including business services, professional technical services, and internet related sectors, with coefficients between 0.038 and 0.053. Although their direct physical demand for chips is lower, digital infrastructure and high intensity data processing depend heavily on computational capacity. Constraints propagate through data centers and artificial intelligence platforms, limiting service efficiency and digital economic expansion.

Overall, sectors with the highest coefficients are concentrated in the midstream and downstream segments of the integrated circuit ecosystem, forming a structure characterized by high dependence and strong transmission capacity. The chip industry functions not only as a key manufacturing input but also as foundational infrastructure for the digital economy. Traditional manufacturing sectors display comparatively lower exposure. The results reveal structural dependence on chip supply and indicate that export controls can generate multilayer chain reactions extending across both industrial production and digital systems.

5. Conclusion

This study applies a supply-side input–output framework to examine how U.S. chip export controls propagate through China's semiconductor value chain. Using the 2020 national input–output table, the analysis constructs a complete distribution coefficient matrix to identify key transmission channels and quantify structural technological dependence. The results show that high-technology manufacturing sectors such as communication equipment, computers, instrumentation, and automotive electronics occupy central positions in the distribution structure and are highly sensitive to chip supply constraints. Modern service industries also display notable dependence, indicating that chips function not only as manufacturing inputs but as core infrastructure for the digital economy.

These findings reveal that supply restrictions in critical upstream technologies can generate cascading systemic effects concentrated in high-technology and digital sectors. Although the analysis reflects relative structural dependence based on the 2020 benchmark, it highlights embedded vulnerabilities within China's industrial network. The framework developed in this study provides a quantitative basis for evaluating industrial resilience and supports long-term strategies aimed at strengthening technological autonomy under conditions of external restriction.

References

[1] Luo, Y. and Van Assche, A. (2023) The Rise of Techno-Geopolitical Uncertainty: Implications of the United States Chips and Science Act. Journal of International Business Studies, page, 1, 1-18.

[2] Kim, M.S. (2025) Chip Security: Reconciling Industrial Subsidies with WTO Rules and National Security Exception. Harvard National Security Journal, 16, 1-74.

[3] Han, P., Jiang, W. and Mei, D. (2021) Mapping US-China Technology Decoupling, Innovation, and Firm Performance. Innovation, 2, 331–337.

[4] Khan, H., Zulfiqar, A. and Chunjie, Q. (2025) Economic, Institutional, and Strategic Effects of Tariff Wars: Systematic Literature Review. Journal of Economic Surveys, 1-22.

[5] Ghosh, A. (1958) Input-Output Approach in an Allocation System. Economica, 25(97), 58–64.

[6] Wang, W. (2021) New Strategic Orientation and China's Strategy in Sino-US Relations. World Socialism Studies, 6(4), 37–42.

[7] Cai, C. and Yin, J. (2024) US Economic Sanctions against China: Trends and Implications. International Studies, (6), 32–52.

[8] Lyu, W.D., Lin, L., Zhao, Y. and Zhong, K. (2020) US High-Tech Export Control and Its Enlightenment to China. Scientific Decision Making, 8, 1–23.

[9] Zhang, X. and Tang, Q. (2023) The Biden Administration's Chip Industry Policy: Balancing Dilemmas and Opportunities. Global Review, 15(3), 95–114.

[10] Zhang, L.Y. and Qi, Y.D. (2021) Disruptive Innovation Model of Integrated Circuit Industry Based on Digital Technology Background. Studies in Science of Science, 39(5), 920-929.

[11] Yang, Y.W., Guo, B.H. and Wang, D.D. (2023) Optimization of Technological Innovation Path of Chinese IC Industry. Studies in Science of Science, 41(2), 369-384.

[12] Leontief, W.W. (1936) Quantitative Input and Output Relations in the Economic Systems of the United States. The Review of Economic Statistics, 18, 105–125.

[13] Zhao, R. and Ni, H. (2023) The Economic Effect of Global Value Chain Reconstruction: Evaluating the Influence of Sino-US Economic and Trade Friction. China Business and Market, (5), 26–31.

[14] Tu, X., Ren, L. and Xing, Y. (2023) Research on Measuring the Potential Impact of China-US Trade Decoupling. Chinese Price, (5), 26–31.

[15] Zhu, K., Liu, Q., Xiong, X., Zhang, Y., Wang, M. and Liu, H. (2022) Carbon Footprint and Embodied Carbon Emission Transfer Network Obtained Using the Multi-Regional Input-Output Model and Social Network Analysis Method: A Case of the Hanjiang River Basin, China. Frontiers in Ecology and Evolution, 10, 941520.

[16] Elguellab, A., Ezzahid, E. and Baddi, H. (2023) A New Identification Method of Economic Large Shocks in the Input-Output Framework: Application to COVID-19. Journal of Economic Structures, 12(1), 1-14.

[17] Shi, J., Hong, Y. and Liu, Y. (2024) Impact of Chips and Science Act of 2022 on China's Related Industries and Policy Suggestions. Bulletin of Chinese Academy of Sciences (Chinese Version), 39(2), 379–387.