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Exploring the Mutualistic Win-win Mechanism of Industrial Transfer Between China and the Countries Along the Belt and Road

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Abstract

Keywords:

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The construction of a "Community of Shared Future for Mankind" requires a concept of mutual benefit and coexistence. The implementation of the "Belt and Road" initiative cannot be separated from the strategy of industrial transfer. Whether the industrial transfer between China and the countries along the "Belt and Road" can achieve the mutual benefit and coexistence of bilateral industries is related to the quality and stability of the joint construction of the "Belt and Road". It can also provide empirical evidence to respond to some countries' doubts about the motives of the "Belt and Road" initiative. This article analyzes the mutual benefit and coexistence effects and their mechanisms of industrial transfer between China and countries along the "Belt and Road" from three dimensions of the mutual benefit and coexistence relationship: integration, interaction, and coordination. It uses the EORA world input-output data from 2003 to 2021 for empirical verification. The research results show that the overall level of industrial mutual benefit and coexistence between China and the countries along the "Belt and Road" continues to improve, but the differences between different industries and regions are significant; the industrial transfer between China and the countries along the "Belt and Road" can promote the mutual benefit and coexistence of bilateral industries. This promotion is mainly achieved by strengthening regional value chain cooperation and improving the level of industrial agglomeration. The mutual benefit and coexistence effects of industrial transfer between China and the countries along the "Belt and Road" vary in regions, industries, and time periods. The effects are more significant with the industrial transfer from developed countries along the route, the industrial transfer from medium and high-tech industries, and the industrial transfer after the initiative proposed. The research of this article provides important implications for deepening the industrial transfer between China and the countries along the "Belt and Road" and constructing a system of regional value chain cooperation with mutual benefit and coexistence.

Introduction

The concept of "symbiosis" originated in the field of biology and was later gradually introduced into economics. In economics, it refers to the continuous material connections between economic entities. Mutualistic symbiosis, in particular, denotes a mode of symbiotic development in which entities within a symbiotic system depend on each other and share benefits. The "Belt and Road" initiative aims to promote more extensive, higher-level, and deeper regional cooperation globally, to establish an open and inclusive international cooperation platform with mutual benefit and win-win cooperation. Its essence embodies the practice of the concept of a "community with a shared future for mankind" and represents an important manifestation of mutualistic symbiotic development. Industrial transfer between countries along the Belt and Road, as a crucial aspect of the initiative's construction, is not only an effective way to implement bilateral industrial cooperation but also an important means to promote

mutualistic symbiotic development in the region. Taking the China-Pakistan Economic Corridor (CPEC) as an example, the CPEC is a pivotal component of the Belt and Road Initiative, which has bolstered cooperation between China and Pakistan by improving infrastructure, particularly in transportation networks and energy projects. For instance, the joint construction of the Gwadar Port not only enhanced Pakistan's maritime capabilities but also facilitated the entry of Chinese goods into the Middle Eastern and African markets (Teipen & Mehl, 2021). Moreover, the CPEC includes the construction of highways, railways, pipelines, and fiber optic networks, all of which are foundations for industrial development and bring about more convenient logistics and stronger connectivity for the countries along the route. However, some Western countries and certain international community groups have expressed skepticism about the intentions of the Belt and Road initiative, even misconstruing it as a geopolitical tool of China. Therefore, it is necessary to delve into the mutualistic symbiotic effects of industrial transfers between China and countries along the Belt and Road from both theoretical and empirical perspectives, providing theoretical support and empirical evidence to promote high-quality industrial cooperation under the Belt and Road and to respond to some countries' doubts about the initiative.

The literature involved in this article is mainly divided into two categories: one focuses on the behavior and theory of industrial symbiosis. Early studies from an industrial ecology perspective explored industrial symbiosis, suggesting that industries can imitate the material and energy cycling mechanisms in biological ecosystems to construct industrial ecosystems akin to natural ones (Frosch & Gallopoulos, 1989). Industrial symbiosis applies the ecological metaphor from industrial ecology to the behavior between firms (Chertow, 2000), aiming to enhance overall resource efficiency and firm competitiveness through the establishment of knowledge-sharing and transaction networks (Laybourn & Morrissey, 2009), and to promote the formation of industrial ecology (Friesen & Jones, 2012; Li, 2010). As the symbiosis theory continues to be refined and developed, some scholars have studied industrial symbiosis within the framework of industrial economics theory, believing that industrial symbiosis is an objectively existing economic phenomenon, a state of integration, interaction, and coordinated development between different value modules of industries under increasingly refined division of labor (Audretsch & Caiazza, 2016; Babikova & Kaplyuk, 2018). The industrial ecosystem is the product of the evolution of industrial symbiosis (Hu et al., 2019), and this symbiotic industrial ecology is particularly prominent in the integration of manufacturing and service industries (Qi et al., 2023). With the rapid development of industrial clusters, more scholars are paying attention to the symbiotic relationships among entities within clusters, believing that collaboration and competition among firms within clusters contribute to the stability of symbiosis, with symmetric mutualistic symbiosis being the most stable form in industrial clusters (Babkin et al., 2021; Evseeva, Starikov, & Voronov, 2021). The co-governance, environmental negotiation, value co-creation, and ecological

symbiosis within clusters have enhanced the interdependence among various elements, promoting the sustained stability and co-evolution of the symbiotic system (Branca et al., 2021; He & Xiao, 2023). However, the vast majority of the literature currently only conducts theoretical discussions and qualitative analyses on the concepts, formation conditions, and functional roles of industrial symbiosis, lacking quantitative research.

Another type of literature is focused on the symbiotic effects triggered by industrial transfer. They generally believe that industrial transfer is the basis for symbiosis, and through the transfer of industries between regions, industries in different regions can achieve mutual dependence, effective complementarity, deep docking, and collaborative innovation, ultimately building a symbiotic economy (Chatterjee, Brehm, & Layton, 2021; Mendez-Alva et al., 2021). After some scholars deeply studied the issue of the distribution of interests among all parties in the process of industrial transfer, they began to pay attention to the issue of mutual benefit and symbiosis in the process of industrial transfer. They believe that industrial transfer is the process of forming and enhancing industrial symbiotic relationships and industrial value creation capabilities, and all parties can share symbiotic benefits in the interaction and integration of the industrial chain (Haq, Välisuo, & Niemi, 2021; Sun et al., 2023). Industrial transfer plays an important role in promoting the establishment of a regional industrial chain system for synergistic development, complementary advantages, and industrial symbiosis (Doddapaneni et al., 2022; Mendez Alva, De Boever, & Van Eetvelde, 2021). Under the condition of division of labor within the product, the chain effect and agglomeration effect of cluster-type industrial transfer should be actively used to promote the symbiotic development of the transferred industry (Chen et al., 2021; Zhang et al., 2023). As the research object continues to expand, more and more scholars begin to explore issues related to China's industrial transfer to countries along the "Belt and Road", proposing to play the interactive role of the "symbiotic system" and "symbiotic environment" of industrial transfer, actively seize the important opportunity of the "Belt and Road" to guide the industrial transfer in an orderly manner, and realize the mutual benefit and symbiosis of the industries of both parties (Ažman Momirski, Mušič, & Cotič, 2021; Noori, Korevaar, & Ramirez, 2021). Some studies have found that China's industrial transfer to countries along the "Belt and Road" can achieve the upgrade of the bilateral value chain, thereby achieving mutual benefit and symbiosis (Asghari et al., 2023; Zhang et al., 2022), especially China and Southeast Asian countries have a good complementarity in industrial structure, and should be based on symbiosis to build mutually beneficial overseas industrial parks in Southeast Asian countries (Agudo, Bezerra, & Gobbo Júnior, 2024; Shan, Guo, & Wei, 2023). Although the above studies have studied the issue of symbiotic effects in the process of industrial transfer from different angles, how to construct a reasonable industrial symbiosis index based on symbiosis theory, systematically analyze the mutual benefit and symbiosis effects of industrial transfer, and explore its intrinsic mechanisms, there is still no in-depth research.

This article takes the "Belt and Road" industrial chain cooperation system as the research background, uses symbiosis theory to establish a theoretical analysis framework for the impact of international industrial transfer on industrial symbiosis, and uses national-industry level data to empirically test the results of theoretical analysis. The significance of this study is outlined as follows: the construction of the index system of inter-country industrial symbiosis from three dimensions: integration, interaction, coordination, the calculation of the symbiosis level of the manufacturing industry between China and countries along the "Belt and Road", and the depiction of the mutual benefit and symbiosis relationship of bilateral industries. The theoretical logic of industrial transfer promoting industrial mutual benefit and symbiosis is clarified from the perspective of symbiosis, the effect of industrial transfer between China and countries along the "Belt and Road" is analyzed, and the internal rules of industrial transfer between China and countries along the "Belt and Road" are deeply understood. The mutual benefit and symbiosis effect of industrial transfer between China and countries along the "Belt and Road" and its mechanism are empirically studied, providing empirical basis and policy suggestions for promoting high-quality industrial cooperation between China and countries along the "Belt and Road".

The remainder of this article is organized as follows: Section two elaborates on the reciprocal symbiotic mechanism of industrial transfer among countries along the "Belt and Road" through related literature and proposes hypotheses to be tested. Section three introduces the empirical model settings, variable definitions, and data sources. Section four and five present the empirical results and analysis, respectively. Section six concludes the study.

Literature Review

The Impact of Industrial Transfer on the Mutualistic Symbiotic of Industries

Industrial symbiosis refers to a state of integration, interaction, and coordination between different value modules within the same industry and business modules with economic connections between different industries, based on increasingly delicate division of labor ([Davis & Aid, 2022](#); [Van Capelleveen et al., 2021](#)). Industrial mutual symbiosis refers to the state where the level of integration, interaction, and coordination is continuously improved, forming a complementary, interactive, and cooperative relationship with win-win and coexistence at its core. This article will explore the mutual symbiotic effects of industrial transfer from the perspectives of integration, interaction, and coordination.

