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The Impact of China's Belt and Road Initiative on the Value Chain Division of Labor Position (GVCP) in Participating Countries

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Abstract

Background and Aim: This study examines the impact of the Belt and Road Initiative (BRI) on the value chain division of labor in participating countries. Through this study, we aim to objectively assess whether the Belt and Road Initiative can promote "inclusive economic growth" and make the division of labor in the value chain more equitable. Additionally, we provide policy recommendations to enhance the effectiveness of the BRI and offer new perspectives and insights for understanding changes in the global economic landscape.

Materials and Methods: This paper primarily uses the DID model and panel regression model as statistical tools. The core of the DID model lies in using two "differences" to estimate the effect of an intervention. In this paper, participation in the co-construction of the Belt and Road Initiative serves as the key policy variable in the DID model. This difference has a significant impact on the degree of value chain participation. Given the relationship between the two and the suitability of the DID model, this paper adopts the DID model as a statistical tool. When estimating the DID model, the panel regression model is employed. This model can more accurately estimate the relationships between variables, control for individual and time-fixed effects, reduce estimation errors, and improve model accuracy. This study obtains panel data from the World Bank database for 45 Belt and Road countries from 2009 to 2022, resulting in a total of 840 samples for analysis.

Results: Through data analysis and interpretation within the framework of the "smile curve," this study finds that the Belt and Road Initiative has a significant positive impact on the value chain position of Central and Eastern European countries, Southwestern and Northern European countries, moderately and less industrialized countries, low-GDP countries. However, it has no significant impact or even a suppressive effect on Southeast Asian countries, highly industrialized

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countries, middle- and high-GDP countries. This may be because these countries have already occupied high-value positions in the global value chain.

Conclusion: Since China proposed the Belt and Road Initiative (BRI) in 2013, this grand vision has not only profoundly reshaped China's opening-up landscape but also created unprecedented development opportunities for participating countries. Countries that have joined the BRI have generally experienced an improvement in their position within the global value chain. This conclusion is supported by data from multiple dimensions, including increased trade flows, expanded foreign investment inflows, deepened technological cooperation, and enhanced infrastructure connectivity. These changes have not only facilitated the optimization and upgrading of participating countries' industrial structures but also strengthened their integration into the global value chain and increased their influence, promoting a fair advancement of the value chain.

Keywords: Belt and Road Initiative (BRI); Global Value Chain (GVC); Difference-in-Differences (DID) Model; Economic Integration; Industrial Upgrading

Introduction

Since the 1980s, globalization has played a crucial role in shaping international economic relations. It has not only facilitated increasingly close economic ties and interdependence among nations but also accelerated economic activities such as international trade, investment flows, and technology diffusion. In this process, the division of labor within the global value chain (GVC) has gradually taken shape, allowing various stages of production—including product design, raw material supply, intermediate goods production, final assembly, sales, and recycling—to be distributed globally. This has significantly improved production efficiency and optimized resource allocation. However, the development of global value chains has also exacerbated the North-South divide, with developed countries occupying high-value-added segments while developing countries are primarily engaged in low-value-added processing and manufacturing.

To systematically understand the division of labor within global value chains, the governance structure and upgrading theory proposed by Gereffi et al (2005) provides a crucial analytical framework. They identified three primary governance structures in global value chains: modular, relational, and hierarchical. These governance modes determine how value is distributed among participants in the chain, thereby influencing the allocation of economic benefits among countries. Additionally, value chain upgrading refers to the process by which nations or enterprises move from lower to higher value-added activities by acquiring technological capabilities, improving product quality, and enhancing market access. For developing countries, a key challenge in the global economic system is transitioning from simple manufacturing and

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assembly to high-end activities such as brand management, research and development, and technological innovation.

Although global value chains have created economic growth and employment opportunities for developing countries, asymmetric governance structures have led many nations and firms to remain locked in low-value-added segments, making substantial upgrading difficult. Meanwhile, developed countries and multinational corporations dominate high-end value chains, capturing most of the value-added benefits. This uneven distribution of gains not only limits the ability of developing nations to enhance their position in global value chains but also hinders the sustainable development of the global economy. As a result, the concept of inclusive economic growth has gained increasing attention. Inclusive economic growth emphasizes that economic benefits should be widely shared across all social groups, ensuring that all participants have fair opportunities and returns from economic activities. This concept calls for fairer and more sustainable governance of global value chains to promote a more balanced and mutually beneficial development trajectory.

The Belt and Road Initiative (BRI) offers new possibilities for optimizing the structure of global value chains. Proposed by Chinese President Xi Jinping in 2013, the initiative aims to foster regional economic cooperation and achieve mutually beneficial development. Through infrastructure development, trade cooperation, and investment facilitation, the BRI has spurred economic growth in participating countries and strengthened their integration into global value chains. Theoretically, the BRI facilitates global value chain upgrading by promoting economic integration, enhancing regional connectivity, and prioritizing infrastructure-led development. For instance, improvements in infrastructure investment help reduce transaction costs, enhance trade efficiency, and foster regional economic collaboration, thereby supporting the optimization of industrial structures and the elevation of value chain positions in participating nations.

However, existing research on the impact of the BRI on global value chains remains limited, particularly regarding the heterogeneous effects on different countries and industries. Therefore, this study will explore how the BRI influences the division of labor within global value chains, with a focus on whether participation in the initiative helps nations advance their position in the value chain. It will also examine the challenges and opportunities faced by different economies in this process. By filling gaps in the existing literature, this research aims to provide policymakers with a more comprehensive reference framework to foster inclusive and sustainable global economic development.

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Objectives

(1) To study the influence of China's "Belt and Road Initiative" on the division of labor position in the value chain of the countries along the routes.

(2) To analyze the effect of the Belt and Road Initiative (BRI) of China on economic development and industrial upgrading in countries along the route.

(3) To provide useful policy recommendations for the development of China's Belt and Road Initiative and for enhancing the value chain division status of countries along the route.

Literature review

1. Theoretical Background of the Belt and Road Initiative and Global Value Chain Division

Since the introduction of the BRI, scholars have examined its role in global governance, economic cooperation, and value chain restructuring from multiple perspectives. From a cultural standpoint, Callahan (2016) argues that the BRI embodies Chinese cultural characteristics, helping to address global deficits in peace and trust. In contrast, Misigile (2016) believes that the initiative carries utilitarian elements of political ideology expansion, reflecting international value differences. Additionally, from a global governance perspective, Willy (2015) posits that the BRI facilitates a shift from state-centrism to a community of shared future for mankind, promoting a more balanced global development model.

In global value chain research, Gereffi et al. (2005) proposed theories on value chain upgrading and governance structures, emphasizing the impact of value chain distribution on economic growth in developing countries. However, while the formation of global value chains presents development opportunities, it also leads to unequal divisions of labor—some countries remain locked in low-value-added segments, while developed nations and multinational corporations dominate high-value-added segments. This unbalanced division structure hinders inclusive growth and is a key issue the BRI seeks to address.

2. The Impact of the Belt and Road Initiative on Global Value Chain Division

Existing research presents mixed views on whether the BRI can enhance global value chain participation and upgrading. Some scholars argue that the initiative provides new economic growth opportunities for participating countries. For example, Hoffman (2013) highlights that the BRI inherits the cultural spirit of the ancient Silk Road and contributes to global economic integration. Linda (2016) asserts that China integrates regional resources through the BRI to enhance regional cooperation and coordinated development. However, skeptics argue that the initiative is overly idealistic, with real-world challenges such as resource allocation disparities and geopolitical complexities potentially hindering its smooth implementation.

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The impact of the BRI on economic growth and value chain positioning in participating countries has sparked broad discussions. Reisen (2017) notes that Russia's shift from initial skepticism to gradual support illustrates the BRI's effectiveness in fostering economic connectivity across Eurasia. Similarly, Hussainf (2017) finds that the initiative promotes regional cooperation, integrating participating countries into global industrial chains while advancing collaboration in technology, environmental protection, and other sectors. Additionally, Yoshikaws (2016) observes that African nations express strong support for the BRI, seeking economic development through its cooperative framework.

However, there are limitations in measuring global value chain positioning. While Hummels (2001) introduced the vertical specialization (VS) indicator as a measurement standard, its assumptions are overly stringent. Koopman et al. (2010) proposed the Global Value Chain Position Index (GVC-Position), improving measurement methodologies to assess a country's placement within the global value chain. Furthermore, Wang et al. (2013) refined these measurements using international input-output tables, offering more precise analytical tools for subsequent research.

