Empirical Analysis of the Sources of Trade Flow in the CAFTA Based on the CMS Model

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Abstract: The China-ASEAN Free Trade Area (CAFTA), as an important achievement of East Asian regional cooperation, officially came into effect in 2010, providing institutional guarantees for wide-ranging tariff reductions and market access facilitation between China and the ten ASEAN countries. This paper innovatively adopts a combined analytical framework of the Constant Market Share (CMS) model and the extended gravity model of trade. From the perspective of trade growth, the paper explores the structural changes and inter-industry synergy effects of Sino-ASEAN trade dynamics after the implementation of CAFTA. From the perspective of trade growth, this paper reveals the dynamic performance of scale effects, structural effects, competitive effects, and second-order effects of bilateral trade growth after the implementation of CAFTA through the decomposition of the CMS model, and analyzes the driving factors behind these effects. The research shows that CAFTA has not only significantly promoted the growth of bilateral trade flows, but also effectively promoted the process of regional economic integration between China and ASEAN by enhancing industrial collaboration and optimizing resource allocation within the region. This conclusion provides important theoretical support and practical reference for deepening regional economic cooperation and optimizing the design of free trade agreements in the future.

1. Mechanism of Trade Growth within the China-ASEAN Region under the Framework of Free Trade Agreements

The mechanism of trade growth within the China-ASEAN region under free trade agreements is generally explored from perspectives such as tariff reductions, trade facilitation, and supply chain coordination.

Tariff Reductions and Market Access: Free trade agreements typically create a freer environment for trade by reducing tariffs and non-tariff barriers. The tariff reductions and preferential policies between China and ASEAN countries lower the circulation costs of goods within the region, stimulating bilateral and multilateral imports and exports.

Trade Facilitation Measures: Free trade agreements often include provisions for simplifying customs procedures, speeding up clearance times, and reducing transaction costs. These measures improve the flow efficiency of goods within the region, reduce logistics and administrative burdens for businesses, and further promote trade growth.

Supply Chain and Industry Coordination: With the reduction of tariffs and other trade barriers, businesses in ASEAN countries and China can better engage in industrial division of labor. China's manufacturing industry complements ASEAN's resource-based and labor-intensive industries, promoting upstream and downstream interactions within the supply chain, which accelerates regional supply chain integration.

Regional Economic Integration and Investment Growth: Free trade agreements also create a better environment for investment, facilitating capital flow. With increased investment, enhanced production capacities, and multinational cooperation, trade growth within the region is further driven.

2. Overview of the CMS Model

2.1. First Decomposition of the CMS Model

The CMS model, which stands for Constant Market Share model, primarily involves the decomposition of a country's exports to another country into several components, namely: "Import Demand Effect," "Export Competitiveness Effect," and "Second-Order Effect." Additionally, further decomposition can be made, where the "Import Demand Effect" is divided into the "Scale Effect" and "Structural Effect," the "Export Competitiveness Effect" is divided into "Overall Competitiveness Effect" and "Specific Product Competitiveness Effect," and the "Second-Order Effect" is decomposed into "Pure Second-Order Effect" and "Dynamic Second-Order Effect."

The CMS model can be constructed from two dimensions: Triple Effect and Sixfold Effect. The model is first constructed from the perspective of the Triple Effect, and the mathematical expression is as follows:

Let S represent the exports of a country to another country. Thus, ΔS represents the increase in exports from the exporting country to the importing country over the period from 0 to t. Let $r_i(0)$ denote the proportion of the total import value of product i from the importing country that is accounted for by the exporting country at the initial time. Let Δr_i denote the change in the proportion of the total import value of product i from the importing country that is accounted for by the exporting country during the period from 0 to t. Let $\Delta s_i(0)$ represent the initial import value of product i from the importing country, and let Δs_i represent the change in the import value of product i from the importing country during the period from 0 to t.

$$\Delta S = \sum r_i(0) \cdot \Delta s_i + \sum r_i \cdot \Delta s_i(0) + \sum \Delta r_i \cdot \Delta s_i \#(1)$$

where:

ΔS: The increase in exports from the exporting country to the importing country during the time period from 0 to t.

$r_i(0)$: The proportion of the total import value of product i in the importing country that is accounted for by the exporting country at the initial time.

Δr_i: The change in the proportion of the total import value of product i from the exporting country in the importing country's total imports during the period from 0 to t.

$\Delta s_i(0)$: The import value of product i by the importing country at the initial time.

Δs_i: The change in the import value of product i by the importing country during the period from 0 to t.

