Market Access and the Relocation of Chinese Supply Chains: Evidence from BRI Countries

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Abstract: *Infrastructure development along the Belt and Road Initiative (BRI) corridors has progressively improved connectivity—both physical ("hard") and institutional ("soft")—among participating economies. This enables China to gradually build a more complex overseas supply chain system under the BRI framework. Using project-level data on transportation infrastructure projects in BRI countries from 2013 to 2018, combined with industry-level input–output tables for these economies, this study examines how improvements in market access induced by BRI transportation infrastructure affect the relocation of Chinese supply chains and identifies the underlying mechanisms. The results indicate that improved market access in BRI countries significantly facilitates the relocation of Chinese supply chains to these destinations. Mechanism analysis also shows that this effect primarily operates through China's outward foreign direct investment (OFDI), especially in the form of non-greenfield investments and industrial projects. Moreover, heterogeneity analysis reveals that coastal countries and middle- and low-income countries are more likely to serve as destinations for relocated Chinese supply chains when market access improves. At the industry level, relocation is concentrated in sectors with low upstreamness, high transport dependence, and labor intensity. Furthermore, Chinese supply chains tend to shift toward country–industry pairs that exhibit stronger comparative advantages. These findings provide valuable insights for optimizing the global layout of Chinese supply chains and have important implications for deepening supply chain integration between China and BRI-participating countries.*

Keywords: *Belt and Road Initiative (BRI); Supply chain relocation; Chinese supply chain security; Transportation infrastructure; Market access*

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1. Introduction

Efficiency-driven transnational relocation of industrial and supply chains represents an objective law of global production organization and a major topic in contemporary economic development. Against the backdrop of the global division of labor in supply chains, China has become deeply embedded in the global supply chain system by leveraging its comparative advantages in factor costs and infrastructure development. Notably, this has enabled China to continuously strengthen its core competitiveness and steadily elevate its position within global industrial and supply chains (Wang, 2020). However, the fragility of global supply chains has become increasingly evident, with industrial organization and supply chain structures exhibiting stronger monopolistic characteristics (Hong and Zhong, 2024). Moreover, some countries have begun employing various measures to constrain China's participation in global supply chains (Gao et al., 2020). In response, multinational corporations and Chinese enterprises alike have accelerated diversification strategies—such as adopting the "China + N" sourcing model—which has further accelerated the restructuring of global supply chains (Zhu and Huang, 2021). Against this backdrop, the Report to the 20th National Congress of the Communist Party of China (2022) explicitly underscores the need to "enhance the resilience and security of industrial and supply chains" and to "promote the deep integration of innovation chains, industrial chains, capital chains, and talent chains." Therefore, figuring out how to leverage the global supply chain system to build a more resilient and China-centric global supply network has become a critical task in optimizing China's global supply chains .

The Belt and Road Initiative (BRI), a pivotal platform for China's efforts to enhance global economic governance and foster a community with a shared future for mankind, has catalyzed broader participation among economies in the reconfiguration of global supply chains. It has also provided a broad space for Chinese enterprises to relocate non-core technology supply segments overseas.[1] Since the proposal of the BRI over a decade ago, China has signed more than 200 cooperation documents with more than 150 countries and over 30 international organizations. In addition, China has concluded mutual recognition agreements for Authorized Economic Operators (AEOs) with more than 30 BRI partner countries and regions. Notably, these efforts have fostered a wide-ranging infrastructure network and an economic and trade cooperation framework centered on industrial and supply chains. Among the numerous BRI cooperation projects, transportation infrastructure development stands out as a priority area. At present, a series of landmark connectivity projects focusing on the "Six Corridors, Six Routes, Multiple Countries, and Multiple Ports" backbone have achieved substantial progress. Importantly, these projects serve as vital bridges for economic and trade exchanges between China and BRI countries and as important safeguards for enhancing supply chain resilience. Taking the China–Laos Kunming–Vientiane Railway as an example, since commencing full operations in 2021, the railway has not only opened a convenient channel for Chinese enterprises to access Southeast Asian markets. Thus, encouraging more firms to relocate non-core supply segments to the region has also significantly enhanced the

[1] Source: Compiled by the authors based on the list of BRI participating countries provided by the official BRI website.

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competitiveness of local manufacturing. Simultaneously, it has enabled Southeast Asian products to flow more smoothly into the Chinese market, thereby enriching domestic supply options. Therefore, guiding the transfer of Chinese supply chains to BRI countries has become a practical and feasible approach to strengthening the resilience of China's industrial and supply chains.

However, methods for scientifically quantifying the extent of supply chain relocation and the development of transportation infrastructure still face considerable limitations. Relevant data have yet to be clearly defined, systematically collected, or properly constructed (Reed and Trubetskoy, 2019). In contrast, most existing studies on the supply chain relocation effects of BRI remain largely at the macro level of benefit estimation (Dai and Song, 2021). Therefore, it is of great significance to accurately quantify the extent of supply chain relocation, effectively identify the impact of BRI transportation infrastructure on such relocation, and uncover the underlying mechanisms. Such efforts are of substantial importance to advancing China's global supply chain configuration within the BRI framework.

This paper makes three main contributions. First, unlike most existing literature on supply chain reconfiguration, which primarily takes a theoretical perspective, this paper adopts an empirical approach, focusing on Chinese supply chain security and stability. It also examines how improvements in market access, induced by transportation infrastructure construction under the BRI, can effectively guide the relocation of Chinese supply chains toward more controllable directions. This elucidates the characteristics and pathways of China's global supply chain layout under the BRI, and offers a new perspective for subsequent quantitative research on the security and resilience of Chinese supply chains. Second, existing data on Chinese supply chain relocation and infrastructure development along the BRI remain relatively immature and are mostly limited to macro-level descriptions. Drawing on the method of Wang et al. (2017) and taking the perspective of outward relocation of Chinese supply chains, this paper employs the indicator of "Chinese value added embodied in a country's exports"[2] to measure the level of Chinese "supply chain relocation." Furthermore, it introduces the market access approach proposed by Donaldson and Hornbeck (2016) to construct a dataset of transportation infrastructure in BRI countries, thereby improving the quality of transportation infrastructure indicators. Compared with previous studies, this paper's approach to measuring Chinese supply chain relocation and BRI transportation infrastructure helps fill existing research gaps and yields more scientifically sound, robust conclusions. Third, in terms of identification strategy, in addition to constructing market access indicators based on transportation infrastructure to reduce endogeneity concerns, this paper also employs two exogenous instruments: the routes of the Ancient Silk Road as a historical indicator and the least-cost path based on terrain conditions (Faber, 2014) as a geographic indicator. Target cities are also excluded to alleviate potential endogeneity bias in causal inference further. By integrating these multiple methods to investigate the actual effect of market access in BRI countries on Chinese supply chain relocation, this paper provides a useful methodological framework for future research.

The remainder of the paper is organized as follows. Section 2 reviews the literature and

[2] In this study, "exports" are broadly defined to encompass not only the external trade of BRI partner countries with international markets but also the domestic absorption of goods within their respective internal markets.

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presents the theoretical analysis. Section 3 introduces the measurement of key variables and the analytical framework and provides stylized facts. Section 4 describes the empirical strategy and data. Section 5 reports and discusses the empirical results. Section 6 presents the mechanism analysis. Section 7 conducts the heterogeneity analysis, and Section 8 concludes and draws policy implications.

2. Literature Review and Theoretical Analysis

This paper examines the impact of improvements in market access on the relocation of Chinese supply chains, with a focus on transportation infrastructure development under the BRI. A review of the existing literature indicates that studies on this topic primarily focus on three aspects: the conceptualization and measurement of supply chain relocation, the impact of BRI transportation infrastructure on supply chain relocation, and the mechanisms by which such infrastructure affects it.

2.1 Conceptualization and Measurement of Supply Chain Relocation

Global supply chains are defined as systems in which "a country's inputs are used in another country's trade flows" (Baldwin et al., 2022). Amid the trend toward localization and regional concentration of global industrial and supply chains, a supply chain is fundamentally concerned with the physical movement and coordination of production stages (Shen et al., 2000), thereby addressing the security and resilience of upstream–downstream linkages — essentially, the "survival" of the production networks. In contrast, value chains emphasize the creation, accumulation, and distribution of value, focusing on how each production stage adds value to the final product and addressing the "development" dimension of production division and cooperation. As a key node in global supply chains, China has seen a growing trend of multinational enterprises and domestic firms relocating production segments out of the country, driven by factors such as rising wages and trade frictions. Moreover, the supply of intermediate goods has shifted across borders, and upstream–downstream relationships between countries and industries have become complex. Consequently, the global supply chain networks involving China are facing significant changes and restructuring, making the "survival" aspect of production division and cooperation the primary concern. Against this backdrop, this paper examines the relocation of Chinese supply chains from a supply chain perspective. Specifically, it investigates the geographical and spatial restructuring of China's global supply chain activities—including material sourcing, production processes, final assembly, and final distribution—that occurs as transportation infrastructure develops and market access conditions change.

Research on supply chain relocation has made the effective measurement of supply chain shifts a primary scientific challenge. As the international division of labor has deepened, multinational corporations have strategically located each production stage in countries and regions where it can be completed at the lowest cost, thereby forming highly complex global supply chain networks that Baldwin et al. (2023) vividly describe as the "Buzz Lightyear Problem" ("Infinity and Beyond").[3]

[3] Buzz Lightyear is a vivid metaphor drawn from the phrase "To Infinity and Beyond" in the Disney film *Toy Story*, capturing the infinite regress of upstream dependencies and the resulting analytical intractability.