3. The Relationship Between the Belt and Road Initiative and Global Value Chain Upgrading in Participating Countries

Scholars generally agree that the BRI promotes value chain upgrading and fosters global economic integration. Zhang Lijuan et al. (2016) suggest that the initiative facilitates international industrial transfers and advances China's domestic industrial restructuring. Sun Hui and Liu Yuanyuan (2016) observe a "flying geese" development pattern along BRI corridors, with China serving as the leading country guiding others toward value chain upgrading. Additionally, Wang Shuli and Wu Chuhao (2018) find that since the BRI's introduction in 2013, participating countries have experienced varying degrees of improvement in their global value chain positioning.

Infrastructure development is considered a key driver of value chain upgrading under the BRI. Lu Xiaoxiao and Liang Ying (2020) argue that infrastructure improvements reduce logistics costs and enhance market accessibility, accelerating regional economic integration. Similarly, Huang Zhimin and Zhang Zhenghua (2019) find that in ASEAN countries, the BRI strengthens trade linkages and establishes a China-ASEAN regional value chain, improving the division of labor within the global value chain.

4. Gaps in Existing Research and Contributions of This Study

Limited research perspectives: Existing studies primarily focus on the BRI's effects on trade and infrastructure development, with insufficient analysis of its impact pathways within the global value chain. For example, while Zhang Lijuan et al. (2016) and Lu Xiaoxiao & Liang Ying (2020) examine how industrial transfer and infrastructure development enhance value chain positioning, few studies conduct micro-level empirical research on how different economies benefit.

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Insufficient exploration of impact mechanisms: Although some studies suggest that the BRI fosters regional economic cooperation, there is no consensus on the specific mechanisms involved (e.g., policy coordination, market liberalization, industrial cooperation). For instance, Wang Shuli & Wu Chuhao (2018) analyze overall regional economic trends but do not delve into how specific policies influence value chain upgrading.

Lack of regional and sectoral heterogeneity analysis: Most existing studies focus on macroeconomic effects, with relatively little research on variations across regions and industries. For example, Dai Xiang & Song Jie (2020) examine the BRI's heterogeneous impact across regions but provide limited insights from an industry-specific perspective.

To address these gaps, this study investigates how the BRI's policy instruments influence the upgrading of participating countries' positions in the global value chain. By integrating theoretical analysis with empirical research, this paper explores how the BRI enhances global value chain division through infrastructure development, industrial cooperation, and trade facilitation. This study contributes to the theoretical framework of BRI-related global value chain research while offering empirical insights for policymakers to optimize international economic cooperation and value chain governance, ultimately promoting sustainable global economic development.

Conceptual Framework

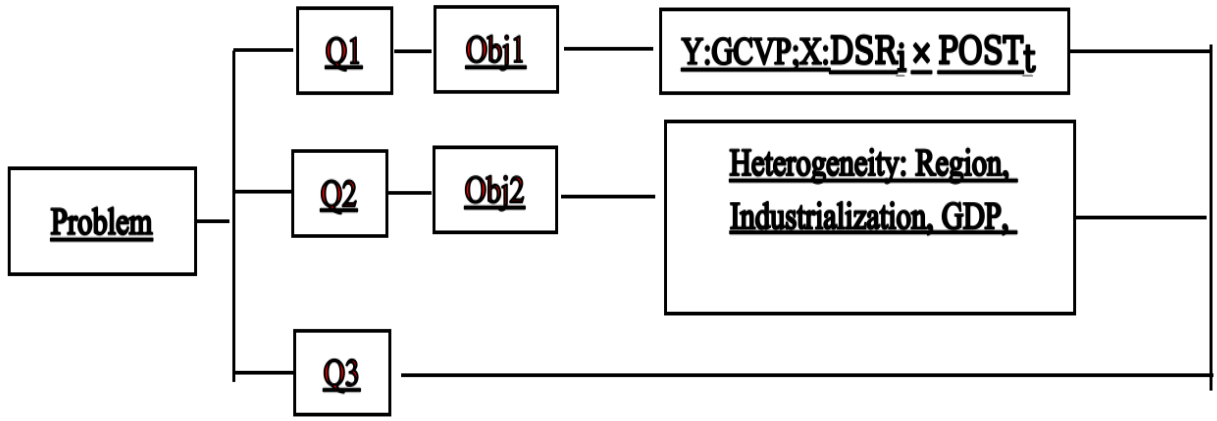

Figure1 Framework

Methodology

This study utilizes panel data from the World Bank database covering the years 2009-2022, encompassing 45 countries along the Belt and Road Initiative (BRI) route as the foundation for

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subsequent data analysis. The reasons for selecting the data period are twofold. First, the chosen range from 2009 to 2022 is based on changes in the global economic landscape. The year 2009 marks the aftermath of the global financial crisis, making it a critical time point for understanding shifts in the global economic environment and their impact on countries' positions in the global value chain. Moreover, the Belt and Road Initiative (BRI) was officially proposed in 2013, and the selected period encompasses the key stages from its initial conception to full implementation. This allows us to observe and analyze changes in the GVCP of BRI-participating countries before and after its introduction. Second, it is crucial to consider the timing of BRI implementation and its potential lagged effects on economic outcomes. As a long-term development strategy, the effects of the BRI do not manifest immediately; rather, they emerge gradually through policy implementation, project execution, and adjustments in economic activities. Therefore, starting the data period from 2009 not only covers the pre- and post-BRI phases but also enables us to capture the delayed impact of its implementation. This is essential for accurately assessing the influence of the BRI on GVCP, as the lagged effects may reveal how the initiative has progressively improved the value chain positions of participating countries through infrastructure development, trade facilitation, and industrial cooperation.

To ensure data completeness and reliability, the following data processing steps were undertaken:

- For countries with minimal missing data, linear interpolation was applied to fill in the gaps.
- For countries with substantial missing data that could not be adequately addressed through linear interpolation, the corresponding samples were excluded from the analysis. It is important to note that this step may introduce a certain degree of sample selection bias. The excluded countries may have specific economic characteristics or geographical locations, and if these excluded countries experienced significant changes in their value chain positions after the implementation of the Belt and Road Initiative, such changes would not be reflected in this study. Consequently, this could affect the generalizability and applicability of the results.

After processing, this study obtained a total of 840 samples, which will be used for subsequent data analysis. The sample countries and indicator data are presented as follows.

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Table 1 The sample countries and indicator data

Region	Whether it is a BRI participating country.	Region	Whether it is a BRI participating country.
AUS:Australia	0	MEX:Mexico	0
AUT:Austria	1	MLT:Malta	1
BEL:Belgium	0	NET:Netherlands	0
BGR:Bulgaria	1	NOR:Norway	0
BRA:Brazil	0	POL:Poland	1
CAN:Canada	0	POR:Portugal	1
SWI:Switzerland	0	ROM:Romania	1
PRC:People's Republic	1	RUS:Russia	1
CYP:Cyprus	1	SVK:Slovak Republic	1
CZE:Czech Republic	1	SVN:Slovenia	1
GER:Germany	0	SWE:Sweden	0
DEN:Denmark	0	TUR:Turkey	1
SPA:Spain	0	USA:United States	0
EST:Estonia	1	BAN:Bangladesh	1
FIN:Finland	0	MAL:Malaysia	1
FRA:France	0	PHI:Philippines	1
UKG:United Kingdom	0	THA:Thailand	1
GRC:Greece	1	VIE:Viet Nam	1
HRV:Croatia	1	KAZ:Kazakhstan	1
HUN:Hungary	1	MON:Mongolia	1
INO:Indonesia	1	SRI:Sri Lanka	1
IND:India	0	PAK:Pakistan	1
IRE:Ireland	0	FIJ:Fiji	1
ITA:Italy	1	LAO:Lao People's Democ	1
JPN:Japan	0	BRU:Brunei Darussalam	1
KOR:Republic of Korea	1	BHU:Bhutan	0
LTU:Lithuania	1	KGZ:Kyrgyz Republic	1
LUX:Luxembourg	1	CAM:Cambodia	1
LVA:Latvia	1	MLD:Maldives	1
SIN:Singapore	1	NEP:Nepal	1

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Explanation: For the dependent variable, IV/E represents GVC forward participation, measuring a country's influence on its downstream value chain partners; FV/E represents GVC backward participation, reflecting a country's dependence on its upstream value chain partners. Therefore, the difference between the two effectively captures the division of labor in the international value chain among Belt and Road Initiative (BRI) countries.

