Impact of the chips act on the GVC participation of China's electronics industry

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Abstract

Purpose – In this paper, we evaluated the impact of the US "Chip Act" on the participation of the Chinese electronics industry in the global value chain based on the dynamic CGE model. This is a meaningful attempt to use the GTAP-VA model to analyze the electronics industry in China.

Design/methodology/approach – We employ a Dynamic GTAP-VA Model to quantitatively evaluate the economic repercussions of the "Chip Act" on the Chinese electronic industries' GVC participation from 2023 to 2040.

Findings – The findings depict a discernible contraction in China's electronic sector by 2040, marked by a −2.95% change in output, a −3.50% alteration in exports and a 0.45% increment in imports. Concurrently, the U.S., EU and certain Asian economies exhibit expansions within the electronic sector, indicating a GVC realignment. The "Chip Act" implementation precipitates a significant divergence in GVC participation across different countries and industries, notably impacting the electronics sector.

Research limitations/implications – Through a meticulous temporal analysis, this manuscript unveils the nuanced economic shifts within the GVC, substantially bridging the empirical void in existing literature. This narrative accentuates the profound implications of policy regulations on global trade dynamics, contributing to the discourse on international economic policy and industry evolution.

Practical implications – We evaluated the impact of the US "Chip Act" on the participation of the Chinese electronics industry in the global value chain based on the dynamic CGE model. This is a meaningful attempt to use the GTAP-VA model to analyze the electronics industry in China.

Social implications – The interaction between policy regulations and global value chain (GVC) dynamics is pivotal in understanding the contemporary global trade framework, especially within technology-driven sectors. The US "Chips Act" represents a significant regulatory milestone with potential ramifications on the Chinese electronic industries' engagement in the GVC.

Originality/value – The significance of this paper is that it quantifies for the first time the impact of the US Chip Act on the GVC participation index of East Asian countries in the context of US-China decoupling. With careful consideration of strategic aspects, this paper substantially fills the empirical gap in the existing literature by presenting subtle economic changes within GVCs, highlighting the profound implications of policy regulation on global trade dynamics.

Keywords Global value chain, Electronic industry, GTAP-Dyn, GTAP-VA

Paper type Research paper

1. Introduction

As tensions between China and the United States in trade relations escalate, a broader array of products is scrutinized. This situation reveals new opportunities to explore global value chains (GVCs). Understanding the extent of participation in GVCs has become crucial for economies to integrate into global economic growth, accumulate production factors and

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influence global trade patterns (Jijun, 2021). Deep integration into the global value chain has heightened interconnections within the world economy (Jijun and Conglai, 2017). Amid the trade disputes between China and the US, it is critical to accurately assess the effects of trade frictions on China's involvement in GVCs across various sectors.

The semiconductor industry, central to the global technology sector, sees China emerging as a key player in the market. However, the US is concerned about China's growing influence in this area and the potential national security implications. The US Chips Act is designed to alleviate these worries by offering financial incentives to domestic semiconductor producers, promoting the establishment of new production centers within the US. In May 2020, the US Senate introduced the "Creating Helpful Incentives to Produce Semiconductors for America Act," informally known as the "Chips Act." The Act aims to reinforce US semiconductor manufacturing, reducing dependency on China and other countries for essential technology. It includes provisions for tax incentives, research funds and grants for firms investing in semiconductor manufacturing. The Act has notably influenced China's manufacturing GVC participation. According to the Asia Society Policy Institute (ASPI) [1], the Act has triggered a shift in the global semiconductor supply chain away from China towards countries like Taiwan, South Korea and Vietnam, thereby weakening China's position as a key player in the global semiconductor field and hindering Chinese firms' integration into the industry's GVC.

The ongoing US-China tensions suggest that the impact of the Chips Act on Chinese manufacturing GVC involvement is likely to persist. The Act has increased operational costs for Chinese semiconductor companies, which now face higher tariffs and trade barriers when exporting to the US. Consequently, competition with international rivals has intensified, and the attraction for investment and talent from abroad has waned. The Information Technology and Innovation Foundation (ITIF) speculates that the Chips Act could lead to a redistribution of semiconductor production away from China, potentially redefining China's role in the GVC as a manufacturer and exporter of semiconductors.

The Semiconductor Industry Association (SIA, 2023) estimates that the Act could boost domestic semiconductor production by 40% in the next decade. This increase might reduce China's market share in the industry and affect its GVC participation. Some analysts suggest that the Chips Act may also prompt a broader separation between the US and Chinese technology sectors, with significant economic and geopolitical consequences, as both countries are leading global economies with aspirations for dominance in several key technological areas.

If China is isolated from the semiconductor GVC, a shortfall could arise. Semiconductors are crucial to the electronics sector, and a shortage could severely impact the entire industry. Some scholars challenge this view, citing the capabilities of China's semiconductor sector. Zhang *et al.* (2020) argue that China could achieve self-reliance in semiconductors, suggesting that the US Chips Act might not significantly impact China's sector, considering China's considerable investment in its semiconductor industry and the development of a robust domestic supply chain. Moreover, China's large domestic market could buffer the effects of the US Chips Act.

In summary, the US Chips Act has markedly influenced China's electronic industry's GVC engagement, disrupting the global semiconductor supply chain and presenting challenges for Chinese firms in competing internationally, though counterarguments persist. The long-term impact will depend on the success of the US in enhancing domestic semiconductor production and whether it prompts a shift in production away from China. Our main finding reveals China's electronic sector will shrink by 2040. In contrast, the U.S., EU and certain Asian countries are expected to grow, signaling a shift in the GVC. The 'Chip Act' triggers divergent GVC impacts by country and industry, especially in electronics. This paper contains three sections. We provide a literature review around two aspects in the second section, a quantitative analysis using the dynamic GTAP model in the third section and finally a conclusion and policy implications.

