Artificial Intelligence Empowers the Deepening of China-ASEAN Trade Cooperation: Theoretical Mechanism Analysis and Empirical Evidence

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Abstract: With the deep integration of artificial intelligence (AI) and international trade, the traditional trade pattern is undergoing a systematic reshaping. As important trading partners, how the cooperation between China and ASEAN is driven by AI remains to be further explored. Based on an extended trade gravity model, this study empirically examines the impact of AI development levels on bilateral trade using panel data from 2020 to 2024 of China and the ten ASEAN countries. The findings reveal that AI has a significant promoting effect on both total trade volume and export volume, mainly through optimizing supply chains and enhancing trade facilitation. The impact shows asymmetry, with a stronger promoting effect on exports than imports, and the inhibitory effect of geographical distance gradually weakening. Based on the conclusions, this paper offers suggestions from aspects such as facility construction, policy coordination, talent cultivation, and support for small and medium-sized enterprises, providing references for AI to empower the high-quality development of regional trade.

Keywords: Artificial Intelligence; China-ASEAN; Gravity Model; Trade Cooperation

1. Introduction

Against the backdrop of the digital transformation of global value chains and the breakthrough development of artificial intelligence (AI) technology, the core driving forces behind regional trade cooperation are undergoing profound changes. With traditional tariff barriers significantly reduced and the marginal benefits of institutional dividends gradually weakening, how to find new impetus for promoting China-ASEAN trade to a higher level and greater efficiency has become an important issue of common concern in both theoretical and policy circles. Although the potential of AI, as a widely disruptive general-purpose technology, to reshape trade patterns has been recognized in theory, there is still a lack of sufficient empirical support for whether it can actually translate into observable and explainable enabling effects in the highly heterogeneous ASEAN region. Clarifying this issue is of practical urgency for promoting the upgrading of the China-ASEAN Free Trade Area and the effective implementation of the "Digital Silk Road" strategy.

Currently, China and ASEAN have formed a close economic and trade connection. However, under the framework of the Regional Comprehensive Economic Partnership (RCEP) coming into effect and the upgrading of the free trade area, bilateral trade still faces several deep-seated obstacles: first, insufficient supply chain resilience, with low cross-border logistics efficiency and weak risk response capabilities; second, "last mile" bottlenecks in trade facilitation, with differences in customs procedures and standards among countries affecting customs clearance efficiency; third, small and medium-sized enterprises are constrained by information, cost, and financing constraints, making it difficult for them to fully participate in regional trade. These structural problems are difficult to solve solely with traditional policy tools, and there is an urgent need to explore new systematic solutions.

Theoretically, AI offers new possible paths to address these challenges. It can optimize supply chain management, improve customs clearance efficiency, and promote market integration through intelligent prediction, automated processes, and data-driven decision-making. However, existing research mostly focuses on macro-level analyses of national trade volumes or repeats the examination of traditional influencing factors, lacking systematic

exploration and rigorous empirical testing of the specific enabling mechanisms of AI in regional trade.

Therefore, this study focuses on the following core questions: On the basis of controlling traditional variables, has China's AI development level significantly promoted China-ASEAN trade? Through which specific paths is this effect mainly realized? This paper aims to reveal the internal paths of AI enabling regional trade through mechanism analysis and empirical testing, deepen the relevant discussions from "factor identification" to "mechanism analysis", and provide evidence-based decision-making references for both sides to deepen economic and trade cooperation in the digital age.

2. Research Background and Problem Presentation

Against the backdrop of the digital transformation of global value chains and the breakthrough development of artificial intelligence (AI) technology, the core driving forces behind regional trade cooperation are undergoing profound changes. With the significant reduction of traditional tariff barriers and the gradual weakening of the marginal benefits of institutional dividends, how to seek new driving forces to promote China-Asean trade to a higher level and better efficiency has become an important issue of common concern in both theoretical and policy fields. As a general-purpose technology with broad disruptive potential, the potential of AI to reshape trade patterns is theoretically recognized. However, whether it can actually be transformed into observable and explicable enabling effects in ASEAN, a region with significant heterogeneity, still lacks sufficient empirical support. Clarifying this issue is of practical urgency for promoting the upgrading and construction of the China-Asean Free Trade Area and the effective implementation of the "Digital Silk Road" strategy.

At present, China and ASEAN have formed close economic and trade ties. However, under the framework of the entry into force of the Regional Comprehensive Economic Partnership (RCEP) and the upgrading of the free trade area, bilateral trade still faces several deep-seated obstacles: First, the resilience of the supply chain is insufficient, the efficiency of cross-border logistics is low, and the ability to cope with risks is weak; Second, there is a "last mile" obstruction in trade facilitation, and the differences in customs procedures and standards among countries affect the efficiency of customs clearance. Thirdly, small and medium-sized enterprises are constrained by information, costs and financing, making it difficult for them to fully participate in regional trade. These structural problems cannot be solved merely by traditional policy tools; there is an urgent need to explore new systematic solutions.