Table 2 Description of variables

Category	Index name	Unit	Symbol	Definition	Reference
Explained variable	Value chain division position	/	GCVP	The following formula is applied to measure the value chain position of Belt and Road Initiative (BRI) countries.$GVCP = \ln\left(1 + \frac{IV}{E}\right) - \ln\left(1 + \frac{FV}{E}\right)$Where **E** represents a country's total export value-added, **IV** represents domestic value-added, and **FV** represents foreign value-added.	Koopman et al. (2014) and Qin Qinghua (2023).
Explanatory variable	The interaction term in differencing	/	$DSR_i \times POST$	If country “i” joins the Belt and Road Initiative (BRI) in year “t”, its value is 1; otherwise, it is 0. Signing a BRI cooperation agreement or a Memorandum of Understanding (MOU) is considered participation in the BRI.	Yu Juanjuan et al. (2023).
Control variable	GDP of the country	/	GDP	Ln(GDP)	
	FDI in the country	/	FDI	Ln(FDI)	
	Industrial structure	%	Ind	Industrial output value/GDP	
	Population size	/	Pop	Ln(Number of population)	
	Urbanization rate	%	Urban	Urban population/total population	
	Foreign trade	%	Open	Import and export/GDP	

Referring to the model design approach of Yu Juanjuan et al. (2023), this paper adopts the Difference-in-Differences (DID) model to study the relationship between the Belt and Road Initiative (BRI) and the value chain division of labor in participating countries. The DID model is a suitable choice for evaluating the causal impact of the BRI, as it effectively isolates the net effect of policy implementation. Firstly, the DID model is appropriate for assessing policy effects across

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time and between treated and untreated groups because it captures the difference in changes between the two groups before and after policy implementation. This helps mitigate endogeneity issues arising from omitted variables or time trends, leading to a more accurate estimation of the causal impact of the BRI. Secondly, the validity of the DID model relies on several fundamental assumptions, the most critical of which is the parallel trends assumption. The parallel trends assumption requires that before policy implementation, the treated and untreated groups exhibit similar development trends. If this assumption does not hold, the DID estimation results may be biased.

The specific model is as follows:

$$GVCP_{it} = \alpha + \beta_0 DSR_i \times POST_t + \gamma X_{it} + \mu_i + \nu_t + \varepsilon_{it} \quad (1)$$

Where"i"represents the"i-th"country,"t"represents the year,"α"is the constant term, and"β_0"represents the effect of BRI (DSR) on the global value chain position (GVCP). "X_{it}"represents the control variables, "μ_i"is the individual fixed effect, "ν_t"is the time fixed effect, and"ε_{it}"is the error term. If the estimated coefficient of β_0 is positive and the null hypothesis can be rejected at the 0.05 significance level, it indicates that participating in the Belt and Road Initiative (BRI) can effectively enhance the value chain division of labor position of BRI countries. Furthermore, addressing potential endogeneity issues is crucial for enhancing the credibility of the research findings. The endogeneity problem arises from the reverse causality between BRI participation and a country's economic development countries with better economic development are more likely to join the BRI, while participation in the BRI further promotes economic growth. To address this issue, this paper will employ the Propensity Score Matching Difference-in-Differences (PSM-DID) method for processing and validation.

Results

Empirical regression results indicate that the policy coefficient is approximately 0.017, and after adding control variables, it decreases to 0.016. Both coefficients are statistically significant at the 1% level, suggesting that participation in the BRI significantly enhances a country's global value chain (GVC) participation. In column (4), the coefficient of regional GDP is -0.029 and is statistically significant at the 1% level, indicating that a country's regional GDP has a significant negative impact on GVC participation. The coefficient of industrial structure is 0.442 and is also statistically significant at the 1% level, implying that improvements in a country's industrial structure can significantly enhance GVC participation. Additionally, the coefficient of trade

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openness is 0.134 and is statistically significant at the 1% level, demonstrating that an increase in trade openness can significantly improve a country's level of GVC participation.

Firstly, the BRI promotes trade and investment liberalization and facilitation, creating broader market opportunities for participating countries. According to the framework established by Gereffi, Humphrey, and Sturgeon (2005), countries can fully leverage their resources and market advantages to engage in highly complementary economic and trade activities. This not only helps expand export scale and increase the added value of exported products but also guides domestic industries toward higher-value segments. As a result, participation in the BRI contributes to enhancing a country's influence in regional and even global value chains. Secondly, the BRI emphasizes the importance of infrastructure connectivity. By strengthening transportation, communication, and other infrastructure, participating countries can more effectively integrate domestic and international resources, reduce transaction costs, and improve efficiency. These improvements in connectivity directly enhance a country's ability to participate in the division of labor and cooperation within global value chains, facilitating deeper integration into the global economy. Moreover, the BRI fosters technological cooperation and exchange among participating countries. With continuous advancements in technology and innovation, global value chains are constantly evolving and upgrading. Joining the BRI provides countries with opportunities to share technological innovations with other member states and collaborate on the development of new products and services. This technological cooperation not only strengthens a country's competitiveness but also supports the innovation-driven transformation of domestic industries, ultimately improving their position in the global value chain. Finally, the BRI provides a platform for institutional cooperation among participating countries. In the context of globalization, a transparent and well-regulated international trade environment is crucial for value chain development. Through institutional cooperation within the BRI framework, countries can work toward more unified and coordinated regional arrangements in trade rules and standard-setting.

Table 3 Benchmark Regression Analysis

	(1)GVCP	(2)GVCP	(3)GVCP	(4)GVCP
DID	0.017***	0.017***	0.015***	0.016***
	[0.005]	[0.004]	[0.004]	[0.004]
GDP		-0.061***	-0.064***	-0.029***
		[0.011]	[0.011]	[0.011]
FDI		0.007	0.007	-0.007
		[0.021]	[0.020]	[0.019]
Industry			0.509***	0.442***
			[0.076]	[0.073]

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	(1)GVCP	(2)GVCP	(3)GVCP	(4)GVCP
Population			-0.276*	-0.180
			[0.152]	[0.145]
Urban_ratio				-0.233
				[0.589]
Trade				0.134***
				[0.016]
_cons	0.412***	2.015***	6.515***	4.102*
	[0.002]	[0.290]	[2.498]	[2.429]
r2_a	0.978	0.979	0.980	0.982
N	840.000	840.000	840.000	840.000

The regression results indicate a significant negative correlation between GDP and Global Value Chain Participation (GVCP), challenging the conventional expectation that wealthier countries should be more deeply integrated into global value chains. This negative association prompts a deeper examination of the concept of diminishing returns to scale in global value chain participation. As a country's economy develops, it already occupies higher-value segments of the value chain, which tend to have lower marginal growth potential. Consequently, even if a country continues to increase its participation in global value chains, the marginal contribution to economic growth may gradually decline.

The regression results also indicate that industrial structure has a significantly positive effect on GVCP, aligning with the view that economic diversification and industrial upgrading enhance a country's ability to participate in higher-value segments of global production networks. The optimization of industrial structure signifies a transition from low-value-added manufacturing to more complex production activities, which is usually accompanied by technological advancements, innovation capacity, and improved production efficiency. This process is closely linked to existing value chain upgrading theories, which suggest that through technological innovation, industrial upgrading, and market expansion, countries can gradually ascend in the global value chain, achieving a higher division of labor position and stronger international competitiveness. Therefore, policy support, the establishment of innovation systems, talent development, and talent introduction can guide Belt and Road Initiative (BRI) countries to participate more effectively in global production networks, enhancing their position in global value chains.

Additionally, the regression results show that trade openness has a positive impact on GVCP, which is consistent with international trade theories. These theories suggest that expanding access

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to global markets helps countries integrate into global value chains and benefit from economies of scale, technology spillovers, and market expansion. Within the context of the BRI, trade liberalization plays a crucial role in reducing entry barriers and encouraging cross-border investment. Infrastructure projects such as roads, railways, and ports can reduce transportation costs and improve regional connectivity, thereby facilitating trade and investment activities. These measures not only help countries integrate into global value chains but also promote regional economic integration and shared development. Therefore, by assessing the direct impact of BRI projects on trade costs, investment environments, industrial upgrading, and economic growth, as well as the ways in which these effects spread globally, we can gain a deeper understanding of the positive role of trade openness in global value chain participation and economic growth.

