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New Western Land–Sea Corridor and Regional Economic Coordination: Evidence from Provincial Panel Data

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Abstract

The New Western Land–Sea Corridor (NWLSC) is a major multimodal transport initiative in China aimed at linking inland regions with global markets through integrated rail–sea logistics. Using provincial panel data for 2014–2022, this study examines the extent to which the corridor has enhanced interregional economic coordination. We construct a province-level urban flow intensity index to capture functional economic linkages across regions and implement a multi-period difference-in-differences strategy that exploits the 2019 introduction of the "13+1" cooperation framework as a quasi-natural experiment. The results show that the NWLSC has generated a statistically significant and economically meaningful improvement in interprovincial linkage strength, amounting to roughly a 17 percent increase on average compared with non-participating regions. The effect has also intensified progressively over time, indicating cumulative gains as the corridor develops. The results are confirmed to be robust through event-study tests, multiple placebo designs, lagged specifications, and alternative operationalizations of the dependent variable. The heterogeneity analysis shows that the gains are concentrated in Southern provinces with established port access and in less-developed inland regions that previously faced substantial connectivity constraints. In contrast, the effects are much weaker or statistically insignificant in central and northern provinces. By integrating a functional linkage metric with a causal identification framework, overall, this study provides new empirical evidence on how large-scale transport corridors reshape regional economic interaction. The findings contribute to broader international discussions on infrastructure-led integration and offer policy insights for corridor-oriented development strategies.

Keywords: New Western Land-Sea Corridor; Regional Economy; Coordinated Development; Difference-in-Differences Model

1. Introduction

Over recent decades, rapid economic expansion has substantially transformed China's development landscape, but pronounced spatial disparities in income, infrastructure, and industrial capacity have persisted between coastal and inland regions (Wang & Fan, 2004; Sun & Zhang, 2021). Provinces in the western interior, including Sichuan, Chongqing, and Guizhou, continue to lag behind eastern coastal areas in terms of market access, transport connectivity, and integration into global value chains. Such disparities pose long-term challenges for economic efficiency, social cohesion, and the transition toward more balanced and inclusive growth.

To mitigate these regional imbalances, China has implemented a series of large-scale spatial development strategies. The Western Development Strategy, launched in 2000, sought to strengthen basic infrastructure and stimulate economic participation in inland regions (Liu, 2017; Zhang & Zhao, 2020). Subsequently, the Belt and Road Initiative (BRI) introduced in 2013 positioned western provinces as emerging gateways for cross-border trade and multimodal transport networks. Within this broader framework, the National Development and Reform Commission issued the Master Plan for the New Western Land–Sea Corridor (NWLSC) in 2019, initiating the "13+1" cooperation mechanism and promoting institutional coordination, multimodal logistics services, and port capacity expansion along the corridor (Fu, 2019; Yang & Zheng, 2019; Babaev & Sazonov, 2022).

Although the NWLSC is grounded in the Chinese context, it reflects a broader global policy trend in which transport corridors are designed not only to facilitate trade but also to promote more integrated and coordinated regional development. By connecting inland western provinces to southern coastal ports and international maritime routes through rail–sea multimodal transport, the corridor is expected to reduce logistics costs, enhance market accessibility, and strengthen the flows of goods, capital, labor, and information (Jiang, Qiao, & Lu, 2020; Zhao, Yu, & Zhu, 2023). These improvements may reshape interprovincial economic linkages, foster functional specialization, and generate spatial spillovers across regions. However, the magnitude and distribution of such effects are likely to differ according to geographical location and development level, making empirical identification essential.

Existing studies have examined aspects of the NWLSC related to logistics performance, infrastructure construction, trade facilitation, and environmental outcomes (Fu, 2019; Cong, 2021; Chen, Wen, & Chen, 2024; Zhao & Wang, 2023). Research on regional coordination has also developed sophisticated frameworks for evaluating spatial integration and identifying key determinants of coordinated development (Najam, 1998; Bai, Huang, & Xian, 2018; Jiang, Sun, & Wu, 2022; Wang et al., 2024). However, three important gaps remain. First, empirical evidence on the causal impact of the NWLSC on interprovincial economic linkages is limited. Second, few studies incorporate explicit measures of functional regional connectivity—such as urban flow intensity—into corridor evaluations. Third, the heterogeneous regional responses to the NWLSC across different geographical zones and development stages

have not been systematically assessed.