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Notably, this has prompted scholars to distinguish further the true sources of value embodied in exported products (Wang et al., 2015), leading to the emergence of two mainstream paradigms in supply chain research: firm-level business value chain analysis (Wei and Hu, 2024) and input–output-based value-added decomposition analysis (Baldwin et al., 2022, 2023). Among these, the input–output approach, which employs matrix algebra to resolve the infinite recursion inherent in the "Buzz Lightyear Problem," has become one of the most widely adopted methods in the literature (Alfaro and Chor, 2023). Building upon this, Wang et al. (2017) decompose a country's value added in global supply chain production activities to explore how a country participates in global supply chains by utilizing other countries and sectors. Scholars have subsequently applied this method to analyze other economies' dependence on Chinese supply chains (Baldwin et al., 2023) and production risks within supply chains (Baldwin et al., 2022; Ni et al., 2024).

Most existing studies draw on the method of Wang et al. (2015) to quantify the value added embodied in a country's exports (e.g., Zhang and Tang, 2018; Zhang et al., 2022). However, these approaches cannot distinguish whether such value added is generated through the exporting country's direct foreign trade or is reflected in the use of its value added by third-party intermediary countries (Wang et al., 2017). Moreover, the method developed by Wang et al. (2017) has not been applied to supply chain research, nor has it been used to analyze outward supply chain relocation from the perspective of the value-added source country (China). Consequently, existing theoretical research, which should provide relevant and even guiding support, has, to some extent, lagged behind practical developments, highlighting the urgent need for innovation in the analytical framework.

2.2 Impact of BRI Transportation Infrastructure on Supply Chain Relocation

Existing studies on the determinants of supply chain dynamics have increasingly examined the role of digitalization and intelligent technologies. Specifically, these studies find that such developments can alleviate uncertainty in export supply chains (Zhang et al., 2023), enhance spillover effects within supply chains (Alfaro and Chor, 2023; Li et al., 2024), promote structural adjustments in intermediate input use (He et al., 2023), and deepen global supply chain networks (Lv et al., 2023). Within the BRI framework, research has mainly focused on its impacts on the divisional status of BRI countries in global supply chains (Dai and Song, 2021) and on the mutually beneficial symbiotic effects of industrial relocation (Liu et al., 2023). However, research on the outward relocation of China's global supply chains remains largely absent.

From the perspective of New Economic Geography, improvements in transportation infrastructure reduce trade and logistics costs (De Soyres et al., 2018; Li and Wang, 2022), expand the effective scope of markets (Bernard et al., 2019), and enhance regional economic competitiveness (Donaldson, 2018), thereby enabling firms to reallocate resources and production activities across broader geographic areas. As early as 1954, Harris proposed the "market potential" indicator, which measures the level of transportation infrastructure based on the number and size of accessible markets under minimum-cost conditions. However, constrained by limited technical capabilities and quantitative methods at the time, the explanatory power of transportation infrastructure in theoretical and empirical research remained weak for a long time. With continuous

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advances in quantitative modeling, scholars have conducted more systematic quantification of transportation infrastructure. In particular, the "market access" method proposed by Donaldson and Hornbeck (2016) quantifies aggregate changes in interregional transaction costs resulting from improved transportation infrastructure, laying the foundation for quantitative analysis of transportation infrastructure development. Therefore, enhanced connectivity under the BRI—especially the prioritized development of transportation infrastructure linkages—may drive the cross-border reallocation of resources and production activities in Chinese supply chains, creating favorable conditions and development opportunities for BRI countries to host the relocation of Chinese supply chains.

Although existing studies generally support the view that the BRI, particularly transportation infrastructure development, has significant potential to promote supply chain relocation, most of this research adopts a macro-level perspective. It relies largely on analytical frameworks based on import and export volumes and domestic value-added calculations. As a result, these studies fail to accurately reflect how China participates in global supply chains through the BRI, and there is a clear lack of analysis from the perspective of transportation infrastructure development. Therefore, it is necessary to thoroughly examine the impact of BRI-driven transportation infrastructure development on supply chain relocation.

2.3 Mechanisms through Which BRI Transportation Infrastructure Affects Supply Chain Relocation

In his New Economic Geography framework, Paul Krugman (1991) argues that transportation costs significantly influence the geographic distribution of firms. Notably, infrastructure improvements can reduce both transportation and transaction costs, thereby enhancing economic interconnectivity across regions and encouraging firms to invest in these areas. Taking high-speed rail construction as an example, on the one hand, high-speed rail operations improve the efficiency of complex information exchange, thereby lowering fixed trade costs (Bernard et al., 2019; Tang et al., 2019). On the other hand, the "release effect" from high-speed rail construction can alleviate pressure on other transport modes, providing substantial convenience for freight transportation and thus reducing variable trade costs (Sun et al., 2019). Therefore, transportation infrastructure development along the BRI can enhance market access across regions, reduce trade costs, and exert profound impacts on investment decisions (Zhang et al., 2018).

Furthermore, Gary Gereffi's Global Commodity Chain theory posits that, to achieve cost minimization and efficiency maximization, firms search worldwide for the most cost-effective production bases when configuring their supply chains (Gereffi, 1999). Through OFDI, Chinese enterprises can therefore gain better access to key raw materials, emerging markets, and advanced technologies, thereby promoting deeper supply chain relocation (Yao, 2017). Consistent with this theoretical perspective, many scholars, primarily from the US, have examined the relationship between outward investment and the global relocation and restructuring of supply chains, exploring how US outward foreign direct investment drives the "major reallocation" trend in its global supply chain position (Alfaro and Chor, 2023). Similarly, Chinese firms, motivated by market-seeking, resource-seeking, and strategic asset-seeking objectives (Huang et al., 2023), have increasingly engaged in efficiency-seeking OFDI in lower-gradient countries and regions.

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By relocating both backward- and forward-linked supply chains overseas (Yao, 2016), they aim to optimize their overall supply chain configuration.

In summary, improvements in market access driven by transportation infrastructure development along the BRI have incentivized Chinese firms to increase local investment, thereby promoting the relocation of Chinese supply chains and the optimization and restructuring of global supply chains. This mechanism has received broad support in existing literature. However, research on how transportation infrastructure influences outward investment and how such investment, in turn, leads to supply chain relocation still requires further deepening. In particular, empirical evidence on the specific role of China's outward foreign direct investment (OFDI) in mediating the construction of BRI transportation infrastructure alongside the relocation of Chinese supply chains remains scant.

3. Measurement Framework and Stylized Facts: Market Access in BRI Countries and Chinese Supply Chain Relocation

3.1 Analytical Framework and Measurement

3.1.1 Measurement of market access induced by transportation infrastructure

In international economics, market access typically refers to the ability of firms or products to enter international markets. In the context of BRI, improvements in transportation infrastructure significantly reduce trade costs and, in practice, expand the physical and economic accessibility of markets. Accordingly, this paper extends the definition of market access by introducing the measurement system proposed by Donaldson and Hornbeck (2016) to construct the core indicator, which is understood as an improvement in geographical and economic accessibility. The measurement of market access is a reduced-form derived from general equilibrium trade theory. It can capture improvements in conditions within the global network, estimate the aggregate effects of changes in interregional trade costs resulting from transportation infrastructure development, and directly control for its potential exogeneity to identify changes in market access induced by such development within the network. Thus, it can reduce or even eliminate interference from other factors that may affect the construction of transportation infrastructure. The construction and specific calculation process of the market access indicator can be roughly divided into the following three steps:

Step 1: Specification of the spatial equilibrium equation:

$$\ln(l_k) = k_l + \lambda_l^H \ln(\overline{H_k}) + \lambda_l^d \ln(\overline{d_k}) + \lambda_l^M \ln(MA_k) \quad (1)$$

$$\ln(W_k) = k_W + \lambda_W^H \ln(\overline{H_k}) + \lambda_W^\delta \ln(\overline{\delta_k}) + \lambda_W^M \ln(MA_k) \quad (2)$$

$$\ln(q_k) = k_q + \lambda_q^H \ln(\overline{H_k}) + \lambda_q^\delta \ln(\overline{\delta_k}) + \lambda_W^M \ln(MA_k) \quad (3)$$

Within this framework, let l_k, W_k, q_k denote the employment level, nominal wage, and housing price in region k, respectively. As shown by the structural equations of the model, the endogenous variables of primary interest can be expressed as functions of two key exogenous drivers: regional land supply ($\overline{H_k}$) in region k and market access (MA_k) in region k. Theoretically, the model predicts positive elasticities of employment, wages, and housing prices ($\lambda_l^M, \lambda_W^M, \lambda_W^M$) with respect to market

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access. Additionally, the elasticity of housing prices with respect to housing stock (λ_q^H) is negative, while the elasticity of employment with respect to housing stock (λ_l^H) is positive. Solving the spatial equilibrium yields the following definition of market access for any region k:

$$MA_k=\sum_{j=1}^{N}\tau_{kj}^{-\theta}X_jT_j \tag{4}$$

In this formulation, $\tau_{kj}^{-\theta}$ denotes the transportation cost from region k to region j, X_j represents the cost for region j to obtain labor from other regions, and T_j is the production technology parameter of region j. Under the assumptions of a CES production function and perfect competition, firms earn zero profits. Thus, total labor cost equals total output ($X_jT_j=T_jGDP$). The production technology parameter T_j can be derived from the average wage level w_j. Given the accounting identity that total input equals total output, we have $\overline{z(j)}L_j=w_jL_j$, where $\overline{z(j)}$ is the average productivity of region j and L_j is the total labor force in region j. For simplification, after further omitting the wage variable, X_jT_j can be approximated by GDP, that is:

$$MA_k=\sum_{j=1}^{N}\tau_{kj}^{-\theta}GDP_j \tag{5}$$

Step 2: Parameterization of Transportation Costs. The key to calculating market access is to construct a bilateral interregional transportation cost matrix τ_{kj}, which incorporates both travel time and monetary cost. This step constitutes the core and most data-intensive part of the measurement. Geographic distance between regions, the number of intermodal transfers, and the number of port calls are calculated using geospatial data from Reed and Trubetskoy (2019). Freight cost assumptions for different transport modes also follow the values in Reed and Trubetskoy (2019), as summarized in Table 1. Consistent with Reed and Trubetskoy (2019), this paper uses the median of their upper-bound estimates.