This study divides the sample into four regions: Southeast Asia, Central and Eastern Europe, Southwestern and Northern Europe, and others. Panel regressions are conducted separately for each region. The results show that in Central and Eastern Europe as well as Southwestern and Northern Europe, the regression coefficients of the policy interaction term are positive and statistically significant at the 1% level. However, in Southeast Asia and other regions, the coefficients are not significant. This indicates that the impact of the policy on global value chain participation exhibits regional heterogeneity.

For Central and Eastern Europe (CEE) and Northwestern Europe, the significantly positive coefficients on the policy interaction terms indicate that the implementation of relevant policies has had a substantial positive impact on the value chain participation of these regions. This can be attributed to their high policy execution efficiency, which allows them to better leverage policy benefits, promote industrial upgrading, and integrate resources, thereby enhancing their position in the global value chain. Additionally, these regions demonstrate strong openness and willingness to cooperate, enabling them to better integrate into regional economic integration processes and reap the benefits of international trade and investment.

In contrast, the insignificant results of the policy interaction terms for Southeast Asia and other regions suggest limitations in the effectiveness of policies in these areas. This is due to a combination of factors, such as insufficient policy implementation, relatively underdeveloped infrastructure, and suboptimal industrial structures. These factors constrain the ability of policies to drive value chain participation, preventing the policy effects from fully materializing in these regions.

A deeper analysis reveals that this regional heterogeneity is rooted in profound economic and social development differences. The relatively advanced economic foundations and higher education levels in CEE and Northwestern Europe provide strong support for effective policy implementation. On the other hand, Southeast Asia and other regions face more complex

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development challenges, such as resource shortages, large populations, and a lack of economic diversification. These disparities lead to significant differences in the effectiveness of policies across regions.

Table 4 Analysis of Regional Heterogeneity

	(1) Southeast Asia	(2) Central and Eastern Europe	(3) Western, Southern and Northern Europe	(4) Others
DID	0.009	0.033***	0.028***	-0.003
	[0.008]	[0.007]	[0.008]	[0.027]
GDP	0.006	0.027	-0.132***	-0.008
	[0.021]	[0.029]	[0.028]	[0.045]
FDI	0.090	-0.057	0.019	-0.055
	[0.066]	[0.034]	[0.019]	[0.216]
Ind	0.730***	0.553***	0.275**	0.264
	[0.149]	[0.188]	[0.107]	[0.195]
Pop	-0.046	-0.118	0.011	-0.728
	[0.250]	[0.300]	[0.197]	[1.142]
Urban	-1.496	1.757	0.790	-6.705
	[1.025]	[1.785]	[0.725]	[8.135]
Open	0.115***	0.195***	-0.013	-0.011
	[0.027]	[0.033]	[0.031]	[0.077]
_cons	1.464	0.170	3.139	18.449
	[4.365]	[5.105]	[3.184]	[21.601]
r2_a	0.980	0.960	0.991	0.919
N	322.000	182.000	252.000	84.000

Standard errors in brackets

* p < 0.1, ** p < 0.05, *** p < 0.01

The significant positive impact of industrial structure on global value chain participation (GVCP) reinforces the view that economic diversification and structural transformation are key drivers of value chain upgrading. Beyond low-value-added activities such as basic manufacturing or raw material exports, achieving production diversification is crucial for enhancing a country's participation in the value chain. This requires not only upgrading and transforming traditional industries but also actively expanding into emerging sectors, particularly high-value-added industries such as advanced manufacturing and services. Through technological innovation,

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industrial upgrading, and market expansion, countries can gradually move from low-value-added production segments to high-value-added ones, thereby improving their position and competitiveness in the global value chain. This transformation process aligns closely with the "smile curve" theory. According to the smile curve theory, value creation is concentrated in the pre-production (e.g., R&D, design) and post-production (e.g., branding, marketing) stages, while the middle-stage production and processing activities generate relatively lower added value. Therefore, to achieve value chain upgrading, countries must extend toward both ends of the smile curve by strengthening key areas such as R&D innovation, brand building, and market expansion.

Trade openness has had a positive impact on the GVCP of Southeast Asia and Central and Eastern Europe (CEE), a result that not only supports the view that international trade growth facilitates deeper integration into global value chains but also reveals significant regional differences in benefiting from an open trade environment. Southeast Asia and CEE have significantly benefited from trade openness due to their relatively open trade policies, higher institutional quality, and more relaxed market access conditions. In contrast, other regions face constraints such as conservative trade policies, weak institutional frameworks, or high market entry barriers, which hinder trade openness and participation in global value chains. These obstacles restrict regional trade activities, increase operational costs for enterprises, and lower the efficiency of global value chain integration.

When examining the relationship between GDP and returns on BRI-related investments, this study observes a negative correlation in Western, Southern, and Northern Europe. This finding suggests that for wealthier economies already deeply embedded in high-value segments of global value chains, the returns from additional BRI-related investments are gradually diminishing. The product cycle theory provides a framework for understanding this phenomenon. According to this theory, as economies develop and industries mature, advanced economies tend to transition from low-value manufacturing to high-value services. In this process, these economies become less dependent on infrastructure-driven global value chain participation, as the service sector relies less on physical infrastructure and more on knowledge, skills, and innovation capabilities. In Western, Southern, and Northern Europe, where economies are highly developed and the service sector plays a dominant role, the potential gains from BRI-related infrastructure investments are relatively limited. Instead, these investments are more beneficial to developing countries and regions that are still in the industrialization process and have a more urgent need for infrastructure development and global value chain participation.

Furthermore, the strength of developed economies in the service sector has reduced their attractiveness for BRI-related investments. Since services typically generate higher added value

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and foster greater innovation, these economies are more inclined to allocate resources to service sector development rather than infrastructure construction and further global value chain integration. However, this does not mean that the BRI holds no value for developed economies such as those in Western, Southern, and Northern Europe. On the contrary, these economies can leverage the BRI to strengthen economic ties with emerging markets and developing countries, expand international markets, and facilitate technology and knowledge transfer, thereby achieving economic diversification and sustainable development.

Taking the CEE region as an example, the regression coefficients in the table show that participation in the BRI has a significant positive impact on GVCP growth in the region, with a specific value of 0.033. Although this figure may seem small, it carries important economic implications. First, a 0.033 growth rate suggests that as the BRI continues to be implemented in CEE, the region's participation in the global value chain will steadily increase year by year. This improvement not only enhances the global competitiveness of these countries but also promotes industrial upgrading, technological innovation, and economic growth.

Second, from a broader economic perspective, an increase in GVCP fosters industry development, creates more job opportunities, and improves living standards. As global value chains become more integrated, businesses in the CEE region will have greater access to international markets and technological resources, further strengthening their global competitiveness. Additionally, the 0.033 growth rate reflects the BRI's potential contribution to economic development in these regions. While this growth rate may not be as striking as that of certain emerging industries or high-tech sectors, in the context of a slowing global economy and rising trade protectionism, this steady growth is crucial for maintaining regional economic stability and promoting sustainable development.

This study divides the sample into three groups based on the level of industrialization: high industrialization, medium industrialization, and low industrialization. Panel regressions are conducted separately for each group. The results show that the policy has a more significant positive effect on global value chain (GVC) participation in low-industrialized countries, followed by medium-industrialized countries, while no significant impact has been found for highly industrialized countries.

First, low-industrialized countries are often in the early stages of economic development, with relatively simple industrial structures primarily focused on resource-intensive or labor-intensive industries. These countries face multiple challenges in integrating into global value chains (GVCs), including technology constraints, limited financial resources, and restricted market access. At this stage, policy intervention becomes particularly crucial. By providing necessary support measures such as tax incentives, financial facilitation, and technical training, policies can

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effectively enhance the competitiveness of enterprises in these countries, expand their market share, and significantly increase their participation in GVCs.

Second, moderately industrialized countries have already developed a certain level of industrial foundation and technological capability, but their industrial structures still require further optimization and upgrading. For these countries, policies primarily play a role in guiding industrial upgrading, promoting technological innovation, and extending industrial chains. By implementing targeted policy measures such as establishing R&D funds, encouraging technological advancements, and fostering industrial clusters, policies can accelerate these countries' transition to high-value-added and high-tech industries, thereby improving their position in GVCs.

