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A Review of Gravity Model Studies on China's Trade Flows

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Abstract

This study provides a structured review of the determinants of China's trade flows based on empirical research employing the gravity model. A total of 67 articles indexed in the Scopus database between 2004 and February 2024 were systematically collected and examined. The study synthesizes the frequency of explanatory variables, as well as the direction and statistical significance of their estimated coefficients across the selected literature. The results indicate that GDP (Gross Domestic Production), common language, common border, and FTAs (free trade agreements) are consistently associated with higher trade flows in gravity-based estimations. In contrast, distance, tariff and landlocked status are frequently linked to trade-reducing effects. Overall, economic scale and institutional integration tend to facilitate China's trade expansion, while trade costs and geographic constraints act as limiting factors. By organizing and comparing empirical findings across studies, this review offers a consolidated understanding of the main determinants of China's trade flows and provides a reference framework for future gravity-model research.

Keywords: China's Trade Flows, Gravity Model, Determinants, Systematic Review, Free Trade Agreements

Introduction

Over the past two decades, China has become one of the most influential actors in the global trading system. According to the World Trade Organization (2024), China ranked as the world's largest merchandise exporter in 2023, accounting for a substantial share of global exports. Its trade expansion has reshaped global supply chains, altered patterns of comparative advantage, and intensified economic interdependence between developed and developing economies. Given this structural transformation, understanding the determinants of China's trade flows is no longer merely an academic issue but a matter of practical significance for policymakers, firms, and international institutions.

Despite the vast body of empirical research examining China's trade performance, findings remain dispersed across different contexts, sectors, and methodological approaches. The

gravity model has become the dominant framework for analyzing bilateral trade flows because of its strong theoretical foundation and intuitive economic interpretation (Tinbergen, 1962; Anderson & van Wincoop, 2003; Helpman et al., 2008). Numerous studies have applied gravity models to China's exports and imports, incorporating variables such as GDP, distance, institutional quality, and trade agreements. However, while individual studies provide valuable insights, there is limited consolidated evidence on which determinants consistently matter, how frequently they appear, and whether their effects are robust across specifications.

This fragmentation creates both a theoretical and practical gap. From a theoretical perspective, researchers lack a structured synthesis of variable selection patterns and empirical regularities in gravity-based studies on China's trade. From a practical perspective, policymakers and trade negotiators require clearer evidence regarding which economic, geographic, and institutional factors most effectively promote or constrain China's trade flows. Without systematic comparison, it is difficult to distinguish core determinants from context-specific findings.

Therefore, this study aims to provide a structured and quantitative review of gravity-model research on China's trade flows. By systematically analyzing 67 Scopus-indexed articles published between 2004 and February 2024, the paper evaluates three key dimensions: (1) the frequency with which explanatory variables are used, (2) the direction and statistical significance of their estimated effects, and (3) the relative magnitude of their influence within model specifications. Through this synthesis, the study identifies the most stable promoting and inhibiting factors shaping China's trade patterns.

The significance of this research lies in three aspects. First, it contributes to academic research by organizing fragmented empirical findings into a coherent analytical framework, thereby providing guidance for future gravity-model specifications and variable selection. Second, it offers policy-relevant insights by clarifying which institutional and policy variables—such as free trade agreements, tariffs, and economic cooperation mechanisms—demonstrate consistent effectiveness in promoting trade. Third, it benefits practitioners and international business stakeholders by highlighting structural trade costs and market size factors that systematically influence bilateral trade outcomes.

Rather than proposing a new econometric estimation, this study focuses on the utility and effectiveness of existing empirical evidence. By synthesizing accumulated research results, it strengthens the understanding of how economic scale, geographic distance, and institutional integration jointly shape China's trade flows. In doing so, the paper provides both theoretical clarification and practical reference for scholars, policymakers, and trade analysts concerned with China's evolving role in global commerce.

Methods

This study conducts a structured literature review based on the Scopus database. Scopus was selected because it is one of the largest multidisciplinary citation databases and is widely used in bibliometric and systematic review research due to its broad journal coverage and standardized indexing system (Falagas et al., 2008; Martín-Martín et al., 2018). Compared

with other academic databases, Scopus provides consistent metadata and citation information, which facilitates transparent and replicable literature selection.