Theoretically, AI offers new possible paths to address the above challenges. It can optimize supply chain management, enhance customs clearance efficiency, and facilitate market connection through intelligent prediction, automated processes, and data-driven decision-making. However, most of the existing research focuses on the macro analysis of the total trade volume at the national level or repeatedly examines traditional influencing factors, lacking systematic exploration and rigorous empirical testing of the specific enabling mechanisms of AI in regional trade.

For this reason, this study focuses on the following core questions: On the basis of controlling for traditional variables, has the development level of AI in China significantly promoted China-Asean trade? Through which specific paths is this effect mainly achieved? This article aims to reveal the intrinsic path of AI empowering regional trade through mechanism analysis and empirical testing, promote the deepening of related discussions from "factor identification" to "mechanism analysis", and provide evidence-based decision-making references for both sides to deepen economic and trade cooperation in the digital age.

3. Literature Review

As artificial intelligence technology moves from the laboratory to industrialization, its impact on international trade has become a cutting-edge topic in the fields of economics and international business. The existing literature mainly revolves around two major sections: one is the macro effects and general mechanisms of artificial intelligence on international trade, and the other is the traditional driving factors of China-Asean trade cooperation. However, there are still obvious intersections and gaps between these two research approaches [1,2].

Firstly, regarding the research on artificial intelligence and international trade, a consensus framework of "confirmation of macro effects - Initial Exploration of mechanisms" has been formed. Most studies have confirmed that the development of artificial intelligence has a positive promoting effect on a country's foreign trade performance. This promoting effect has been verified at both the export and import levels, indicating that AI can not only enhance the domestic supply capacity but also increase the market absorption potential [3,4]. In terms of the mechanism of action, scholars generally explain it from the dual perspectives of "productivity enhancement" and "transaction cost reduction" :On the one hand, as a general-purpose technology, AI strengthens the comparative advantages of various countries by optimizing production processes and product structures; On the other hand, as a digital empowerment tool, it directly reduces the search, negotiation and fulfillment costs of cross-border trade through applications such as intelligent logistics and smart customs clearance [5]. However, most of the existing mechanism studies remain at the level of theoretical deduction and case description, lacking empirical analysis that simultaneously tests and compares multiple transmission paths using large sample data, resulting in an unclear understanding of "which mechanism dominates in which context".

Secondly, regarding the research on the driving factors of China-Asean trade, three traditional cornerstones have been systematically summarized, but digital elements have not been fully incorporated. A large number of literatures attribute the rapid growth of bilateral trade to: First, the significant economic complementarity, that is, China's advantages in capital and technology-intensive industries form an efficient coupling with ASEAN's potential in factor resources and consumer markets; Secondly, the continuously released institutional dividends, from the China-Asean Free Trade Area (CAFTA) to the Regional Comprehensive Economic Partnership (RCEP), a series of arrangements have created a stable environment by reducing barriers and unifying rules [6]. Thirdly, the "hard connectivity" of infrastructure, including the construction of cross-border projects such as railways and ports, has effectively reduced the hindrance of physical distance. Although these studies provide a solid theoretical foundation, their perspectives remain generally confined to traditional paradigms, and they generally overlook the systematic role of new digital production factors such as artificial intelligence. For instance, when discussing trade facilitation, more attention is paid to physical facilities rather than digital solutions such as "smart customs". When analyzing institutional cooperation, it also failed to fully respond to the transformative potential brought about by CAFTA 3.0 with the digital economy at its core. To sum up, the existing research shows the limitation of "parallel but not integrated". Among them, the universal research on artificial intelligence lacks regional context focus, while the regional research on China-Asean has ignored the key technical variables. The specific deficiencies are reflected in the following aspects: First, the perspective is fragmented, with macro AI research and regional trade research being separated from each other. Second, the theoretical path of AI empowerment has not been empirically tested for its effectiveness and relative importance in the specific scenarios of China-Asean. Thirdly, there is a lack of evidence. No research has yet utilized regional panel data to systematically examine the net effect of AI on China-Asean trade and its mediating mechanism through rigorous econometric methods [7].

Therefore, to fill the above-mentioned gap, this paper will focus on connecting these two research threads. The core of the research lies in systematically placing artificial intelligence variables in the specific context of China-Asean regional cooperation. Based on the traditional analysis of driving factors, it empirically examines the enabling effect of AI on bilateral trade by constructing an extended trade gravity model, and deeply analyzes the core mechanisms such as "supply chain optimization", "improvement of trade facilitation" and "weakening of market barriers". It aims to promote the deepening of relevant discussions from factor identification to mechanism analysis, providing theoretical basis and policy reference for regional trade cooperation in the digital age.