However, for highly industrialized countries, where economic development has reached an advanced stage and industrial structures are already mature and diversified, the direct impact of policies on increasing GVC participation is relatively limited. This does not mean that policies are irrelevant in these countries, but rather that their effects are more indirect and complex. For instance, policies in highly industrialized countries focus more on maintaining fair market competition, promoting environmental protection, and ensuring sustainable development. By improving the overall economic environment, these policies indirectly enhance enterprises' international competitiveness.

In low- and moderately industrialized countries, the role of policy in promoting GVC participation is particularly evident. These countries often face significant barriers to participating in high-value production segments due to underdeveloped infrastructure and weak institutional frameworks. However, the Belt and Road Initiative (BRI), through large-scale infrastructure development and trade facilitation measures, has provided these countries with unprecedented opportunities for growth. Infrastructure improvements not only reduce trade barriers and facilitate the movement of goods and services but also lay a solid foundation for industrial upgrading and functional improvements within GVCs. As a result, these countries can integrate more effectively into global production networks and enhance their positions in the value chain.

In contrast, highly industrialized countries, which already possess well-developed infrastructure and advanced industrial systems, experience diminishing marginal benefits from participating in the BRI. Since these countries already hold relatively high positions in GVCs, their potential for further upgrading through BRI participation is more limited. This explanation is supported by the economic catch-up theory, which suggests that latecomer countries can accelerate their industrialization process and narrow the gap with developed economies through targeted investments, particularly in infrastructure and institutional development. Driven by the BRI, low- and moderately industrialized countries are leveraging improvements in infrastructure

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and trade facilitation to achieve economic catch-up and enhance their competitiveness in global value chains.

Table 5 Analysis of Industrial Structure Heterogeneity

	(1) Low Industrialization	(2) Medium Industrialization	(3) High Industrialization
DID	0.025***	0.012*	0.005
	[0.008]	[0.006]	[0.009]
GDP	-0.040*	-0.065***	-0.019
	[0.024]	[0.017]	[0.021]
FDI	0.002	-0.048	0.064
	[0.028]	[0.030]	[0.055]
Ind	1.169***	0.456***	0.317***
	[0.273]	[0.100]	[0.116]
Pop	-0.523**	-0.106	0.699
	[0.261]	[0.176]	[0.555]
Urban	1.830	0.699	-2.508**
	[1.630]	[0.757]	[1.132]
Open	0.041	0.130***	0.178***
	[0.033]	[0.023]	[0.029]
_cons	8.307*	3.205	-9.534
	[4.704]	[2.854]	[9.433]
r2_a	0.986	0.984	0.976
N	252.000	336.000	252.000

Standard errors in brackets
* p < 0.1, ** p < 0.05, *** p < 0.01

In the controlled variable analysis, a negative correlation is observed between GDP and global value chain participation (GVCP) in low- and moderately industrialized countries. This finding suggests that wealthier economies within these countries do not benefit significantly from the Belt and Road Initiative (BRI). To better understand this phenomenon, we can analyze it through the lens of economic complexity theory. This theory emphasizes that a country's economic development is not only dependent on its infrastructure and resource abundance but also closely related to the complexity and diversity of its economic structure. It posits that

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wealthier nations tend to have more complex and diversified economic structures, with more varied and deeper forms of participation in GVCs.

For low- and moderately industrialized countries, although the BRI provides significant opportunities for infrastructure development and improved market access, the wealthier economies within these countries have already reached the stage where the marginal benefits of infrastructure investment are diminishing. At this stage, relying solely on infrastructure investment is insufficient to further enhance their position and participation in GVCs. Instead, these wealthier nations require more advanced forms of economic engagement, such as technological innovation, industrial upgrading, and brand development, to gain higher value-added and stronger competitiveness in GVCs. However, the BRI is currently primarily focused on infrastructure development and resource extraction, with relatively limited support for technological innovation and industrial upgrading. Therefore, for wealthier economies within low- and moderately industrialized countries to gain more benefits from the BRI, they need to consider their economic structure and development needs more comprehensively and formulate more targeted policies and measures. For example, they could strengthen support for technological innovation and industrial upgrading, promoting a more complex and diversified economic structure. Additionally, they could enhance their connections and cooperation with international markets to expand the forms and depth of their GVC participation.

This study finds that foreign direct investment (FDI) does not have a significant impact on GVCP across all levels of industrialization. This result contradicts some predictions in GVC research, which often emphasize FDI as a key driver of GVC integration and upgrading. First, the impact of FDI on GVCP depends not only on the total amount of investment but also on the quality of investment. High-quality investment is typically accompanied by advanced technology transfer, management experience sharing, and market expansion, all of which are crucial for enhancing a country's position in GVCs. However, if FDI is primarily concentrated in low-value-added or resource-intensive industries, its role in promoting GVCP will be limited.

Moreover, differences in investment quality may also stem from investor motivations and strategies. Some investors prioritize short-term profit maximization rather than long-term technological and industrial upgrading. Such short-sighted investment behavior weakens the positive impact of FDI on GVCP. Second, the sectoral distribution of FDI is a key factor influencing its effect on GVCP. Different industries occupy different positions and levels of importance in GVCs, meaning that the impact of FDI varies depending on where it is directed. If FDI mainly flows into manufacturing, especially low-value-added labor-intensive manufacturing, its contribution to GVCP will be relatively limited. In contrast, if FDI is directed toward high-value-added service industries or high-tech manufacturing, its effect on GVCP enhancement will be more significant.

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Additionally, the sectoral distribution of FDI influences its technological spillover effects. In some industries, FDI is more likely to generate technology spillovers, fostering technological innovation and industrial upgrading in local firms. In others, these spillover effects are relatively weak.

This study finds that the industrial structure variable (Ind) consistently has a significant positive impact across all levels of industrialization, with the strongest effect observed in low-industrialized countries. This result not only underscores the importance of domestic industrial capacity in improving a country's position in GVCs but also aligns closely with the literature on industrial upgrading and capacity-building strategies in emerging economies. Industrial structure serves as a key indicator of a country's economic diversity and complexity, reflecting its role and positioning within global production networks. A diversified and highly specialized industrial structure typically indicates greater competitiveness and bargaining power in GVCs.

The study's findings highlight the critical role of industrial structure optimization and upgrading, particularly for low-industrialized countries, which often occupy the lower end of GVCs and face urgent demands for industrial upgrading and technological progress. Over the past decades, emerging economies have undergone rapid economic growth and industrial transformation, often accompanied by significant changes in industrial structures. Many of these economies have successfully improved their positions in GVCs by implementing various industrial upgrading and capacity-building strategies, such as technological innovation, talent development, policy support, and market liberalization. The positive impact of industrial structure on GVCP, as observed in this study, aligns with the practical experiences of emerging economies in their industrial upgrading strategies. It suggests that by optimizing industrial structures and enhancing domestic industrial capacity, emerging economies and low-industrialized countries can integrate more effectively into global production networks, achieving sustained economic growth and industrial advancement.

This study finds that population size (Pop) has mixed effects on GVC participation across different levels of industrialization. In low-industrialized countries, population size exhibits a significant negative impact, which may be associated with resource constraints or weak infrastructure. Conversely, in highly industrialized countries, population size has a significant positive effect, benefiting from well-developed infrastructure and efficient human capital utilization. The population-economy framework provides a comprehensive analytical perspective, emphasizing the interactions between population size, structure, quality, and economic development. Under this framework, population is not only a factor of economic development but also an important influence on economic structure and policy-making.

In low-industrialized countries, rapid population growth is often accompanied by resource shortages, increased pressure on infrastructure, and employment challenges. Due to their lack of

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sufficient economic and technological foundations to support large-scale population growth, population expansion becomes a burden, limiting their GVC participation. Specifically, resource constraints lead to higher production costs, reducing these countries' competitiveness in global markets. At the same time, weak infrastructure hampers production and trade efficiency, further weakening their position in GVCs. Additionally, large-scale unemployment and underemployment may lead to social instability and poverty, further obstructing economic development.

In contrast, in highly industrialized countries, population growth becomes an advantage. These countries typically have advanced infrastructure and efficient human capital utilization, allowing them to fully leverage the scale effects and talent advantages brought by population growth. On one hand, population growth expands market size, increasing demand for goods and services, which drives economic growth and industrial upgrading. On the other hand, highly industrialized countries often have well-established education systems and highly skilled labor forces, enabling them to better adapt to technological changes and industrial upgrades, further enhancing their positions in GVCs.