The integration of industrial symbiosis mainly reflects the complementary relationship between bilateral industries in the process of value augmentation. The ways to achieve integration include technological complementarity, product supply and demand, business module

combination, etc. (Faria et al., 2022; Ma et al., 2022). Under the division pattern of the global value chain, cross-regional industrial transfer can optimize market division in a larger spatial range, arrange some production and processing links in areas with more "comparative advantages," and establish more complementary business connections that can better play to their comparative advantages (Jacob et al., 2023; Zhuang & Pan, 2021). With the deep development of industrial transfer under the global value chain model, good industrial complementary connections can be reflected from the input and demand of intermediates. From the demand perspective, the improvement of complementary connections between countries will increase the mutual demand for intermediates between bilateral countries; from the input perspective, the strengthening of complementary connections between countries will promote the input of intermediates and final goods in both countries, thereby expanding the production scale. This growth of intermediate goods trade volume caused by industrial transfer accelerates the changes in bilateral industrial input and demand, benefiting the enhancement of mutual dependence and integration relationships between industries in bilateral countries. Therefore, it can be inferred that the industrial transfer between China and the countries along the "Belt and Road" has strengthened the integration relationship between bilateral industries.

The interactivity of industrial symbiosis mainly manifests in the bi-directional linkage relationship in the win-win process of bilateral industries. Strictly speaking, the industrial interaction relationship under the symbiotic framework must bring benefits, and these benefits are mainly achieved through participation in the division of the global value chain and the import and export of intermediates. With the development of economic globalization and international division, countries can focus on vertical specialized production of certain links of products and realize mutual connections through intermediate trade activities, enhancing the interactive level between upstream and downstream of the value chain (Olasehinde-Williams & Oshodi, 2021). According to gradient transfer theory, upstream countries in the value chain will transfer part of the industrial production links to downstream countries in a "gradient" manner, downstream countries accept the industrial transfer from upstream countries and obtain resources such as technology and services from related industries, promote the development of their own industries through "reverse gradient" transfer methods such as R&D cooperation with upstream countries. And upstream countries can release more resources for the research and development of other higher-end production links in this transfer process, realizing the industrial upgrade of their own countries. In this way, both upstream and downstream countries can benefit from the industrial transfer process, forming a mutually beneficial relationship of bi-directional linkage between upstream and downstream countries (Białowas & Budzyńska, 2022). Therefore, it can be inferred that the industrial transfer between China and the countries along the "Belt and Road" has strengthened the interactive relationship between bilateral industries.

The coordination of industrial symbiosis refers to the cooperative division of labor that forms during the process of cross-regional industrial transfer. This type of transfer not only deepens international division of labor, but also optimizes the industrial structure and resource allocation between regions through interregional flow of elements, enhancing the coordination level of industries in different countries. Additionally, the orderly transfer of industries promotes the division of labor coordination of different processes within the same industry across regions (He, Yao, & Ji, 2021). For instance, the country transferring its industries can achieve the structural upgrade and high-end service of local industries by transferring some production processes, while the country receiving the industries can integrate into the new international division of labor, stimulating the transformation and upgrade of local industries by taking on some production links. In this way, both parties can achieve mutual dependence, orderly operation, virtuous cycle, and mutual progress of industries through reasonable division of labor, cooperative collaboration, and mutual benefit (Dai & Xu, 2023; Liu et al., 2022). Especially, China, based on the concept of a "community of shared future", has proposed industrial transfer following the principle of extensive consultation, joint contribution and shared benefits, focusing more on the balanced development of "righteousness and profit", which helps China establish a more coordinated industrial division of labor model with the countries along the "Belt and Road". Therefore, this article believes that the industrial transfer between China and the countries along the "Belt and Road" has enhanced the coordination of bilateral industries. Based on the above analysis, this article proposes research hypothesis 1:

Hypothesis 1: The industrial transfer between China and the "Belt and Road" countries can enhance the level of industrial symbiosis characterized by bilateral integration, interaction, and coordination.

The Intermediate Mechanism of How Industrial Transfer Affects the Mutual Symbiosis of Industries

The rise of global value patterns and the deepening of international division of labor have made the production and processing links of the same product more dispersed globally, allowing economies within a region to better optimize resources and industrial structures through participation in the division of labor cooperation of the global value chain (Caspersz et al., 2022; Gao, 2023; Van Onzen, 2021). As regional value chain cooperation deepens, companies tend to produce near large markets to obtain higher profits and reduce transportation costs, thereby promoting industrial agglomeration in the region. In theory, both the enhancement of regional value chain cooperation and the level of industrial agglomeration will facilitate the integration, interaction, and collaboration of industries within a region (Ellison & Glaeser, 1997), thereby improving the mutual symbiosis of industries between regions. Therefore, it can be speculated that the industrial transfer between China and the countries along the "Belt and Road" can enhance the mutual symbiosis of the industries of both countries by strengthening regional value chain cooperation and improving the level of industrial agglomeration.

1 Regional value chain cooperation is a new type of industrial development and value chain division of labor model, which makes use of the technological and market advantages of countries within the region and promotes trade cooperation between economies in the region through regional coordination or product division of labor. This method of cooperation can promote industrial transfer and thus achieve industrial symbiosis. Many theoretical studies and empirical evidence have shown that regional value chain cooperation can promote the two-way flow of production factors within the region, not only can it realize the "going out" of regional surplus production capacity and capital but also by combining with external vertical or horizontal division of labor, attract related service institutions and promote interaction and coordination of industries within the region (Teipen & Mehl, 2021). Additionally, according to the theory of industrial integration, the establishment of regional value chains can promote complementary and integrated development methods during the process of industrial innovation and value-added. In fact, research on China's industrial cooperation with countries along the "Belt and Road" finds that the regional value chains established between China and these countries can fully utilize the advantageous industries and resource factors within the region to build a new value chain model of mutual symbiosis with reasonable industrial division of labor and complementary advantages (DeBerge, 2024). Therefore, if industrial transfer can enhance the level of regional value chain cooperation, it can promote the mutual symbiosis of the industries of both countries through this pathway and mechanism.

New economic geography theory believes that industrial transfer has the characteristic of value chain link separation, meaning that the deepening of industrial division of labor leads to the new phenomenon of headquarters and production links moving in different directions (Duranton & Puga, 2005). High-end value chain segments move to developed regions with high technology levels, high levels of informatization, and concentrated specialized services, while low-end value chain segments move to underdeveloped regions with abundant labor and relatively low production costs. This kind of industrial transfer, based on the global value chain model, strengthens the division of labor and cooperation within the regional value chain (Paiva & Miguel, 2022; Wang & Han, 2021). On the one hand, industrial transfer can achieve regional industrial restructuring and optimization of resource allocation through the transfer and diffusion of resource factors, which is an important way to improve regional value chain cooperation (Angelidis & Varsakelis, 2023; Singh, 2023); on the other hand, industrial transfer optimizes the product chain, industry chain, and service chain according to the comparative advantages of countries within the region, forming a reasonable industrial regional distribution and regional value division of labor system, promoting the continuous deepening of regional value chain cooperation. The countries along the "Belt and Road" include both those at the upstream and downstream of the value chain; in the value division of labor system, the production process of the same product is split into multiple links and dispersed among these

countries. There are inter-country input-output links using intermediate goods, and through the form of industrial transfer, these value links are effectively integrated through import and export trade of intermediate goods, jointly constructing the "Belt and Road" regional value chain. The higher the value of intermediate goods from other countries in its exports or outflows, the higher the degree of regional value chain cooperation (Szymczak, Parteka, & Wolszczak-Derlacz, 2022; Wang et al., 2022).

2 Industrial transfer can promote the development of industrial mutual symbiosis by enhancing the level of industrial agglomeration. Industrial agglomeration is a spatial organization mode of division of labor. Its formation and development is a process where spatial division of labor deepens, transaction efficiency increases, and transaction costs decrease (Ajide et al., 2023; Lee, Gaspar, & Du, 2021). Industrial agglomeration provides the organizational foundation and premise for the development of industrial mutual symbiosis: on the one hand, with the continuous deepening of international division of labor, the production process of a single product is split into multiple specialized industrial agglomeration areas, and through the trade of intermediate goods, a vast transnational symbiotic production network is formed. Due to increasing returns to scale and positive external economic effects, agglomeration effects further promote the concentration of product production in this production network, conducive to the interaction, integration, and coordinated development between various industries within the production network. On the other hand, industrial agglomeration as a regional organization mode can be formed by the spatial distribution of the same industry, or by the dependencies, connections, and interactive relationships formed by different industries or upstream and downstream industries in spatial distribution. Its formation and development bring many advantages such as the symbiotic effect and synergistic effect of industries (Nadeem et al., 2023; Qian et al., 2022), effectively enhancing the level of industrial mutual symbiosis. Therefore, if industrial transfer can promote industrial agglomeration, it can promote bilateral industrial mutual symbiosis through the pathway and mechanism of enhancing the level of industrial agglomeration. Industrial transfer mainly promotes industrial agglomeration through the division of labor effect and the circular cumulative causation effect. On the one hand, under the background of global value chain division of labor, industrial transfer has deepened spatial division of labor, resulting in the phenomenon of specialized agglomeration within small regions and diversified agglomeration within large regions. Multinational corporations, in order to maximize profits, will transfer various production links of products to countries with comparative advantages and form close technological, production, and market ties with them. When multinational corporations make investment behaviors, it will drive the upstream and downstream enterprises associated with the industrial chain to invest successively, thereby promoting industrial agglomeration within the region and the formation of cross-regional industrial chain clusters (Selnes, Giesbers, & van den Burg, 2021). This highly specialized division of labor brought about by industrial agglomeration has enhanced the industrial correlation effects within the countries in the agglomeration area. On the other hand, industrial transfer has

promoted industrial agglomeration, and the resulting market proximity effect, cost of living effect, and externality benefits will have a positive feedback effect on industrial transfer and form a circular cumulative causation relationship with industrial agglomeration, further promoting the elevation of industrial agglomeration level (Krugman, 1991). Industrial transfer between China and the countries along the "Belt and Road" not only promotes industrial specialization and diversification but also promotes the formation of industrial agglomeration within specific regions. The continuous improvement of the level of industrial agglomeration will further promote the further transfer of different links within the regional value chain, and the circular cumulative causation relationship brought about by this forward and backward linkage promotes the agglomeration of industries within the region.