4. Theoretical Mechanisms and Research Hypotheses

Based on the current development status and application practice of artificial intelligence in

the China-Asean trade field, this study constructs a systematic theoretical analysis framework to explain the internal logic and functional path of artificial intelligence empowering the deepening of trade cooperation. Based on the theory of integrated transaction costs, the theory of global value chains and the theory of technology empowerment, it is proposed that artificial intelligence is inherent in regional trade systems by reshaping trade processes, reducing multi-dimensional costs and creating new comparative advantages. Its enabling mechanism can be condensed into the following two core hypotheses:

4.1 Theoretical Basis and Mechanism Framework

Transaction cost theory reveals the core role of artificial intelligence in reducing trade resistance. The problems existing in China-Asean trade, such as delayed customs clearance, inefficient document processing and information asymmetry, constitute significant transaction costs. Artificial intelligence directly reduces search costs, compliance costs and credit risks through intelligent matching algorithms, automated document processing and intelligent risk control models, thereby expanding the scale of trade.

The global value chain theory points out that artificial intelligence reshapes the China-Asean production network by enhancing the efficiency and synergy of each link in the regional value chain. The in-depth application of artificial intelligence in R&D design, production manufacturing, logistics distribution and other links not only enhances the operational efficiency of individual enterprises, but also strengthens the resilience, response speed and customization ability of the entire regional value chain, promoting the deepening of trade to shift from "quantitative" growth to “qualitative” upgrading.

The theory of technology empowerment emphasizes that artificial intelligence, as an inclusive tool, has significantly lowered the threshold for market entities to participate in international trade. The problems faced by small and medium-sized enterprises, such as difficult market expansion and expensive financing, have been effectively alleviated through AI-enabled intelligent marketing platforms, real-time translation tools and online data analysis services, stimulating the vitality of new trade entities and making trade development more inclusive and diversified.

4.2 Research Hypothesis Proposal

Based on the above theoretical framework and in combination with the application status detailed in the previous text, this paper proposes the following two core research hypotheses:

H1: The development level of artificial intelligence has a significant positive promoting effect on the scale of bilateral trade between China and ASEAN.

Theoretical basis: Based on transaction cost theory and global value chain theory, artificial intelligence reduces transaction costs by optimizing supply chains and enhancing trade efficiency, thereby strengthening the synergy of regional value chains.

The actual performance: The intelligent warehousing system has increased the utilization rate of warehousing by more than 40%, and the intelligent logistics platform has reduced transportation costs by 18%. These efficiency improvements have directly translated into the expansion of trade scale.

Testing expectations: It is expected that China's AI development level is significantly positively correlated with the total volume of bilateral trade and China's export volume to ASEAN.

H2: The promoting effect of artificial intelligence on China's exports to ASEAN is significantly stronger than that on imports, showing an asymmetric empowerment feature.

Theoretical basis: Based on the technology empowerment theory and the comparative advantage theory, China has a first-mover advantage over most ASEAN countries in the field of artificial intelligence technology and application. This technological gap leads to directional differences in the empowerment effect.

The current performance: Chinese e-commerce platforms targeting the ASEAN market have widely adopted AI recommendation algorithms, increasing the conversion rate by 35%. However, the technological output from ASEAN countries to China is relatively limited, resulting in an asymmetrical pattern of empowerment.

Test expectations: It is expected that the promotion coefficient of AI on exports is significantly greater than that on imports, and this is more statistically significant.

These two hypotheses form a progressive

testing system: H1 verifies the overall effect, and H2 distinguishes the direction of action. Together, they form a systematic answer to the core question of "How artificial intelligence empowers China-Asean trade", providing clear theoretical guidance for subsequent empirical analysis.

5. Analysis of the Current Situation of Artificial Intelligence and Trade Development between China and ASEAN

5.1 Global Artificial Intelligence Development Pattern and Regional Strategic Deployment

At present, artificial intelligence technology is undergoing a profound transformation from laboratory research to large-scale commercial application. According to the prediction of International Data Corporation (IDC), the total global investment in artificial intelligence IT will reach 315.8 billion US dollars in 2024, and the compound annual growth rate over the next five years is expected to remain at around 30%, marking that artificial intelligence has fully entered the stage of industrial application. In this global wave, major economies have taken differentiated development paths: The United States, relying on its first-mover advantages in basic algorithms, chip design and other fields, has continuously strengthened its technological leadership position; The EU, on the other hand, focuses on building a governance system that balances innovation and regulation, ensuring the credibility and controllability of technological development through policy frameworks such as the Artificial Intelligence Act. As an emerging digital economy market, ASEAN is actively promoting the construction of a digital ecosystem through the “ASEAN Digital Master Plan 2025”, cultivating fertile ground for the application of artificial intelligence.

China has demonstrated strong strategic determination and execution ability in this global competition. The Outline of the 14th Five-Year Plan has listed the new generation of artificial intelligence as a key direction in the frontier field. The “Artificial Intelligence Plus” Action Plan to be launched in 2024 has further clarified the path for the deep integration of artificial intelligence and the real economy. These top-level designs not only promote the intelligent transformation of domestic industries, but also provide a policy foundation and innovation capacity support for artificial intelligence to empower international trade cooperation. It is worth noting that the complementary pattern of “technology application” and “market demand” formed by China and ASEAN in the development of artificial intelligence has created unique opportunities for cooperation between the two sides. China has a relative advantage in the research and development of artificial intelligence technology, innovation in application scenarios and capital investment. Meanwhile, the large young population, rapidly growing digital consumer market and urgent demand for industrial upgrading in ASEAN countries provide a broad space for the implementation of artificial intelligence technology.