This study finds that the urbanization variable (Urban) has a significant negative impact in highly industrialized countries, while its effects in other levels of industrialization are negligible. This finding prompts deeper reflection on the relationship between urbanization and economic development, particularly regarding the potential negative effects of urbanization in highly industrialized countries. Urban saturation occurs when urbanization reaches a point where spatial, resource, and environmental capacities approach their limits, creating bottlenecks for further development. The diminishing returns to urban development refer to the phenomenon where, as urbanization progresses, the economic and social benefits derived from additional urbanization gradually decrease or even turn negative.

In highly industrialized countries, urbanization levels have often reached or are approaching saturation. At this stage, further urbanization may lead to a range of negative effects, such as traffic congestion, environmental pollution, housing shortages, and social inequality. These issues not only reduce the quality of urban life but may also constrain economic growth. The significant negative impact of urbanization in highly industrialized countries observed in this study is linked to urban saturation and diminishing returns to urban development. As urbanization advances, the marginal benefits of urban infrastructure and public services decline, while the costs of urban management and governance increase. These changes weaken the economic benefits of urbanization and may even generate negative effects.

This study finds that the openness variable (Open) has a significant positive impact on GVCP in moderately and highly industrialized countries. This observation aligns with comparative advantage theory and international trade theory, emphasizing the importance of trade

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liberalization and economic openness in supporting more developed economies in achieving higher positions in GVCs. Trade openness provides moderately and highly industrialized countries with opportunities to access and learn from advanced international technologies and management practices. Through imports of high-tech intermediate and capital goods, firms in these countries can directly absorb and apply cutting-edge global technologies, thereby improving their productivity and technological capabilities.

This study divides the sample into three groups based on GDP levels: high GDP, medium GDP, and low GDP. Panel regressions are conducted separately for each group. The results show that the policy has a significantly positive effect on low-GDP countries, whereas it has a suppressing effect on high-GDP countries and no impact on medium-GDP countries.

For low-GDP countries, the role of policy promotion is particularly significant. These countries often face numerous challenges in the early stages of economic development, such as underdeveloped infrastructure, low technological levels, and capital shortages. At this stage, policy intervention acts as a "timely rain," providing essential support measures such as financial subsidies, tax incentives, and technical assistance to help these countries overcome development obstacles and accelerate their integration into the global value chain. This positive effect of policy not only promotes business growth and industrial upgrading but also brings more opportunities for international trade and investment, significantly enhancing their participation in the global value chain.

However, in high-GDP countries, policy interventions tend to have a restraining effect. This is because these countries already possess well-established economic systems and high market competitiveness, and further government intervention disrupts the existing market balance and competitive order. For example, excessive government subsidies or protectionist policies can lead to resource misallocation, reducing firms' motivation for innovation and weakening market competitiveness. Moreover, high-GDP countries often prioritize long-term development goals such as environmental protection and social equity, which may conflict with short-term increases in value chain participation, thereby diminishing the effectiveness of policies.

For middle-GDP countries, the impact of policy is relatively neutral. These countries are in a transitional phase of economic development, possessing a certain industrial foundation and market competitiveness while also facing pressures for industrial upgrading and structural adjustments. As a result, the effects of policies in these countries are influenced by multiple factors, making it difficult to produce a distinctly positive or negative outcome.

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Table 6 Analysis of Income Level Heterogeneity

	(1)	(2)	(3)
	Low GDP	Medium GDP	High GDP
DID	0.029***	0.008	-0.019**
	[0.009]	[0.006]	[0.007]
GDP	-0.014	-0.001	-0.047***
	[0.025]	[0.017]	[0.015]
FDI	0.000	-0.009	-0.062*
	[0.038]	[0.026]	[0.033]
Ind	0.986***	0.121	0.392***
	[0.185]	[0.090]	[0.099]
Pop	-0.461	-0.100	-0.216
	[0.314]	[0.201]	[0.244]
Urban	-1.668	-0.045	1.810**
	[1.504]	[0.784]	[0.816]
Open	0.120***	0.239***	0.058*
	[0.027]	[0.029]	[0.035]
_cons	8.223*	1.944	4.022
	[4.852]	[3.241]	[4.545]
r2_a	0.965	0.989	0.974
N	280.000	280.000	280.000

Standard errors in brackets
* p < 0.1, ** p < 0.05, *** p < 0.01

This study found that, within the context of the "Belt and Road" initiative, the GDP variable has a negative and significant impact on high-income countries (-0.047, $p < 0.01$), suggesting that higher economic output may be associated with weaker positions in the global value chain (GVC). This observation raises important considerations regarding the role of high-income countries in the Belt and Road Initiative and the relationship between economic scale and GVC position. Although high-income countries typically possess strong economic power and technological foundations, they face unique challenges within the global value chain. As the global economy evolves and competition intensifies, high-income countries have gradually lost their former competitive advantages in certain industrial sectors. Additionally, the rapid rise of emerging markets and developing countries, along with their advancements in specific industries and

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technologies, poses a threat to the GVC position of high-income countries. In this study, the negative impact of the GDP variable on the GVC position of high-income countries may reflect such competitive pressures. Higher economic output may indicate that high-income countries face greater challenges in resource allocation, industrial restructuring, and innovation capacity, which affects their position in the global value chain. The Belt and Road Initiative, as a significant international cooperation platform, aims to enhance economic connectivity and cooperation among countries along the route. For high-income countries, this initiative brings both opportunities and challenges. On the one hand, high-income countries can expand their overseas markets, acquire resources, and invest through participation in Belt and Road projects, thereby improving their GVC position. On the other hand, as emerging markets and developing countries strengthen their cooperation within the Belt and Road framework, high-income countries face increasingly intense international competition, which potentially threatens their GVC position.

The study found that foreign direct investment (FDI) exhibited mixed effects based on income levels, but it remained statistically insignificant for most groups, showing only a negative impact in high-GDP countries. This observation suggests that, within the framework of the Belt and Road Initiative, increased foreign investment may not always be beneficial to high-income countries. The theory of economic saturation and structural transformation in developed economies posits that as markets mature and economies grow, these countries face challenges of slower growth and diminishing competitive advantages. This is primarily due to resource constraints, market demand saturation, technological bottlenecks, and aging industrial structures. In this context, an increase in foreign direct investment no longer has the significant positive effects on economic growth and industrial upgrading as it did in the past. Instead, it may exacerbate market competition, compress local businesses' profit margins, and even lead to the decline of certain industries. In high-GDP countries, the negative impact of foreign direct investment arises from two aspects: competition with local companies and the shift of value chain activities to emerging markets. On the one hand, the entry of foreign investors intensifies market competition, forcing local businesses to lower prices, improve production efficiency, or innovate to remain competitive. However, this competition also leads to the elimination of weaker local companies, reducing market diversity and vitality. On the other hand, as global value chains are restructured and emerging markets rise, some multinational corporations move production activities to regions with lower costs and greater market potential, which may lead to a decline in the GVC position of high-GDP countries and a reduction in employment opportunities.

The study found that the industrial structure variable (Ind) had a significant positive impact on both low-income and high-income countries, indicating that stronger industrial capacity can effectively increase global value added in both cases. This observation not only validates the

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importance of industrial structure optimization in enhancing a country's economic strength but also prompts further exploration of the role of industrial upgrading theory in this process. Industrial upgrading theory emphasizes that through technological innovation, industrial restructuring, and improved production efficiency, countries can better integrate into global production networks and improve their position in the value chain. This theory provides a theoretical foundation for understanding the impact of industrial structure variables on global value added. For low-income countries, industrial upgrading means transitioning from low-value-added industries to high-value-added industries. By introducing advanced technologies, improving labor quality, and strengthening infrastructure, these countries can gradually establish competitive industrial systems, thereby obtaining more value added in the global value chain. For high-income countries, industrial upgrading is more about optimizing and upgrading existing industries and nurturing emerging industries. These countries can maintain their leading position in the global value chain and obtain more value added through continuous technological innovation and industrial upgrading. The positive impact of industrial structure variables on global value added further emphasizes how countries with strong industrial foundations can better integrate into global production networks and enhance their position in the value chain. A strong industrial base not only means higher production efficiency and lower costs but also stronger technological innovation capabilities and market competitiveness. These advantages make these countries more competitive in the global value chain, enabling them to obtain more value added.