TABLE 1. Assumptions on Freight Costs for Road, Rail, and Maritime Transport (in US dollars per TEU per kilometer)

Mode of Transport	Highway		Railway		Marine transport	
	Min.	Max.	Min.	Max.	Min.	Max.
Emerson & Vinokurov (2009)	-	-	0.47	0.47	0.07	0.73
Rodemann & Templar (2014)	0.66	0.78	0.39	0.53	-	-
Seo et al. (2017)	0.52	0.54	0.23	0.45	0.03	0.04
Sladkowski & Cieśla (2015)	0.60	1.78	0.23	0.56	0.04	0.70
Sun, et al. (2017)	0.84	0.92	0.14	0.25	-	-
Median	0.63	0.85	0.23	0.47		0.04

Source: Compiled by the authors.

Step 3: Computation of Results. Based on the above equations and parameter assumptions, the calculated market access is the sum of the ratios of the GDP of all other regions to the transportation cost to this city. The general pattern is that the closer a city is to large economic regions, the higher its market access will be. Since the denominator becomes smaller (both transportation cost and required time are lower) when two regions are geographically closer, market access can be disproportionately large. Therefore, we further normalize the index.

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Compared with methods used in existing studies to quantify transportation infrastructure, the market access index has two main advantages. First, the index captures the overall impact of transportation infrastructure on each region. Additionally, the calculation considers all possible transportation plans globally; that is, market accessibility is determined by the overall convenience of the transportation network and the degree of connectivity to key economic regions. Second, the index can reflect both the direct and indirect effects of transportation infrastructure development (Liu et al., 2020). Transportation costs included in the calculation imply that when transportation facilities in adjacent regions improve, the local region's market access can be significantly enhanced even if its own conditions remain unchanged.

3.1.2 Analytical framework for measuring Chinese supply chain relocation

As noted above, the essence of modern supply chains lies in their multi-layered and nested structure. A country's procurement of intermediate goods involves both the geographical origins of its direct suppliers (Face Value Exposure) and the need to penetrate the secondary, and even more distant, supplier networks behind them (Look-Through Exposure). When a country shifts its intermediate goods procurement from country H to country G, Face Value Exposure is directly reflected in the immediate rise in the value added of country G. However, if country G itself relies on intermediate inputs from China (country C), China's value added can still be implicitly retained in the final products through recursive calculation.

Accordingly, this paper uses the value added embodied in a country's exports as a proxy for "Chinese supply chain relocation," which we refer to as "Supply Chain Value Added." From another perspective, the measurement method of "Chinese supply chain relocation" can be understood as follows: when the production stages originally belonging to China are relocated to countries undertaking Chinese supply chains, these countries create new value added in their own production chains and carry the original value added of China in the supply chain. As these intermediate products flow downstream to third-party markets, the proportion of Chinese value added embedded in the host country's exports increases accordingly. This mechanism serves as a robust proxy, allowing us to gauge the true scale and trajectory of Chinese supply chain relocation.

Specifically, this study builds on the gross trade accounting framework proposed by Wang et al. (2017) to analyze and quantify the potential pathways of Chinese supply chain relocation. We assume a four-country setting consisting of C, G, H, and U, where C represents China, and G, H, and U denote three distinct countries other than China. Meanwhile, multiple industrial supply chains (1, 2, and 3) are considered. As illustrated in Figure 1, country G serves as either a user or a re-exporter of Chinese supply chain value added (in this paper, G is defined as a BRI country); country H represents a third country among non-BRI economies; and country U represents a third country among BRI economies. With reduced trade costs driven by improved transportation connectivity under the BRI, Chinese supply chain value added in BRI countries may increase, reflecting the relocation of industrial supply chains (C1, C2, C3) from China to BRI countries. Under this setting, depending on the final destination of China's value added, supply chain relocation can be categorized into four modes: Mode 1: Chinese supply chain value added passes through country G and is ultimately absorbed by G itself. Mode 2: Chinese supply chain value added passes through country G and is ultimately absorbed by country U, a third BRI country.

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Mode 3: Chinese supply chain value added passes through country G and is ultimately absorbed by country H, a third non-BRI country. Mode 4: Chinese supply chain value added passes through country G and is ultimately reabsorbed by China. Among these, Mode 1 involves a single cross-border transfer of Chinese supply chain value added and thus represents shallow supply chain relocation. In contrast, Modes 2–4 involve at least two cross-border transfers between the exporting country and the final destination country, and therefore constitute deep supply chain relocation.

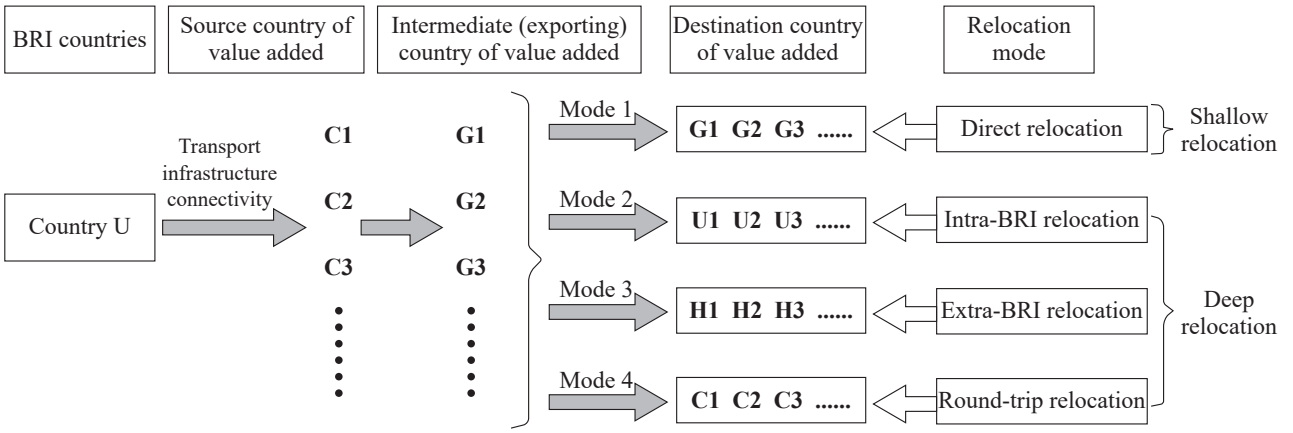

Fig.1. Conceptual Framework of Chinese Supply Chain Relocation Modes

Source: Illustrated by the authors.

Given the relative maturity of research on value-added export decomposition models, this study does not present the step-by-step transformation of the Inter-Country Input-Output (ICIO) tables. Instead, we derive the expression for measuring foreign value added embodied in a country's exports as follows:

$$VA_C^G = V^C B^{CG} X^G = V^C B^{CG} [X^{GG} + X^{GU} + X^{GH} + X^{GC}] \quad (6)$$

Where VA_C^G denotes the scale of value added from China's (Country C) supply chain used in the exports of Country G, expressed as a column vector composed of the sectoral export elements of Country G. Specifically, VA_C^G can be represented as the product of Country G's total export column vector X^G, the complete consumption matrix B^{GG} (reflecting Country G's total dependence on China), and the value-added coefficient matrix V^C (consisting of the value-added coefficients of China's various industries). Further deriving this, we decompose Country G's total exports into the sum of its exports to various destinations worldwide: domestic shipments within G (X^{GG}), exports to third-party BRI country U (X^{GU}), exports to third-party non-BRI country H (X^{GH}), and exports to China (X^{GC}).

Drawing on Wang et al. (2013), a country's total or bilateral exports can be expressed as a combination of final goods exports and intermediate goods exports. Therefore, bilateral exports to any country can be expressed through the following:

$$X^{G^*} = F^{G^*} + A^{G^*} \# P^* \quad (7)$$

In this context, X^{G^*} denotes Country G's export vector to any destination, F^{G^*} denotes the final goods export vector from Country G to any destination, and $A^{G^*} \# P^{G^*}$ represents the intermediate goods export column vector from Country G to any destination. This intermediate export is considered the demand for Country G's intermediate products induced by the gross output (P^*)

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of the destination country. Here, P^{*} is the sectoral gross output column vector of the destination country, A^{G*} is the direct consumption matrix of Country G's intermediate goods by the destination country, and # denotes matrix (or vector) multiplication.