To ensure reproducibility, the initial search was conducted on February 12, 2024. The search strategy combined keywords related to the gravity model and China's trade flows, including "gravity model," "China," "trade," "export," and "import," which were searched in titles, abstracts, and keywords. Only English-language journal articles in the field of Economics and related disciplines were retained.

Studies were included if they explicitly constructed and estimated a gravity model of China's trade flows (exports, imports, or bilateral trade) and reported regression coefficients of explanatory variables. Articles focusing solely on foreign direct investment, trade structure, welfare effects, or predictive modeling without interpretable gravity estimations were excluded.

After applying these criteria through title–abstract screening and full-text review, 67 articles were retained for analysis. The detailed screening process is presented in Figure 1.

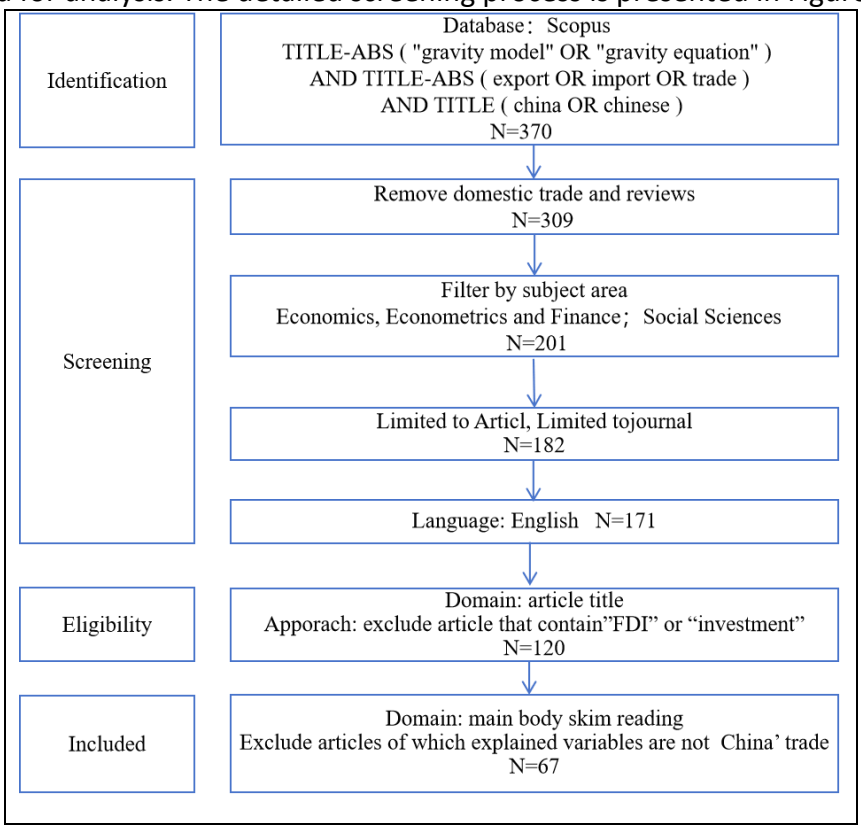

Figure 1 Flowchart For Determining The Sample Literature

Result and Discussion

Basic Information Of Samples

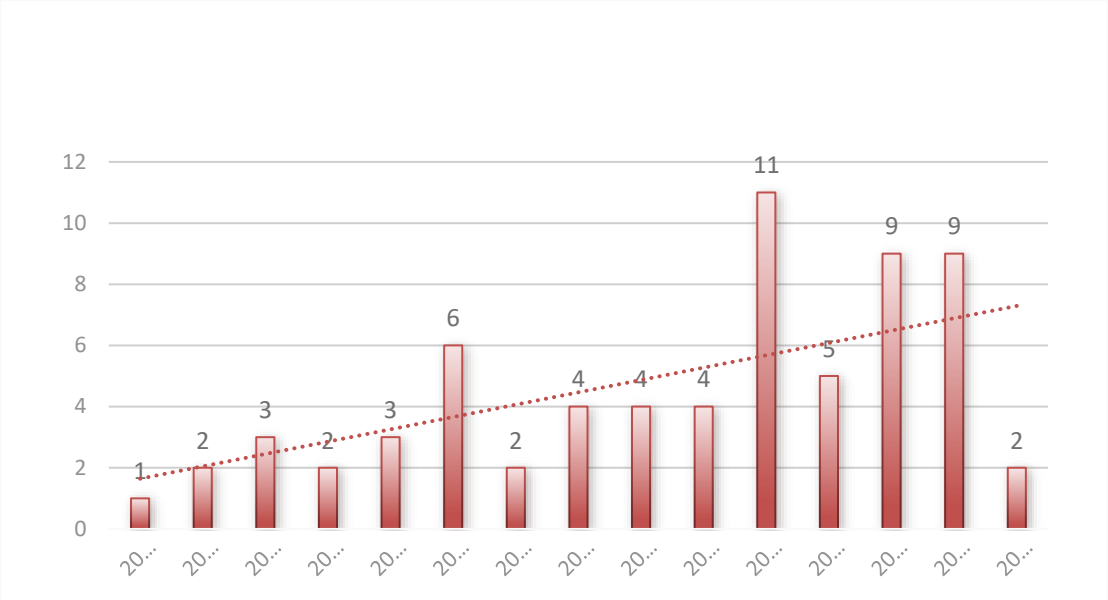

Figure 2 Annual Distribution of Sample Studies

Figure 2 illustrates the annual distribution of the 67 selected studies published between 2004 and January 2024. Although the sample spans two decades, publication activity was concentrated in 15 years, with an average of approximately 4–5 articles per active year. Prior to 2015, annual publications did not exceed three articles. In 2015, the number increased to six, followed by moderate fluctuations in subsequent years. A notable peak occurred in 2020, with 11 publications. The years 2022 and 2023 also recorded relatively high output, each with nine publications. Even in January 2024, two relevant studies were identified, suggesting continued research interest. Overall, research applying the gravity model to analyze China's trade flows remains relatively specialized, but scholarly attention has increased noticeably in recent years.

Figure 3 presents the distribution of gravity model specifications adopted in the 67 studies. The augmented gravity model is by far the most frequently used specification (61 articles, 91%), followed by the stochastic frontier gravity model (4 articles, 6%). The structural gravity model and the spatial gravity model each appear in one study (1.5%). Notably, none of the selected studies relied solely on the classic gravity model, which traditionally includes only economic size and geographic distance as explanatory variables (Pöyhönen, 1963).

This pattern suggests that empirical analyses of China's trade flows have generally adopted extended model specifications incorporating additional economic, institutional, or policy-related variables. The earliest application of the stochastic frontier gravity model in the sample appeared in 2015, while studies using structural and spatial gravity approaches emerged more recently, in 2023 and 2020 respectively. These findings indicate a gradual diversification of methodological approaches, although the augmented gravity model continues to dominate the literature.