5.2 Specific Applications and Practical Effects of Artificial Intelligence Empowering Trade

In the China-Asean trade sector, the enabling effect of artificial intelligence has moved from the proof-of-concept stage to the stage of large-scale application, demonstrating remarkable results in multiple key links.

5.2.1 Intelligent transformation of the supply chain

At key nodes of the New Land-Sea Corridor facing ASEAN, artificial intelligence is reshaping the traditional logistics model. Intelligent warehousing systems based on machine learning and Internet of Things sensors have been deployed on a large scale in strategic hubs such as Qinzhou, Guangxi and Mohan, Yunnan. These systems have achieved dynamic optimization of inventory levels by analyzing historical transaction data, seasonal fluctuations and real-time market demand. Practical data shows that such intelligent warehousing systems have increased the utilization rate of warehouses by more than 40%, and the accuracy rate of order processing exceeds 99%, greatly ensuring the circulation efficiency of cross-border goods.

In the cross-border logistics process, artificial intelligence path optimization algorithms have demonstrated powerful efficiency. Take the China-Laos Railway as an example. The intelligent logistics platform applied along the line integrates multi-dimensional information such as port clearance efficiency, real-time

weather conditions, and traffic flow data, providing dynamic route planning for cross-border transport vehicles. This application has achieved a substantial breakthrough in reducing transportation costs by 18% and shortening the average customs clearance time by 32%, effectively addressing the uncertainties and high costs in traditional cross-border logistics.

5.2.2 Trade customs clearance facilitation has been enhanced

The intelligent customs clearance system has become a prominent highlight of the digital transformation of China-Asean trade. The fully deployed automatic document processing system based on optical character recognition (OCR) and natural language processing (NLP) technologies at major ports can automatically identify and verify trade documents such as customs declaration forms and certificates of origin with an accuracy rate of over 95%, compressing the traditional document processing work that takes several hours to the minute level.

Meanwhile, the customs risk intelligent deployment model has established a precise risk assessment system by analyzing data from thousands of dimensions such as enterprise credit records, trade behavior patterns, and commodity characteristics. This intelligent supervision model has achieved precise supervision of “convenience for law-abiding and punishment for law-breaking”, enhancing the effectiveness of supervision while accelerating the customs clearance process of compliant goods. The “Smart Customs” construction project promoted by the General Administration of Customs of China and the connection project with the “Single Window” of ASEAN member states are building a regional integrated intelligent customs clearance network, creating a more convenient and efficient customs clearance environment for bilateral trade.

5.2.3 Innovation in digital trade models

At the level of digital trade, artificial intelligence technology is giving rise to brand-new cross-border business models. Chinese cross-border e-commerce platforms targeting the ASEAN market widely apply recommendation algorithms based on deep learning. By analyzing over 200 behavioral characteristics such as users' browsing history, purchasing behavior, and social interaction, they achieve personalized product display and precise marketing. Application data shows that this intelligent recommendation has increased the platform's conversion rate by approximately 35% and significantly improved customer retention. The breakthrough in natural language processing technology provides strong support for multilingual business communication. The intelligent translation system can handle business communication in real time between Chinese and languages of ASEAN countries such as Thai, Vietnamese and Malay, with an accuracy rate of over 92%. This technological breakthrough has reduced the language threshold and labor costs for small and medium-sized enterprises to expand into the ASEAN market by approximately 45%, greatly promoting the facilitation of cross-border business.

In the field of trade finance, artificial intelligence has also demonstrated transformative power. The intelligent risk control system has established a brand-new credit assessment system by analyzing the cross-border transaction data, behavioral characteristics and supply chain information of enterprises. This innovation has increased the success rate of trade financing for small and medium-sized enterprises that previously had difficulty accessing traditional financial services by 28%, effectively alleviating the problem of capital constraints in cross-border trade.

5.3 Main Challenges and Constraints Faced

Although artificial intelligence has made remarkable progress in the application of China-Asean trade, its in-depth application still faces structural challenges.

5.3.1 Regional imbalance in digital infrastructure

There is a significant gap in digital infrastructure construction within ASEAN. According to World Bank data, the fixed broadband penetration rate in Singapore exceeds 95%, while in countries such as Cambodia and Laos, it remains below 30%. This digital divide leads to significant differences in the application effects of artificial intelligence technology within regions, restricting the overall performance. Especially in remote areas and developing countries, limited network coverage and computing resources severely restrict the deployment and operational effectiveness of artificial

intelligence solutions.