This study addresses these gaps in three ways. First, we construct a province-level urban flow intensity index to measure outward economic functions and interprovincial linkages along the corridor, extending existing applications of this framework in research on Belt and Road cities (Zhao & Yu, 2017; Zhao, Wang, & Zhao, 2018; Qin, Qian, Zeng, & Wei, 2022). Second, we exploit the 2019 launch of the NWLSC "13+1" cooperation mechanism as a quasi-natural experiment and employ a multi-period difference-in-differences (DID) design using provincial panel data from 2014 to 2022 to identify the corridor's causal effects on regional economic coordination. Third, we assess heterogeneity by geographical zone—northern inland, central transitional, and southern coastal—and by development level to evaluate how spatial and structural characteristics shape the distribution of policy benefits. Through these contributions, the study adds empirical evidence to the literature on infrastructure-led regional integration and provides policy-relevant insights for improving the effectiveness and inclusiveness of corridor-oriented development strategies.

This study not only contributes to understanding the NWLSC but also provides broader insights into how large-scale multimodal corridors can promote regional integration in developing economies, complementing global evidence from the Greater Mekong Subregion, East Africa, and the Trans-European Transport Network.

The remainder of this paper is structured as follows. Section 2 reviews relevant literature on the NWLSC and regional coordinated development. Section 3 details the research design, variable construction, data sources, and empirical strategy. Section 4 presents the baseline results and robustness checks. Section 5 investigates geographical and developmental heterogeneity in policy effects. Section 6 concludes with key findings, policy implications, and directions for future research.

2. Literature Review

2.1 Research on the New Western Land–Sea Corridor

Existing research on the New Western Land–Sea Corridor (NWLSC) has largely focused on its strategic role within China's broader opening-up and regional development frameworks. Studies highlight that the NWLSC enhances multimodal logistics efficiency, strengthens connections between inland provinces and ASEAN markets, and improves participation in global value chains (Fu, 2019; Quan, 2021; Chen & Xie, 2023). Micro-level analyses similarly document improvements in supply chain organization, port–rail coordination, and logistics network structures across the provinces engaged in the International Land–Sea Trade Corridor (Zhao & Wang, 2023; Ding et al., 2021).

From an international perspective, transport corridors similar to the NWLSC—such as those in the Greater Mekong Subregion (GMS) provide important conceptual insights. Banomyong (2008) shows that physical connectivity alone is insufficient; instead, border procedures, regulatory harmonization, and coordinated logistics

services are critical for unlocking corridor-wide benefits. The broader transport geography literature also emphasizes that corridors reshape accessibility and network structures, influencing trade, logistics performance, and spatial integration (Rodrigue, 2020). These findings provide a comparative context suggesting that the NWLSC's effects should be evaluated not only in terms of logistics performance but also through its capacity to transform regional economic linkages.

Despite these contributions, the existing NWLSC literature remains primarily descriptive and logistics focused. Few studies investigate whether the corridor has strengthened interprovincial functional linkages or facilitated coordinated regional development, leaving a significant empirical gap.

2.2 Research on Coordinated Regional Economic Development

International research on coordinated regional development highlights that regional integration is driven by improvements in accessibility, reductions in transport costs, and the development of cross-regional institutional frameworks. Studies in the European Union emphasize that integrated transport networks such as the Trans-European Transport Network (TEN-T) can promote cohesion and reduce disparities, although the distribution of benefits is often uneven (Ortega, López, & Monzón, 2012). Extensive transport surveys similarly show that infrastructure investment produces broader economic and spatial impacts by reshaping competitiveness, labor mobility, and regional hierarchies (Rosik & Wójcik, 2023).

Beyond Europe, research on transport corridors in South and Southeast Asia—the Greater Mekong Subregion, South Asia Subregional corridors, and related cross-border initiatives—demonstrates that infrastructure and institutional coordination jointly drive regional growth (Banomyong, 2008; Quium, 2019). These studies emphasize that while corridors can promote spatially balanced and inclusive development, the magnitude and direction of effects vary significantly across locations depending on pre-existing connectivity, institutional quality, and industrial base.