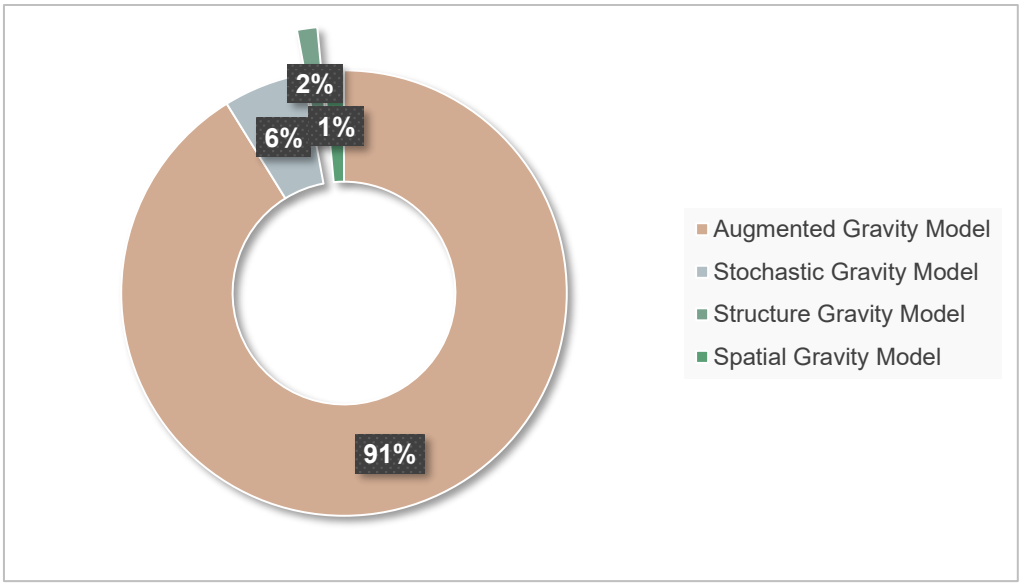

Figure 3 Proportion of Different Types of Gravity Models

Frequency of Various Variables

This study categorizes variables appearing at least three times in the gravity models of the 67 sampled studies into two groups: natural factors and human factors. Following Nisa and Antriyandarti (2023), natural factors refer to relatively exogenous characteristics such as geographic conditions, cultural distance, and resource endowments, which are generally difficult to modify in the short term. In contrast, human factors capture policy- and institution-related variables that can change through government decisions and economic behavior.

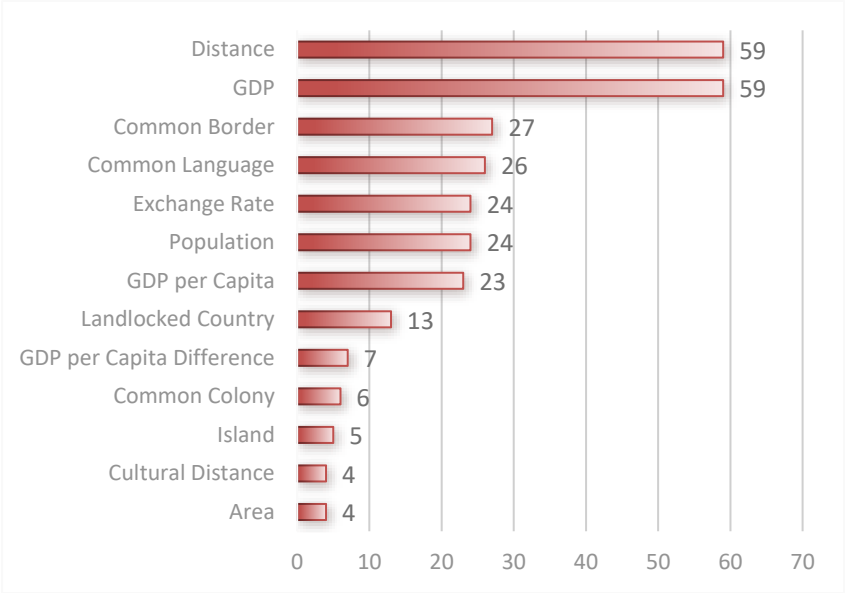

Figure 4 Occurrences of Natural Variables

Figure 4 reports the frequency of 13 natural variables. GDP and Distance are the most frequently used variables, each appearing 59 times, and jointly included in 52 models. This finding is consistent with the traditional gravity framework established by Tinbergen (1962) and Pöyhönen (1963), in which economic size promotes trade while geographic distance represents trade costs.

Common Border and Common Language follow, appearing 27 and 26 times, respectively. Exchange Rate and Population are also frequently included (24 times each). By contrast, Cultural Distance and Area appear relatively less often (four times each). Overall, GDP and Distance remain the core natural variables in empirical studies of China's trade flows across different trade types and sectors.

Human factors represent policy, institutional, and economic variables that may influence trade flows. As shown in Figure 5, Free Trade Agreements (FTAs) are the most frequently included human factor, appearing in 24 studies. Tariffs and Non-Tariff Barriers (NTBs) follow, appearing 13 and 12 times, respectively. Variables related to economic cooperation arrangements—such as the Belt and Road Initiative (BRI), APEC, OECD, and other regional groupings—appear 12 times in total. WTO-related variables appear 11 times.

The frequent inclusion of FTAs, tariffs, NTBs, and cooperation frameworks suggests that policy instruments and institutional arrangements are commonly incorporated into gravity models to capture market access conditions and trade costs. These results indicate that, in addition to structural natural determinants, policy-driven factors play an important role in explaining variations in China's trade flows.