The study found that the population size (Pop) had no statistically significant impact at any income level. This result, though seemingly unexpected, is worth further exploration. The size of the labor market, or the number of available workers, is an important factor affecting a country's position in the global value chain. However, this study found that population size itself did not have a significant impact on GVC participation, meaning that the number of workers is not a decisive factor. Instead, the quality of the labor force, including skill level, productivity, and innovation capabilities, plays a more crucial role. In the labor market, high-quality human capital often leads to higher production efficiency and innovation capabilities, thus enhancing a country's competitiveness in the global value chain. Therefore, even with a large population, a country may still struggle to obtain a higher level of participation in the global value chain if the labor force is not highly skilled. Human capital quality, which includes factors such as education level, skill level, innovation ability, and work experience, is a key determinant of a country's position in the global value chain. High-quality human capital can drive technological innovation and industrial upgrading, improve production efficiency and market competitiveness, and thus enhance a country's participation in the global value chain. Although this study did not directly explore the impact of human capital quality on GVC participation, based on labor market and human capital

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theories, we can infer that among countries with similar population sizes, those with higher-quality human capital may achieve greater participation in the global value chain.

The study found that the urbanization variable (Urban) was significantly and positively correlated in high-GDP countries, suggesting that in wealthier economies, higher urbanization levels are associated with higher GVC participation. Urbanization often leads to significant improvements in infrastructure, including transportation, communication, energy, and water supply. These infrastructure improvements not only increase production efficiency but also promote the rapid circulation of goods and services, enhancing the integration capacity of the value chain. Cities serve as important centers for technological innovation and diffusion. A higher level of urbanization means that more research institutions, innovative enterprises, and higher education institutions are concentrated, forming a strong technological innovation ecosystem. This innovation not only drives industrial upgrading but also increases the value added and competitiveness of the value chain. Urbanization brings about the concentration of population and labor, especially high-quality and skilled labor. These labor resources provide essential talent support for various links in the value chain, promoting the extension and upgrading of industrial chains. In developed economies, the integration and upgrading of the value chain are key drivers of economic growth and industrial advancement. The potential benefits of urbanization, such as better infrastructure, advanced technologies, and skilled labor resources, strongly support value chain integration.

The study found that economic openness (Open) had a significant positive impact on all income groups, with the greatest impact on middle-income countries. This result is highly consistent with international trade theory, which emphasizes the critical role of trade liberalization in improving global market access and promoting technological exchange. International trade theory suggests that trade liberalization can lower tariff and non-tariff barriers, improving market access and encouraging countries to engage in international trade and global production networks. In this process, countries can leverage their comparative advantages, focus on producing competitive products or services, and obtain the necessary resources and technologies through international trade. The study found that economic openness had the greatest impact on middle-income countries, which is related to their unique position in the global value chain. These countries typically have a certain industrial base and labor advantage, but there is still a gap compared to international advanced levels. Increasing openness helps these countries better utilize international markets and resources, accelerating industrial upgrading and technological innovation, thereby gaining more development space in the global value chain.

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Conclusion

This paper uses data from the World Bank database, focusing on 45 Belt and Road countries. Panel data from 2009 to 2022 were obtained from the World Bank database, and after excluding missing values, 840 samples were collected. In the empirical analysis, a DID model was employed to construct a panel regression equation. The findings show that participation in the Belt and Road Initiative (BRI) significantly improves a country's participation in the global value chain. Based on this, the paper conducts heterogeneity studies from regional, industrialization level, GDP level, with the following key conclusions:

1. Participation in the Belt and Road Initiative has a significant positive effect on the value chain division of labor in Central and Eastern Europe and Northern Europe, while there is no significant effect on Southeast Asia and other regions:

The study found that the BRI has a significant positive impact on the value chain division of labor in Central and Eastern Europe and Northern Europe, but no significant impact on Southeast Asian countries. This reflects the complexity of global value chains, where geographical factors, institutional preparedness, and infrastructure quality play a crucial role in determining a country’s ability to integrate into international production networks. Geographically, Central and Eastern European countries are closer to the core economic area of Europe, making it easier to participate in European integration and benefit from EU market access. In contrast, Southeast Asian countries are geographically more isolated, and their regional integration process lags, limiting their ability to benefit from the BRI. Regarding infrastructure connectivity, the BRI emphasizes infrastructure, which is crucial for improving trade facilitation and attracting foreign investment. Central and Eastern European countries have improved transportation, energy, and communication infrastructure through BRI projects, significantly enhancing their ability to attract international investment and participate in the global value chain. However, infrastructure improvements in Southeast Asian countries have been relatively limited, which somewhat restricts their value chain position improvement. From the perspective of economic convergence and industrial upgrading, the BRI promotes economic convergence and industrial upgrading among participating countries. Central and Eastern European countries have accelerated their industrialization process and upgraded their industries' value and technology levels through the BRI. Southeast Asian countries face more challenges in industrial upgrading, partly due to their relatively simple industrial structure and reliance on low-value-added manufacturing.

2. Participation in the Belt and Road Initiative has a significant positive effect on the value chain division of labor in countries with medium to low levels of industrialization, while there is no significant effect on highly industrialized countries:

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The study found that the BRI has a greater positive impact on countries with lower to medium industrialization levels. This result aligns with global value chain theory, suggesting that countries in the early stages of industrial development are more likely to benefit from international investment and infrastructure improvements. From the perspective of industrial upgrading and technological development, the BRI provides medium- and low-income industrialized countries with opportunities for industrial upgrading and technological advancement. By participating in BRI projects, these countries can introduce advanced technologies and management experiences, improving their industry's value-added and competitiveness. Additionally, the BRI promotes international investment and technology spillover effects, helping these countries accelerate their industrialization. From the perspective of the "smile curve" theory and value chain upgrading, according to the "smile curve," developing countries face challenges when transitioning from low-value manufacturing to high-value activities (e.g., R&D or branding). The BRI offers these countries an opportunity to break through this challenge. By participating in high-value-added segments of the global value chain, these countries can gradually achieve industrial upgrading and value chain elevation.

3. Participation in the Belt and Road Initiative has a significant positive effect on the value chain division of labor in low-GDP countries, no significant effect on middle-GDP countries, and a suppressive effect on high-GDP countries:

The study found that low-GDP countries benefited positively from the BRI, while high-GDP countries faced a suppressive effect. This result is closely related to economic differentiation theory and the global redistribution of production activities. From the perspective of economic differentiation and competitive pressure, high-GDP countries are in a leading position in the global value chain, but emerging economies participating in the BRI challenge them by improving infrastructure and industrial competitiveness. This leads to a relative decline in the position of high-GDP countries in the value chain and increased competitive pressure. From the perspective of the global redistribution of production activities, the BRI facilitates the redistribution of global production. Low-GDP countries have successfully integrated into the global value chain through infrastructure improvement and foreign investment attraction, enhancing their industry's value-added and competitiveness. In contrast, high-GDP countries need to adapt to this change by focusing on innovation and strengthening their participation in high-value segments of the global value chain to maintain their leading position.

Discussion

To deepen the understanding of the BRI's impact, this paper draws on global value chain theory. Gereffi categorizes industrial upgrading into four stages: process upgrading, product

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upgrading, functional upgrading, and chain upgrading. Process upgrading involves improving production efficiency, reducing costs, and optimizing manufacturing processes. Product upgrading focuses on developing new products or enhancing the functionality and quality of existing ones. Functional upgrading entails shifting from low-value-added activities to high-value-added ones, such as transitioning from manufacturing to design, marketing, and brand building. Chain upgrading refers to transitioning from one value chain to another with higher added value.

The mechanisms by which the BRI promotes industrial and functional upgrading mainly include process upgrading, product upgrading, functional upgrading, and chain upgrading.

1. Process upgrading: The BRI enhances manufacturing efficiency in participating countries by introducing advanced technologies and best practices. For example, improvements in transportation and communication infrastructure accelerate information flow and logistics coordination, reducing production costs and increasing overall efficiency.

2. Product upgrading: The BRI fosters international trade and technological exchange, providing participating countries with opportunities to access new products and technologies in international markets. This not only facilitates improvements in existing products but also stimulates innovation in new product development.

3. Functional upgrading: The BRI promotes industrial diversification and economic resilience, driving the transition from low-value-added manufacturing to high-value-added services and innovation activities. As infrastructure improves, participating countries can attract more investment in high-end manufacturing and service industries, facilitating industrial and functional transformation.

4. Chain upgrading: The BRI offers participating countries the opportunity to transition to higher-value-added segments of the global value chain. Through cross-border cooperation projects, countries gain access to more advanced production technologies and market networks, enabling chain upgrading.