Within China, scholars have developed multidimensional frameworks to measure coordinated development, considering industrial structure, innovation, population dynamics, and environmental sustainability (Bai et al., 2018; Sun & Zhang, 2021; Qin & Cui, 2019). Spatial econometric studies identify significant spillovers within major urban clusters, with transportation infrastructure and institutional coordination playing central roles (Wang et al., 2024; Jiang et al., 2022). Additional evidence shows that new forms of infrastructure—such as high-speed rail or digital networks—can enhance factor mobility and convergence, although effects again vary spatially (Du et al., 2022; Zhang et al., 2024).

Overall, the literature suggests that coordinated development depends on both physical connectivity and institutional integration. However, most studies focus on national planning or specific urban clusters, and few examine how a major transport corridor—such as the NWLSC—affects functional economic linkages at the provincial level. This gap underscores the need for empirical evaluation of the corridor's regional coordination effects.

2.3 Theoretical Mechanisms Linking Transport Corridors and Regional Coordination

Transport corridors influence regional coordination through multiple theoretical channels. From the perspective of spatial economics, reductions in transportation and trade costs reshape the spatial organization of economic activity, altering firm location choices, market access, and the structure of interregional interactions (Redding & Turner, 2015). Improved connectivity expands market reach, lowers logistics frictions, and facilitates the movement of goods, information, labor, and capital, thereby strengthening functional economic linkages across regions.

Evidence from international corridor development further indicates that the impacts of improved connectivity are often spatially heterogeneous and cumulative. Ortega et al. (2012) show that accessibility gains tend to be concentrated near major nodes, while more remote areas may experience weaker or delayed benefits. Similar findings emerge from corridor experience in the GMS and South Asia, where significant socio–economic improvements occur only when physical infrastructure is complemented by institutional coordination and regulatory integration (Banomyong, 2008; Quium, 2019).

These theoretical insights suggest that the NWLSC may enhance regional coordination by reducing logistic and institutional frictions and improving network accessibility. However, the magnitude and distribution of these effects likely depend on geographic location, port access, and pre-existing development levels. Despite theoretical expectations, empirical evidence quantifying these effects at the provincial level remains scarce—highlighting the need for rigorous causal analysis.

2.4 Research Gaps and Contributions of This Study

Despite substantial progress in related fields, the existing literature exhibits several notable limitations. Most research lacks causal identification and relies primarily on descriptive mapping, case studies, or partial-equilibrium analysis, leaving unresolved whether and to what extent the New Western Land–Sea Corridor (NWLSC) has strengthened interprovincial economic coordination. Moreover, functional linkage indicators—such as urban flow intensity, which directly capture outward economic roles and the structure of interregional interactions—remain underutilized in assessments of the corridor, constraining understanding of how it reshapes regional economic connectivity. In addition, although spatial heterogeneity in corridor impacts is frequently acknowledged, studies seldom undertake systematic comparisons across northern, central, and southern provinces or across regions at different development stages. Addressing these gaps, this study constructs a province-level urban flow intensity index to measure functional economic linkages, employs a multi-period difference-in-differences design using the 2019 launch of the “13+1” cooperation framework as a quasi-natural experiment to identify the causal effects of the NWLSC, and examines both geographical and developmental heterogeneity to reveal how spatial conditions shape the distribution of policy benefits. Through these efforts, the study contributes empirical evidence on how large-scale transport corridors influence

coordinated regional development and provides policy-relevant insights for enhancing the effectiveness of infrastructure-led integration strategies.

3. Research Design

3.1 Policy Background and Identification Strategy

The New Western Land–Sea Corridor (NWLSC) was formally introduced in 2019, when China's National Development and Reform Commission released the Master Plan and established a cross-provincial cooperation mechanism designed to coordinate multimodal logistics, rail–sea integration, and institutional harmonization among participating regions. Although the corridor had been discussed prior to 2019, the policy announcement marked the first time that a unified regulatory and governance framework was implemented. This policy change created a clear and exogenous temporal boundary that can be used for empirical identification.

The official launch of the NWLSC expanded multimodal rail–sea services, strengthened connections between western inland provinces and southern coastal ports, and promoted a standardized set of logistics coordination rules across multiple provincial-level jurisdictions. Importantly, the 2019 reform applied only to a specific group of provinces, while other provinces were not directly incorporated into the corridor framework. This staggered and selective policy rollout provides the conditions necessary for a quasi-natural experiment.