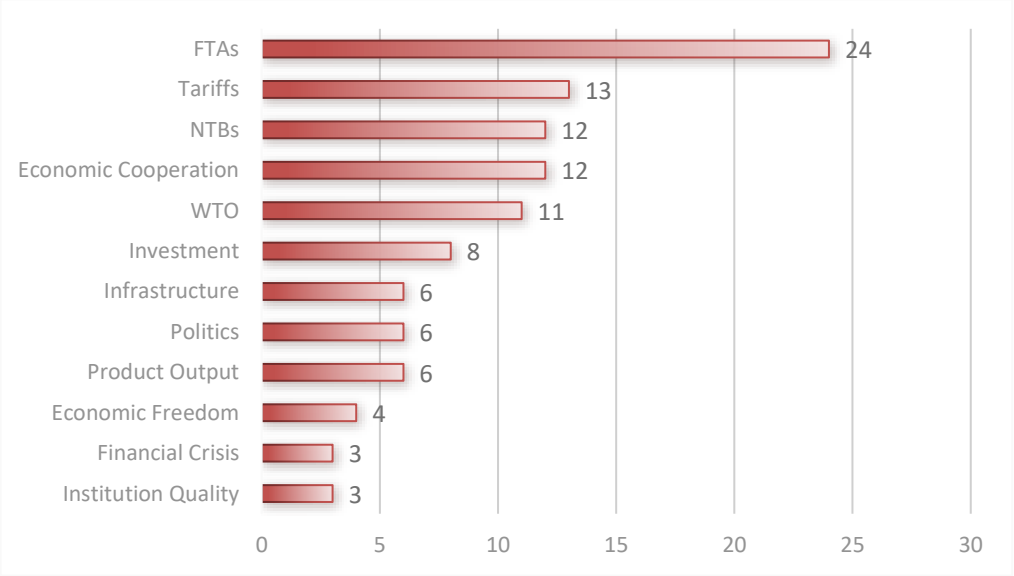

Figure 5 Occurrences of Human Variables

Correlation of Variables

In the reviewed studies, the relationship between explanatory variables and China's trade flows is evaluated based on the sign and statistical significance of regression coefficients. A positive and statistically significant coefficient indicates that a variable is associated with higher trade flows, whereas a negative and significant coefficient suggests a trade-reducing effect. Insignificant results imply that the relationship is not robust under specific model specifications (Anderson and van Wincoop, 2003; Helpman et al., 2008).

Table 1 reports the frequency and proportion of positive and statistically significant coefficients across the 67 sample studies. Among natural factors, GDP shows the highest frequency of positive association (89%), reinforcing its role as the core determinant in gravity-

based trade analysis. Common Language and Common Border also display relatively high positive probabilities, suggesting that cultural proximity and geographic adjacency facilitate bilateral trade. GDP per capita and Population demonstrate moderate positive associations, while variables such as Distance, Cultural Distance, and Landlocked status rarely exhibit positive effects.

Table 1
Positive Correlation Statistics of Variables

Natural Factors	Positive Correlation Times	Positive %	Human Factors	Positive Correlation Times	Positive %
GDP	54	89%	Economic Freedom	4	100%
Common Language	22	81%	Product Output	5	83%
Common Colony	5	71%	WTO	9	82%
Common Border	19	70%	Economic Cooperation	10	77%
Population	17	57%	Politics	5	71%
GDP per Capita	14	56%	Investment	6	67%
Area	2	50%	Infrastructure	4	67%
Island	3	50%	Institution Quality	2	67%
Exchange Rate	9	33%	FTAs	17	65%
Landlocked Country	3	21%	NTBs	6	44%
GDP per Capita Difference	1	14%	Tariffs	0	0%
Distance	2	3%	Financial Crisis	0	0%
Cultural Distance	0	0%			
Average	11.6	46%	Average	5.67	60%

Among human factors, FTAs appear most frequently with positive and significant coefficients, followed by Economic Cooperation arrangements and WTO-related variables. Economic Freedom and Product Output display particularly high positive probabilities when included in models. These patterns indicate that institutional integration, production capacity, and trade liberalization are generally associated with enhanced trade flows. In contrast, Tariffs and Financial Crisis variables do not exhibit positive associations, implying that they are more often linked to trade-reducing effects.