Substituting Equation (7) into Equation (6), we obtain the following expression:

$$VA_c^G=\{V^CB^{CG}F^{GG}+V^CB^{CG}[A^{GG}\#P^G]\}+\{V^CB^{CG}F^{GU}+V^CB^{CG}[A^{GU}\#P^U]\}$$
$$+\{V^CB^{CG}F^{GH}+V^CB^{CG}[A^{GH}\#P^H]\}+\{V^CB^{CG}F^{GC}+V^CB^{CG}[A^{GC}\#P^C]\} \quad (8)$$

Specifically: $V^CB^{CG}F^{GG}$ and $V^CB^{CG}[A^{GG}\#P^G]$ represent the Chinese supply chain value added (SCVA) used in Country G's exports of final and intermediate goods to itself; these two components constitute Mode 1 in the analytical framework (Domestic Absorption within the Host);

$V^CB^{CG}F^{GU}$ and $V^CB^{CG}[A^{GU}\#P^U]$ represent the SCVA used in Country G's exports of final and intermediate goods to Country U (a third-party BRI country), which constitute Mode 2 (Intra-BRI Relocation);

$V^CB^{CG}F^{GH}$ and $V^CB^{CG}[A^{GH}\#P^H]$ represent the SCVA used in Country G's exports of final and intermediate goods to Country H (a non-BRI third-party country), which constitute Mode 3 (Extra-BRI Relocation);

$V^CB^{CG}F^{GC}$ and $V^CB^{CG}[A^{GC}\#P^C]$ represent the SCVA used in Country G's exports of final and intermediate goods back to China (Country C), which constitute Mode 4 (Round-trip Relocation).

In summary, this analytical framework overcomes the limitations of the classical Leontief approach by quantifying Chinese supply chain relocation as changes in the share of Chinese value added embodied in other countries' exports. Although supply linkages themselves do not guarantee value creation, the attribution of value added at each production stage effectively maps the geographical distribution characteristics of supply chains. Moreover, transnational relocation of supply chains inevitably leads to a redistribution of global production and value creation. Therefore, value-added decomposition enables the capture of value creation, accumulation, and flows within supply chains. By using the decomposed Chinese value added embodied in the exports of various countries and industries, this approach enables researchers to track the utilization and final destinations of China-led global supply chains, thereby providing a powerful tool for studying China's position in the global supply chain network.

3.2 Market Access in BRI Countries and Stylized Facts of Chinese Supply Chain Relocation

First, building on the preceding derivations, this section calculates the trade cost matrix after the completion of transportation infrastructure projects in BRI cities. Then it measures the resulting market access levels for each region. The results show that following the completion of these transport facilities, the average improvement in market access across BRI regions exceeds 36%, with a maximum of 61.44%. This finding strongly confirms that infrastructure connectivity under BRI can significantly enhance market integration along the routes. From a spatial perspective, regions with stronger pre-existing economic foundations and higher spatial agglomeration tend to experience larger gains in market access from transportation infrastructure projects. For instance, cities with the most significant improvements on the Eurasian continent are densely concentrated in China's southeastern coastal areas and India's coastal regions. The results for the African continent are broadly consistent with those for Eurasia, indicating that BRI infrastructure development

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can similarly deliver substantial improvements in market access for African countries and their cities. Furthermore, counterfactual analysis (assuming zero tariff barriers and zero cross-border costs between countries) and long-term projections (based on 2035 population forecasts and 2019 per capita GDP to represent changes in regional market size) both show that these transportation infrastructure projects not only significantly raise market access levels but also accelerate regional economic integration over the long run, demonstrating considerable potential for sustained growth.

Secondly, using the measured Chinese "supply chain relocation" indicator, this section conducts a comparative analysis of the relocation of Chinese supply chains toward BRI and non-BRI countries. As shown in Figure 2, over the 14 years from 2005 to 2018, the total volume of Chinese supply chain value added (SCVA) exported to the global market through BRI countries exhibited an overall upward trend. The value grew from 30 billion US dollars in 2005 to 120.4 billion US dollars in 2018, representing a remarkable 301.3% increase.[4] Similarly, the share of China's SCVA contributed to the world via BRI countries has risen steadily, from 21.8% in 2005 to 32.8% in 2018. Notably, this share has increased year by year since the launch of the "Belt and Road" Initiative in 2013. In contrast, although the majority of China's SCVA is still channeled through non-BRI countries (ranging from 67.2% to 78.2%), their relative share has shown a persistent downward trend.

The stylized facts presented above provide a brief overview of the improvements in market access along the BRI and the relocation of Chinese supply chains toward those countries. However, descriptive analysis alone is insufficient to establish a causal relationship between these two phenomena firmly. Therefore, the following sections will employ a more rigorous and standardized empirical strategy to analyze the impact of BRI-induced improvements in market access on Chinese supply chain relocation and to investigate the specific pathways by which these supply chains shift toward BRI countries.

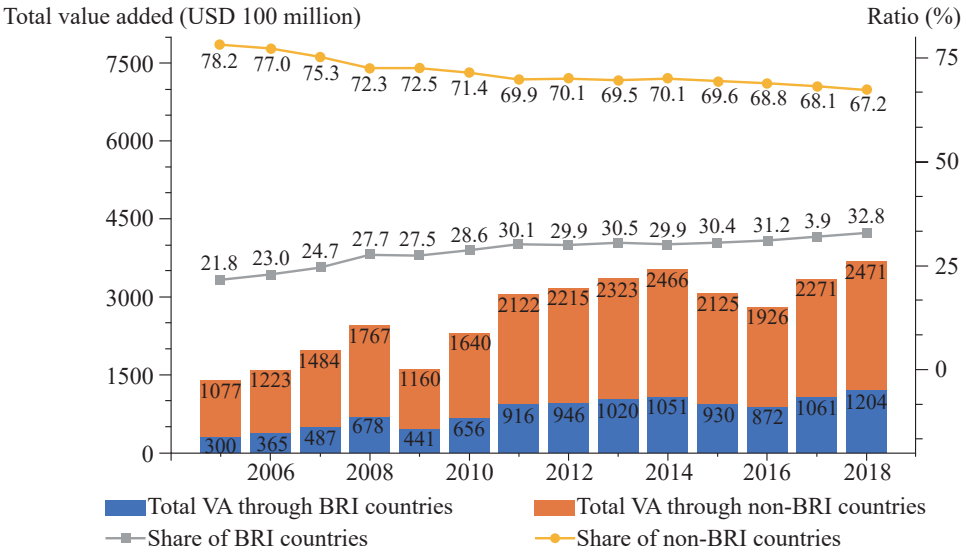

Fig.2. Comparative Trends of Chinese Supply Chain Relocation between BRI and Non-BRI Countries

Source: Calculated by the authors.

[4] Between 2015 and 2016, the indicator declined due to what is known in academia as the "Global Trade Big Plateaus".

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4. Empirical Strategy and Data

4.1 Econometric Model Specification

This study empirically examines the impact of market access in BRI countries on the relocation of Chinese supply chains. To address potential endogeneity, we employ several econometric methods, including the instrumental variable (IV) method and the Target-Clearing method. Based on a fixed-effects model, we construct a baseline regression equation at the exporter-sector-year level as follows:

$$lnVA_{izt+1}=\alpha_0+\alpha_1 lnMA_{it}+\alpha_2 X_{it}+\alpha_3 Z_{izt}+\sigma_{iz}+\sigma_t+\varepsilon_{izt} \quad (9)$$

Where the dependent variable, $lnVA_{izt+1}$, represents the total Chinese value added used by sector z in exporting country i in year $t+1$, which measures the extent of Chinese supply chain relocation. The core explanatory variable, $lnMA_{it}$, denotes the level of market access in exporting country i in year t induced by transport infrastructure construction. Additionally, the model selects control variables at the country-year level (X_{it}) and the country-sector-year level (Z_{izt}). The country-year controls include: bilateral trade flows between the exporting country and China ($lnFlow_{it}$); natural resource endowment, proxied by the share of natural resource rents in GDP ($lnRES_{it}$); market size, proxied by the exporter's population ($lnPOP_{it}$) and Gross Domestic Product ($lnGDP_{it}$); and institutional factors, represented by the institutional distance between the exporting country and China ($Policydis_{it}^{c}$). The country-sector-year controls include: the sectoral Revealed Comparative Advantage (RCA) index (RCA_{izt}), the sectoral output structure ($Structure_{izt}$), and the sectoral degree of openness ($Open_{izt}$). To mitigate potential reverse causality and omitted variable bias, the model employs a "lagged" specification for the dependent and explanatory variables. To account for heterogeneity across countries and sectors, the model incorporates exporter-sector fixed effects (σ_{iz}) and year fixed effects (σ_t), with robust standard errors clustered at the exporting country level.

4.2 Variable Selection and Data Sources

4.2.1 Dependent variable

This study utilizes the OECD Inter-Country Input-Output (ICIO) Tables (2013–2018) to measure Chinese supply chain relocation. Notably, the database covers 66 major economies and 45 industries, providing detailed input–output relationships for intermediate and final goods, as well as data on gross output and value added. Leveraging this database, we decompose the Chinese value added embodied in the exports of BRI countries across industries, enabling us to trace the utilization and destination of China-led supply chains along the Belt and Road.