Therefore, this study believes that industrial transfer can promote the mutual symbiosis of industries between bilateral countries through pathways and mechanisms such as advancing regional value chain cooperation and enhancing the level of industrial agglomeration. Hence, this paper proposes:

Hypothesis 2: The promotion effect of industrial transfer between China and the countries along the "Belt and Road" on the mutual symbiosis of bilateral industries is mainly achieved through pathways and mechanisms such as advancing regional value chain cooperation and enhancing the level of industrial agglomeration.

The article intends to use a fixed effects model for the regression analysis in arguing the research hypothesis. The advantages of using this method include the following:

1. Control of unobservable heterogeneity: Fixed effects models can control for any individual-specific factors that do not change over time, even if these factors are unobservable. This can reduce omitted variable bias and allow researchers to explore causal relationships at the individual level (Mostafaei, Ghojzadeh, & Hajebrahimi, 2023).
2. Reduction of estimation bias: By eliminating the influence of individual inherent unobservable characteristics, fixed effects models help to reduce estimation bias caused by individual-specific effects (Wang, Zhang, & Ye, 2023). Improve the accuracy of model estimation: Compared to mixed effects models or random effects models, fixed effects models can provide more accurate estimates, especially when individual effects are correlated with explanatory variables.
3. Focus on internal changes: Fixed effects models are particularly suitable for analyzing time series changes within individuals because they focus on the intrinsic dynamics of each individual over time (Freeman & Weidner, 2023).
4. Ease of interpretation and understanding: The results of the model are usually easier to interpret because they represent the internal changes after removing the inter-individual constant heterogeneity (Li et al., 2022).

5. Suitable for testing causal relationships: Fixed effects models are suitable for testing causal relationships at the individual level because they can identify the temporal relationships between variables by controlling for constant individual characteristics (Barry, Oualkacha, & Charpentier, 2023).

Data Description and Model Design

Data Description

Dependent Variable: Construction of Industrial Symbiosis Index

This section establishes the evaluation indicators of bilateral national industrial symbiosis based on the global value chain division system, according to the previous definition of symbiosis, from three dimensions: integration, interaction, and coordination.

1. Integration. This paper starts from the perspective of value-added trade, and believes that the supply and demand of intermediate goods can better reflect the product supply and demand relationship in the definition of integration. Therefore, this paper measure the integration level of bilateral national industries with the input rate and demand rate. The calculation formula for the integration of the same industry between two countries is as follows:

$$IC_{ic,ir} = \frac{(IIR_{ic,ir} + IDR_{ic,ir} + IIR_{ir,ic} + IDR_{ir,ic})}{4}$$

The subscript *i* represents the industry, *c* represents China, and *r* represents the countries along the "Belt and Road". The integration ($IC_{ic,ir}$) of industry *i* in China with industry *i* in country *r* along the "Belt and Road" is calculated as the average value of four indicators:

The input rate of industry *i* in China ($IIR_{ic,ir}$). The calculation formula is as follows:

$$IIR_{ic,ir} = \frac{VAI_{ic,ir}}{ITI_{ir}}$$

In this context, $VAI_{ic,ir}$ represents the value-added input of China's *i* industry to the *i* industry of country *r*, and ITI_{ir} represents the total input of *i* industry in country *r*. $IIR_{ic,ir}$ reflects how much of the total input of *i* industry in country *r* comes from China's *i* industry.

China's *i* industry demand rate ($IDR_{ir,ic}$). The calculation formula is:

$$IDR_{ir,ic} = \frac{VAC_{ir,ic}}{ITO_{ic}}$$

Among them, $VAC_{ir,ic}$ represents the consumption of the added value of country *r*'s industry *i* by China's industry *i*, and ITO_{ic} represents the total output of China's industry *i*. $IDR_{ir,ic}$ reflects how much of the total output of China's industry *i* is consumed by the industry *i* of country *r*.

"The 'Belt and Road' along the country r , industry i investment rate ($IIR_{ir,ic}$). The calculation formula is:

$$IIR_{ir,ic} = \frac{VAI_{ir,ic}}{ITI_{ic}}$$

Among these, $VAI_{ir,ic}$ represents the value-added input from industry i of country r to industry i in China, while ITI_{ic} represents the total input for industry i in China. $IIR_{ir,ic}$ reflects the proportion of the total input for industry i in China that comes from industry i of country r .

"One Belt One Road" along the line of country r and industry i demand rate ($IDR_{ic,ir}$). The calculation formula is:

$$IDR_{ic,ir} = \frac{VAC_{ic,ir}}{ITO_{ir}}$$

Here, $VAC_{ic,ir}$ represents the consumption of the added value of industry i in country r by industry i in China. ITO_{ir} represents the total output of industry i in country r . $IDR_{ic,ir}$ reflects how much of the total output of industry i in country r is consumed by industry i in China.

The aforementioned indicators, ($IIR_{ic,ir}$) and ($IDR_{ir,ic}$) measure the degree of integration of China's i industry into the i industry of the Belt and Road Initiative (BRI) countries r from the perspective of input and demand, respectively. Conversely, ($IIR_{ir,ic}$) and ($IDR_{ic,ir}$) measure the degree of integration of the i industry of BRI countries r into China's i industry from the perspectives of demand and input, respectively.

(2) Interactivity. With the deepening division of labor in the global value chain, the production process of a product involves a vertical trade chain that spans multiple countries, where countries make the entire production process more tightly integrated through the import and export of intermediate goods (Hummels, Ishii, & Yi, 2001). From the perspective of value-added trade, the proportion of foreign value-added contained in a country's exports reflects the level of vertical specialization in production. A higher foreign value-added in export goods indicates close trade links in intermediate goods between countries and a high level of interaction between upstream and downstream industries. Therefore, this paper measures the level of industry interaction between countries based on the proportion of foreign industry value-added in a country's industrial exports. The formula for measuring the interactivity between the same industries of two countries is as follows:

$$Inn_{ic,ir} = \frac{(\theta_{ic,ir} + \theta_{ir,ic})}{2}$$

Here, $Inn_{ic,ir}$ represents the interaction between industry i in China and industry i in country r along the "Belt and Road". $\theta_{ic,ir}$ is the interaction between industry i in China and industry i in country r , and $\theta_{ir,ic}$ is the

interaction between industry i in country r and industry i in China. The specific calculation formula is:

$$\theta_{ic,ir} = \frac{FVA_{ic,ir}}{E_{ic}}$$

$$\theta_{ir,ic} = \frac{FVA_{ir,ic}}{E_{ir}}$$

Here, $(FVA_{ic,ir})$ represents the added value from country r 's industry i in the exports of China's industry i , while (E_{ic}) denotes the total exports of China's industry i . $(FVA_{ir,ic})$ indicates the added value from China's industry i in the exports of country r 's industry i , and (E_{ir}) is the total exports of country r 's industry i .

3 Coordination. The symbiosis theory suggests that the quality parameters characterize the internal features of symbiotic units, while the symbiosis degree reveals the correlation of quality parameter changes among symbiotic units. Thus, the degree of symbiosis can effectively assess the industry's coordination within the region. Based on this, this paper selects the domestic added value of industrial exports as a quality parameter, and uses the symbiosis degree of value-added trade to reflect the coordination between the industries of both countries. The formula for calculating the coordination of the same industry in two countries is as follows:

$$IIH_{ic,ir} = \frac{\left(\frac{1}{|\delta_{ic,ir} - 1|} + \frac{1}{|\delta_{ir,ic} - 1|} \right)}{2}$$

Here, $IIH_{ic,ir}$ represents the coordination between industry i in China and industry i in Belt and Road Initiative (BRI) countries. $\delta_{ic,ir}$ and $\delta_{ir,ic}$ are symbioses depicted by China and country r using quality parameters. According to the theory of symbiosis, when $\delta_{ic,ir} = \delta_{ir,ic} > 0$, the most ideal state of symbiosis is achieved (positive symmetric symbiosis). According to the calculation method of symbiosis and the optimal state of positive symmetric symbiosis, we know that the closer the symbiosis is to 1, the better the bilateral symbiotic state. Therefore, this paper uses the absolute value of the difference between the symbiosis and 1 and measures it through mathematical transformation. The larger the value, the better the coordination. The specific formulas for calculating $\delta_{ic,ir}$ and $\delta_{ir,ic}$ are:

$$\delta_{ic,ir} = \frac{\frac{dVAX_{ic}}{VAX_{ic}}}{\frac{dVAX_{ir}}{VAX_{ir}}}, (dVAX_{ir} \neq 0)$$

$$\delta_{ir,ic} = \frac{\frac{dVAX_{ir}}{VAX_{ir}}}{\frac{dVAX_{ic}}{VAX_{ic}}}, (dVAX_{ic} \neq 0)$$

Among these, VAX_{ic} represents the domestic value-added in exports of industry i from China, while VAX_{ir} represents the domestic value-added in

exports of industry i from country r . The term $\delta_{ic,ir}$ reflects the rate of change in the domestic value-added in exports from industry i in country r (VAX_{ir}) that causes a change in the rate of domestic value-added in exports from industry i in China (VAX_{ic}). Conversely, $\delta_{ir,ic}$ reflects the rate of change in the domestic value-added in exports from industry i in China (VAX_{ic}) that causes a change in the rate of domestic value-added in exports from industry i in country r (VAX_{ir}).