Table 2 summarizes negative and statistically significant coefficients. Distance is the most consistent negative factor, appearing with a negative sign in 85% of cases, confirming its persistent role as a proxy for trade costs. Landlocked status and Cultural Distance also show relatively high negative probabilities. Among human factors, Tariffs demonstrate both high frequency and high probability of negative association, while Financial Crisis variables also tend to reduce trade flows. These findings suggest that structural trade costs and policy barriers remain dominant constraints in China's bilateral trade patterns.

Table 2
Negative Correlation Statistics of Variables

Natural Factors	Negative Correlation Times	Negative %	Human Factors	Negative Correlation Times	Negative %
Distance	51	85%	Tariffs	11	79%
Cultural Distance	3	75%	Financial Crisis	3	75%
Landlocked Country	10	71%	NTBs	7	47%
GDP per Capita Difference	4	57%	Infrastructure	2	33%
Area	2	50%	Investment	2	22%
Exchange Rate	13	48%	Product Output	1	17%
GDP per Capita	9	36%	Economic Cooperation	2	15%
Population	8	27%	FTAs	4	15%
Common Border	5	19%	Politics	1	14%
Island	1	17%	Institution Quality	0	0%
GDP	3	5%	WTO	0	0%
Common Language	1	4%	Economic Freedom	0	0%
Common Colony	0	0%			
Average	8.46	41%	Average	2.75	26%

Table 3 presents the frequency of insignificant coefficients. For most variables, insignificance occurs in fewer than 20% of cases. This indicates that core gravity variables generally exhibit statistically meaningful relationships with China's trade flows, although their direction and magnitude vary across studies and specifications.

Table 3
Insignificance Statistics of Variables

Natural Factors	Insignificant Times	Insignificant %	Human Factors	Insignificant Times	Insignificant %
Island	2	33%	Institution Quality	1	33%
GDP per Capita Difference	2	29%	Financial Crisis	1	25%
Common Colony	2	29%	Tariffs	3	21%
Cultural Distance	1	25%	FTAs	5	19%
Exchange Rate	5	19%	WTO	2	18%
Population	5	17%	Politics	1	14%
Common Language	4	15%	NTBs	2	13%
Distance	7	12%	Investment	1	11%
Common Border	3	11%	Economic Cooperation	1	8%
GDP per Capita	2	8%	Product Output	0	0%
Landlocked Country	1	7%	Infrastructure	0	0%
GDP	4	7%	Economic Freedom	0	0%
Area	0	0%			
Average	2.92	16%	Average	1.42	14%

Overall, the results confirm that economic size and institutional openness tend to promote trade, while geographic distance and trade barriers consistently constrain it. The findings are broadly consistent with the theoretical foundations of modern gravity models.
Tables 4 and 5 summarize the frequency and probability of variables that exhibit the largest statistically significant positive and negative coefficients within individual gravity estimations.

Table 4
Statistics of Variables with the Largest Positive Correlation Coefficients

Natural Factors	Frequency of Largest Positive Correlation	Probability	Human Factors	Frequency of Largest Positive Correlation	Probability
GDP	19	31%	Product Output	3	50%
Common Colony	2	29%	Institution Quality	1	33%
Common Border	7	26%	WTO	3	27%
Common Language	7	26%	Economic Freedom	1	25%
Population	4	13%	Economic Cooperation	2	15%
GDP per Capita	3	12%	NTBs	2	13%
Distance	2	3%	FTAs	3	12%
Area	0	0%	Investment	0	0%
GDP per Capita Difference	0	0%	FTAs	0	0%
Landlocked Country	0	0%	Politics	0	0%
Island	0	0%	Tariffs	0	0%
Cultural Distance	0	0%	Financial Crisis	0	0%
Exchange Rate	0	0%			

As shown in Table 4, among natural factors, GDP most frequently appears as the variable with the largest positive coefficient, indicating that economic size often exerts the strongest promoting effect on China's trade flows within multivariate specifications. Common Border and Common Language also appear several times as dominant positive factors.