2. Literature review

The literature review in this paper comes from two main sources: 1. The economic effects of trade frictions between China and U.S. 2. The formation of regionalization Global Value Chain.

2.1 Economic effects of trade frictions between China-US

Since President Trump announced the imposition of tariffs in 2018, the U.S. trade deficit has increased rather than decreased. US domestic production has not increased significantly, and the Trump administration's goal of "manufacturing re-shoring" has not been achieved, which has rather intensified its domestic structural inflationary pressure. At the same time, China-US trade frictions have aroused widespread concern in the academic circles. This article mainly reviews the relevant research results of China-US trade frictions from three perspectives: trade balance, consumption and industrial impact.

The first, from the perspective of trade balance, Trump's charging higher tariffs has a negative impact on China, but the impact of the U.S. trade deficit is much lower than expected. and Chinese export companies. It has a strong ability to cope with digestion and competitiveness. Originally, China, which has high price competitiveness, was not greatly affected by the US tariff increase. In fact, the imposition of additional tariffs does not conform to the optimal tariff theory and has not significantly reduced the US merchandise trade balance Fajgelbaum *et al.* (2020). Overall, most economies except China and the United States have benefited from the China-US trade friction, and the trade friction will have a positive spillover effect on third countries, because the China-US trade friction has led to a large-scale trade diversion effect Mary Amiti *et al.* (2019).

Second, from the perspective of consumption, it was thought that China-US trade frictions will cause serious losses to American consumers. Usually, the impact of trade on household income distribution is mainly through the expenditure channel and the income channel. Imposing tariffs increases the tax-included prices of imported goods, and the cost is basically borne by domestic consumers Fajgelbaum *et al.* (2020), constructed a general equilibrium model based on Jonathan Eaton and Kortum (2002) Multi-Sector-Multi-Country-Multi-industry linkages and found that the loss of American consumer welfare is quite serious, because high tariffs are directly linked to the price of imports. Thereby increasing the domestic price level in the United States, reducing the real wages of workers and ultimately resulting in the loss of social welfare. On the other hand, a few researchers have reported that China-US trade frictions have caused more serious losses in China than in the United States. For example, Lianbiao *et al.* (2018) simulated China-US trade friction based on the GTAP 9.0 database and found that China's welfare decreased by 0.23%, while American welfare increased by 0.03%. Zhang *et al.* (2022) used the WITS-SMART model to simulate trade reduction effects, welfare effects and trade diversion effects and found that China's welfare loss was more than that of the United States, about 2.6 times that of the United States, and China's soybean and automobile sectors suffered the most serious losses. In the United States, the electromechanical product industry suffered a lot. Research by Borusyak and Jaravel (2021) shows that the impact of additional tariffs on different income groups is not consistent, and the low-income groups and the middle class suffer greater losses. In essence, the real revenue loss caused by the tariffs has partially offset the effect of the Trump administration's tax cuts.

Third, from the perspective of industrial impact, trade frictions have caused great losses to the industries of both China and the United States, and different industries are affected to different degrees. Most scholars believe that due to the refinement of the global value chain division of labor, there is a strong correlation between the industrial sectors of China and the United States. In addition to final consumer goods, trade products between China and the United States also cover many intermediate goods, and the United States imposed additional tariffs on intermediate goods. Therefore, in addition to the loss of consumer welfare, China-US trade frictions will also indirectly cause a major impact on the production capacity of the two countries, causing serious damage to the global value chain system that conforms to the principle of division of labor. US exports suffer a loss of competitiveness due to increased production costs for taxed industries that use imported products as intermediate inputs Charbonneau and Landry (2018). As the scale of bilateral trade frictions expands, the negative impact on China will also gradually expand, and the global value chain will play a buffer role in China-US trade frictions, thereby realizing the rebalancing of the global economy. Ding *et al.* (2019) have empirically tested that the status of global value chains has a "catalyst effect", while the degree of participation in GVC has a "lubricant effect". The "lubricant effect" of global value chains in China-US trade frictions should be fully utilized. To realize the reconstruction of the global value chain and resolve the risks of international economic and trade frictions.

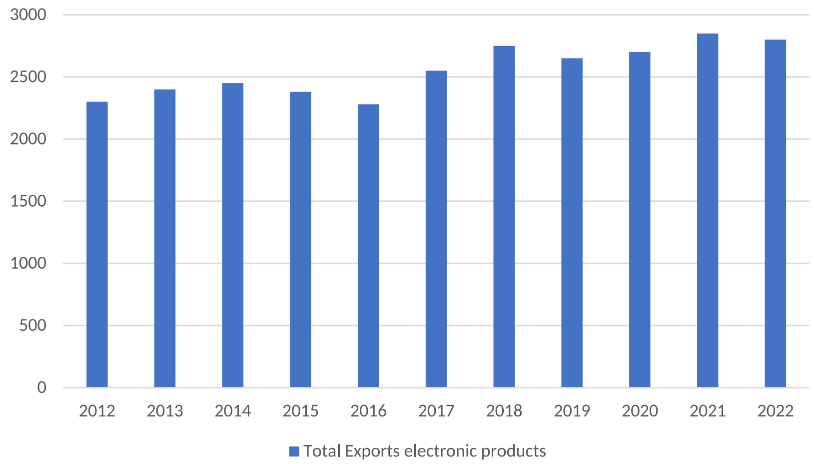
2.2 Regionalization of the global value chain