To estimate the causal effect of the NWLSC on regional economic coordination, we employ a multi-period difference-in-differences (DID) design. The treated group consists of the provinces officially included in the NWLSC—Chongqing, Guangxi, Guizhou, Gansu, Qinghai, Xinjiang, Yunnan, Ningxia, Shaanxi, Sichuan, Inner Mongolia, Tibet, and Hainan—while all other provincial-level regions serve as the control group. The pre-policy period is defined as 2014–2018, and the post-policy period as 2019–2022.

This identification strategy rests on the assumption that, in the absence of the NWLSC, the treated and control provinces would have followed similar trends in regional economic linkage strength. The multi-period DID model allows us to control for time-invariant regional characteristics as well as shocks common to all provinces in a given year. By exploiting both cross-sectional variation in NWLSC participation and temporal variation around the 2019 policy implementation, the framework isolates the corridor's impact on interregional economic coordination from broader macroeconomic trends.

This approach aligns with international empirical studies that use corridor openings, infrastructure upgrades, or institutional reforms as quasi-natural experiments to identify the effects of connectivity improvements (e.g., Ortega et al., 2012; Quium, 2019; Banomyong, 2008). It also allows us to examine dynamic and heterogeneous effects across geographical zones and across provinces at different development stages.

3.2 Variable Definitions and Measurement

(1) Dependent Variable: Urban Flow Intensity (UFI)

UFI captures outward-oriented functional economic linkages and serves as a proxy for interregional connectivity, aligning with international approaches that measure economic interaction through specialization and network intensity.

The main dependent variable is the logarithm of urban flow intensity (lnUFI), which measures the outward functional linkages of each province within the national economic system. UFI reflects the strength of interprovincial economic interactions and has been used in analyses of regional connectivity and functional economic networks (Zhao & Yu, 2017; Zhao et al., 2018; Cheng & Xu, 2023). UFI is computed through three steps:

1. Location Quotient (LQ):

$$LQ_{ij} = \frac{Q_{ij}/Q_i}{Q_j/Q} \quad (1)$$

where q_{ij} is employment in industry j in province i; q_i is total provincial employment; Q_j is national employment in industry j; and Q is total national employment.

Industries with $LQ_{ij} > 1$indicate functional specialization.

2. Outward Functional Volume (E_i):

For industries with $LQ_{ij} > 1$, the outward functional volume of province i is:

$$E_i = \sum_{j=1}^{m} E_{ij} = \sum_{j=1}^{m} \left(Q_{ij} - Q_i \left(\frac{Q_j}{Q} \right) \right) \quad (2)$$

If LQ < 1, then $E_i = 0$.

3. Functional Efficiency

$$UFIi = ln(E_i/Q_i) \quad (3)$$

Higher values indicate stronger outward functional linkages. To ensure industry representativeness and reduce regional differences in economic levels and industrial structures, 12 key industries are chosen (Table 1) (Zhao and Yu, 2017; Zhao et al., 2018).

Table 1: Industries for Calculating Urban Flow Intensity

Industry	Sector	Function
Secondary Industry	Manufacturing	Urban productive function
Tertiary Industry	1. Warehousing and Postal Services; 2. Finance; 3. Wholesale and Retail; 4. Information Transmission, Computer Services, and Software; 5. Culture, Sports, and Entertainment; 6. Public Administration and Social Organizations; 7. Transportation; 8. Education; 9. Scientific and Technological Services and Geological Exploration; 10. Real Estate; 11. Accommodation and Catering	Urban service function

(2) Core Explanatory Variable

The treatment variable is constructed as $pol_{it} = treat_i \times post_t$, where $treat_i = 1$ if province i belongs to the NWLSC, $post_t = 1$ for years ≥ 2019, and $pol_{it} = 1$ only for treated provinces after the policy implementation. This interaction term identifies the policy exposure of each province–year observation.