Core Explanatory Variable: Industrial Transfer

Studying the flow of product value under the global value chain model from the perspective of input-output can more clearly distinguish the transfer path and regional attribution of product value, and more reasonably perceive the current situation and trend of international industrial transfer. Therefore, this article considers the change in foreign industry added value caused by domestic final demand as the transfer of domestic industry to foreign countries.

Under the framework of the global value chain, an increase in a country's product output is mainly driven by the following three factors: the growth of domestic final demand, the growth of foreign final demand, and the growth of foreign intermediate demand. For example, consider a global value chain formed by three countries a , b , and d . When country a exports to country b , the transfer of a certain industry in country b to an industry in country a can be divided into three parts: The first part is the added value ($FIN_{ia,b}$) generated by the export of the final product from industry i in country a to country b triggered by the final demand in country b ; The second part is the added value ($INT_{ia,b}$) that is caused by the final demand in country b and is used for the export of the intermediate product from a certain industry in country a to country b to produce the final demand; The third part is the added value ($INTREX_{ia,b}$) that is caused by the final demand in country b , which causes the export of an intermediate product from a certain industry in country a to country b , then by country b to produce an intermediate product exported to country d , and finally, the final product manufactured by country d is exported back to country b and consumed by country b . When country a exports to country d , the transfer of a certain industry in country b to an industry in country a includes two parts: One part is the added value ($INT_{ia,d}$) that is caused by the final demand in country b , which leads to the export of an intermediate product from a certain industry in country a to country d , and then the final product produced by country d is exported back to country b and consumed by country b ; The other part is the added value ($INTREX_{ia,d}$) that is caused by the final demand in country b , which leads to the export of an intermediate product from a certain industry in country a to country d , and then country d is used to produce an intermediate product exported back to country b , and used for the final demand in country b .

Therefore, the industrial transfer from industry *i* in country *b* to country *a* is:

$$T_{ib,a} = FIN_{ia,b} + INT_{ia,b} + INTREX_{ia,b} + INT_{ia,d} + INTREX_{ia,d}$$

Here, *a*, *b*, and *d* represent three different countries, with *i* representing the industry.

Based on this, this paper calculates the total volume of industrial transfer between China and each country along the "Belt and Road" initiative. The specific calculation formula is as follows:

$$ITR_{ic,ir}^t = T_{ic,r} + T_{ir,c}$$

Here, $T_{ic,r}$ represents the amount of industrial transfer from China's industry *i* to the countries *r* along the "Belt and Road", $T_{ir,c}$ indicates the amount of industrial transfer from industry *i* in countries *r* along the "Belt and Road" to China, and $ITR_{ic,ir}^t$ signifies the total bilateral transfer amount between China and the industry *i* in the countries *r* along the "Belt and Road".

Control Variable

This study used multiple control variables, divided into two major categories. The first is the distance variables, which include Political System Distance (POL), Economic Distance (ECO), Cultural Distance (CUL), and Geographic Distance (DIS). The Political System Distance is mainly based on the differences between China and the countries along the "Belt and Road" in terms of rule of law, corruption control, power distribution, regulatory quality, government efficiency, and political stability. The Economic Distance is measured by comparing the difference in GDP per capita between the two countries. The Cultural Distance is calculated based on Hofstede's cultural dimension indices, and the average value of neighboring countries is used to replace the missing data. The Geographic Distance is measured by calculating the distance between the two countries' capitals and factoring in the oil price.

Secondly, other control variables include Global Value Chain Participation Rate (GVC_P), GVC Position Gap (GVC_D), and Revealed Comparative Advantage Gap (RCA_D). The GVC Participation Rate reflects the degree of a country's industry participation in the global value chain, while the GVC Position Gap shows the difference between China and the "Belt and Road" countries in terms of their positions in the industrial value chain. The Revealed Comparative Advantage Gap is used to showcase the difference in industrial competitiveness between the two countries.

In addition, the study also considers whether a Free Trade Agreement (FTA) has been signed as a variable to reflect the economic and trade cooperation relationship between the two countries.

The description of the variables is as follows (Table 1):

Table 1: Description of The Variables.

Variable		Unit	Reference
Dependent variable	Integration	RH	% (Yang, 2022)
	Interactivity	HD	% (Wen & Xian, 2022)
	Coordination	XT	% (Wang, Pan, & Wu, 2023)
Core explanatory variable	Industrial transfer	ITR	- (Bai, Xie, & Zhang, 2024)
Control Variable	Chain Participation Rate	GVC_P	% (Jeong & Shin, 2022)
	GVC Position Gap	GVC_D	- (Doan & Le, 2023)
	Revealed Comparative Advantage Gap	RCA_D	- (Wang, Wang, & Li, 2023)
	Political System Distance	POL	- (Dou et al., 2021)
	Economic Distance	ECO	% (Wang & Han, 2021)
	Cultural Distance	CUL	- (Hulme, 2021)
	Geographic Distance	DIS	KM·\$ (Lu et al., 2022)
	Free Trade Agreement	FTA	- (Jahanger et al., 2022)

Data Source and Processing

This article calculates industry-level indicators such as industrial transfer and industrial symbiosis based on the EORA global input-output data. Given the severe data deficiencies in some countries, this study encompasses a sample of 121 countries along the "Belt and Road" initiative, with the sample period from 2003 to 2021, focusing on the manufacturing industries from C4 to C11. The measurement data for political system distance is sourced from the Worldwide Governance Indicators (WGI) database, for economic distance from the World Bank's World Development Indicators (WDI) database, for cultural distance from Hofstede's data, for geographical distance from the CEPII database, and for free trade agreements from the WTO database. To mitigate the influence of outliers, the article implements a top and bottom 1% winsorization for all continuous variables in the empirical tests. Before starting the data analysis, this study conducted a series of preprocessing and cleaning steps on the raw data to ensure accuracy and stability. First, to reduce the scale effect between different indicators, the initial data were normalized. Referencing the research by He et al. (2019) and Liu et al. (2019), the original data were normalized, which is a common data preprocessing method. By transforming various indicators to the same scale range, normalization eliminates the influence of dimensions on the analysis results and ensures comparability between different indicators. The processed data are then more convenient for subsequent statistical analysis and modeling.

$$X_{ij} = \frac{X_{ij} - \min(X_{ij})}{\max(X_{ij}) - \min(X_{ij})}$$

Model Design

Regarding studies on bilateral trade relations, the existing literature mostly adopts the trade gravity model for analysis (Lypko, 2022; Yotov, 2022). This model posits that economic cooperation between two countries is directly proportional to their economic sizes and inversely proportional to the distance between them. Drawing on the approach of most related studies, this paper applies the logarithmic form of the gravity model to the empirical research and introduces bilateral institutional distance, economic distance, cultural distance, and geographical distance to construct the following baseline regression model:

$$Y_{ic,ir}^t = \alpha_0 + \alpha_1 ITR_{ic,ir}^t + \alpha_2 D_{cr}^t + X_{control} \alpha_3 + c_i + \eta_c + \lambda_t + \varepsilon_{ic,ir}^t$$

Within this, $Y_{ic,ir}^t$ is the mutually beneficial symbiosis index calculated based on value-added trade, representing the reciprocal symbiosis between China's industry i and country r 's industry i in period t , that is, the integration, interaction, and coordination ($IC_{ic,ir}$, $IIn_{ic,ir}$, $IIH_{ic,ir}$). $ITR_{ic,ir}^t$ represents the transfer situation between China's industry i and country r 's industry i in period t ; D_{cr}^t represents the distance variable between China and country r in period t . $X_{control}$ represents a series of other control variables in period t . c_i , η_c , λ_t , $\varepsilon_{ic,ir}^t$ respectively represent industry, country, time fixed effects, and the random error term. Given that the dataset in this article is panel data, the study employs a fixed effects regression method. Fixed effects models can control for individual characteristics that do not change over time, even if those characteristics are unobservable. By using a differencing approach, fixed effects models are able to eliminate individual inherent traits that could lead to endogeneity bias. Compared to Ordinary Least Squares regression (OLS), fixed effects models reduce the bias caused by omitted variables, thus providing a more accurate assessment of causal relationships (Henderson, Soberon, & Rodriguez-Poo, 2022).

Empirical Results

Benchmark Regression

Based on the model set up as described, this paper employs fixed effects to examine the impact of industrial transfers between China and the countries along the "Belt and Road" initiative on reciprocal and symbiotic industry relations. The regression results are presented in Table 2. In models (1)-(3), no control variables were included, and the industrial transfer was directly regressed on the bilateral industries' integration, interaction, and coordination. The results show that industrial transfer has a significant positive impact on the integration, interaction, and coordination between bilateral industries. This indicates that the industrial transfer between China and the countries along the "Belt and Road" has improved the integration, interaction, and coordination among industries, thereby promoting the improvement of reciprocal and symbiotic industry relations. Models (4)-(6) show the regression results with the inclusion of control

variables, and the results also indicate that industrial transfer has a significant positive effect on the integration, interaction, and coordination between bilateral industries.

Table 2: Benchmark Regression.