The emergence of mega-trade agreements has gradually become an important trade policy in the Asia–Pacific region. Baldwin and Lopez Gonazalez (2015) point out that the global value chain reshaping effect has led to a North-South trade pattern of components and assemblies, and that the linkages between regional trade agreements and global value chains are crucial Antràs and Staiger (2012). Michele Ruta (2017) shows that the depth of FTAs has a greater impact on sectors that are more deeply embedded in GVCs. In contrast, Laget *et al.* (2020) argue that the depth of FTAs increases GVC participation. For example, the member countries of RCEP are important trading partners of China. In recent years, the increasing number of RTAs has been accompanied by a corresponding increase in related studies. The earliest systematic study combining GVCs and RTA dates to Johnson and Noguera (2012a, b), who found in their value-added trade analysis that geographical distance is an important factor influencing the value added of cross-country bilateral trade, while regional trade agreements are more important for value-added trade. According to Baldwin and Venables (2013), "value chain trade is more regionalized than globalized" and "global production networks consist of three main modules: Asian factories, North American factories, and European factories". Los *et al.* (2015) find that in global value production chains, the significant growth of major countries since 1995 has been mostly dependent on the development of regional value chains. According to the analysis of Diakantoni *et al.* (2017), the trade in intermediate goods was found to be divided into three regional value chains, namely the Asian regional value chain centered on mainland China, the European regional value chain centered on Germany and the American regional value chain centered on the United States.

2.3 U.S. "Chips Act" and Chinese electronic industry

Over the past decade, despite ups and downs, global electronics exports have steadily increased. As electronic products are digitized, product prices are rising and a growing trend of exports will continue in the future.

East and Southeast Asia is a crucial hub of the global electronic industry (Figure 1); its global role is the highest in the production and exports of electronic components, including semiconductors and consumer electronic goods such as smartphones. The regions is clearly



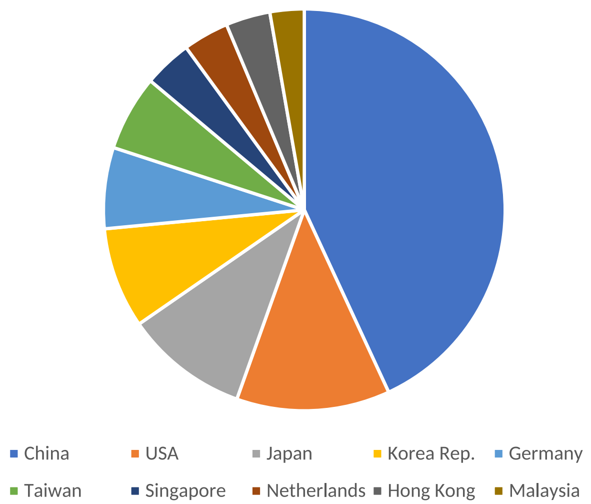
Source(s): Global Trade Atlas (GTAS)

Figure 1. Total exports of China electronic products (12–22)

characterized by data on exports scales, export growth rates as well as export specialization indices relative to the world.

According to Figure 2, the value of global exports of electronic sectors (with the semiconductor being a part of it) has grown. This results imply that the electronic GVCs to be invested more and locations to be reconsidered in the long term context.

The wave of counter-globalization and the U.S.-led de-Chinalization of supply chains had a significant impact on China's electronics industry, and the trend of counter-globalization triggered by political games has led to a change in the pattern of global value chains. The introduction of the Chips Act is a typical representative, and the impact of the Act on the



Source(s): WITS world bank

Figure 2. Top 10 electronics exporters in 2022 (billion $)

Chinese electronics industry's participation in the global value chain is significant in the context of the comprehensive decoupling between China and the United States.

3. Model and methodology

3.1 Model

The standard version of GTAP is a static model with the basic assumptions of a perfectly competitive market and constant returns to scale. The model takes several assumptions: Each economy contains land, capital, skilled labor, unskilled labor and natural resources; Three representative agents of private households, government and manufacturers are included in the model. Antimiani *et al.* (2018) analyze value added in trade flows within a Computable General Equilibrium (CGE) framework, tracking it from its origins to its final destinations. They introduce a novel Value-Added module to the standard version GTAP model. This paper builds on the dynamic GTAP model (GDyn) as developed by Ianchovichina and McDougall (2012) and enhanced by Ianchovichina and Walmsley (2012). It integrates global value chains (GVCs) into the model's intermediate transactions, transforming it into a recursive dynamic CGE model. The study examines the effects of introducing GVCs on trade policy impacts.

For evaluating the impact of the "Chips Act" on Chinese electronic industries' Global Value Chain participation. The global computable general equilibrium model we adopt is the dynamic GTAP model and we extend the value chain accounting system based on it. The dynamic GTAP model, widely used in academia, is a CGE model consisting of multiple countries and sectors designed by Purdue University in the U.S. based on neoclassical economic theory, which is widely used to analyze and evaluate the impact of various types of policies. It is widely used to analyze and assess the effects of multiple factors such as policies on macroeconomics and industries in one or more countries. Subsequently, we apply the global value chain accounting approach of Koopman *et al.* (2014) to the dynamic GTAP analysis framework, transforming the value-added trade perspective into a value-added income perspective to clarify the sources and destinations of value added and the changes in the value chain system.

3.2 Data

In this paper, we extend the GTAP 11 database, aggregated to 8 regions and 9 sectors, to capture the Global Value Chain structure. The quantitative analysis utilizes the GTAP 11 database (Version 11 published Mar 6, 2023), which is based on the year 2017, to conduct an extensive analysis of the source countries using data from IOCO tables. GTAP version 11 provides broader geographic coverage than version 10, encompassing 141 individual countries and 19 aggregate regions, which represent global economic activity. The included individual countries account for 99.1% of the world's GDP and 96.4% of the world's population. Sectoral coverage remains the same as in GTAP version 10, with each country/region distinguishing 65 products and services in the standard GTAP data version (See Appendix Table A1 for a complete list). GTAP version 11 classifies agriculture, food, resource extraction, manufacturing and service activities to describe all economic sectors within each country. Additionally, 20 new countries, mainly from the Middle East and Central Africa, have been incorporated into GTAP version 11 compared to GTAP version 10 (Aguiar *et al.*, 2019).