4.2.2 Core explanatory variable

The primary explanatory variable is a measure of market access, constructed following the methodology of Donaldson and Hornbeck (2016) to quantify transportation infrastructure development across BRI countries. Data on relevant construction and planning projects were compiled from World Bank reports (Reed and Trubetskoy, 2019) and official government repositories. Using these sources, we built a comprehensive longitudinal database of transportation infrastructure projects covering the 2013–2018 period, including road, rail, and maritime port

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networks across Asia and Europe. Additional parameters required to estimate market access—specifically, border costs and tariff rates—were obtained from the World Bank's World Development Indicators (WDI).

4.2.3 Control variables

Control variables are incorporated at two levels. At the country level, we control for (1) market size, measured by the exporting country's population and GDP (World Bank); (2) natural resource endowment, proxied by the share of natural resource rents in GDP (World Bank); (3) bilateral trade flows, measured by the trade volume between the exporting country and China (BACI database); and (4) institutional factors, measured by institutional distance between the exporting country and China (Worldwide Governance Indicators database). At the industry level, we control for the sectoral competitiveness index, the sectoral output structure, and the sectoral degree of openness, all of which are constructed using data from the OECD ICIO tables.

5. Empirical Results and Analysis

5.1 Baseline Regression

We conducted the baseline regression to examine the impact of market access in BRI countries on Chinese supply chain relocation using Equation (9). As reported in Column (1) of Table 2, the coefficient on market access is 1.537 and statistically significant at the 1% level after controlling relevant covariates, fixed effects, and clustering standard errors at the appropriate level. This result confirms that improvements in market access in BRI countries significantly promote the relocation of Chinese supply chains toward these destinations.

Furthermore, based on the analytical framework outlined above, we decompose the supply chain relocation indicator into two broad categories comprising four specific modes and conduct separate regressions. The results are reported in Columns (2) to (5) of Table 2. Column (2) estimates the effect of market access on the direct relocation of Chinese supply chains to the exporting country, i.e., shallow relocation. The results also indicate that improvements in market access in BRI countries do not exert a statistically significant effect on this mode. Columns (3) to (5) present the estimation results for the impact of market access on deep supply chain relocation, specifically intra-BRI relocation, relocation to non-BRI countries, and relocation back to China. In Column (3), the coefficient on market access is 1.309 and statistically significant at the 5% level, suggesting that enhanced market access strengthens linkages and communication among BRI countries and contributes to the preliminary formation of an integrated "BRI mega-market." In Column (4), the coefficient on market access is 1.235 and statistically significant at the 5% level, indicating that improved market access encourages Chinese firms to use BRI countries as a "springboard" to sell goods to other global markets through regional supply chain networks. In Column (5), the coefficient on market access is 0.996 and statistically significant at the 5% level, implying that enhanced market access enables BRI countries to leverage their comparative advantages, thereby becoming an important link in the inward supply of China's overall supply chain.

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TABLE 2. Baseline Regression Results

Variables	F.*lnVA*: One-period forward log of Chinese value-added used by foreign countries				
	(1)	(2)	(3)	(4)	(5)
	Total effect	Direct relocation	Intra-BRI relocation	Extra-BRI relocation	Round-trip relocation
lnMA	1.537*** (0.512)	2.274 (1.392)	1.309** (0.590)	1.235** (0.590)	0.996** (0.472)
Controls	Yes	Yes	Yes	Yes	Yes
Exporter-sector FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Clustered robust SE	Yes	Yes	Yes	Yes	Yes
Observations	5175	5175	5175	5175	5175
R^2	0.996	0.994	0.996	0.996	0.989

Notes: *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are reported in parentheses. Unless otherwise specified, all subsequent tables control for exporter country–sector fixed effects and year fixed effects, and employ clustered robust standard errors.

5.2 Addressing Endogeneity

5.2.1 Instrumental variable approach

To address potential endogeneity concerns, this section employs two instrumental variables: the least-cost path for transportation infrastructure construction and a measure based on the Ancient Silk Road. First, following Faber (2014), we construct an instrumental variable for transportation infrastructure using geospatial information to compute the least-cost path of infrastructure development. This geography-based measure influences infrastructure planning while remaining exogenous to policymakers' preferences, thereby satisfying both the relevance and exogeneity conditions. The corresponding regression results are reported in Columns (1) and (2) of Table 3. Second, we construct an alternative instrumental variable based on the distance between modern countries and the historical routes of the Ancient Silk Road, using data released by the China Academy of Cultural Heritage. Specifically, we employ the ArcGIS "Distance Tool" to calculate the shortest distance from each country to the Silk Road routes. Countries are then classified into five categories based on distance: 5 (within 10 km), 4 (within 50 km), 3 (within 200 km), 2 (within 500 km), and 1 (beyond 500 km). As a historical artifact, the Ancient Silk Road is plausibly exogenous to contemporary economic conditions, satisfying the exclusion restriction. At the same time, modern transport infrastructure projects often follow the routes of historical trade corridors, thereby satisfying the relevance condition. The results using this instrument are presented in Columns (3) and (4) of Table 3. Columns (1) and (3) report the first-stage results, where the coefficients on both instrumental variables are significantly positive. The Cragg–Donald Wald F-statistics exceed the 10% critical threshold, rejecting the null hypothesis of weak instruments, while the significant Kleibergen–Paap rk LM statistics confirm that the model passes the under-identification test. Columns (2) and (4) present the second-stage results, in which the coefficient on the market access indicator remains significantly positive. These findings indicate that improvements in market access driven by transportation infrastructure along the Belt and Road significantly promote the relocation of Chinese supply chains toward participating countries.

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5.2.2 Targeted exclusion method (target-city exclusion)

To further address potential endogeneity concerns, we adopt the inconsequential units approach (also known as the irrelevant layout method), which constructs a sample set where unobservable variables do not influence transportation layout (Tang et al., 2019). Following the methodology of Redding and Turner (2015), we exclude "target cities"—those with a relatively higher likelihood of being connected by infrastructure due to economic or political considerations. Specifically, based on the policy documents *Vision and Actions on Jointly Building Silk Road Economic Belt and 21st-Century Maritime Silk Road*[5] and *The Belt and Road Initiative: Progress, Contributions and Prospects*[6], target cities are identified and removed according to the following criteria: (i) national capital cities; (ii) the aforementioned capitals and cities with populations exceeding 3 million in 2021; and (iii) cities located within a 50 km radius of the first two categories. Using the transportation data after excluding these target cities, we recalculate the market access index, aggregate it at the national level, and re-estimate the model. The results are reported in Columns (5)–(7) of Table 3. The estimated coefficients on market access remain consistently positive and statistically significant, and their magnitudes are larger than those in the baseline regression. Moreover, as the scope of the target-city exclusion expands, the coefficients increase. These findings suggest that the baseline results remain robust and indicate that potential endogeneity bias is limited.

TABLE 3. Addressing Endogeneity

Variable	Instrumental variable				Target exclusion		
	(1) *lnMA*	(2) F.*lnVA*	(3) *lnMA*	(4) F.*lnVA*	(5) Standard 1	(6) Standard 2	(7) Standard 3
lnMA		5.666** (2.080)		6.944*** (2.432)	1.538*** (0.512)	1.538*** (0.512)	1.655** (0.736)
Least cost path (IV)	0.111*** (0.026)						
Ancient silk road (IV)			0.021** (0.009)				
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Kleibergen-Paap rk LM statistic	6.206**		4.916**				
Cragg-Donald Wald F statistic	961.016 [16.38]		172.072 [16.38]				
Observations	5175		5175		5175	5175	5175
R^2	0.117		0.037		0.996	0.996	0.996

Notes: The table reports the Kleibergen–Paap rk LM statistic for the under-identification test and the Cragg–Donald Wald F-statistic for the weak instrument test. Square brackets indicate the Stock–Yogo 10% critical values. Target-city criteria are as follows: Criterion 1 includes national capital cities; Criterion 2 includes national capitals and cities with 2021 populations exceeding 3 million; Criterion 3 includes national capitals, cities with 2021 populations exceeding 3 million, and those within a 50 km radius of a national capital. All other specifications are consistent with Table 2.

[5] In March 2015, *Vision and Actions on Jointly Building the Silk Road Economic Belt and 21st-Century Maritime Silk Road*, jointly released by the National Development and Reform Commission (NDRC), the Ministry of Foreign Affairs, and the Ministry of Commerce, emphasized focusing on "key transport corridors, key nodes, and major projects," with priority given to "linking up unconnected road sections and removing bottlenecks."

[6] In May 2017, *The Belt and Road Initiative: Progress, Contributions and Prospects*, issued by the Office of the Leading Group for Promoting the Belt and Road Initiative, formally outlined the "Six Corridors, Six Roads, Multiple Countries, and Multiple Ports" cooperation framework, noting that economic corridors are intended to "connect major cities, population centers, and industrial clusters" along the routes.