$\sum r_i(0) \cdot \Delta s_i$: Import Demand Effect

This represents the effect caused by the change in the total import value of the importing country under the assumption of constant share of the exporting country's products in the importing country's total imports. If the effect is positive, it indicates that the exporting country's exports to the importing country will increase with an increase in the importing country's total imports. If the effect is negative, it suggests that the exporting country's exports to the importing country will decrease as the importing country's total imports rise.

$\sum r_i \cdot s_i(0)$: Export Competitiveness Effect

This reflects the increase in the exporting country's exports to the importing country due to changes in the competitiveness of the exporting country's products. If the effect is positive, it indicates an improvement in the exporting country's competitiveness in the importing country's market. If the effect is negative, it indicates a reduction in the exporting country's competitiveness in the importing country's market.

$\sum \Delta r_i \cdot \Delta s_i$: Second-Order Effect

This represents the dynamic interplay between changes in both the import share and the import value of the product in the importing country. The second-order effect captures the interaction between these two variables, and its impact could provide additional insights into the overall trade flow dynamics.

2.2. Second Decomposition of the CMS Model

Next, we further construct the sixfold effect CMS model, which involves modifying Equation (1) and can be expressed in mathematical form as follows:

Let $\Delta s_i(t)$ represent the import value of the importing country at time t , $\Delta r(0)$ represent the proportion of the exporting country's exports in the importing country's total imports at the initial time, and $\Delta s(0)$ represent the import value of the importing country at the initial time. Let Δs represent the increase in the import value of the importing country from 0 to t , and Δr represent the change in the proportion of the exporting country's exports in the total imports of the importing country from 0 to t . Thus, we have:

$$\Delta S = r(0) * \Delta s + \left[\sum r_i(0) * \Delta s_i - r(0) * \Delta s\right] + \Delta r * s(0) + \left[\sum \Delta r_i * s_i(0) - \Delta r * s(0)\right]$$
$$+ \left[\frac{s(t)}{s(0)} - 1\right] + \sum r_i * s_i(0) + \left\{\sum \Delta r_i * \Delta s_i - \left[\frac{s(t)}{s(0)} - 1\right] * \sum r_i * s_i(0)\right\}$$
$$\sim(2)$$

$r(0) * \Delta s$: Scale Effect represents the increase in the exporting country's export value to the importing country due to the increase in the importing country's import scale.

$\sum r_i(0) * \Delta s_i - r(0) * \Delta s$: Structural Effect represents the change in the exporting country's export value to the importing country caused by changes in the structure of the importing country's imports.

$\Delta r * s(0)$: Comprehensive Competitiveness Effect refers to the increase in the exporting country's export value to the importing country caused by changes in the share of the exporting country in the total imports of the importing country, assuming the total import value of the importing country is fixed. A positive effect indicates an increase in the exporting country's overall competitiveness, while a negative effect indicates a decrease.

$[\sum \Delta r_i * s_i(0) - \Delta r * s(0)]$: Specific Product Competitiveness Effect refers to the increase in the exporting country's export value to the importing country due to changes in the share of specific products from the exporting country in the importing country's imports, assuming the total import value and import structure of the importing country are fixed. A positive effect indicates that the export structure of the exporting country is shifting towards more favorable conditions for export

growth, while a negative effect suggests the opposite.

$\left[\frac{s(t)}{s(0)} - 1\right] * \sum ri * si(0)$: Pure Second-Order Effect represents the change in the exporting country's competitiveness caused by changes in the export competitiveness of the exporting country, while assuming the import structure of the importing country remains fixed.

$\{\sum \Delta ri * \Delta si - \left[\frac{s(t)}{s(0)} - 1\right] * \sum ri * si(0)\}$: Dynamic Second-Order Effect refers to the mutual influence between the import structure of the importing country and the corresponding export structure, which leads to changes in the exporting country's export value to the importing country. A positive effect indicates that the share of exports from the exporting country to products with rapidly growing import demand in the importing country is increasing faster. A negative effect suggests that the export share to such products is increasing more slowly.

2.3. Overview of Data Sample Sources

The data samples used in this study are sourced from the United Nations Commodity Trade Statistics Database (UN Comtrade), primarily using the United Nations International Trade Classification, Revision 4 (SITC.Rev04). According to the SITC classification standard, all merchandise trade can be divided into 10 categories, namely SITC0–9. Categories SITC0–4 are primary products, including food and live animals mainly for human consumption, beverages and tobacco, non-food raw materials, mineral fuels, lubricants and related materials, and animal and vegetable oils and waxes. Categories SITC5–9 are industrial manufactured products, including chemicals and related products, manufactured goods classified by material, machinery and transport equipment, miscellaneous manufactured articles, and products not elsewhere classified. Additionally, SITC5 and SITC7 can be further categorized as capital and technology-intensive manufactured goods, while SITC6 and SITC8 are grouped as labor-intensive manufactured goods.