	(1)	(2)	(3)	(4)	(5)	(6)
	IC	IIn	IIH	IC	IIn	IIH
ITR	0.5985**	0.5288**	0.2297**	0.5939**	0.5307**	0.2364**
	[52.3558]	[38.1958]	[27.4475]	[53.1751]	[40.0476]	[27.7693]
GVC_P				0.0298**	0.0970**	-0.0198**
				[3.7822]	[10.3783]	[-3.2972]
GVC_D				0.0019	0.1201**	0.0095**
				[0.3402]	[17.9477]	[2.2093]
RCA_D				0.2158**	0.1508**	-0.0117
				[20.3406]	[11.9784]	[-1.4483]
POL				0.0350**	-0.0096	-0.0171**
				[3.7008]	[-0.8560]	[-2.3699]
ECO				0.0066	-0.0511**	-0.0023
				[0.7036]	[-4.5636]	[-0.3232]
CUL				-0.1212**	-0.0363	0.0075
				[-1.9998]	[-0.5055]	[0.1633]
DIS				-0.1027**	-0.0651	-0.0388
				[-1.9745]	[-1.0555]	[-0.9783]
FTA				0.0019	0.0018	0.0031
				[0.4247]	[0.3291]	[0.8807]
_cons	0.1536**	-0.0576**	0.1303**	0.1974**	-0.1239**	0.1632**
	[33.4950]	[-10.3735]	[38.8207]	[4.6628]	[-2.4667]	[5.0572]
N	17630	17630	17630	17630	17630	17630
R ²	0.6863	0.6858	0.8996	0.7115	0.7226	0.8999
F	2.70E+03	1.50E+03	753.3648	500.6626	441.7622	88.9084
P	0.000	0.000	0.000	0.000	0.000	0.000
Control Variables	NO	NO	NO	YES	YES	YES
Industry Fixed Effects	YES	YES	YES	YES	YES	YES
Country Fixed Effects	YES	YES	YES	YES	YES	YES
Time Fixed Effects	YES	YES	YES	YES	YES	YES

To mitigate potential issues such as reverse causality and other endogeneity problems, this study further validates the core explanatory variable and control variables by lagging them by one period (Table 3). The results indicate that industrial transfer significantly and positively affects the integration, interaction, and coordination between bilateral industries, which further supports the research findings of this paper. It demonstrates that China's industrial transfer with countries along the "Belt and Road" initiative has promoted the enhancement of mutually beneficial symbiosis between bilateral industries, confirming Hypothesis 1.

Table 3: Mitigate Reverse Causality.

	(7)	(8)	(9)
	IC	IIn	IIH
L.ITR	0.5865*** [49.3424]	0.5319*** [37.2702]	0.2323*** [27.6820]
L.GVC_P	0.0252*** [3.0670]	0.0913*** [9.2547]	-0.0165*** [-2.8481]
L.GVC_D	-0.0021 [-0.3642]	0.1100*** [15.6066]	0.0076* [1.8289]
L.RCA_D	0.1851*** [16.5367]	0.1390*** [10.3462]	-0.0102 [-1.2952]
L.POL	0.0411*** [3.9451]	0.0044 [0.3558]	-0.0118 [-1.6032]
L.ECO	0.0084 [0.8321]	-0.0640*** [-5.2726]	-0.0029 [-0.4037]
L.CUL	-0.0687 [-1.0252]	0.0128 [0.1595]	0.0102 [0.2162]
L.DIS	-0.1243** [-2.2137]	-0.0622 [-0.9231]	-0.0293 [-0.7395]
L.FTA	-0.0004 [-0.0843]	0.0082 [1.2864]	0.0012 [0.3246]
_cons	0.2056*** [4.4205]	-0.1349** [-2.4152]	0.1651*** [5.0281]
N	16610	16610	16610
r2	0.7076	0.7176	0.9132
F	388.6977	345.8244	87.7278
p	0.000	0.000	0.000
Control Variables	YES	YES	YES
Industry Fixed Effects	YES	YES	YES
Country Fixed Effects	YES	YES	YES
Time Fixed Effects	YES	YES	YES

Robustness Test

To ensure the reliability and accuracy of the research findings, the following measures were taken to verify the robustness of the basic regression analysis (Tables 4-1, 4-2):

1. Changing the main explanatory variables. The industry transfer volume ITRic, ir between China and the countries along the "Belt and Road" initiative, in comparison with the global total output, was used to measure industry transfer.
2. Replacing the dependent variables. The integration, interaction, and coordination of a specific industry with all industries of other countries were calculated to replace the original bilateral country-specific industry indicators.
3. Updating the sample data. Using the report published in 2018 by the "Belt and Road" Big Data Center, which mentioned 71 countries along the "Belt and Road" route, and pairing these with the existing 121 countries, a re-analysis was conducted on a selection of 64 countries.

After the above adjustments in the regression analysis, the results showed that whether through changing variables or samples, the industry transfer between China and the countries along the "Belt and Road" initiative has promoted the mutual symbiosis of bilateral industries. This is consistent with the original analysis results, confirming the robustness of the research conclusions.

Table 4.1: Robustness Test.

	(10)	(11)	(12)	(13)	(14)	(15)
	Changing the Main Explanatory Variables			Replacing the Dependent Variables		
	IC	IIn	IIH	RH1	HD1	XT1
ITR1	0.1566***	0.7127***	0.3070***	0.5310***	0.3276***	0.2241***
	[8.6987]	[35.5645]	[23.9316]	[60.8909]	[38.9987]	[25.5890]
GVC_P	0.0929***	0.1342***	-0.0029	0.0632***	0.1731***	-0.0174***
	[11.0868]	[14.3866]	[-0.4813]	[10.2852]	[29.2149]	[-2.8139]
GVC_D	-0.0034	0.1181***	0.0086**	-0.0138***	0.0565***	0.0113**
	[-0.5678]	[17.4952]	[1.9809]	[-3.1253]	[13.3286]	[2.5524]
RCA_D	0.1754***	0.1359***	-0.0187**	0.1942***	0.3908***	-0.0164**
	[15.3967]	[10.7198]	[-2.3056]	[23.4450]	[48.9848]	[-1.9701]
POL	0.0543***	0.0313***	0.0007	0.0261***	0.0064	-0.0188**
	[5.3224]	[2.7514]	[0.0927]	[3.5293]	[0.8965]	[-2.5300]
ECO	0.0159	-0.0542***	-0.0035	0.004	-0.0543***	-0.0009
	[1.5649]	[-4.7982]	[-0.4852]	[0.5488]	[-7.6478]	[-0.1212]
CUL	-0.1154*	-0.0047	0.0212	-0.1301***	-0.0982**	0.006
	[-1.7710]	[-0.0648]	[0.4554]	[-2.7492]	[-2.1544]	[0.1262]
DIS	-0.1330**	-0.0779	-0.0447	-0.1118***	-0.2602***	-0.0401
	[-2.3782]	[-1.2514]	[-1.1224]	[-2.7535]	[-6.6546]	[-0.9843]
FTA	0.0095*	0.0017	0.0032	0.0005	0.0065*	0.0026
	[1.9324]	[0.3144]	[0.9031]	[0.1345]	[1.8748]	[0.7275]
_cons	0.4117***	0.0289	0.2320***	0.4205***	0.1967***	0.1445***
	[9.0844]	[0.5732]	[7.1828]	[12.7206]	[6.1765]	[4.3513]
N	17630	17630	17630	17630	17630	17630
r2	0.6663	0.7176	0.8988	0.7561	0.9083	0.8837
F	169.6161	399.4158	66.8276	716.5384	1.90E+03	76.3004
p	0.000	0.000	0.000	0.000	0.000	0.000
Control Variables	YES	YES	YES	YES	YES	YES
Industry Fixed Effects	YES	YES	YES	YES	YES	YES
Country Fixed Effects	YES	YES	YES	YES	YES	YES
Time Fixed Effects	YES	YES	YES	YES	YES	YES

Table 4.2: Robustness Test.

	(16)	(17)	(18)
	Updating the sample data		
	IC	IIn	IHH
ITR	0.6506***	0.5015***	0.2755***
	[42.4822]	[23.4726]	[22.1141]
GVC_P	0.0877***	0.0971***	-0.0114
	[8.2510]	[6.5489]	[-1.3246]
GVC_D	-0.0117	0.1328***	0.0042
	[-1.4335]	[11.6246]	[0.6325]
RCA_D	0.1622**	0.1675***	-0.0159
	[11.1575]	[8.2565]	[-1.3447]
POL	0.0279**	-0.002	-0.0231**
	[2.1487]	[-0.1095]	[-2.1858]
ECO	0.0201	-0.0062	0.0168
	[1.4176]	[-0.3140]	[1.4509]
CUL	-0.1228	0.2384	0.0107
	[-1.0715]	[1.4908]	[0.1145]
DIS	-0.1726***	-0.0669	-0.0433
	[-3.1499]	[-0.8748]	[-0.9715]
FTA	0.0092*	0.0094	0.004
	[1.7725]	[1.3042]	[0.9503]
_cons	0.1391**	-0.2800***	0.1307***
	[2.2746]	[-3.2816]	[2.6262]
N	9417	9417	9417
r2	0.7164	0.7175	0.8951
F	300.7242	191.4917	57.5081
p	0.000	0.000	0.000
Control Variables	YES	YES	YES
Industry Fixed Effects	YES	YES	YES
Country Fixed Effects	YES	YES	YES
Time Fixed Effects	YES	YES	YES

Endogeneity problem

To further alleviate the endogenous problems existing in bilateral national industrial transfer and industrial symbiosis, this paper attempts to find an instrumental variable that is highly related to industrial transfer but exogenous to industrial symbiosis. This means that the instrumental variable can only affect industrial symbiosis through industrial transfer. In terms of relevance, the labor resources of host countries significantly affect the industrial transfer between bilateral countries, especially promoting labor-intensive industries. In terms of exogeneity, the prerequisite for the formation of bilateral national industrial symbiosis is the need for a carrier for mutual connection between the two countries' industries (i.e., the symbiotic interface). Industrial transfer, as this symbiotic interface, is the foundation for the formation of bilateral industrial symbiosis. The labor force of the host country needs to influence industrial symbiosis

through the industrial transfer, which is this symbiotic interface, without a direct impact on industrial symbiosis itself, thus satisfying the exclusivity constraint of the instrumental variable. The results of the instrumental variable regression are shown in Table 5. From the first-stage regression results in the table, the labor force of the host country significantly promotes the industrial transfer between China and the "Belt and Road" countries. The unidentifiable test LM statistic is 263.67, and the weak instrumental variable test Wald F statistic is 265.38, passing the unidentifiable test and weak instrumental variable test, indicating that the instrumental variable is overall effective. The second-stage regression results show that the impact of industrial transfer on the integration, interaction, and coordination of bilateral industries is significantly positive, overall consistent with the baseline regression results, further confirming that industrial transfer between China and the "Belt and Road" countries has promoted the enhancement of the bilateral national industrial symbiosis level.