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5.3 Robustness Checks

This paper conducts a series of robustness checks to validate the baseline regression results. First, following Caliendo and Parro (2014), we adjust the parameters used to calculate market access to assess whether the effect of infrastructure-induced improvements in market access on Chinese supply chain relocation remains robust. Second, we exclude the 16 Central and Eastern European countries (CEECs) participating in the "16+1" cooperation framework, given its substantial overlap with the BRI. This allows us to isolate the effect of market access among other BRI countries after removing this overlapping group. Third, we replace the dependent variable with two alternative measures: (i) the share of Chinese value added in each exporting country's sectoral total exports, and (ii) the share of Chinese value added in each exporting country's sectoral total output. Fourth, we extend the sample period from 2013–2018 to 2013–2020 to assess whether the empirical results remain robust amid large-scale public health shocks and non-standard market conditions. Fifth, we modify the clustering level from the exporter-country level to a two-way clustering at the exporter-country and industry level. Across all specifications, the results remain consistent, confirming the robustness of the baseline findings.

6. Mechanism Analysis

The preceding theoretical analysis suggests that improvements in market access induced by transportation infrastructure development under BRI reduce logistics and transportation costs, shorten delivery times for goods and services, and enhance overall transport efficiency. These changes expand firms' access to external markets, enabling Chinese investors to enter new markets more easily and engage in deeper local operations. In addition, improved transportation infrastructure facilitates the rapid circulation of goods and services, thereby encouraging Chinese firms to increase their OFDI in BRI countries. This expansion of investment entails not only capital flows but also the transfer of technology, managerial expertise, and human capital, as well as the optimization and restructuring of local supply chain systems. Through these channels, improvements in market access drive the broader-scale relocation of Chinese supply chains.

To identify the mechanism, this study follows the approach of Lv et al. (2019). It uses the number of Chinese OFDI projects in BRI countries over 2013–2018 as the dependent variable. Data on Chinese outward investment are obtained from the China Global Investment Tracker (CGIT) database[7], which records China's OFDI and contracted construction projects since 2005, along with detailed information on investment values, project status, and participating firms. To mitigate potential simultaneity bias and definitional overlap between BRI transportation infrastructure and OFDI, we exclude all transportation-sector investment projects from the sample. To empirically test the mechanism—that improved market access under the BRI promotes supply chain relocation by attracting outward investment — we apply the mechanism identification framework developed by Jiang (2022). The regression specification is as follows:

[7] To address potential simultaneity bias and definitional overlap between BRI transportation infrastructure and Chinese OFDI, we exclude all investment projects in the transportation sector from the database.

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$$INV_{izt+1}=\beta_0+\beta_1 lnMA_{it}+\beta_2 X_{it}+\beta_3 Z_{izt}+\sigma_{iz}+\sigma_t+\varepsilon_{izt} \quad (10)$$

In this specification, INV_{izt+1} denotes the mechanism variable: the number of Chinese OFDI projects in BRI countries. The selection of control variables is consistent with the baseline regression, and both the dependent and explanatory variables are introduced with a one-period lag. To account for heterogeneity across countries and industries, the model includes exporter country–sector fixed effects (σ_{iz}) and year fixed effects (σ_t), with robust standard errors clustered at the exporter-country level.

Furthermore, drawing on detailed information from the CGIT database, we conduct additional regression analyses by disaggregating Chinese outward foreign direct investment into projects and industries. The results of the mechanism tests are reported in Table 4. Column (1) presents the effect of market access improvements in countries participating in the BRI on Chinese investment in these economies. Outward investment, as a mechanism variable, is statistically significant, indicating that transportation infrastructure development under the BRI effectively attracts investment from Chinese firms. This process involves not only capital flows but also the transfer of technology, managerial expertise, production facilities, and human capital. Such a comprehensive reallocation of resources reduces production costs and enhances firms' responsiveness and flexibility to market changes. At the same time, it enables host countries to exploit their sectoral comparative advantages and integrate more effectively into China-centered global supply chain networks.

Columns (2)–(3) of Table 4 report sub-sample regression results categorized by whether the investments are greenfield or non-greenfield. Greenfield investment refers to firms establishing entirely new production facilities or business operations in foreign markets, involving from-scratch project development, such as constructing new plants and installing new equipment. In contrast, non-greenfield investment primarily involves entry through mergers and acquisitions (M&A), joint ventures, or the acquisition of existing firms and their assets (Jiang and Jiang, 2017). Notably, the regression results show that greenfield and non-greenfield investments are statistically significant. However, improvements in market access have a stronger effect on capital inflows associated with non-greenfield projects. One possible explanation is that, through non-greenfield investment, Chinese firms not only gain immediate access to new markets, established business networks, and customer bases, but also directly leverage the target firms' existing production capacity and technological capabilities. This, in turn, enhances production efficiency and facilitates the rapid geographical and strategic relocation of supply chains.

Columns (4)–(5) of Table 4 present the sectoral heterogeneity analysis by partitioning the sample into industrial and service sectors. The results indicate that improvements in market access along the BRI significantly drive capital inflows into industrial sectors. This finding is economically intuitive: for industrial investment—particularly in heavy industry and manufacturing—transportation costs are a decisive factor in the location-choice matrix. Reduced logistics costs enhance the economic viability of establishing production facilities in new regions. Moreover, high-quality transportation infrastructure fosters industrial agglomeration, which generates economies of scale and bolsters production efficiency. Compared with service-oriented projects, industrial investments typically entail more intensive spatial relocation of

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production activities and the formation of integrated upstream and downstream supply networks. Consequently, these investments serve as a direct conduit for BRI countries to integrate into the broader reconfiguration and global shift of China's industrial supply chains.

TABLE 4. Mechanism Test Regression Results

Variables	(1) Number of projects	(2) Greenfield projects	(3) Non-Green field projects	(4) Industrial projects	(5) Service projects
lnMA	12.060*** (3.630)	11.073** (4.015)	35.093** (11.288)	31.026*** (6.309)	2.400 (3.133)
Controls	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	2382	1157	1513	1517	1371
R^2	0.743	0.589	0.763	0.726	0.748

Notes: *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are reported in parentheses. Unless otherwise specified, all subsequent tables control for exporter country–sector fixed effects and year fixed effects, and employ clustered robust standard errors.

7. Heterogeneity Analysis

7.1 Country-Level Heterogeneity

Given the substantial differences among BRI countries in terms of geographical location, economic development levels, and market size, it is necessary to examine in greater detail how these factors shape their capacity to undertake supply chain relocation from China. Therefore, this section provides a heterogeneity analysis of how improvements in market access along the BRI influence different countries' ability to receive relocated Chinese supply chains.

7.1.1 Geographical heterogeneity

To examine heterogeneity from a geographical perspective, BRI countries are partitioned into landlocked and coastal sub-samples. A test for coefficient equality across groups validates this classification. Unlike their landlocked counterparts, coastal nations benefit from multimodal connectivity, leveraging not only inland rail and road networks but also maritime gateways (ports) for international commerce. Consequently, coastal states typically possess superior supporting infrastructure and higher transportation endowments. The regression results in Columns (1)–(2) of Table 5 confirm that the effect of improved market access along the BRI on Chinese supply chain relocation is significantly larger for coastal countries than for landlocked ones.

7.1.2 Development-level heterogeneity

To examine heterogeneity by income level, we classify BRI countries as middle- or low-income and high-income according to the World Bank's 2022 income classification standards. Columns (3)–(4) of Table 5 report the regression results for these two groups. This classification passes the inter-group coefficient difference test. The results indicate that improvements in market access along the BRI exert a significantly stronger positive effect on the relocation of Chinese supply chains toward middle- and low-income countries than toward high-income countries. This

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is attributable to two main factors: on the one hand, middle- and low-income countries possess clear cost advantages; on the other hand, enhanced market access directly strengthens their relatively weak production and logistics capabilities, thereby providing essential support for the smooth operation of supply chains.

TABLE 5. Country-Level Heterogeneity Regression Results

Variables	Chinese value added used by each country (lead) *F.lnVA*			
	(1) Landlocked	(2) Coastal	(3) Low/middle-income	(4) High-income countries
lnMA	1.164* (0.563)	4.373** (1.697)	1.839** (0.661)	4.114 (3.913)
Controls	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes
Observations	3855	1320	2130	3045
R^2	0.997	0.994	0.995	0.997

Notes: *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are reported in parentheses. Unless otherwise specified, all subsequent tables control for exporter country–sector fixed effects and year fixed effects, and employ clustered robust standard errors.

7.2 Sectoral Heterogeneity Analysis

Industries vary significantly in their structural characteristics and operational requirements when relocating their supply chains. Consequently, we conduct a sectoral heterogeneity analysis to examine how the relationship between BRI market access and supply chain shifts varies across industries.

7.2.1 Heterogeneity by sectoral upstreamness

Sectoral upstreamness is a key indicator that captures an industry's position in the global supply chain, reflecting its relative distance from final consumption. A country–industry pair with an upstreamness index above the mean is considered relatively upstream (closer to raw material production). In contrast, one below the mean is regarded as relatively downstream (closer to final consumers). Since low-upstreamness industries are closer to the consumption end, infrastructure improvements that reduce transportation costs and enhance logistics efficiency tend to have a stronger direct impact on their competitiveness and market share. Therefore, transportation infrastructure development is more likely to drive the relocation of low-upstreamness industries to BRI countries. The regression results in Columns (1)–(2) of Table 6 confirm this hypothesis.