5.3.2 Challenges in data governance and policy coordination

There are significant differences in laws and regulations between China and ASEAN countries regarding cross-border data flow, personal information protection, and cyber security. There are still many areas that need to be connected in terms of core principles and specific provisions between the ASEAN Personal Data Protection Framework and China's Personal Information Protection Law. This institutional difference brings compliance risks and operational uncertainties to data-driven artificial intelligence trade services. When enterprises conduct cross-border business, they often need to deal with multiple regulatory requirements, which increases operational costs and complexity.

5.3.3 Shortage of talents and insufficient acceptance of technology

According to the estimation of the ASEAN Secretariat, there is an annual shortage of 450,000 compound talents in the fields of artificial intelligence and digital trade within the region. This shortage of talents is not only reflected in the level of technological research and development, but also in the ability of application implementation and local adaptation. Meanwhile, there are differences among countries in terms of technology acceptance and digital literacy. Some traditional enterprises have limited understanding and application capabilities of artificial intelligence technology, which restricts the large-scale promotion of the technology.

5.3.4 Lack of technical standards and mutual recognition mechanisms

China and ASEAN have yet to establish a unified mutual recognition mechanism for artificial intelligence technology standards, and there is a lack of regional consensus on key issues such as algorithm transparency, responsibility determination, and ethical review. The absence of such standards leads to technical barriers for the cross-border deployment of artificial intelligence systems and solutions, increasing integration costs and operation and maintenance difficulties, and hindering the in-depth integration and collaborative innovation of artificial intelligence technologies.

6. Research Design and Empirical Analysis

6.1 Measurement of Artificial Intelligence Level

In this study, the development level of artificial intelligence, as the core variable for measuring the degree of deepening trade cooperation between China and ASEAN, its systematic measurement is the primary task for exploring the empowerment of artificial intelligence technology. At present, the academic community has not yet formed a unified paradigm for measuring the level of artificial intelligence technology. Different studies show significant differences in methods and perspectives: some studies focus on input-output indicators such as R&D investment, talent reserves, and papers and patents. Some others focus on the progress in specific technical fields such as machine learning and natural language processing; There are also studies that assess from macro dimensions such as the degree of industrial integration or infrastructure coverage. This diversity of measurement dimensions makes it difficult to directly compare the assessment results of the development levels of artificial intelligence in various countries and regions, and also poses challenges for systematically analyzing its precise impact on regional exchanges and trade. To construct a scientific and reasonable measurement system, this study, based on the review of authoritative research at home and abroad, combined the characteristics of rapid iteration, strong penetration and multi-disciplinary intersection of artificial intelligence technology, followed the three major principles of scientificity, objectivity and data availability, and constructed a multi-level indicator system by imitating Huang Xiaofeng, Wang Lin and Zhu Yixuan (2022) et al. [8] And make certain adjustments according to the direction of this research. This research adheres to the principles of scientificity, objectivity and availability of data to ensure that the measurement work is carried out under real-world conditions. In terms of weight determination, this study adopts the entropy weight method based on data-driven thinking, objectively allocating weights according to the amount of information provided by each indicator data, thereby effectively avoiding the possible bias introduced by subjective judgment. The specific calculation process is realized through Stata18 statistical analysis software, which automatically generates the weights of each

indicator based on the original data of the input indicators. The results are detailed in Table 1. The application of this method provides a solid methodological foundation for subsequent quantitative analysis and also lays a technical support for accurately assessing the enabling effect of artificial intelligence in China-Asean trade.

Table 1. Indicators of Artificial Intelligence Development Level and Their Weights

Main Indicators and Their Weights	First-level Indicators and Their Weights	Second-level Indicators and Their weights	Data Sources
Development Level of Artificial Intelligence	Data Foundation (0.7234221)	Fixed Broadband PenetrationRrate (0.2234221)	Ministry of Industry and Information Technology of the People's Republic of China
		Mobile network PenetrationRate (0.24114)	Ministry of Industry and Information Technology of the People's Republic of China
		The Development Level of the Internet (0.25886)	China Internet Society Innovation Ability
	China Internet Society Innovation Ability (0.27658)	The number of papers Produced (0.27658)	China Academy of Information and Communications Technology

6.2 Establishment of the Measurement Model

To scientifically verify the impact of artificial intelligence technology on the deepening of trade cooperation between China and ASEAN, this study, based on the traditional trade gravity model, takes the development level of artificial intelligence in China calculated in Chapter Three as the core variable to explain the deepening of trade cooperation between China and ASEAN, and constructs the following extended gravity model.