Table 5: Endogeneity Problem.

	(19)	(20)	(21)	(22)
	Phase One	Phase Two		
	ITR	IC	IIn	IIH
LF	0.5748*** [16.29]			
ITR		0.4650*** [5.0789]	1.2070*** [10.3472]	0.1434** [2.0514]
GVC_P	0.1085*** [20.68]	0.0464*** [3.6007]	0.0228 [1.3905]	-0.0085 [-0.8666]
GVC_D	-0.0055 [-1.45]	-0.0023 [-0.4054]	0.1261*** [17.2612]	0.0100** [2.2881]
RCA_D	-0.0702*** [-9.80]	0.2075*** [16.1385]	0.2020*** [12.3307]	-0.0214** [-2.1797]
POL	0.0214*** [3.34]	0.0337*** [3.4118]	-0.0287** [-2.2799]	-0.0155** [-2.0594]
ECO	-0.0372*** [-4.89]	0.0392*** [3.3914]	-0.0374** [-2.5396]	0.004 [0.4545]
CUL	0.0143 [0.35]	-0.1266** [-2.0826]	-0.0395 [-0.5096]	0.0068 [0.1465]
DIS	-0.0612* [-1.75]	-0.1097** [-2.0927]	-0.0268 [-0.4015]	-0.0441 [-1.1022]
FTA	0.00676** [2.16]	0.0042 [0.8738]	-0.0084 [-1.3739]	0.0046 [1.2451]
N	17372	17372	17372	17372
F	265.38	186.7983	239.3285	3.9093
LM	263.67			
p	0.000	0.000	0.000	0.0001
Control Variables	YES	YES	YES	YES
Industry Fixed Effects	YES	YES	YES	YES
Country Fixed Effects	YES	YES	YES	YES
Time Fixed Effects	YES	YES	YES	YES

Heterogeneity Analysis

For the numerous countries covered by the "Belt and Road" initiative, including both developed and developing countries, there is a significant difference in their levels of economic development. This discrepancy affects the scale of industrial cooperation and the degree of relatedness between these countries and China. Studying the industrial transfer between China and countries at different levels of economic development is crucial for enhancing the impact of mutually beneficial symbiotic relationships between industries. This study adopts the World Bank's classification method and introduces a variable $D1$ to represent countries at different levels of economic development, categorizing "Belt and Road" participant countries into developed countries ($D1=1$) and developing countries ($D1=0$). By analyzing the heterogeneity of the mutually beneficial symbiosis in industrial transfers among these countries, the study finds that China can promote mutually beneficial symbiosis between industries, whether the transfer is with developing or developed countries. Especially with developing countries, due to China's advantages in manufacturing and infrastructure construction, coupled with the urgent need for manufacturing development in developing countries, this type of industrial transfer is even more significant in enhancing industrial integration between both parties.

1 Regional heterogeneity based on different levels of development. The "Belt and Road" covers more than 100 countries, including developed and developing countries. Due to different actual economic foundations and capacities, there is a considerable difference in the scale and relatedness of industrial cooperation between countries at different levels of economic development and China. Therefore, does the industrial transfer between China and countries along the "Belt and Road" differ in its impact on the mutual symbiosis between the industries of both parties? Researching this issue is beneficial for China to engage in precise cooperation with "Belt and Road" countries and to efficiently improve the industrial symbiosis level of both parties. For this purpose, this paper introduces a dummy variable $D1$ for the economic development level of countries, based on the World Bank's classification standards. It splits the "Belt and Road" country samples into developed and developing countries, with developing countries assigned a value of 0 and developed countries a value of 1. The paper then separately analyzes the heterogeneous impact of industrial transfer on the mutual symbiosis between industries in countries at different levels of development along the route, with regression results shown in Table 6. From the table, it is evident that China's industrial transfer with both developing and developed countries along the "Belt and Road" can promote the enhancement of mutual symbiosis levels between industries of both countries. From the integration perspective seen in column (1) of Table 6, $ITR \times D1$ is significantly negative, indicating that China's industrial transfer with developing countries along the "Belt and Road" has a superior effect on enhancing industry integration compared to developed

countries. This could be due to China's well-established manufacturing sector and strong infrastructure construction capabilities, which provide excellent technical support and high-quality production capacity for the development of manufacturing in developing countries along the route. Additionally, the cost and resource advantages of these developing countries, along with their strong demand for manufacturing development, are more conducive to the integrated development of industries during the industrial transfer process. From the interaction and coordination perspectives seen in columns (2) and (3) of Table 6, $ITR \times D1$ is significantly positive, indicating that the effect of China's industrial transfer with developed countries on enhancing industry interaction and coordination is stronger compared to developing countries. This could be because developed countries have a better investment environment, infrastructure, and relatively more comprehensive legal systems, which are more favorable for interactive and coordinated industrial development during the industrial transfer process between the two countries.

Table 6: Heterogeneity 1.

	(23)	(24)	(25)
	IC	IIn	IIH
ITR	0.5999***	0.4991***	0.2227***
	[52.8652]	[37.2444]	[25.7957]
ITR × D1	-0.0433***	0.2266***	0.0985***
	[-2.9775]	[13.2089]	[8.9107]
GVC_P	0.0295***	0.0984***	-0.0192***
	[3.7490]	[10.5790]	[-3.2031]
GVC_D	0.0015	0.1224***	0.0105**
	[0.2617]	[18.3786]	[2.4485]
RCA_D	0.2158***	0.1507***	-0.0117
	[20.3456]	[12.0356]	[-1.4530]
POL	0.0317***	0.0077	-0.0096
	[3.3307]	[0.6801]	[-1.3239]
ECO	0.0056	-0.0455***	0.0001
	[0.5903]	[-4.0821]	[0.0141]
CUL	-0.1203**	-0.0407	0.0056
	[-1.9865]	[-0.5689]	[0.1226]
DIS	-0.1050**	-0.0532	-0.0336
	[-2.0186]	[-0.8659]	[-0.8490]
FTA	0.002	0.0015	0.003
	[0.4357]	[0.2823]	[0.8500]
_cons	0.2016***	-0.1459***	0.1536***
	[4.7606]	[-2.9183]	[4.7683]
N	17630	17630	17630
r2	0.7117	0.7254	0.9003
F	451.6857	418.9804	88.3167
p	0.000	0.000	0.000
Control Variables	YES	YES	YES
Industry Fixed Effects	YES	YES	YES
Country Fixed Effects	YES	YES	YES
Time Fixed Effects	YES	YES	YES

2 Industry heterogeneity based on different technological classification standards. The industrialization processes of countries along the "Belt and Road" differ from one another, and the capabilities and technological levels of their manufacturing industries vary as well, resulting in differences in manufacturing technology levels between countries. This affects the patterns and extent of industrial cooperation between them. Some countries utilize their traditional strengths to closely cooperate with China in low-tech fields, while others, due to the need for developing mid-to-high-tech industries, have stronger ties with China's high-tech industries. Hence, will the industrial transfer between China and the Belt and Road countries at different technological levels have varying impacts on the mutual beneficial relationship of their manufacturing industries? For this purpose, this paper introduces an industrial dummy variable D2 based on the OECD classification standard, dividing the manufacturing industry into low-tech and mid-to-high-tech industries. It analyzes the impact of industrial transfer on the win-win cooperation of different manufacturing industries. Here, low-tech industries are assigned a value of 0 and mid-to-high-tech industries a value of 1. The regression results are presented in Table 7. From the table, it can be seen that industrial transfers, whether in low-tech or mid-to-high-tech sectors, can promote the level of mutually beneficial cooperation between industries of both countries. Looking at the integration from column (1) of Table 7, $ITR \times D2$ is significantly negative, indicating that industrial transfers in low-tech industries are more conducive to the integrated development of industries on both sides. The possible reason is that barriers and thresholds between low-tech industries are relatively lower, making it easier to realize the integrated development of low-tech industries during the transfer process. From columns (2) and (3) of Table 7, regarding interaction and coordination, $ITR \times D2$ is significantly positive. This indicates that industrial transfers have a stronger effect on enhancing the interaction and coordination among mid-to-high-tech industries compared to low-tech ones. A possible reason is that China's mid-to-high-tech industries have a certain technological advantage in countries along the Belt and Road. The transfer of mid-to-high-tech industries can not only promote the upgrading of domestic mid-to-high-tech industries, but also drive the coordinated development of mid-to-high-tech industries in the countries along the route. This is beneficial for enhancing the degree of interaction and linkage between mid-to-high-tech industries of both sides, and therefore, the effect of industrial transfer on enhancing the interaction and coordination of mid-to-high-tech industries is relatively good.

Table 7: Heterogeneity 2.