(3) Control Variables

To account for other factors that may influence interprovincial economic linkages, we include a set of standard control variables commonly used in studies of regional development and policy evaluation (Chen et al., 2021; Cheng & Xu, 2023). Government intervention is measured by the logarithm of provincial government expenditure. Industrial structure is captured by the share of value added in the secondary sector. Transport infrastructure is represented by highway density. Investment level is measured using the logarithm of fixed asset investment, while openness is represented by the logarithm of total imports and exports. Finally, market consumption capacity is captured by the logarithm of total retail sales of consumer goods. All monetary variables are expressed in logarithmic form to reduce heteroskedasticity and improve comparability across provinces.

(4) Data Sources and Descriptive Statistics

All data are drawn from the *China Statistical Yearbook*, *China City Statistical Yearbook*, and provincial statistical bulletins. The final dataset covers 13 NWLSC provinces and a balanced panel from 2014 to 2022. Variable descriptions and summary statistics are shown in Table 2.

Table 2: Descriptive Statistics of Variables

Variable	(1)	(2)	(3)	(4)	(5)
	Observations	Mean	Std. Error	Min	Max
Lnufi	162	7.401	1.025	5.511	10.21
Gov	162	0.342	0.247	0.144	1.346
Lninv	162	9.457	0.973	7.167	10.93
Ind	162	0.405	0.0668	0.191	0.540
Lncon	162	8.642	1.153	6.012	10.70
Tran	162	0.804	0.535	0.0615	2.237
Trade	162	0.146	0.161	0.00947	0.875

3.3 Econometric Model

To estimate the causal effects of the NWLSC, we adopt a multi-period DID model $lnUFI_{it} = \alpha + \beta pol_{it} + \gamma X_{it} + \mu_i + v_t + \epsilon_{it}$, where $lnUFI_{it}$ denotes the logarithm of urban flow intensity for province i in year t. The term pol_{it} is the treatment indicator capturing whether a province is included in the NWLSC and observed after the 2019 policy implementation. The vector X_{it} represents the set of control variables discussed earlier. The term μ_i denotes province fixed effects, which absorb all time-invariant regional characteristics such as geographical endowments and long-standing industrial structures. The term λ_t represents year fixed effects, capturing macroeconomic shocks or national policy changes common to all provinces in a given year. The error term is represented by ϵ_{it}.

The coefficient of interest is β, which measures the average treatment effect of the NWLSC on interprovincial economic linkage strength. This modeling strategy follows established empirical approaches in the evaluation of policy-induced changes in connectivity and regional development (e.g., Ortega et al., 2012; Quium, 2019; Banomyong, 2008). Province and year fixed effects jointly ensure that identification relies on within-province changes relative to the control group, net of common time shocks.

To verify the validity of the DID design, we conduct several auxiliary tests. First, an event-study specification is used to examine the parallel trends assumption prior to the policy intervention. Second, placebo analyses—based on alternative pseudo-policy years and on random reassignment of treatment status—assess whether spurious effects are present. Third, additional robustness checks are performed using lagged specifications of the policy variable and alternative constructions of the UFI measure. These procedures collectively strengthen the causal interpretation of the estimated policy effect.

4. Empirical Analysis

4.1 Baseline Regression Results

Table 3 reports the baseline estimates of the multi-period DID model. Column (1) presents the specification without control variables, while Column (2) incorporates

government intervention, industrial structure, investment level, transport infrastructure, openness, and consumption capacity. Both specifications include province and year fixed effects.

Table 3: Baseline Regression Results

Variable	(1) lnufi1	(2) lnufi2
Pol	0.137*** (0.0514)	0.170*** (0.0581)
Gov		0.0815 (0.527)
Lninv		0.250*** (0.0921)
Ind		0.708 (0.660)
Lncon		-0.143 (0.121)
Tran		-0.0117 (0.0718)
Trade		-0.269 (0.361)
Constant	7.349*** (0.0259)	5.940*** (1.085)
Time Fixed Effects	Yes	Yes
Region Fixed Effects	Yes	Yes
Observations	162	162
R-squared	0.962	0.964

*Note: *, **, *** show significance at 10%, 5%, and 1% levels, respectively.*

The coefficient of the policy variable *pol*, which captures the interaction between NWLSC participation and the post-2019 period, is positive and statistically significant at the 1% level in both models. Specifically, the estimated coefficient increases from 0.137 in Column (1) to 0.170 in Column (2), indicating that the NWLSC leads to an average 17% increase in urban flow intensity relative to non-participating provinces after controlling for other factors. This finding provides strong causal evidence that the NWLSC significantly strengthens interprovincial economic linkages and contributes to coordinated regional development.