In the Baseline scenario, we use global macro data from the French Centre for Economic Research, the World Bank and the International Monetary Fund to adjust for changes in macro indicators such as the GDP of each country during this period.

Since there is no separate Chips industry in the GTAP 11 database, we shocked the electronics industry(ele) in the modeling process and then analyzed it with the weight of the Chips industry in the total electronics industry.

3.3 Scenario design

To analyze the impact of the U.S. CHIPS Act of 2022 Global Value Chain (GVC) participation of China's electronics industry using the Dynamic GTAP model, a baseline scenario needs to be set up which describes how the world economy might move in the absence of policy effects, is an important part of the assessment of policy impacts using dynamic modeling. This scenario will serve as a reference point to assess the changes brought about by the Act. As we scrutinized the contents of the U.S. CHIPS Act of 2022, we have identified several key provisions that could significantly impact the global semiconductor industry.

(1) Funding Allocation: The Act provides $52.7 billion in emergency supplemental appropriations to support the rapid implementation of semiconductor provisions. This includes $50.0 billion over 5 years for the CHIPS for America Fund, aimed at developing domestic manufacturing capability, research and development (R&D) and workforce development.

(2) Incentive Program: $39 billion is allocated over 5 years, with $2 billion focused solely on legacy chip production, essential for various industries including automotive and military. The program also allows for up to $6 billion for direct loans and loan guarantees.

(3) R&D and Workforce Development Programs: An allocation of $11 billion over 5 years is directed towards programs including the National Semiconductor Technology Center (NSTC), the National Advanced Packaging Manufacturing Program and other related R&D and workforce development initiatives.

(4) CHIPS for America Defense Fund: This fund, amounting to $2 billion, supports the Microelectronics Commons, focusing on university-based prototyping and semiconductor workforce training, including Department of Defense-specific applications.

(5) International Technology Security and Innovation Fund: $500 million over 5 years is designated for supporting international ICT security and semiconductor supply chain activities, including developing secure and trusted technologies.

(6) Semiconductor Incentives: The Act clarifies eligibility criteria for receiving CHIPS funding and authorizes additional financial incentives for manufacturing mature technology nodes.

(7) Prohibitions and Restrictions: The Act restricts recipients of incentive funds from expanding and/or building new manufacturing capacities for certain advanced semiconductors in countries deemed a national security threat to the U.S.

(8) Diversity and Inclusion: The Department of Commerce must ensure that CHIPS manufacturing incentive recipients increase the participation of economically disadvantaged individuals and support minority-owned, veteran-owned and women-owned businesses.

(9) Wireless Supply Chain Innovation Fund: $1.5 billion is appropriated to encourage development in open architecture, software-based wireless technologies and other innovative technologies in the mobile broadband market of the U.S.

(10) Advanced Manufacturing Investment Credit: A 25% investment tax credit for semiconductor production investments, applicable to property placed in service after 2022, and for constructions beginning before January 1, 2027.

By comparing the baseline scenario with simulations incorporating these policy changes, we can assess the Chip Act's impact on China's GVC participation in the electronics sector. The scenario setup for this paper is as follows.

(1) Baseline Scenario: Based on historical data and forecasts from authoritative institutions, we construct a BAU(Business-as-usual) scenario for the period 2018–2040.

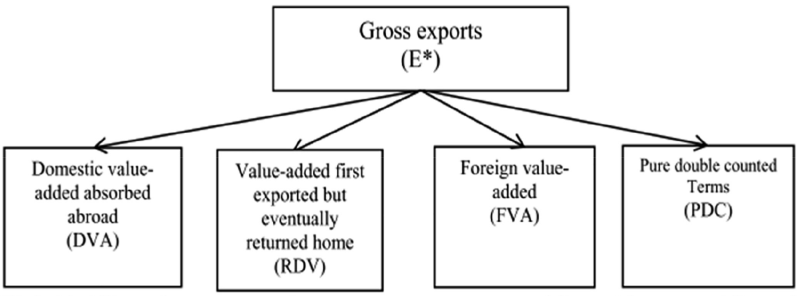
(2) Policy Scenario: The "Chips Act" is implemented in 2030, and the capacity of Chinese Chips starts to decline until it stagnates.

3.4 The extended GTAP model for value-added analysis

According to Koopman *et al.* (2014), Global Value Chains (GVCs) refer to a cross-country and cross-sectoral network of sources and destinations of value-added. This process involves adding value at each stage of production, where the amount added corresponds to the payments made to primary factors of production in the country/sector where the specific production stage takes place. The concept of Trade in VA decomposition offers a perspective by segregating the contributions of different countries to the value embedded in gross trade flows. This approach is particularly relevant in the context of analyzing the flow of intermediate goods that traverse multiple borders, thereby challenging the accuracy of traditional trade statistics in reflecting the intricacies of global production patterns. In response to the complex nature of contemporary global trade, a variety of indicators have been formulated within the VA analytical framework, leveraging ICIO tables.

We decompose the total value of a country's export trade into four components: value added embedded in export trade absorbed domestically (VAX_G), value-added returned domestically from export trade (RDV), value-added embedded in export trade from abroad (FVA) and double counting (PDC), based on the differences in the destination and channel of absorption of export products. value-added. To summarize, Koopman *et al.* divided the value added of export trade into four major components to elaborate its economic implications (as shown in Figure 3).