This study selects data from the period of 2007 to 2023 for analysis, considering both total trade and specific category trade. The CMS model requires a base year. To maximize the presentation of annual changes, this study takes the previous year as the base year. For example, if the current year is 2023, the base year will be 2022, and so on. The effects in this study will be displayed as decomposition contribution rates.

3. Decomposition of Effects at the Total Trade Level

3.1. Decomposition of China's Total Exports to ASEAN

According to the decomposition method in Formula 2, the trade factors between China and ASEAN are decomposed. In the decomposition of China's total exports to ASEAN (Table 1), the main contribution comes from export competitiveness, with the overall competitiveness contributing approximately 151.31%, while the specific product competitiveness is -39.08%. However, changes in China's export structure are unfavorable to the expansion of exports to ASEAN. Among them, the import demand effect is 3.13%, the structural effect is 28.44%, and the scale effect is -25.30%. This indicates that changes in ASEAN's import structure promote China's exports to ASEAN, but the expansion in scale is unfavorable to China's exports. The second-order effect is negative, suggesting that the products with rapid growth in ASEAN's import structure do not align with the products experiencing rapid growth in China's export structure. As a result, changes in demand for Chinese products in the ASEAN market are not well adapted.

3.2. Decomposition of China's Total Exports to ASEAN

Table 1. Decomposition of China's Total Exports to ASEAN

Year	Scale Effect	Structural Effect	Import Scale Effect	Overall Competitiveness Effect	Specific Product Competitiveness Effect	Export Competitiveness Effect	Pure Second-Order Effect	Dynamic Second-Order Effect	Second-Order Effect
2022-2021	75.77	-18.96	56.81	21.04	19.04	40.07	5.94	-2.82	3.12
2021-2020	125.06	-16.53	108.54	-17.09	13.46	-3.63	-1.04	-3.87	-4.91
2020-2019	-132.5	12.96	-119.5	259.79	-18.23	241.56	-20.44	-1.54	-21.98
2019-2018	5.54	15.46	21.00	94.03	-15.68	78.34	0.55	0.11	0.66
2018-2017	84.65	-7.82	76.84	14.19	7.29	21.47	2.56	-0.87	1.69
2017-2016	167.29	-31.63	135.66	-53.91	26.09	-27.82	-4.05	-3.80	-7.84
2016-2015	11.42	-43.08	-31.66	100.77	31.68	132.4	-1.04	0.25	-0.79
2015-2014	-1163	668.3	-495.5	1535.7	-764.0	771.6	-88.47	-87.60	-176.0
2014-2013	-11.11	15.97	4.86	114.38	-17.81	96.57	-1.21	-0.22	-1.43
2013-2012	16.40	-0.35	16.05	80.79	0.57	81.37	2.60	-0.02	2.59
2012-2011	31.43	7.39	38.82	64.75	-7.65	57.10	3.60	0.48	4.08
2011-2010	107.80	-16.05	91.75	-5.12	14.63	9.51	2.33	-3.59	-1.26
2010-2009	76.24	-3.78	72.46	19.14	4.02	23.16	5.31	-0.92	4.38
2009-2008	19.35	-126.2	-106.8	115.65	92.39	208.04	-2.11	0.94	-1.17
2008-2007	207.07	-29.15	177.92	-74.44	28.07	-46.37	-19.66	-11.90	-31.55
Average Contribution Rate	-25.30	28.44	3.13	151.31	-39.08	112.23	-7.68	-7.69	-15.37