Among human factors, Product Output shows a relatively high probability of being the largest positive contributor when included. WTO-related variables, FTAs, and Economic Cooperation arrangements also appear as the strongest positive factors in some studies. However, many variables never emerge as the largest positive coefficient, suggesting that their promoting effects, while statistically significant, are often secondary relative to core determinants such as GDP.

Overall, production capacity and market size tend to represent the most powerful positive drivers in gravity-based analyses of China's trade flows.

Table 5
Statistics of Variables with the Largest Negative Correlation Coefficients

Natural Factors	Frequency of Largest Negative Correlation	Probability	Human Factors	Frequency of Largest Negative Correlation	Probability
Distance	38	63%	Tariffs	6	43%
Landlocked Country	5	36%	NTBs	1	6%
Cultural Distance	1	25%	Investment	0	0%
Population	5	17%	Product Output	0	0%
GDP	3	5%	Infrastructure	0	0%
GDP per Capita	1	4%	Politics	0	0%
Exchange Rate	1	4%	Institution Quality	0	0%
Area	0	0%	WTO	0	0%
GDP per Capita Difference	0	0%	Economic Cooperation	0	0%
Common Border	0	0%	Economic Freedom	0	0%
Island	0	0%	FTAs	0	0%
Common Language	0	0%	Financial Crisis	0	0%
Common Colony	0	0%			

Table 5 presents variables that most frequently exhibit the largest negative coefficients. Distance overwhelmingly dominates this category, appearing as the strongest negative factor in 63% of the sample studies. This highlights the persistent importance of geographic trade costs in constraining bilateral trade flows.

Tariffs rank second among human factors, frequently representing the largest negative policy-related determinant. Landlocked status also appears as a notable negative structural constraint. In contrast, many other variables never appear as the largest negative coefficient, indicating that their trade-reducing effects are generally weaker compared with distance and tariff barriers.

Taken together, these findings suggest that while multiple variables influence China's trade flows, economic size and geographic distance remain the most structurally dominant positive and negative forces, respectively.

Conclusion

This study provides a structured and quantitative review of 67 empirical articles published between 2004 and February 2024 that examine China's trade flows using gravity models. By systematically organizing the explanatory variables adopted in these studies, the analysis evaluates their roles from three complementary perspectives: frequency of usage, direction of statistical significance, and relative magnitude of impact within model specifications.

The findings confirm that economic size remains the most fundamental driver of China's bilateral trade. GDP consistently appears as the core promoting factor across specifications, reinforcing the central role of market scale in shaping trade patterns. Geographic distance emerges as the most persistent trade-reducing factor, reflecting the continued relevance of transport costs and structural trade barriers even in an era of globalization. Among institutional and policy-related variables, free trade agreements (FTAs), WTO participation, and broader economic cooperation arrangements demonstrate relatively stable positive associations with trade expansion. In contrast, tariffs and landlocked status frequently exhibit negative effects.

Beyond summarizing empirical regularities, this study contributes by clarifying which determinants demonstrate stable effectiveness across different contexts and model specifications. By distinguishing consistently robust variables from those with mixed or context-specific effects, the review enhances the transparency of gravity-model applications in China-related trade research. This structured synthesis can support more informed model construction and variable selection in future empirical studies.

The practical significance of the findings is equally important. For policymakers, the results highlight the continued importance of institutional integration and trade liberalization mechanisms in facilitating bilateral trade growth. The consistent negative impact of distance and tariffs suggests that reducing trade costs and strengthening infrastructure connectivity remain essential policy priorities. For international business practitioners and trade analysts, the findings provide clearer evidence on the structural and institutional factors that systematically shape China's trade opportunities and constraints. Understanding these determinants can improve strategic market selection, risk assessment, and trade planning decisions.

While this study focuses exclusively on gravity-model research, it lays a foundation for broader analytical development. Future research may extend the review to alternative empirical approaches or conduct formal meta-analyses to quantify effect sizes more precisely. Further exploration of sectoral heterogeneity, regional dynamics, and evolving trade policy frameworks could also deepen understanding of China's changing position in global trade networks.

Overall, by consolidating dispersed empirical findings into a coherent analytical framework, this study strengthens both the academic and practical understanding of the determinants of China's trade flows. It provides a clearer reference point for future research and offers evidence-based insights relevant to trade policy formulation and international business strategy.

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