To demonstrate the impact of the implementation of the "Chips Act" on the degree of participation in the global value chain of the Chinese electronics industry, we imported the



Note(s): E* can be at country/sector, country aggregate, bilateral/sector or bilateral aggregate; both DVA and RDV are based on backward linkages

Source(s): Koopman *et.al* (2014)

Figure 3.
Gross exports accounting: major categories

GVC model into the GTAP model for analysis. The GVC index has been adopted by many international organizations, such as the UNCAD and OECD, according to the following method of calculation:

$$\text{GVC Participation Index} = (\text{FVA} + \text{DVA}) / \text{Gross Exports}$$

We tried to calculate the effects of the U.S. "Chips Act" on GVC based on various scenarios by comparing the changes in major GVC indices with those of the baseline. However, there are two key issues in the interface between the GTAP model and the GVC model: First, although the database of the GTAP model was originally constructed based on the world input-output table, it must first be converted to the world input-output table, given that the database was adjusted and processed during the construction process and is very different from the original form of the input-output table, while the KWW model decomposition is based on the world input-output table. Second, the KWW model decomposition is based on the inter-country input-output table that can describe the distribution of different traded goods among different users in different importing countries. Compared with the ICIO table, the global trade analysis model lacks a dimension of users of imported goods, and we refer to the method of Ni and Xia (2018) to construct a global regional input-output model with fixed proportional coefficients.

4. Simulation results and interpretation

4.1 Macroeconomic

Table 1 presents a nuanced macroeconomic impact of the "Chips Act" across various economies, differentiated by short-term and long-term effects. We can clearly find that the Chinese economy is negatively impacted, and the U.S. economy has improved in the short

	Year	China	US	EU (28)	Japan	Korea rep	Taiwan	ASEAN	Row
GDP	2023	−0.067	0.001	0.004	−0.003	0.009	0.004	−0.007	−0.001
	2030	−0.144	−0.018	0.028	0.001	0.057	0.105	0.034	0.021
	2040	−0.168	−0.078	−0.006	0.020	0.130	0.216	0.161	0.114
GDP deflator	2023	−0.080	0.029	0.035	0.048	0.078	0.139	0.063	0.032
	2030	−0.074	0.009	0.035	0.095	0.145	0.195	0.061	0.037
	2040	0.019	−0.022	0.052	0.209	0.355	0.301	0.030	0.024
Export	2023	−0.158	0.066	−0.004	−0.002	−0.016	−0.079	0.077	−0.027
	2030	−0.160	0.184	−0.005	−0.203	−0.017	−0.048	0.078	−0.076
	2040	−0.751	0.304	−0.068	−0.371	−0.086	0.036	0.238	0.055
Import	2023	−0.270	−0.071	0.018	−0.005	0.074	0.072	0.142	0.001
	2030	−0.391	−0.184	0.009	0.030	0.152	0.198	0.216	0.031
	2040	−0.430	−0.395	−0.119	0.016	0.243	0.303	0.366	0.028
Resident investment income	2023	−0.178	0.023	0.034	0.039	0.116	0.179	0.086	0.044
	2030	0.012	0.162	0.105	0.140	0.262	0.284	0.128	0.165
	2040	1.029	0.678	0.404	0.476	0.946	0.835	0.468	0.537
Resident investment income (Local)	2023	−0.212	0.019	0.039	0.040	0.139	0.268	0.091	0.044
	2030	−0.060	0.154	0.083	0.136	0.342	0.482	0.182	0.183
	2040	1.314	0.692	0.224	0.423	1.078	0.968	0.619	0.586
Resident investment income (International)	2023	−0.025	0.030	0.023	0.033	−0.004	0.005	−0.005	0.042
	2030	0.186	0.174	0.154	0.157	−0.002	0.044	−0.663	−0.059
	2040	0.725	0.657	0.806	0.704	0.689	0.727	−1.264	−0.744

Source(s): Author simulation

Table 1. The cumulative macroeconomic impact of the implementation of the "Chips Act" on countries relative to the baseline scenario (%)

term, but the improvement is very limited, while there will be some impact on other countries in Asia. In the long term, the negative impact on the Chinese economy is further expanded, the U.S. economy is also hit, but to a weaker extent than China; but other major economies, especially Japan, South Korea, Taiwan and ASEAN are very positively affected. This suggests that the U.S. "Chips Act" will not have the expected positive effect on the U.S. macroeconomy.

Regarding international trade, China's imports and exports generally declined; while U.S. exports increased and imports decreased, and the trade balance problem was somewhat alleviated. As for residents' investment income, there is a decline in China in the short term, but there is an increasing trend of residents' investment income in all countries in the long term; among them, China's growth mainly comes from investment in local enterprises, while the U.S. *comes* from both local and international sources. This indicates that the implementation of the "Chips Act" has, to a certain extent, promoted China's investment and consumption in the local market, which is conducive to the internal circulation of the Chinese economy.

4.2 Industries

Table 2 shows the projected cumulative impact of the implementation of the U.S. Chips Act in 2040 on the output of each country and each industry compared to the baseline scenario. We can clearly see that the impact of the policy shock of the Chips bill, the electronics industry, China's electronics industry output significantly decreased (−2.95%), while the United States (1.91%) and other major economies' output significantly increased. Among them, the United States does not have the most significant growth, the EU, Japan and ASEAN in the electronics industry output growth is more robust. The results in Table 2 show that the United States has not actually consolidated its strong position in the electronics industry. Instead, it received a negative impact on other industries; meanwhile, China was affected by lower domestic prices, and the output growth of other industrial production in China, especially labor-intensive industries, was obvious; in contrast, other industries in the United States generally suffered. This indicates that the U.S. Chips bill is promoting the growth of the electronics industry at the expense of other industries as a cost.

We also examine the cumulative impact of the implementation of the "Chips Act" on the trade side of various industries in each country.