7.2.2 Heterogeneity by transport dependency

Due to constraints in production efficiency, product quality, and market competitiveness, industries such as traditional manufacturing, pharmaceuticals, and electronics have extremely high requirements for transportation costs, time efficiency, and logistics reliability, and thus are classified as high-transport-dependency industries. In contrast, industries such as services and digital products are less susceptible to changes in logistics efficiency and are categorized as low transport-dependency industries. Following the methodology of Duranton et al. (2014), we examine these two industry groups separately. A test for coefficient equality across groups

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validates this classification. The regression results, reported in Columns (3)–(4) of Table 6, indicate that improvements in market access along the BRI have a significantly stronger positive effect on the supply chain relocation of high-transport-dependency industries.

TABLE 6. Heterogeneity Results by Sectoral Upstreamness and Transport Dependency

Variables	Chinese value added used by each country (lead) F.*lnVA*			
	(1) High upstreamness	(2) Low upstreamness	(3) High transport dependency	(4) Low transport dependency
lnMA	1.275** (0.511)	1.703*** (0.551)	1.905*** (0.530)	1.296** (0.532)
Controls	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes
Observations	2579	2574	2111	3064
R^2	0.997	0.995	0.994	0.997

Notes: *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are reported in parentheses. Unless otherwise specified, all subsequent tables control for exporter country–sector fixed effects and year fixed effects, and employ clustered robust standard errors.

7.2.3 Heterogeneity by sectoral factor intensity

Since industries with different factor intensities occupy distinct positions in global supply chains and exhibit varying degrees of dependence on imported intermediate inputs for processing, assembly, and other manufacturing activities (Lv et al., 2018), the effect of transportation infrastructure on Chinese supply chain relocation is likely to vary with sectoral factor intensity. We therefore classify the sample into labor-, capital-, and technology-intensive industries using industry codes and conduct separate regressions. The results, reported in Columns (1)–(3) of Table 7, show that improvements in market access along the BRI significantly promote the relocation of labor-intensive industries toward BRI countries. This is primarily because these countries typically offer lower labor costs, making them attractive destinations for labor-intensive production as firms seek to reduce costs. This finding is consistent with the earlier heterogeneity results based on countries' income levels.

7.2.4 Heterogeneity by sectoral comparative advantage

Recognizing that comparative advantages vary significantly across nations and industries, we follow Wu et al. (2021) and use 2013—the inception year of the BRI—as the baseline to calculate the Revealed Comparative Advantage (RCA) index at the country-industry level. To capture these effects, we construct a binary indicator, *RCAdummy*, which equals 1 if a country-industry pair's initial RCA exceeds the sectoral mean, and 0 otherwise. By employing the initial-period RCA, we utilize a predetermined measure that mitigates potential reverse causality and endogeneity concerns, thereby enhancing the robustness of our estimates. The results in Columns (4)–(5) of Table 7 indicate that Chinese supply chain relocation is disproportionately concentrated in country-industry pairs with superior comparative advantages. This pattern suggests that by aligning with competitive local sectors, Chinese firms not only secure immediate cost and

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efficiency gains but also foster long-term technological spillovers and innovation. These findings provide further empirical support for the mechanism of non-greenfield outward investment discussed previously.

TABLE 7. Heterogeneity Results by Sectoral Factor Intensity and Comparative Advantage

Variables	Chinese value added used by each country (lead) F.*lnVA*				
	(1) Labor-intensive	(2) Capital-intensive	(3) Technology-intensive	(4) Low-competitiveness	(5) High-competitiveness
lnMA	1.893*** (0.453)	1.201** (0.537)	1.581** (0.570)	1.416** (0.514)	1.744** (0.678)
Controls	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	1519	2004	1652	3174	2001
R^2	0.996	0.997	0.995	0.995	0.997

Notes: *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are reported in parentheses. Unless otherwise specified, all subsequent tables control for exporter country–sector fixed effects and year fixed effects, and employ clustered robust standard errors.

8. Concluding Remarks and Policy Recommendations

The world is undergoing profound changes unseen in a century amid a complex international environment and escalating geopolitical conflicts. Major economies have thus heightened their focus on economic security, with the EU, the US, Japan, and others adopting measures to intervene in and constrain China's participation in global supply chains for certain products. In contrast, BRI, proposed by President Xi Jinping in 2013, has been continuously enriched and developed over the past decade. Driven by infrastructure development, the BRI has fostered new drivers of global economic growth, encouraged more economies to participate in the restructuring of global value chains, and further deepened the division of labor in the global supply chain system. Against this backdrop, this study investigates how improved market access—driven by BRI transportation infrastructure—affects the relocation of China's supply chains. We do so by leveraging data on transportation infrastructure projects and industry-level input–output data for BRI countries from 2013 to 2018.

The main findings are as follows: First, improved market access in BRI countries has effectively promoted China's supply chain relocation, especially deep supply chain relocation, with more significant effects on intra-BRI relocation, indirect relocation to non-BRI countries, and round-trip relocation back to China, indicating that BRI countries play a pivotal role in China's overall inward and outward supply chain provision. These results hold after a series of endogeneity treatments and robustness checks. Second, improved market access in BRI countries primarily drives China's supply chain relocation by attracting China's outward investment, particularly in non-greenfield and industrial projects. Third, heterogeneity analysis shows that coastal countries and lower-middle-income countries are more likely to host China's supply chain relocation as market access improves; low-upstreamness, high-transport-dependency, and labor-intensive

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industries are the main sectors involved. In terms of relocation direction, China's supply chains tend to shift toward country–industry pairs with stronger comparative advantages. Notably, this study provides a reference for optimizing the global layout of China's supply chains and is of great significance for promoting supply chain integration between China and BRI countries. Based on the findings, this paper puts forward the following policy recommendations:

First, China should actively promote the high-quality development of cooperation under the BRI. Against the backdrop of an increasingly complex and volatile global political and economic environment, China should continue to advance infrastructure connectivity, optimize transportation network layouts, and enhance the efficiency and quality of infrastructure development. To this end, coordinated efforts across land and maritime transport systems are essential. This includes accelerating the high-quality development of the China-Europe Railway Express, actively participating in the construction of the Trans-Caspian International Transport Corridor, promoting port-shipping-trade integration under the Silk Road Maritime, and advancing cross-border intermodal transport along the New International Land-Sea Trade Corridor. In addition, China should develop cross-border e-commerce platforms and industrial transaction chains, build the Air Silk Road, and ultimately establish a multi-layered and multidimensional connectivity network under the BRI. In key destination countries for China's supply chain relocation, greater investment should be directed toward upgrading critical transport corridors—particularly railways, highways, and ports—to improve logistics efficiency, reduce transportation costs, and reserve sufficient space for future economic expansion. Building on regional transport integration, China should follow the guidance of the Eight Actions to implement a host of flagship projects and small yet beautiful livelihood projects. Through these efforts, China and BRI partner countries can jointly build a secure, stable, smooth, efficient, open, inclusive, and mutually beneficial global supply chain system, thereby deepening international cooperation in industry and supply chains through concrete actions.

Second, China should continue to optimize the outward-investment environment for Chinese enterprises. Amid intensifying global economic competition and a changing external environment, improving the outward investment climate has become a strategic imperative for Chinese enterprises to enhance their international competitiveness and pursue high-quality development. First, infrastructure connectivity should be further improved by increasing investment in transportation, energy, telecommunications, and other sectors in BRI partner countries, to build efficient, seamless cooperation networks and provide more convenient overseas market access for Chinese enterprises. Second, the Chinese government should actively sign multilateral trade and investment agreements with BRI countries and strengthen policy coordination on tariffs, investment access, technical standards, and other areas to ensure the full protection of Chinese enterprises' overseas investment interests. This includes establishing overseas economic and trade cooperation zones and industrial parks to promote industrial agglomeration and economies of scale, and setting up regional investment protection and dispute settlement mechanisms to reduce political and legal risks in international expansion, thereby lowering operating costs and improving market competitiveness. Third, China should conduct in-depth research into the economic policies and market environments of key stakeholders, trading partners, and host countries, and formulate

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more targeted and efficient outward-investment strategies. By combining government guidance with enterprise transformation and upgrading, China will ultimately form a new pattern of outward investment centered on factor-driven development, market orientation, and collaborative innovation.

Third, China should vigorously promote the international extension and upgrading of competitive industrial chains. Efforts should focus on cultivating interconnected development chains, consolidating and strengthening the global leading position of China's competitive industries, and tightening international industrial and supply chains' dependence on China, while firmly opposing the politicization and weaponization of industrial and supply chains. On the one hand, by leveraging internationalized industrial and supply chains, China can better secure control over key resources and markets, fully identify and utilize comparative advantages across regions, optimize industrial structure and resource allocation, and ultimately establish multi-level, multi-field industrial cooperation with BRI countries. On the other hand, in line with the principles of horizontal differentiation and vertical specialization, China should strengthen cooperation with BRI countries in key competitive industries. Furthermore, greater emphasis should be placed on establishing overseas R&D centers and production bases in BRI countries and other key markets. Such facilities will help reduce transportation costs and response times, leverage local resource advantages, accelerate technological exchange and innovation, and ultimately optimize the global spatial layout of Chinese supply chains while enhancing the resilience and security of China's industrial and supply chains.