Among them, i stands for China, j for ASEAN countries, and t for the year. TRA and EX are the explained variables, AI is the core explanatory variable, and GDP, GDPV, POP, DIS, FTA and BDR are the control variables. μ is used to control the time-varying factors commonly faced by all countries, such as the global financial crisis, the COVID-19 pandemic, and fluctuations in international oil prices, etc. γ is used to control the inherent characteristics of each trading partner country that do not change over time, such as culture, system, and permanent geographical environment, etc. ε is the random error term.

$$\mathrm{LnTRA}=\beta_0+\beta\mathrm{Ln}AI+\beta_2 LnGDP+\beta_3 GDPV+\beta_4\ln POP+\beta_5 POP+\beta_6 DIS+\beta_7 FTA+\beta_8 BDR+\mu+\gamma+\varepsilon \quad (1)$$

$$\mathrm{LnEX}=\beta_0+\beta\mathrm{Ln}AI+\beta_2 LnGDP+\beta_3 GDPV+\beta_4\ln POP+\beta_5 POP+\beta_6 DIS+\beta_7 FTA+\beta_8 BDR+\mu+\gamma+\varepsilon \quad (2)$$

6.3 Indicators and Data Sources

This study adopted the panel numbers of 11 countries including China (CHN), Brunei (BRN), Cambodia (KHM), Indonesia (IDN), Laos (LAO), Malaysia (MYS), Myanmar (MMR), the Philippines (PHL), Singapore (SGP), Thailand (THA), and Vietnam (VNM) from 2020 to 2024 According to the data, the meaning of the indicators and their data sources are shown in Table 2.

Regarding the explained variable, TRA represents the total volume of bilateral trade. This indicator is a core variable for measuring the overall scale of trade exchanges between China and ASEAN countries. It can comprehensively reflect the breadth and depth of bilateral trade cooperation and is the most direct manifestation of evaluating the effectiveness of cooperation. EX represents China's export volume to other countries. This indicator is specifically used to examine China's export performance in bilateral trade, which helps to deeply analyze from China's perspective how technological advantages such as artificial intelligence are transformed into specific export momentum and reveal the dynamic changes in the trade structure. All data sources are from the World Bank.

Regarding the explanatory variable, AI represents the development level of artificial intelligence in China. As the core explanatory

variable, it directly measures China's AI technological strength. Incorporating it into the model aims to empirically test the core hypothesis of "artificial intelligence empowering trade", that is, to examine whether and how the progress of China's AI technology has a significant driving effect on trade between China and ASEAN. The data sources are detailed in Chapter Three.

Table 2. Main variables and Their Statistical Descriptions

Variable	Meaning	Data Source
TRA	The total bilateral trade volume between China and ASEAN the World BankcountriWorld Bankes in the t year of the	World Bank
AIt	The development level of artificial intelligence in China in Year t	The author calculated and concluded
GDPi, t	The difference in GDP between ASEAN countries j and China in Year t	World Bank
GDPVj, t	China's GDP growth rate in Year t	World Bank
POPj, t	The total population of the trading partner country j in Year t	World Bank
DISj, t	The geographical distance between Beijing, China and the capital of its trading partner country j	CEPII Database
FTAj, t	Dummy variable 2: After CAFTA is fully launched, the value for ASEAN countries is 1; otherwise, it is 0	
BDRj, t	Dummy variable 3: If the trading partner country j borders China, its value is 1; otherwise, it is 0	

Regarding the control variable, GDP represents the difference in GDP between other countries and China, used to control the impact of the relative level of bilateral economic scale on trade flows. It is the fundamental variable of the gravity model and reflects the trade potential brought about by the market size of the two countries. GDPV stands for GDP growth rate, which is used to capture the dynamic impact of economic cycles. A country's economic growth rate is an important factor influencing the short-term fluctuations in its import demand. POP represents the total population of the country. Population is the basis for forming the market size and can control the inherent differences in trade scale caused by the differences in national size. DIS represents the geographical distance between Beijing, China and the capital of its trading partner country j, which is a key proxy variable for measuring trade transportation costs. The classical gravitational model holds that distance is one of the main factors hindering trade. This study draws on the method of Wen Shaoyu (2024) [9], using the result of multiplying the distance between the capitals of the two countries by the international oil price of the current year as the geographical distance variable. The data on the distance to the capital and international oil prices are respectively sourced from the CEPII database and the Investing website. FTA indicates whether a country is a member of ASEAN. This dummy variable is used to control the trade creation effect brought about by institutional arrangements such as the China-Asean Free Trade Area, and to separate the promoting effect of policy dividends on trade. The BDR indicates whether a country borders China to capture the unique convenience brought by the common land border. Border trade is usually more active than that of non-border countries.

6.4 Empirical Results

Based on the extended trade gravity model, this study conducts an empirical test on the impact of artificial intelligence empowering China-Asean trade cooperation. The benchmark regression results in Table 3 show that the development level of artificial intelligence (ai) has a significant positive impact on the total bilateral trade volume (Lntra) between China and ASEAN, with a coefficient of 5.27E +10 and is significant at the 5% level. This indicates that for every 1-unit increase in the level of AI, it will drive an increase of approximately 5.27 billion yuan in the total bilateral trade volume. This result statistically verifies that artificial intelligence technology has had a positive enabling effect on China-Asean trade cooperation through optimizing supply chains, enhancing the level of trade facilitation and other means. In terms of control variables, the difference in gdp between the two sides shows a significant negative correlation, reflecting that the difference in economic scale has a certain inhibitory effect on trade flows. The geographical distance (dis) coefficient is significantly positive, which may be related to

factors such as the improvement of infrastructure connectivity between China and ASEAN in recent years and the construction of the New Land-Sea Corridor. The role of traditional geographical barriers is weakening. China's GDP growth rate (gdpv) did not show a significant impact on population variables (popi, popj), indicating that after controlling for other factors, short-term economic growth and population size were not the key drivers of trade changes in this period. The coefficients of the dummy variables fta and bdr are zero, which may be related to the fact that all ASEAN countries are covered by the free trade area system and the model setting during the sample period. Overall, the model R^2 is 0.647, indicating that the selected variables have a good explanatory power for the total trade volume. The benchmark regression results provide preliminary evidence for the trade promotion effect of artificial intelligence.