In terms of market access and resource allocation efficiency, the BRI facilitates infrastructure connectivity and provides easier access to international markets. This helps optimize resource distribution and enhances value-added activities in participating countries. As market entry barriers lower, countries can better utilize international resources, achieving optimized resource allocation and efficient utilization. Meanwhile, competition in the international market encourages participating countries to enhance their competitiveness, driving industrial and functional upgrading.

A more detailed analysis reveals that the impact of the BRI on value chain positioning is particularly significant for Central and Eastern European (CEE) and Northwestern European countries. These regions are geographically close to Europe's economic core, and their

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participation in BRI projects not only strengthens economic and trade ties with China but also broadens cooperation channels with other European countries, accelerating regional economic integration. Furthermore, CEE and Northwestern European countries generally possess well-established industrial bases and strong technological innovation capabilities. Participation in the BRI enables them to acquire advanced technologies and management expertise, further consolidating and elevating their position in the global value chain.

In contrast, Southeast Asian and other regional countries, despite their involvement in the BRI, have not generally shown significant improvements in their value chain positioning. This is related to factors such as their stage of economic development, industrial structure, and international competitive environment. While Southeast Asian countries have advantages in labor costs and natural resources, they still face challenges in technological innovation and high-end manufacturing. Other regional countries may experience limited benefits from the BRI due to geographical constraints or historical factors.

Despite their active participation, Southeast Asian countries have not seen significant improvements in value chain positioning due to several factors:

1. Dependence on low-value-added manufacturing: Many Southeast Asian economies rely heavily on low-value-added manufacturing exports, which limits their ability to upgrade within the value chain. Although the BRI provides opportunities for infrastructure investment, simply improving infrastructure without simultaneously promoting industrial upgrading and technological innovation is insufficient to enhance value chain positioning.

2. Limited technological capacity: Technological innovation and R&D capabilities are crucial for value chain upgrading. However, Southeast Asian countries lag in these areas, lacking sufficient R&D capacity and innovation capabilities. This hinders their development in high-end manufacturing and services, restricting their movement up the value chain.

3. Competition from more advanced economies: In the context of globalization, Southeast Asian countries face fierce competition from more developed economies. These advanced economies have significant advantages in high-end manufacturing, services, and technological innovation, posing challenges to Southeast Asia's value chain upgrading.

From the perspective of the "middle-income trap," this concept refers to the stagnation in economic growth experienced by developing countries when they struggle to transition from low-value-added industries. This theory provides insight into the challenges Southeast Asian nations face in upgrading within the value chain. To overcome the middle-income trap, these countries must drive industrial upgrading and technological innovation to enhance their global value chain positioning. Southeast Asian nations must improve their business environments, strengthen

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intellectual property protection, and facilitate technology transfer and talent development to create favorable conditions for value chain upgrading.

From an industrialization perspective, participation in the BRI has significantly benefited the value chain positioning of countries with low to moderate levels of industrialization. The BRI's impact on these nations primarily manifests in two ways:

1. Technology learning and capacity building: The BRI provides invaluable opportunities for technology learning. By participating in large-scale infrastructure projects, these countries gain exposure to advanced engineering techniques and management practices. Additionally, technology transfer and joint R&D under BRI projects foster local enterprise innovation and industrial upgrading. Investments in human capital, education, and training further enhance technical capacity.

2. Transition from low-value manufacturing to high-value activities: As technological capabilities improve, low-to-moderate industrialized countries gradually shift from low-value-added manufacturing to high-value-added activities such as research, design, and branding. The BRI provides opportunities to integrate into higher-value segments of the global value chain, enhancing product quality and market competitiveness.

For highly industrialized nations, the impact of the BRI on value chain positioning is relatively limited due to their already well-established industrial systems and competitive advantages. However, these nations can leverage the BRI for market expansion and strategic resource allocation.

1. Market expansion: BRI countries present vast markets with substantial consumer potential. Highly industrialized nations can use BRI engagement to understand market demands, adjust product strategies, and expand their market reach.

2. Strategic resource allocation: The BRI serves as a platform for global resource allocation. Through participation, highly industrialized nations can optimize access to natural and human resources, supporting economic growth.

From an economic scale perspective, the BRI has a significant positive impact on low-GDP countries' value chain positioning, a limited effect on middle-GDP countries, and a restraining effect on high-GDP countries. Middle-GDP countries face challenges in internal structural adjustments and competition from both advanced and developing economies, while high-GDP countries often view the BRI as a competitive threat but can respond strategically through market diversification and innovation.

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Recommendation

Based on the conclusions of this study, recommendations are provided from the following two perspectives:

Government Perspective

Against the backdrop of profound adjustments in the global economic landscape, China's Belt and Road Initiative (BRI) has become a crucial driver for international cooperation and development. The conclusions of this study reveal the positive impact of participating in the BRI on a country's position in the global value chain, providing strong support for government policy-making. From the perspective of the Chinese government, and based on these research findings, this paper proposes the following policy recommendations:

1. Formulating Differentiated Cooperation Strategies and Optimizing Resource Allocation

The government should conduct in-depth analyses of the regional characteristics, development levels, and institutional environments of BRI countries to formulate differentiated cooperation strategies. For countries in Central and Eastern Europe, as well as Northern and Western Europe, which possess strong industrial foundations and geographical advantages, the government can enhance cooperation in high-end manufacturing and technological innovation through bilateral or multilateral agreements, jointly promoting industrial upgrading and value chain advancement. For countries with lower levels of industrialization, the government should provide necessary policy support and financial assistance to help improve infrastructure, enhance the business environment, and attract foreign investment and technology inflows, facilitating their gradual integration into the global value chain.

2. Promoting Innovation-Driven Development and Industrial Upgrading

Innovation is key to improving a country's position in the global value chain. The government should increase investment in technological innovation and support enterprises in conducting research and development (R&D) and industrial upgrading. Specifically, the government can establish dedicated funds to support the research of critical technologies and key sectors. By driving innovation and industrial progress, the government can assist BRI countries in climbing the value chain and gaining greater value-added benefits and competitiveness.

3. Promoting Cultural Exchanges and Strengthening People-to-People Connectivity

Cultural exchange is a key component of the BRI. The government should strengthen cultural and people-to-people exchanges with BRI countries to foster mutual understanding and friendship among nations. This can be achieved through cooperation in education, culture, and tourism, as well as increased media collaboration and public diplomacy efforts to spread positive and friendly narratives. By deepening cultural exchanges, the government can lay a solid public and social foundation for the long-term success of the BRI.

Enterprise Perspective

Amid global economic integration and the promotion of the BRI, enterprises are facing unprecedented opportunities and challenges. The findings of this study highlight the positive impact of BRI participation on the position of enterprises in the global value chain, providing

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valuable insights for corporate strategy adjustments and market expansion. From an enterprise perspective, this paper proposes the following strategic recommendations:

1. Seizing Market Opportunities and Deepening Presence Along the BRI

Enterprises should keenly observe the vast market potential of BRI countries, actively adjust their market strategies, and deepen their presence along the route. Through market research and risk assessments, businesses should identify countries and regions with strong growth prospects and competitive advantages as key target markets, increasing investment and expanding business operations. Furthermore, companies must closely monitor policy trends and shifts in market demand in BRI countries, allowing them to adapt their business strategies flexibly and seize development opportunities.

2. Strengthening Industry Chain Cooperation and Optimizing Resource Allocation

Under the BRI framework, enterprises should actively seek industry chain cooperation opportunities with partner countries by forming joint ventures, partnerships, or mergers and acquisitions to optimize resource allocation in terms of capital, technology, and markets. Businesses can leverage their strengths in specific industries to establish upstream and downstream partnerships with local enterprises, developing a complete and efficient industrial chain. This approach can help reduce production costs, enhance operational efficiency, and strengthen competitive advantages in the global market.

3. Enhancing Technological Innovation and Driving Industrial Upgrading

Technological innovation is essential for enterprises to enhance their core competitiveness and position in the global value chain. Companies should increase R&D investments, accelerate technological innovation and product development, and continuously launch high-value-added products with independent intellectual property rights. Additionally, firms should keep up with international technological trends and market shifts, actively adopting and integrating foreign advanced technologies and management practices to drive industrial transformation and upgrading. Through continuous innovation and upgrading, enterprises can secure a more advantageous position in BRI markets and capture greater value-added benefits.

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