Among the control variables, fixed asset investment exhibits a consistently positive and significant effect, suggesting that greater capital investment enhances outward economic functions and strengthens regional connectivity. Government intervention and industrial structure are positive but statistically insignificant, implying that their independent contributions to coordinated development are

limited once other factors are controlled.

Openness, consumption capacity, and transportation infrastructure show negative but insignificant coefficients. Several explanations may account for this pattern. First, increased openness may intensify competition across provinces, causing resources—capital, technology, and talent—to concentrate in already advantaged regions, thereby weakening interregional connection strength. Second, differences in consumption structure and market size may create fragmented regional markets, hindering cross-border economic linkages. Third, the unequal distribution of transportation infrastructure may exacerbate disparities between well-connected and poorly connected regions, reducing the overall level of coordinated development. These findings are consistent with evidence from Xie et al. (2023), who show that the NWLSC's economic benefits tend to be spatially heterogeneous, shaped by regional accessibility and existing industrial bases.

4.2 Robustness Tests

(1) Parallel Trends Test

A valid DID design requires the treatment and control groups to exhibit parallel pre-policy trends. Following Huang and Zhang (2019), we construct a series of leads and lags of the pol variable covering the five years before and after 2019. Figure 1 illustrates the estimated dynamic coefficients with 95% confidence intervals.

Results show that all pre-policy coefficients (pre5–pre1) are statistically indistinguishable from zero, confirming that treated and control provinces followed comparable trajectories prior to the NWLSC. The coefficients begin to rise after 2019, with statistical significance emerging in the second post-policy year. This dynamic pattern indicates that the NWLSC generated gradually increasing impacts over time rather than abrupt short-term shocks, consistent with the corridor's infrastructure-driven nature.

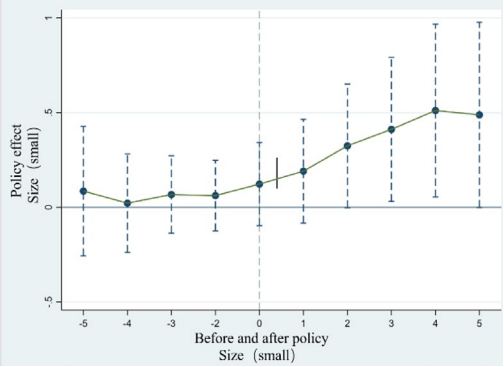

Figure 1: Parallel Trends Test Results

(2) Time Placebo Test

To further confirm that the observed treatment effects are not driven by spurious time patterns, we perform a time placebo test by artificially assigning the policy implementation year to 2014, 2015, and 2016. Table 4 presents the results. In all placebo settings, the pseudo-policy coefficients (*pol*) are statistically insignificant,

demonstrating that no false effects are detected in pre-policy periods. This reinforces the credibility of the baseline DID estimates and suggests that the NWLSC impact is not the result of underlying pre-trends or random temporal noise.

Table 4: Time Placebo Test Results

Variable	lnufi1	lnufi2	lnufi3
Pol_*	0.0555 (0.0703)	0.0316 (0.0749)	0.0226 (0.0848)
Gov	-0.122 (0.691)	-0.158 (0.692)	-0.187 (0.687)
Lninv	0.179 (0.116)	0.17 (0.116)	0.168 (0.116)
Ind	0.48 (0.820)	0.456 (0.821)	0.445 (0.821)
Lncon	-0.0898 (0.19)	-0.0803 (0.189)	-0.0795 (0.19)
Tran	0.00229 (0.132)	0.00988 (0.132)	0.0141 (0.131)
Trade	-0.163 (0.551)	-0.16 (0.554)	-0.147 (0.553)
Constant	6.323*** (1.695)	6.358*** (1.698)	6.376*** (1.698)
Observations	162	162	162
Rsquared	0.962	0.962	0.962

(3) Province-Level Placebo Test

Following Li et al. (2016), we perform a placebo test by randomly reassigning treatment status across provinces and constructing 500 pseudo-samples. The resulting kernel density distribution of the placebo coefficients is centred around zero and displays an approximately normal distribution (Figure 2). Moreover, the vast majority of placebo coefficients are statistically insignificant, while the true treatment effect (vertical line) lies far in the right tail of the distribution. These results confirm that the estimated NWLSC effects are unlikely to be driven by unobservable province characteristics or sample-specific factors.