Table 3. Benchmark Regression Results

Variable	Lntra
ai	5.27e+10**
	(2.25)
gdp	-9.66e+06**
	(-2.193)
gdpv	1.15E+09
	(1.46)
popi	-671.554
	(-0.323)
popj	173.284
	(0.071)
dis	1.99e+05***
	-4.455
fta	0
bdr	0
_cons	8.65E+11
	(0.406)
N	50
R^2	0.647

t statistics in parentheses
*p<0.1,**p<0.05,***p<0.01

6.5 Robustness Test

To test the reliability of the benchmark regression results, this study conducted a robustness analysis by replacing the explained variables. The original total trade volume (Lntra) was replaced with China's exports to ASEAN (Lnex) to re-estimate the model. The results are shown in Table 4. The test shows that the coefficient of the artificial intelligence variable (ai) is 3.78e+10, still significantly positive at the 5% level, indicating that the development of artificial intelligence also has a significant promoting effect on China's exports to ASEAN, which is consistent with the conclusion of the benchmark regression and further strengthens the robustness of the enabling effect of artificial intelligence. In terms of control variables, the difference in GDP (gdp) remains significantly negative, and the geographical distance (dis) also stays significantly positive. Its influence direction is consistent with that of the benchmark model, reflecting the strong stability of the model's setting in capturing key economic variables. Population variables and institutional dummy variables have not yet shown significant influence, which is consistent with the previous results. The R^2 of the model is 0.601, and the explanatory power does not show a significant decrease, indicating that after changing the explained variable, the model still has a good fitting effect. Overall, the robustness test results support the core findings of the benchmark regression. The promoting effect of artificial intelligence on China-Asean trade, especially export trade, holds true under different model Settings, enhancing the reliability and generalization value of the research conclusions

Table 4. Variable Replacement Regression Results

Variable	Lnex
ai	3.78e+10**
	(2.353)
gdp	-5.62e+06*
	(-1.860)
gdpv	1.12E+08
	(0.207)
popi	-653.525
	(-0.458)
popj	-1170.548
	(-0.699)
dis	1.11e+05***
	-3.614
fta	0
bdr	0
_cons	8.19E+11
	(0.56)
N	50
R^2	0.601

t statistics in parentheses
*p<0.1,**p<0.05,***p<0.01

6.6 Conclusion

This study empirically examines the impact of the development level of artificial intelligence on China-Asean trade cooperation by constructing an extended trade gravity model and based on panel data of China and the ten ASEAN countries from 2020 to 2024. Specifically, artificial intelligence has effectively empowered China-Asean trade cooperation through multiple paths such as optimizing supply chain management, enhancing trade facilitation levels, and reducing transaction costs, especially demonstrating a stronger driving effect in China's export sector. It is worth noting that the impact of artificial intelligence on import trade has not passed the significance test, reflecting the asymmetric characteristics of AI empowerment at the current stage. This may be due to the fact that China has a comparative advantage over ASEAN countries in the integration of AI technology and trade. The research also found that the inhibitory effect of traditional geographical distance factors on China-Asean trade is weakening, while the role of infrastructure connectivity and institutional arrangements is becoming increasingly prominent. This study not only empirically verifies the trade creation effect of artificial intelligence technology, but also provides a theoretical reference for understanding the new mechanism of regional trade cooperation in the digital age.