Table 3 shows the cumulative impact of the implementation of the Chips Act on exports by country and by industry in 2040, and Table 4 shows the impact on imports. We can see that the impact of the U.S. Chips Act is received, China's exports in the electronics industry declined significantly (−3.5%), while imports increased slightly (0.45%), and the dependence

Table 2. The cumulative impact of the implementation of the Chips Act in 2040 on output by industry in each country relative to the baseline scenario

	China	US	EU(28)	Japan	Korea rep	Taiwan	ASEAN	Row
Agricultural products	−0.06	0.13	0.16	0.05	0.00	−0.05	−0.11	−0.02
Textile and apparel	0.05	0.18	0.22	0.06	0.05	−0.30	−0.21	−0.17
Chemical products	−0.11	0.05	−0.07	−0.13	−0.04	−0.02	−0.21	0.27
Metallic products	0.26	−0.49	−0.46	−0.31	−0.34	−1.62	0.47	0.11
Machine	0.39	−0.07	0.03	−0.75	−0.78	−1.14	−0.77	−0.18
Vehicles	0.12	−0.05	0.04	−0.48	−0.50	−0.09	0.03	−0.09
electronic product	−2.95	1.91	2.31	1.93	1.08	1.09	2.15	1.94
Other manufacturing	−0.09	−0.03	−0.34	−0.02	0.09	0.06	0.40	0.38
Services	−0.06	−0.10	0.00	0.07	0.14	0.24	0.19	0.05

Source(s): Author simulation

of China's electronics industry on the international market increased; while the U.S. situation is just the opposite, exports increased (4.29%) while imports decreased (−1.24%), and the rate of increase in exports was roughly the same as the rate of decrease in Chinese exports. Except for Japan, all other major economies saw growth in exports and imports, which indicates that the trade division of labor linkages in the electronics industry has been strengthened. In China's other industrial sectors, exports increased significantly, while imports decreased. The implementation of the U.S. Chips Act has to some extent strengthened China's comparative advantage in other industries.

4.2.1 Electronic industry. As an important raw material, the Chips industry has a direct impact on the electronics industry, through our model analysis (Table 5), China's electronics

	China	US	EU(28)	Japan	Korea rep	Taiwan	ASEAN	Row
Agricultural products	−0.22	0.52	0.26	−0.45	−0.53	−0.52	−0.56	−0.20
Textile and apparel	0.13	0.72	0.26	0.03	−0.12	−0.63	−0.30	−0.36
Chemical products	−0.02	0.15	−0.08	−0.29	−0.04	−0.17	−0.46	0.38
Metallic products	2.20	−1.13	−0.71	−0.46	−0.48	−2.33	0.60	0.01
Machine made	1.68	0.90	0.17	−1.16	−1.30	−1.82	−0.99	−0.56
Vehicles	0.82	0.57	0.07	−0.65	−0.77	−0.61	−0.22	−0.29
Electronic product	−3.50	4.29	3.07	2.26	0.90	1.00	2.23	2.90
Other manufacturing	−0.17	0.29	−0.52	−0.37	0.01	−0.32	0.46	0.57
Services	0.40	0.48	0.10	−0.37	−0.62	−0.58	−0.18	−0.22

Source(s): Author simulation

Table 3. Cumulative impact of the implementation of the Chips Act in 2040 on export by industry in each country relative to the baseline scenario (%)

	China	US	EU(28)	Japan	Korea rep	Taiwan	ASEAN	Row
Agricultural products	0.14	−0.29	0.02	0.25	0.40	0.36	0.24	0.13
Textile and apparel	−0.22	−0.25	0.00	0.14	0.27	0.31	0.03	0.11
Chemical products	−0.26	−0.03	0.03	0.06	0.25	0.34	0.21	0.02
Metallic products	−1.44	0.06	−0.14	−0.22	−0.18	−0.46	0.24	0.00
Machine made	−1.15	−0.81	−0.24	0.35	0.47	0.60	0.38	0.30
vehicles	−0.45	−0.58	−0.08	0.04	0.33	0.31	0.28	0.10
Electronic product	0.45	−1.24	0.00	−0.51	0.08	0.39	0.96	−0.35
Other manufacturing	−0.23	−0.26	−0.10	0.15	0.16	0.17	0.10	−0.17
Services	−0.33	−0.33	−0.09	0.32	0.64	0.65	0.27	0.17

Source(s): Author simulation

Table 4. Cumulative impact of the implementation of the Chips Act in 2040 on import by industry in each country relative to the baseline scenario (%)

	Year	China	US	EU (28)	Japan	Korea rep	Taiwan	ASEAN	Row
Output	2023	−2.78	1.35	1.77	1.66	1.07	0.77	1.54	1.56
	2030	−2.65	1.57	2.00	1.69	1.11	0.82	1.69	1.60
	2040	−2.95	1.91	2.31	1.93	1.08	1.09	2.15	1.94
Export	2023	−3.30	2.58	2.25	1.89	0.95	0.70	1.61	2.42
	2030	−3.13	3.18	2.55	1.93	0.96	0.75	1.75	2.45
	2040	−3.50	4.29	3.07	2.26	0.90	1.00	2.23	2.90
Import	2023	0.35	−0.82	0.18	−0.49	0.07	0.13	0.59	−0.32
	2030	0.38	−0.95	0.16	−0.43	0.11	0.18	0.70	−0.30
	2040	0.45	−1.24	0.00	−0.51	0.08	0.39	0.96	−0.35

Source(s): Author simulation

Table 5. Cumulative impact of Chips Act implementation on the electronics industry in each country relative to the baseline scenario (%)

industry output decline has not increased significantly over time, and the impact of the "Chips Act" is manageable. Similarly, the U.S. advantage has not increased significantly, the only significant growth in Taiwan and ASEAN countries, which indicates that a large number of Chips production factories left China and moved to various countries in Southeast Asia, Taiwan and ASEAN will be affected by this, and the electronics industry in China to form a certain alternative.