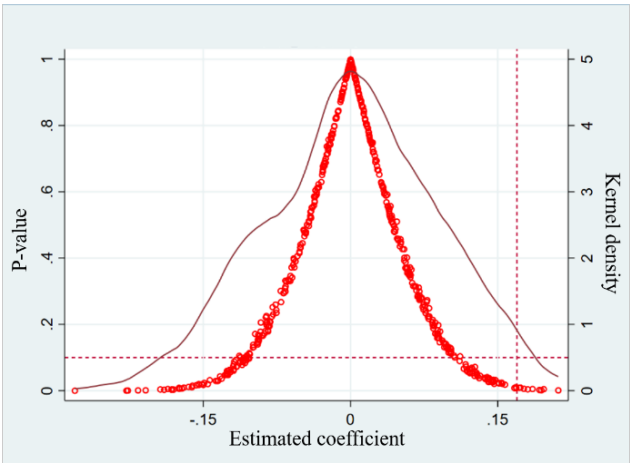

Figure 2. Placebo Test Result

(4) Alternative Dependent Variable

To address potential biases arising from industrial structure heterogeneity, we recalculate the urban flow intensity measure by excluding industries with uneven outward-function distributions (such as construction and accommodation/catering), following Zhao et al. (2018). Table 5 reports the results. The *pol* coefficient remains positive and significant, indicating that the main conclusion does not depend on the specific definition of outward economic functions. This provides further validation of the baseline results.

(5) Additional Robustness Checks

We conduct three further tests to address potential endogeneity and outlier concerns. First, lagging the core explanatory variable by one period yields a coefficient of 0.200, significant at the 1% level (Column 1, Table 6). Second, lagging all control variables also produces consistent results, with the pol coefficient remaining positive and significant at the 5% level (Column 2). Third, trimming all variables at the 1% and 99% percentiles to mitigate extreme-value distortions yields a similar estimate of 0.152 (Column 3). These tests demonstrate that the NWLSC's positive effect is robust to different model specifications, lag structures, and sample adjustments.

Table 5: Robustness Test Results 1

Variables	*lnufi*
Pol	0.217**
	(0.107)
Gov	-0.765
	(0.929)
Lninv	0.0697
	(0.113)

Ind	1.054 (1.024)
Lncon	-0.0343 (0.177)
Tran	0.272 (0.202)
Trade	-0.809 (0.541)
Constant	6.317*** (1.682)
Observations	162
R-Squared	0.895

Overall, the robustness evidence strongly supports the conclusion that the NWLSC has substantially enhanced economic linkages and strengthened regional coordination among participating provinces.

Table 6: Robustness Test Results 2

Variables	(1)	(2)	(3)
	lnufi	lnufi_lag1	lnufi_lag2
Pol_Lag1	0.200*** (0.0676)	0.150** (0.0597)	0.152** (0.0596)
Gov	0.102 (0.496)		
Lninv	0.206** (0.101)		
Ind	0.856 (0.746)		
Lncon	-0.139 (0.113)		
Tran	-0.0245 (0.0802)		
Trade	-0.455 (0.347)		
Gov_Lag1		0.128 (0.507)	0.0663 (0.541)
Lninv_Lag1		0.212** (0.098)	0.227** (0.0997)
Ind_Lag1		0.387 (0.692)	0.346 (0.693)
Lncon_Lag1		-0.132 (0.151)	-0.145 (0.152)
Tran_Lag1		0.0864 (0.149)	0.0966 (0.152)

Trade _Lag1		-0.257 (0.364)	-0.278 (0.427)
Constant	6.338*** (1.198)	6.230*** (1.221)	6.230*** (1.244)
Observations	144	144	144
R-Squared	0.963	0.964	0.963