	(26)	(27)	(28)
	IC	IIn	IIH
ITR	0.6231***	0.4918***	0.1249***
	[51.5756]	[34.3198]	[13.9502]
ITR × D2	-0.0364***	0.0485***	0.1391***
	[-6.3006]	[7.0689]	[32.4488]
GVC_P	0.0330***	0.0927***	-0.0322***
	[4.1908]	[9.9078]	[-5.5119]
GVC_D	0.0003	0.1223***	0.0158***
	[0.0468]	[18.2825]	[3.7836]
RCA_D	0.2184***	0.1473***	-0.0217***
	[20.5935]	[11.7101]	[-2.7567]
POL	0.0342***	-0.0085	-0.0140**
	[3.6173]	[-0.7592]	[-1.9905]
ECO	0.0067	-0.0512***	-0.0026
	[0.7132]	[-4.5799]	[-0.3784]
CUL	-0.1224**	-0.0348	0.0121
	[-2.0216]	[-0.4842]	[0.2691]
DIS	-0.0995*	-0.0693	-0.0508
	[-1.9160]	[-1.1249]	[-1.3194]
FTA	0.0017	0.0021	0.0038
	[0.3813]	[0.3787]	[1.1326]
_cons	0.1912***	-0.1157**	0.1867***
	[4.5210]	[-2.3060]	[5.9559]
N	17630	17630	17630
r2	0.7122	0.7234	0.9056
F	455.5639	403.697	190.1267
p	0	0	0
Control Variables	YES	YES	YES
Industry Fixed Effects	YES	YES	YES
Country Fixed Effects	YES	YES	YES
Time Fixed Effects	YES	YES	YES

3 Consider the temporal difference before and after the implementation of the "Belt and Road" initiative. In 2013, China proposed the "Belt and Road" initiative and subsequently, relevant national departments introduced multiple preferential policies and measures to promote industrial cooperation between China and countries along the "Belt and Road" routes. The aim was to establish a partnership of shared interests, destiny, and responsibilities, which means that industrial cooperation between the countries involved has entered a new stage. Thus, after the implementation of the initiative, will the industrial transfer between China and the countries along the "Belt and Road" have a greater impact on the symbiotic benefits of industries on both sides? To explore this question, this paper uses the year 2013 as a boundary, introducing a time dummy variable D3, setting the value to 0 for years up to and including 2013, and to 1 for years after 2013. The regression results are shown in Table 8. As can be seen from Table 8,

whether before or after the implementation of the initiative, industrial transfers between the parties help to improve the level of symbiotic benefit in the industries of both countries. Additionally, whether it is in terms of coordination, interaction, or integration, $\ln ITR \times D3$ is significantly positive, indicating that after the implementation of the "Belt and Road" initiative, industrial transfer has a more obvious promoting effect on the symbiotic benefit between the industries of the participating countries. A possible reason is that, after the implementation of the initiative, China has intensified its efforts in policy coordination, facility connectivity, unimpeded trade, financial integration, and strengthening people-to-people bonds with the countries along the route, creating better cooperative conditions for the industries of both sides. Therefore, after the implementation of the "Belt and Road" initiative, industrial transfer is more conducive to the symbiotic development of industries between the partner countries.

Table 8: Heterogeneity 3.

	(30)	(31)	(32)
	IC	Iln	IIH
ITR	0.5873***	0.4305***	0.1640***
	[50.1919]	[31.5362]	[18.7857]
g2	0.0117*	0.1782***	0.1288***
	[1.8817]	[24.5827]	[27.7862]
GVC_P	0.0298***	0.0975***	-0.0194***
	[3.7869]	[10.6128]	[-3.3048]
GVC_D	0.0014	0.1115***	0.0033
	[0.2402]	[16.9282]	[0.7838]
RCA_D	0.2180***	0.1850***	0.0131
	[20.4248]	[14.8591]	[1.6404]
POL	0.0381***	0.0366***	0.0163**
	[3.9644]	[3.2668]	[2.2755]
ECO	0.0062	-0.0584***	-0.0076
	[0.6524]	[-5.3056]	[-1.0825]
CUL	-0.1218**	-0.0464	0.0003
	[-2.0108]	[-0.6559]	[0.0066]
DIS	-0.1076**	-0.1396**	-0.0926**
	[-2.0660]	[-2.2980]	[-2.3839]
FTA	0.0016	-0.0028	-0.0002
	[0.3592]	[-0.5175]	[-0.0637]
_cons	0.1999***	-0.0856*	0.1909***
	[4.7201]	[-1.7326]	[6.0410]
N	17630	17630	17630
r2	0.7116	0.7319	0.9041
F	451.016	471.7434	160.7557
p	0	0	0
Control Variables	YES	YES	YES
Industry Fixed Effects	YES	YES	YES
Country Fixed Effects	YES	YES	YES
Time Fixed Effects	YES	YES	YES

Mechanism Inspection

Mechanism analysis suggests that industrial relocation from China to countries along the "Belt and Road" can facilitate the enhancement of bilateral symbiosis through channels and mechanisms such as advancing regional value chain cooperation and improving industrial agglomeration levels. To this end, this paper introduces regional value chain cooperation and industrial agglomeration as mediating variables for examination, in order to better understand the intrinsic logic behind the impact of China's industrial relocation to "Belt and Road" countries on industrial symbiosis. The mediating effect model is as follows:

$$M_{ic,ir}^t = \beta_0 + \beta_1 ITR_{ic,ir}^t + \beta_2 D_{cr}^t + X_{control} \beta_3 + c_i + \eta_c + \lambda_t + \varepsilon_{ic,ir}^t$$

$$M_{ic,ir}^t = \gamma_0 + \gamma_1 ITR_{ic,ir}^t + \gamma_2 D_{cr}^t + \gamma_3 M_{ic,ir}^t + X_{control} \gamma_4 + c_i + \eta_c + \lambda_t + \varepsilon_{ic,ir}^t$$

In this, $M_{ic,ir}^t$ is the intermediary variable, which is the proxy variable of the degree of regional value chain cooperation and industrial agglomeration level. The meanings of other symbols are consistent with the previous text. If β_1 , γ_3 and γ_1 have the same sign, it indicates that $M_{ic,ir}^t$ has an intermediary effect in the impact of industrial transfer on industrial mutual benefit and symbiosis. Otherwise, there is a "masking" effect. Among them, Industrial Concentration (INC) refers to prior literature, using the sum of the annual added value of industry i in China and all countries as a percentage of the global added value of industry i as a measure. The degree of Regional Value Chain Cooperation (RVC) refers to Wang et al. (2021), which is defined as:

$$RVC_{ic,ir} = \frac{VAR_{ic,ir} + VAR_{ir,ic}}{EXP_{ic} + EXP_{ir}}$$

Here, $VAR_{ic,ir}$ represents the added value of country r 's industry i in the exports of industry i in China, $VAR_{ir,ic}$ represents the added value of China's industry i in the exports of industry i in country r , EXP_{ic} represents the total exports of industry i in China, and EXP_{ir} represents the total exports of industry i in country r .

The mediating effect of regional value chain cooperation. From column (1) of Table 8, it can be seen that the regression coefficient of industrial transfer (ITR) is significantly positive at the 1% level, indicating that industrial transfer from China to the "Belt and Road" countries significantly promotes regional value chain cooperation. Column (2) of Table 9 shows that regional value chain cooperation has a significant negative effect on integration, while industrial transfer has a significant positive effect on integration, suggesting that there is a "masking" effect of regional value chain cooperation on the impact of industrial transfer from China to the "Belt and Road" countries on the bilateral industry integration. The possible reason is the imbalance in industrial development between China and the "Belt and Road" countries, along with the differences in industrial development stages, which has resulted in differences in industrial undertaking capabilities and significant divergences in industrial structures among the countries along the route. This has led to issues such as weak industrial compatibility and a fragile industry

support system in the process of regional value chain cooperation, greatly undermining the integration between the bilateral industries, thus presenting a certain "masking" effect in the regression results. Therefore, this paper further conducts regression tests using "Belt and Road" countries with industrial development stages similar to China as samples. The results show that industrial transfer between China and the "Belt and Road" countries can enhance the integration between bilateral industries through promoting regional value chain cooperation. In addition, the results in Columns (3) and (4) of Table 9 show that regional value chain cooperation has a significant positive impact on both interaction and coordination. Meanwhile, the regression coefficients of industrial transfer on interaction and coordination are also significantly positive and lower than the corresponding coefficients in Columns (5) and (6) of Table 2. This indicates that industrial transfer between China and the "Belt and Road" countries can enhance the interaction and coordination between bilateral industries through the avenue and mechanism of promoting regional value chain cooperation. Accordingly, the mediating mechanism of regional value chain cooperation proposed in Hypothesis 2 is validated.

Table 9: Mechanism 1.

	(33)	(34)	(35)	(36)
	RVC	IC	Iln	IIH
ITR	0.0918***	0.6368***	0.4486***	0.1753***
	[30.3003]	[56.0240]	[33.7055]	[20.6539]
RVC		-0.4670***	0.8944***	0.6659***
		[-16.8886]	[27.6247]	[32.2573]
GVC_P	0.0121***	0.0355***	0.0861***	-0.0279***
	[5.6764]	[4.5339]	[9.4073]	[-4.7746]
GVC_D	-0.0018	0.0011	0.1217***	0.0107**
	[-1.1780]	[0.1925]	[18.5803]	[2.5615]
RCA_D	0.0112***	0.2210***	0.1408***	-0.0191**
	[3.8768]	[20.9916]	[11.4218]	[-2.4357]
POL	-0.0165***	0.0273***	0.0052	-0.0061
	[-6.4304]	[2.9058]	[0.4688]	[-0.8692]
ECO	-0.0013	0.006	-0.0499***	-0.0014
	[-0.5133]	[0.6437]	[-4.5547]	[-0.2075]
CUL	-0.013	-0.1273**	-0.0247	0.0162
	[-0.7932]	[-2.1173]	[-0.3506]	[0.3616]
DIS	-0.0224	-0.1132**	-0.045	-0.0238
	[-1.5904]	[-2.1935]	[-0.7459]	[-0.6189]
FTA	-0.0001	0.0019	0.0019	0.0032
	[-0.1028]	[0.4150]	[0.3576]	[0.9316]
_cons	-0.0065	0.1944***	-0.1181**	0.1675***
	[-0.5621]	[4.6287]	[-2.4024]	[5.3425]
N	17630	17630	17630	17630
r2	0.6717	0.7162	0.7342	0.9055
F	133.0235	486.4475	491.2376	188.831
p	0.000	0.000	0.000	0.000
Control Variables	YES	YES	YES	YES
Industry Fixed Effects	YES	YES	YES	YES
Country Fixed Effects	YES	YES	YES	YES
Time Fixed Effects	YES	YES	YES	YES

Table 10: Mechanism 2.