We further predict the cumulative impact of the implementation of the Chips Act in 2040 on the trade flows of the electronics industry in major countries and regions, and the results are shown in Table 6. imports from economies other than China also generally increased. This indicates that the U.S. in the electronics industry and other economies in addition to China's ties to further strengthen, to a certain extent, to achieve the purpose of excluding China from the international electronics industry production and trade system.

4.3 Global value chain analysis

Following the method of Wang *et al.* (2017), we decompose the value added of the sector into four components: pure domestic production (DVA), traditional trade (RT), simple GVC and complex GVC. Among them, pure domestic production refers to the value-added used to produce final goods (including products and services) that are absorbed by the domestic market; traditional trade refers to the value added in the trade of final goods; simple GVC is the intermediate inputs that are used locally for production after the intermediate goods are exported, which is reflected in the trade as a one-time cross-border export or import and complex GVC is reflected in the trade as two or more cross-border exports or imports of intermediate goods. From the flow direction of GVC, it can be divided into forward decomposition and backward decomposition, which is forward decomposition from the perspective of value-added production and backward decomposition from the perspective of value-added demand. Based on this, forward and backward value chain participation indicators, i.e. the share of GVC value added (which can be further classified as simple and complex), can be constructed to measure the degree of participation in GVC activities.

Based on the value chain decomposition of the value added of the electronics industry, we further analyze the impact of the Chips bill coming into effect on the global value chain participation index of the electronics industry. Using the results in Table 7, we find that the share of value-added of the Chinese electronics industry from pure domestic production has increased, while the share from traditional trade and value chain activities has generally decreased, especially international value chain production activities. China's participation in the international value chain of the electronics industry has declined. This corresponds to a general decline in the share of value added in the electronics industry from pure domestic

Table 6.
Cumulative impact of the implementation of Chips Act in 2040 on the electronics industry in each country relative to the baseline scenario (%)

		Import country							
		China	US	EU (28)	Japan	Korea rep	Taiwan	ASEAN	Row
Export country	China	0.00	−3.54	−3.43	−2.45	−2.06	−2.81	−2.72	−2.88
	US	2.74	0.00	3.47	4.63	5.99	5.37	5.45	4.53
	EU	1.99	2.75	2.74	3.84	5.09	4.48	4.41	3.65
	Japan	1.29	2.34	2.39	0.00	4.57	3.92	3.93	3.22
	Korea	0.19	1.52	1.91	2.63	0.00	2.80	2.59	2.35
	Taiwan	0.12	1.43	1.62	2.56	3.43	0.00	2.80	2.20
	ASEAN	0.91	2.25	2.38	3.40	4.23	3.57	3.46	2.98
	Row	1.70	2.73	2.72	3.86	4.79	4.22	3.83	3.45

Source(s): Author simulation

production and an increase in the share from traditional trade and value-added activities in the United States and other major economies in the world. China's participation in the international electronics industry chain has significantly decreased. Under the backward decomposition based on final goods production, China's final goods produced in the electronics industry relies more on domestic value added and simple value chain activities, especially the reliance on pure domestic production increases significantly, which further reflects China's inward contraction in the electronics industry. The U.S., on the contrary, relies more on traditional trade to produce final goods in its electronics industry, suggesting that the U.S. has indeed increased its involvement in electronics production.

Table 8 shows the cumulative impact of implementing the 2040 Chips Act on global value chain participation by industry. We find that except for China, Korea Rep. and Taiwan the forward GVC participation of the United States and other major economies in the electronics industry has generally increased, and except for China the backward GVC participation of other major economies has decreased, indicating that these economies have moved up the international chain in the electronics industry; the opposite is true for China's electronics industry. However, China's forward participation in value chain activities in most industries has increased, which indicates that although the electronics industry has been damaged, other industries have received more resources and have the possibility of development and growth; other industries in the United States, especially machinery manufacturing and electrical products, have also seen this trend, which is largely influenced by the electronics industry, and the position of other industries in the international industrial chain has There has been a rise.

5. Conclusions and policy implications

The implementation of the U.S. CHIPS Act is poised to have a significant redistribution effect on the global value chain (GVC) in the electronics industry. Our simulations predict a relative diminution in China's GVC participation, particularly in forward linkages in the electronics sector, by 2040. Conversely, the U.S. is projected to see augmented GVC integration, especially in backward linkages within the same industry. This suggests a strategic

		China	US	EU(28)	Japan	Korea rep	Taiwan	ASEAN	Row
Forward	Domestic Value Add	0.53	−0.61	−0.42	−0.19	0.00	0.00	−0.08	−0.19
	Traditional Trade	−0.23	0.19	0.14	−0.02	0.07	0.04	0.01	−0.01
	Simple participation	−0.23	0.23	0.19	0.16	0.22	0.17	0.18	0.09
	Complex participation	−0.06	0.19	0.10	0.04	−0.29	−0.21	−0.11	0.11
Backward	Domestic Value Add	0.29	−0.22	−0.20	−0.07	0.00	0.00	0.01	0.13
	Traditional Trade	−0.49	0.40	0.30	0.23	0.17	0.11	0.22	0.05
	Simple participation	0.15	−0.20	−0.18	−0.15	−0.05	0.00	−0.10	−0.12
	Complex participation	0.05	0.02	0.07	−0.01	−0.12	−0.11	−0.13	−0.06

Source(s): Author simulation

Table 7. The cumulative impact of the implementation of the Chips Act in 2040 on the forward and backward decomposition of the electronics industry GVC relative to the baseline scenario (%)