Data Source: United Nations Trade Database

Table 2. Decomposition of ASEAN's Exports to China

Year	Scale Effect	Structural Effect	Import Scale Effect	Overall Competitiveness Effect	Specific Product Competitiveness Effect	Export Competitiveness Effect	Pure Second-Order Effect	Dynamic Second-Order Effect	Second-Order Effect
2022-2021	24.25	-28.94	-4.68	38.21	65.95	104.16	1.42	-0.90	0.52
2021-2020	102.36	-5.74	96.62	-2.52	6.65	4.13	1.22	-1.96	-0.74
2020-2019	-5.94	28.68	22.74	106.19	-28.43	77.76	-0.36	-0.13	-0.50
2019-2018	-93.36	66.05	-27.31	163.77	-32.30	131.48	-3.35	-0.82	-4.17
2018-2017	227.65	-2.21	225.44	-116.66	9.56	-107.10	-16.83	-1.50	-18.34
2017-2016	52.43	1.72	54.15	38.07	1.65	39.72	6.40	-0.27	6.13
2016-2015	663.26	-12.30	650.96	-602.80	18.95	-583.85	31.86	1.03	32.89
2015-2014	304.63	-46.53	258.10	-214.39	25.68	-188.70	26.94	3.67	30.60
2014-2013	44.20	92.84	137.04	-5.62	-31.40	-37.02	-0.18	0.15	-0.03
2013-2012	96.32	-20.49	75.84	4.40	19.44	23.85	1.73	-1.41	0.32
2012-2011	224.85	14.43	239.29	-126.83	-7.01	-133.85	-5.74	0.30	-5.44
2011-2010	101.28	-1.88	99.40	-1.52	2.50	0.98	0.24	-0.62	-0.38
2010-2009	52.72	6.42	59.15	27.95	2.05	30.00	11.65	-0.80	10.85
2009-2008	-37.31	2.45	-34.86	152.39	-0.45	151.95	-17.04	-0.05	-17.09
2008-2017	105.01	-13.43	91.58	0.56	7.75	8.32	1.53	-1.43	0.10
Average Contribution Rate	124.16	5.41	129.56	-35.92	4.04	-31.88	2.63	-0.32	2.32

Data Source: United Nations Trade Database

3.3. Decomposition of ASEAN's Exports to China

In Table 2, which decomposes ASEAN's exports to China, the import demand effect is the most significant determinant of exports, contributing approximately 129.56%. Among this, the scale effect accounts for 124.16%, indicating that the increase in ASEAN's exports to China is primarily driven by the overall growth in China's import demand. The structural effect contributes 5.41%, showing that ASEAN's export product structure somewhat aligns with China's import structure.

The export competitiveness effect is -31.88%, indicating that ASEAN products are facing decreasing competitiveness and adaptability in the Chinese market.

The second-order effects are positive, with the pure second-order effect being positive and the dynamic second-order effect being negative. This suggests that the products in China's import structure that are growing rapidly are somewhat consistent with the products in ASEAN's export structure, meaning that ASEAN's products are more adaptable to changes in China's import demand. However, ASEAN's products are less competitive in meeting the rapidly increasing demand for certain products in China's import market.

4. Conclusion

First, the import demand effect is the primary driver of bilateral trade growth between China and ASEAN, particularly reflected in ASEAN's exports to China. The increase in ASEAN's total exports to China is largely driven by the strong demand in the Chinese market for ASEAN products, especially in the resource and industrial manufacturing sectors. Similarly, China's exports to ASEAN are also driven by demand from the ASEAN market, though to a lesser extent. Since the establishment of the China-ASEAN Free Trade Area, the significant reduction in tariff barriers has led to a remarkable increase in bilateral trade flows. Furthermore, the economic complementarity between China and ASEAN is strong, not only in the resource and manufacturing sectors but also in the production and consumption of high-value-added products. The complementary trade model has further facilitated the growth of bilateral trade.

Second, the contribution of the export competitiveness effect in China-ASEAN trade is not evenly distributed. China's export competitiveness effect to ASEAN shows strong positive contributions, especially in high-tech products and machinery, where China's competitiveness has significantly improved, driving export growth. However, in some primary product sectors, the competitiveness of specific products has declined, limiting further export growth. In contrast, ASEAN's export competitiveness effect to China is less favorable, particularly the decline in the competitiveness of specific products, which has suppressed the growth of ASEAN's exports. This reflects the overall decrease in ASEAN's ability to compete in the Chinese market, particularly in sectors where ASEAN's products face strong competition.

Third, the second-order effects also play a significant role in the overall trade dynamics. The pure second-order effect is positive, suggesting that the products experiencing the fastest-growing demand in China are more aligned with the growing export sectors of ASEAN. However, the dynamic second-order effect is negative, indicating that ASEAN's products are not sufficiently competitive in responding to China's rapidly growing import demands in specific sectors. This discrepancy signals areas where ASEAN may need to enhance its product competitiveness in the Chinese market.

Overall, this analysis underscores the importance of import demand effects and export competitiveness in shaping the trade dynamics between China and ASEAN. The findings suggest that further deepening economic cooperation and addressing structural challenges in product competitiveness could lead to more balanced and sustainable trade growth in the future.

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