References:

Alfaro L., Chor D. Global Supply Chains: The Looming "Great Reallocation"[R]. NBER Working Paper, 2023 (No. 31661).

Baldwin R., Freeman R., Theodorakopoulos A. Hidden Exposure: Measuring US Supply Chain Reliance[J]. Brookings Papers on Economic Activity, 2023(Fall): 79-134.

Baldwin R., Freeman R., Theodorakopoulos A. Horses for Courses: Measuring Foreign Supply Chain Exposure[R]. NBER Working Paper, 2022 (No. 30525).

Bernard A. B., Moxnes A., Saito Y. U. Production Networks, Geography and Firm Performance[J]. Journal of Political Economy, 2019(2): 639-688.

Caliendo L., Parro F. Estimates of the Trade and Welfare Effects of NAFTA[J]. The Review of Economic Studies, 2014(1): 1-44.

Dai X., Song J. Global Value Chain Optimization Effect of the Belt and Road Initiative——Based on the Perspective of Improving the GVC Position of Participating Countries along the Belt and Road[J]. China Industrial Economics, 2021(6): 99-117.

De Soyres F., Mulabdic A., Murray S., et al. How much will the Belt and Road Initiative Reduce Trade Costs?[R]. World Bank Policy Research Working Paper, 2018 (No. 8614).

Donaldson D. Railroads of the Raj: Estimating the Impact of Transportation Infrastructure[J]. American Economic Review, 2018(4-5): 899-934.

Donaldson D., Hornbeck R. Railroads and American Economic Growth: A "Market Access" Approach[J]. The Quarterly Journal of Economics, 2016(2): 799-858.

Duranton G., Morrow P. M., Turner M. A. Roads and Trade: Evidence from the US[J]. Review of Economic Studies, 2014(2): 681-724.

中国知网 https://www.cnki.net

Emerson M., Vinokurov E. Optimisation of Central Asian and Eurasian Trans-continental Land Transport Corridors[R]. EUCAM Working Paper, 2009(7): 1-18.

Faber B. Trade Integration, Market Size, and Industrialization: Evidence from China's National Trunk Highway System[J]. Review of Economic Studies, 2014(3): 1046-1070.

Gao X., Xu R., Shi Y. Y., et al. Facing the Trade War, What Can Be Enlightened from the Relocation Paths of China's Typical Manufactures[J]. Systems Engineering — Theory & Practice, 2020(9): 2203-2221.

Gereffi G. International Trade and Industrial Upgrading in the Apparel Commodity Chain[J]. Journal of International Economics, 1999(1): 37-70.

Harris C. D. The Market as a Factor in the Localization of Industry in the United States[J]. Annals of the Association of American Geographers, 1954(4): 315-348.

He Y. X., Li D., Wang S. Output Effects of Intermediate Input Structural Adjustment: Dual Perspectives of Internalization and Digitization[J]. The Journal of Quantitative & Technical Economics, 2023(8): 154-177.

Hong J., Zhong X. H. Research on the Emerging Trends of Global Value Chain Restructuring from the Dual Perspectives of Geopolitics and Trade Conflict[J]. Journal of China Economics, 2024(1): 1-20+281-282.

Huang X. F., Fang F. F., Xu Y. Value Chain Position and Outward Foreign Direct Investment Decision: Evidences from Chinese Listed Firms[J]. Journal of Management Sciences in China, 2023(6): 57-80.

Jiang G., Jiang D. Greenfield Investment or Cross-border Mergers and Acquisitions: A Research on Chinese Companies outward Investments[J]. The Journal of World Economy, 2017(7): 126-146.

Jiang T. Mediating Effects and Moderating Effects in Causal Inference[J]. China Industrial Economics, 2022(5): 100-120.

Krugman P. Geography and Trade[M]. Cambridge: MIT Press, 1991.

Li B., Yang R., Lu J., et al. Enterprise Digital Transformation, Supply Chain Spillover and Labor Skill Preference[J]. The Journal of Quantitative & Technical Economics, 2024(8): 133-153.

Li J., Wang H. The Launching of CR-Express and the Competitiveness of Urban Export[J]. Journal of China Economics, 2022(3): 130-167+287-290.

Liu C., Wu Q. F., Liu Q. Transportation Infrastructure, Market Access and Firm Productivity: A Competition and Resource Reallocation Perspective[J]. Economic Research Journal, 2020(7): 140-158.

Liu Y. J., Zhou J., Zeng X. M. Mutualism Effect of Industrial Transfer between China and the Belt and Road Countries[J]. China Industrial Economics, 2023(2): 55-73.

Lv Y., Chen S., Sheng B. Does Embedding the Global Value Chain Lead to Chinese Manufacture's "Low-end Locking"?[J]. Management World, 2018(8): 11-29.

Lv Y., Gu W., Wei Y. N., et al. Artificial Intelligence and Deepening of the Global Value Chain Network[J]. The Journal of Quantitative & Technical Economics, 2023(1): 128-151.

Lv Y., Lu Y., Wu S. B., et al. The Effect of the Belt and Road Initiative on Firms' OFDI: Evidence from China's Greenfield Investment[J]. Economic Research Journal, 2019(9): 187-202.

Ni H. F., Zhong D. C., Fan Z. J. Measurement, Structure, and International Comparison of Risk Exposures in China's Industry Chains: A Perspective Based on Production Chain Length[J]. Management World, 2024(4): 1-26+46+27-45.

Redding S. J., Turner M. A. Transportation Costs and the Spatial Organization of Economic Activity[C]. Handbook of Regional and Urban Economics, 2015(5): 1339-1398.

Reed T., Trubetskoy A. Assessing the Value of Market Access from Belt and Road Projects[R]. World Bank Policy Research Working Paper, 2019 (No. 8815).

Rodemann H., Templar S. The Enablers and Inhibitors of Intermodal Rail Freight between Asia and Europe[J]. Journal of Rail Transport Planning & Management, 2014(3): 70-86.

Seo Y. J., Chen F., Roh S. Y. Multimodal Transportation: The Case of Laptop from Chongqing in China to Rotterdam in Europe[J]. The Asian Journal of Shipping and Logistics, 2017(3): 155-165.

Shen H. C., Tao Q., Chen Y. B. Supply Chain Management: Theory and Method[J]. Chinese Journal of Management Science, 2000(1): 1-9.

Sladkowski A., i Cieśla M. Influence of a Potential Railway Line Connecting the Caspian Sea with the Black Sea on the

中国知网 https://www.cnki.net

Development of Eurasian Trade[J]. NAŠE MORE, 2015(4): 264-271.

Sun F., Wang X. F., Jin L., et al. Improvement of Rail-sea Multimodal Transport with Dry Port Construction: Case Study of Ningbo-Zhoushan Port[J]. Science Journal of Business and Management, 2017(2): 78-87.

Sun P. Y., Zhang T. T., Yao S. J. Tariff Transmission, Domestic Transport Costs and Retail Prices[J]. Economic Research Journal, 2019(3): 135-149.

Tang Y. H., Yu F., Lin F. Q., et al. China's High-speed Railway, Trade Cost and Firm Export[J]. Economic Research Journal, 2019(7): 158-173.

Wang Y. M. Changes Unseen in a Century, High-Quality Development, and the Construction of a New Development Pattern[J]. Management World, 2020(12): 1-13.

Wang Z., Wei S. J., Yu X. D., et al. Measures of Participation in Global Value Chains and Global Business Cycles[R]. NBER Working Paper, 2017 (No. 23222).

Wang Z., Wei S. J., Zhu K. F. Gross Trade Accounting Method: Official Trade Statistics and Measurement of the Global Value Chain[J]. Social Sciences in China, 2015(9): 108-127+205-206.

Wang Z., Wei S. J., Zhu K. F. Quantifying International Production Sharing at the Bilateral and Sector Levels[R]. NBER Working Paper, 2013 (No. 19677).

Wei J. Y., Hu R. D. Trade Network Position and ESG Performance: Transmission Along the Supply Chain Under Network Topology[J]. Journal of China Economics, 2024(2): 158-185+296-297.

Wu Q.F., Liu C., Liu Q. Domestic Market Integration and Firm Export Behavior: A Research Based on Market Access Approach[J]. China Economic Quarterly, 2021(5): 1639-1660.

Yao Z. Q. Study on Chinese Enterprises' OFDI Efficiency Under the Background of Global Value Chains[J]. Intertrade, 2016(2): 13-17.

Zhang M. T., Yu F., Zhong C. B., et al. High-speed Railways, Market Access and Enterprises' Productivity[J]. China Industrial Economics, 2018(5): 137-156.

Zhang P. Y., Feng K., Tang Y. H. Unlocking the Induced Mystery of Global Trade Protection: A Study from the Perspective of Value-Added Transfer[J]. The Journal of World Economy, 2022(5): 57-80.

Zhang P. Y., Liu H. J., Zhang S., et al. Enterprise Digital Transformation and Export Supply Chain Uncertainty[J]. The Journal of Quantitative & Technical Economics, 2023(9): 178-199.

Zhang P. Y., Tang Y. H. How Does FDI Have the Effects on the Domestic Value-Added in Export?[J]. The Journal of Quantitative & Technical Economics, 2018(7): 79-96.

Zhu X. L., Huang H. Q. The Evolution of Global Supply Chain and Its Impact on China's Industry Development[J]. Reform, 2021(4): 60-67.

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