	China	US	EU(28)	Japan	Korea rep	Taiwan	ASEAN	Row
Forward participation								
Agricultural products	−0.03	0.08	0.02	−0.03	−0.08	−0.08	−0.06	−0.01
Textile and apparel	0.01	0.03	0.00	−0.02	−0.08	−0.07	−0.05	−0.03
Chemical products	−0.05	0.04	−0.03	−0.07	−0.07	−0.07	−0.12	0.02
Metallic products	−0.01	−0.19	−0.15	−0.08	−0.11	−0.40	0.01	−0.10
Machine made	0.01	0.08	0.00	−0.11	−0.09	−0.16	−0.10	−0.03
Vehicles	0.02	0.09	0.01	−0.06	−0.10	−0.10	−0.05	−0.02
Electronic product	−0.30	0.42	0.28	0.20	−0.06	−0.04	0.07	0.20
Other manufacturing	−0.08	0.04	−0.14	−0.08	−0.08	−0.17	−0.02	0.00
Services	−0.03	0.03	0.00	−0.03	−0.10	−0.10	−0.01	−0.02
Backward participation								
Agricultural products	−0.04	−0.05	−0.06	−0.07	−0.10	−0.05	−0.03	−0.04
Textile and apparel	−0.07	−0.06	−0.03	−0.07	−0.12	−0.07	−0.05	−0.06
Chemical products	−0.08	−0.06	−0.05	−0.12	−0.14	−0.08	−0.10	−0.11
Metallic products	−0.14	−0.03	−0.03	−0.17	−0.19	−0.06	−0.07	−0.11
Machine made	−0.11	−0.06	−0.04	−0.10	−0.16	−0.07	−0.11	−0.10
Vehicles	−0.12	−0.06	−0.04	−0.09	−0.15	−0.06	−0.09	−0.09
Electronic product	0.20	−0.18	−0.11	−0.17	−0.17	−0.11	−0.23	−0.18
Other manufacturing	−0.11	−0.10	−0.14	−0.17	−0.14	−0.12	−0.07	−0.08
Services	−0.08	−0.03	−0.04	−0.09	−0.16	−0.13	−0.12	−0.09

Source(s): Author simulation

Table 8. Cumulative impact of the implementation of the Chips Act in 2040 on GVC participation by industry relative to the baseline scenario(%)

realignment in the global electronics sector, with the U.S. bolstering its domestic production capabilities and China experiencing a contraction in its export-oriented electronics industry. the backward decomposition, based on the production of final products, shows an increase in China's simple participation index in global value chains at a greater rate than complex participation in the production of final goods within the electronics industry. Based on our analysis results, it is projected that China's electronics industry will further contract domestically in the future.

5.1 Policy implications

Considering these findings, it is imperative for policymakers in China to formulate strategic responses that can mitigate the adverse impacts on its GVC participation. This could involve diversifying its export markets, fostering innovation in high-tech industries and climbing the value chain in other industrial sectors where it maintains competitive advantages. For the U.S., the policy implication is to ensure sustained investment in the semiconductor industry to capitalize on the increased GVC participation. This requires not only financial investment but also human capital development to maintain a competitive edge in the evolving global market. Furthermore, the EU and other technologically advanced economies should consider similar national strategies to protect and enhance their GVC standings in the face of such policy shifts.

The subsidies provided by the CHIPS Act are likely to bolster U.S. chip production and research. However, they are not anticipated to significantly undermine China's dominance in producing basic chips or alleviate the acute chip shortages faced by American manufacturing firms during 2021 and 2022. While not a primary objective of the CHIPS Act, job creation resulting from it will play a vital role in local economies, although the number of jobs generated will be modest on a national scale. The U.S. should continue to adhere to the logic of comparative advantage by exporting advanced, high-value chips and importing basic, lower-value chips, rather than striving for self-sufficiency.

Note

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Appendix

No.	Code	Description	No.	Code	Description
1	pdr	Paddy rice	34	bph	Basic pharmaceutical products
2	wht	Wheat	35	rpp	Rubber and plastic products
3	gro	Cereal grains, not elsewhere classified (n.e.c.)	36	nmm	Mineral products n.e.c
4	v.f	Vegetables, fruit, nuts	37	is	Ferrous metals
5	osd	Oil seeds	38	nfm	Metals n.e.c
6	cb	Sugar cane, sugar beet	39	fmp	Metal products
7	pfb	Plant-based fibers	40	ele	Computer, electronic and optical products
8	ocr	Crops n.e.c	41	eeq	Electrical equipment
9		Cattle, sheep, goats, horses	42	ome	Machinery and equipment n.e.c
10	oap	Animal products n.e.c	$	mvh	Motor vehicles and parts
11	rmk	Raw milk	44	otn	Transport equipment n.e.c
12	wol	Wool, silk-worm cocoons	45	omf	Manufactures n.e.c
13	frs	Forestry	46	ely	Electricity
14	fsh	Fishing	47	gdt	Gas manufacture, distribution
15	coa	Coal	95	wtr	Water
16	oil	Oil	6	cns	Construction
17	gas	Gas	50	trd	Trade
18	oxt	Other extraction (formerly omn Minerals n.e.c.)	51	afs	Accommodation, Food and service activities
19	cmt	Meat: cattle, sheep, goats, horse	52	otp	Transport n.e.c
20	omt	Meat products n.e.c	53	wtp	Sea transport
21	vol	Vegetable oils and fats	54	atp	Air transport
22	mil	Dairy products	55	whs	
23	pcr	Processed rice	56	cmn	Warehousing and support activities
24	sgr	Sugar	57	ofi	Financial services n.e.c
25	ofd	Food products n.e.c	58	ins	Insurance (formerly ist)
26	b_t	Beverages and tobacco products	59	rsa	Real estate activities
27	tex	Textiles	60	obs	Business services n.e.c
28	wap	Wearing apparel	61	ros	Recreation and other services
29	lea	Leather products	62	osg	Public administration and defense
30	lum	Wood products	89	edu	Education
31	PPP	Paper products, publishing	64	hht	Human health and social work activities
32	p-c	Petroleum, coal products	65	dwe	Dwellings
33	chm	Chemical products			

Table A1. GTAP 11 sector classification

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