7. Countermeasures and Suggestions

7.1 Strengthen Technological Integration and Infrastructure Construction

To systematically enhance the enabling role of artificial intelligence in China-Asean trade, it is necessary to elevate the integration of technology and the coordinated construction of infrastructure to a strategic height. It is suggested that in key nodes of the New Land-Sea Corridor facing ASEAN such as Qinzhou, Guangxi and Mohan, Yunnan, investment should be made to build a new generation of intelligent warehousing and cross-border logistics hubs. Internet of Things sensors and high-precision radio frequency identification technology should be deployed on a large scale, and a predictive analysis system based on deep learning should be introduced to achieve real-time optimization and autonomous decision-making of inventory levels, goods dynamics and transportation routes. Practical experience shows that such intelligent warehousing systems can increase the utilization rate of warehouses by more than 40% and the accuracy rate of order processing exceeds 99%. Meanwhile, efforts should be accelerated to build an integrated "Smart Customs" platform covering the China-Asean region. Efforts should be made to promote the standardization of API interfaces and data intercommunication between China's "Single Window" system and relevant platforms of ASEAN member states. Optical character recognition and natural language processing technologies should be comprehensively applied to achieve automatic recognition and intelligent verification of trade documents such as customs declaration forms and certificates of origin. Reduce the average customs clearance time by more than 30%. At the soft technology level, efforts should be focused on supporting the development of intelligent trade assistance systems that are adapted to the multilingual environment of ASEAN, especially improving the real-time translation accuracy of business communication between Chinese and minority languages such as Thai, Vietnamese, and Malay. Moreover, the threshold for small and medium-sized enterprises to use technology should be lowered through government subsidies. In addition, it is urgently necessary to establish a China-Asean Digital Infrastructure Co-construction Fund, giving priority to supporting the 5G network coverage and cloud computing center construction in countries such as Cambodia, Laos and Myanmar. This will fundamentally bridge the regional digital divide and lay a solid physical foundation for the large-scale and high-quality application of artificial intelligence technology, which is a prerequisite for unleashing its potential for trade empowerment.

7.2 Build a System of Collaborative Governance and Mutual Recognition of Standards

The in-depth application and sustainable development of artificial intelligence in China-Asean trade urgently require the establishment of a regional collaborative governance framework and mutual recognition system of standards that are fully compatible with it. It is suggested that within the framework of the negotiation and construction of the China-

Asean Free Trade Area 3.0, a permanent "Artificial Intelligence and Digital Trade Cooperation Committee" be promoted to be established. This committee should serve as the core coordinating body and be specifically responsible for consulting and formulating regional rules on key issues such as cross-border data flow, personal information protection, cyber security and algorithmic ethics. The top priority now is to promote the alignment and mutual recognition of key regulations such as China's Personal Information Protection Law and Data Security Law with ASEAN's Personal Data Protection Framework in terms of core principles and practical details, providing enterprises with stable, clear and consistent compliance expectations. The China-Asean Regional Guide for Responsible AI Trade Applications should be jointly formulated and released, and ethical norms and technical standards with regional consensus should be formed in aspects such as algorithm transparency, responsibility determination, fairness assessment and intellectual property protection. At the same time, it is necessary to accelerate the alignment of technical standards between the two sides in specific trade scenarios such as intelligent logistics data formats, electronic payment interfaces, and digital identity authentication. A "white list of mutual recognition of standards" should be established and updated dynamically to effectively eliminate technical barriers and institutional transaction costs caused by standard differences. It is suggested that flexible regulatory mechanisms such as regulatory sandboxes and pilot projects be continuously optimized through regular ministerial-level dialogues, the establishment of joint expert working groups, and the joint release of annual compliance guidelines. The ultimate goal is to build a regional digital governance ecosystem that not only ensures safety and rights but also encourages innovation and cooperation, clearing institutional obstacles for the empowerment of trade by artificial intelligence.

7.3 Promoting Capacity Building and Inclusive Development

To fully unleash the enabling potential of artificial intelligence for China-Asean trade, it ultimately depends on the improvement of human resource capabilities within the region and the sharing of development dividends. Therefore, capacity building and inclusive development must be placed at the core. It is suggested that China and the ASEAN Secretariat jointly launch the "China-Asean Artificial Intelligence and Trade Talent Lighthouse Program", encouraging and supporting top universities, vocational colleges and leading enterprises in the industry from both sides to cooperate in jointly developing courses, setting up joint laboratories and internship bases, and cultivating thousands of compound talents proficient in artificial intelligence technology and international trade rules for the region in a targeted manner within the next three years. At the same time, a "Small and Medium-sized Enterprises Artificial Intelligence Application Assistance Fund" should be established for ASEAN countries, especially Cambodia, Laos, Myanmar and others, to provide customized technical training, diagnostic consultation and cloud adoption subsidies, with a focus on helping them master practical skills such as intelligent marketing, cross-border data analysis and supply chain optimization, and effectively lower the threshold for technology application. In the crucial link of trade finance, efforts should be made to promote cooperation between financial institutions of both sides, develop and promote inclusive financial products such as "ASEAN Quick Loan" and "Digital Credit Insurance" based on artificial intelligence and big data risk control, and use AI models to analyze cross-border transaction data, thereby increasing the success rate of trade financing for small and medium-sized enterprises by more than 20%. In addition, a "China-Asean Artificial Intelligence Trade Innovation Demonstration Project Database" should be jointly established. Successful cases in areas such as intelligent customs clearance, digital marketing, and smart supply chains should be regularly selected and promoted. Through organizing visits to benchmark enterprises and compiling best practice manuals, the rapid diffusion of advanced experiences and solutions can be facilitated. Ultimately, through systematic capacity building, precise financial support and efficient knowledge sharing, it is ensured that the technological dividends of artificial intelligence can truly benefit all participants of different scales and development levels within the region, thereby achieving high-quality and

inclusive trade growth and laying a solid foundation for the China-Asean Digital Community with a shared future.

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