	(37)	(38)	(39)	(40)
	INC	IC	IIn	IIH
ITR	1.7138***	0.5673***	0.4798***	0.1596***
	[20.5855]	[50.5272]	[36.4125]	[20.6070]
INC		0.0155***	0.0297***	0.0448***
		[15.3897]	[25.1197]	[64.4724]
GVC_P	-0.6438***	0.0398***	0.1161***	0.0091*
	[-10.9656]	[5.0669]	[12.6041]	[1.6740]
GVC_D	-0.1042**	0.0035	0.1232***	0.0142***
	[-2.4802]	[0.6311]	[18.7363]	[3.6670]
RCA_D	0.7205***	0.2046***	0.1293***	-0.0440***
	[9.1122]	[19.3706]	[10.4361]	[-6.0412]
POL	0.012	0.0349***	-0.01	-0.0176***
	[0.1693]	[3.7060]	[-0.9035]	[-2.7192]
ECO	0.0237	0.0063	-0.0518***	-0.0034
	[0.3366]	[0.6691]	[-4.7091]	[-0.5238]
CUL	0.1947	-0.1242**	-0.0421	-0.0012
	[0.4310]	[-2.0635]	[-0.5964]	[-0.0285]
DIS	0.9614**	-0.1176**	-0.0937	-0.0819**
	[2.4803]	[-2.2761]	[-1.5454]	[-2.2977]
FTA	-0.0101	0.0021	0.0021	0.0035
	[-0.2960]	[0.4620]	[0.3912]	[1.1242]
_cons	7.2886***	0.0843**	-0.3405***	-0.1635***
	[23.0964]	[1.9754]	[-6.7966]	[-5.5538]
N	17630	17630	17630	17630
r ²	0.979	0.7154	0.7323	0.9191
F	55.9657	480.3618	475.0196	514.7153
p	0.000	0.000	0.000	0.000
Control Variables	YES	YES	YES	YES
Industry Fixed Effects	YES	YES	YES	YES
Country Fixed Effects	YES	YES	YES	YES
Time Fixed Effects	YES	YES	YES	YES

The Mediating Effect of Industrial Agglomeration. As can be seen from column (1) of Table 10, the regression coefficient of industrial transfer is significantly positive at the 1% level, indicating that the industrial transfer between China and countries along the "Belt and Road" significantly enhances the level of industrial agglomeration in the bilateral countries. The regression results in columns (2) to (4) of Table 10 show that, whether the explained variable is integration, interaction, or coordination, the impact of industrial agglomeration on all three is significantly positive. At the same time, the regression coefficients of industrial transfer on integration, interaction, and coordination are all significantly positive and smaller than the corresponding coefficients in columns (4) to (6) of Table 1, indicating that industrial transfer between China and countries along the "Belt and Road" can promote the interaction, integration, and coordination between bilateral industries by enhancing the level of bilateral industrial agglomeration. That is, industrial agglomeration plays a mediating role in the process of promoting symbiotic benefits between bilateral industries in the industrial transfer between China and "Belt and Road" countries. Thus, the mediating mechanism of industrial agglomeration proposed in Hypothesis 2 is verified.

Conclusion

This article combines symbiosis theory with global value chain theory to analyze the mutually beneficial symbiotic effects of industrial transfer between China and the "Belt and Road" countries from three aspects: integration, interaction, and coordination. It explores the theoretical logic of how industrial transfer promotes mutual symbiosis and uses EORA global input-output data from 2003 to 2021 to measure the level of industrial mutual symbiosis between China and the "Belt and Road" countries, conducting empirical tests. The study finds:

1. The level of mutual symbiosis of the manufacturing industry between China and the "Belt and Road" countries has gradually increased, but there are differences between various sub-sectors and regional blocks. The mutual symbiosis levels are higher in market-oriented electrical and mechanical industries as well as labor cost-oriented textiles and apparel industries, and the level of industrial mutual symbiosis between China and neighboring East Asian and Southeast Asian countries is relatively high.
2. The theoretical hypothesis that industrial transfer between China and the "Belt and Road" countries can promote bilateral industrial mutual symbiosis is well supported by econometric testing. The mutually beneficial symbiotic effects of China's industrial transfer with the "Belt and Road" are mainly realized through promoting regional value chain cooperation and enhancing industrial agglomeration levels. However, due to the imbalances in industrial development and differences in industrial development stages between China and the countries along the route, there are differences in the mediating effects of regional value chain cooperation.
3. The mutually beneficial symbiotic effects of industrial transfer between China and the "Belt and Road" countries have regional, industrial, and temporal heterogeneity. Industrial transfer between China and developed "Belt and Road" countries and in medium and high-tech industries have a better effect on enhancing bilateral industrial interaction and coordination. At the same time, the proposal of the "Belt and Road" initiative is more conducive to enhancing the integration, interaction, and coordination of bilateral industries through industrial transfer, with obvious policy effects.

Mutual symbiosis is the driving force behind industrial transfer between China and the "Belt and Road" countries, and this paper demonstrates the mutually beneficial symbiotic effects of "Belt and Road" industrial transfer from both theoretical and empirical perspectives, responding to the narrow political conjectures of some countries. The research conclusions of this article have important policy implications for how to orderly promote industrial transfer between China and the "Belt and Road" countries and to accelerate the high-quality construction of the "Belt and Road."

1. Promote the interaction and mutual promotion of upstream and downstream industries, and enhance the integration, interaction, and coordination of transferred industries bilaterally. Key measures include:

- I. Optimize the bilateral and multilateral free trade network between China and the "Belt and Road" countries, improve the trade facilitation mechanism, advance the construction and upgrade of regional free trade zones, enhance the level of investment liberalization and facilitation under the framework of free trade zones, and create a high-quality service platform for the integrated development of bilateral industries.
 - II. Promote interactive and mutually beneficial cooperation between China and the "Belt and Road" countries in upstream and downstream industries, further strengthen bilateral cultural exchanges, political communication, and infrastructure connectivity, establish and improve regional investment promotion and protection mechanisms, strengthen policy coordination with the "Belt and Road" countries, and create a favorable external environment for the interactive development of bilateral industries.
 - III. Encourage China's advantageous industries to "go global," utilize the domestic big cycle, connect the international big cycle with the "Belt and Road" as the hub, build a multi-level regional industrial division system along the "Belt and Road" countries, form a closely cooperative industrial division and collaboration relationship, and provide strong support for the coordinated development of upstream and downstream industries within the region.
2. Focus on the orderly promotion of transferred industries in a step-by-step manner, and continuously deepen bilateral and multilateral industrial cooperation with the countries along the route. Key measures include:
 - I. From the perspective of industry selection, prioritize cooperation with the "Belt and Road" countries in the electrical and mechanical industries and textiles and apparel industries, where the symbiotic relationship is relatively high, fully utilize the large market scale and abundant labor resources of the "Belt and Road" countries, accelerate the transfer of market-oriented and labor cost-oriented industries, and at the same time, pay attention to bilateral and multilateral cooperation in medium and high-tech industries, and through the exchange of technology and management experience, achieve the common development of medium and high-tech industries along the "Belt and Road."
 - II. From the perspective of location selection, continue to strengthen industrial cooperation with East Asia and Southeast Asia, and based on cooperation with East Asia and Southeast Asia and other "Belt and Road" countries, promote China's multi-level and multi-field industrial cooperation with other countries along the route in a regional and stepwise manner.
 3. Guide cross-regional integration and localization agglomeration of transferred industries, and build a mutually beneficial industry chain and supply chain cooperation system. Key measures include:

- I. Orderly promote the expansion and extension of China's leading industries and core enterprises' industry chains to the "Belt and Road" countries, actively carry out various cooperation models in the fields of capital, technology, brand, and channels, and jointly build a regional value chain cooperation system that fits the development of the "Belt and Road."
- II. Continue to improve the service system of overseas investment institutions and cooperation parks, accelerate the construction of high-quality and high-standard integrated regional industrial cooperation, promote industrial transfer between China and the "Belt and Road" countries through the construction of international cooperation parks, and enhance the level of industrial agglomeration of the "Belt and Road."
- III. Actively promote the construction of the industrial chain supporting system between China and the "Belt and Road" countries, encourage the upstream and downstream enterprises of advantageous capacity industries to relocate in groups, improve trade facilitation mechanisms, security guarantee mechanisms, financing support mechanisms, etc., and help the regional industrial cluster development of the "Belt and Road."

This study has relevance for government policy research, corporate business strategies, and multilateral cooperation.

Policy Impact

Governments can foster specific sub-sectors and industries with high levels of mutual symbiosis, such as electrical, mechanical, textiles, and clothing, by enacting more favorable trade policies or investing in infrastructure to further promote trade and investment in these areas. Recognizing the differences in regional symbiosis can shape corresponding policies and strengthen regional cooperation with East Asian and Southeast Asian nations, where the levels of symbiosis are relatively high.

The findings of this study can also influence the strategic direction of the Belt and Road Initiative (BRI), encouraging a focus on industry sectors and regions with potential for enhanced symbiosis.

Business Strategy Development

Manufacturers can use the conclusions of this study to deeply investigate strategic investment opportunities in Belt and Road countries, with a focus on regions and industries with a high degree of symbiosis.

When planning to outsource or relocate production facilities to Belt and Road countries, companies can also consider symbiotic relationships.

Understanding of regional value chain cooperation and the level of industrial clustering can influence decisions related to supply chain management and the establishment of joint ventures or alliances with local enterprises in Belt and Road countries.

Industrial Transfer and Multilateral Cooperation

The results of this study support the notion that industrial transfer can be a tool to promote multilateral cooperation. This can lead to collaboration in policy-making, infrastructure development, and standard-setting to facilitate smooth industrial transfer and strengthen bilateral industrial win-win situations. This research can provide a framework for assessing the potential of industrial parks or special economic zones, which can be established in strategic locations to promote industrial clustering and value chain integration.

This study also has some limitations. Due to the constraints of length, this paper only investigates some of the mechanisms through which mutual benefits can be achieved in industrial relocation among the countries along the "Belt and Road" initiative. Future researchers can build upon this work to explore additional operative mechanisms.

Declaration of No Conflict of Interest

I declare that there is no conflict of interest in this article.

Data Declaration

I declare that I will abide by the open data policy of Journal, will store data exclusively, and will make data and materials freely available as needed.

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