5. Heterogeneity Analysis

5.1 Geographical Heterogeneity

To examine whether the impact of the NWLSC differs across space, we first divide the sample into three geographical zones: **northern inland** (Shaanxi, Gansu, Ningxia, Xinjiang, Inner Mongolia, Tibet, Qinghai, Shanxi), **central inland** (Chongqing, Sichuan, Guizhou, Hubei, Hunan, Henan), and **southern coastal** (Guangxi, Yunnan, Hainan, Guangdong). This classification reflects differences in location, access to ports, and historical development patterns along the corridor. Consistent with our DID-based results, recent township-level Gradual-DID evidence on rail–sea intermodal services also find persistent and lagged regional benefits with spatial spillovers, agglomeration effects, and distance attenuation along the ILSTC (Ou & Yang, 2025). To capture geographic heterogeneity, we estimate the following extended model:

$$lnufi_{it} = \alpha + \beta pol_{it} * Region + \gamma Control_{it} + v_t + \mu_t + \varepsilon_{it} \quad (6)$$

where $Region_i$ is a set of dummy variables indicating whether province i belongs to the northern inland, central transitional, or southern coastal zone. The interaction term $pol_{it} \times Region_i$ allows the policy effect to vary by region.

Table 7 reports the results. After including control variables, the estimated coefficients on the interaction term are approximately 0.107 for the northern inland region and –0.0289 for the central transitional region, both statistically insignificant. In contrast, the coefficient for the southern coastal region is about 0.210 and significant at the 1% level. These findings indicate that the NWLSC has not yet produced a statistically significant improvement in coordinated economic development for northern or central provinces, whereas it has generated a strong and robust positive effect in the southern coastal region.

This pattern is consistent with several underlying mechanisms. Southern provinces enjoy clear port and shipping advantages, with the corridor providing direct access to maritime routes and international markets. They also host dense industrial clusters in manufacturing, logistics, tourism, and services, which are more immediately able to exploit improved rail–sea connectivity and derive network externalities from the corridor. By contrast, northern inland provinces are more distant from key ports, have more fragmented transport networks, and face greater natural and geographic constraints. Although China has continuously expanded its transport infrastructure, the degree of integration between northern inland nodes and the main NWLSC trunk remains relatively low, limiting the short- to medium-term gains in economic linkages.

Central provinces, while better connected than the north, may primarily function as transit corridors rather than final destinations, so the incremental effect on their own outward functional strength is smaller.

Overall, the geographic heterogeneity results suggest that the NWLSC currently acts as a stronger growth and coordination engine for southern coastal provinces, while additional complementary policies and infrastructure investments are needed to translate corridor access into tangible coordination gains in central and northern inland regions.

Table 7: Geographical Heterogeneity Regression Results

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	North	North	Central	Central	South	South
	lnufi	lnufi	lnufi	Lnufi	lnufi	lnufi
Pol_Region	0.0473 (0.0614)	0.107 (0.075)	0.00164 (0.0526)	-0.0289 (0.057)	0.189*** (0.0542)	0.210*** (0.0571)
Gov		-0.0428 (0.592)		-0.231 (0.58)		-0.187 (0.538)
Lninv		0.244** (0.102)		0.191** (0.0902)		0.173* (0.0887)
Ind		0.44 (0.659)		0.41 (0.7)		0.693 (0.12)
Lncon		-0.0557 (0.12)		-0.0805 (0.127)		-0.117 (0.125)
Tran		0.0444 (0.0721)		0.0245 (0.0626)		-0.0328 (0.0549)
Trade		-0.137 (0.381)		-0.215 (0.384)		-0.421 (0.382)
Constant	7.392*** (0.0221)	5.379*** (1.413)	7.401*** (0.0184)	6.216*** (1.316)	7.385*** (0.017)	6.625*** (1.229)
Observations	162	162	162	162	162	162
R-Squared	0.961	0.963	0.961	0.962	0.962	0.964

5.2 Heterogeneity by Economic Development Level

We investigate whether the effects of the NWLSC differ by the level of economic development. Following Yang et al. (2023), provinces are grouped according to the median of provincial GDP into three categories: developed (Guangdong, Sichuan, Hubei, Hunan, Chongqing), developing (Henan, Shaanxi, Yunnan, Guangxi, Shanxi, Hainan), and less-developed (Inner Mongolia, Guizhou, Xinjiang, Gansu, Ningxia, Qinghai, Tibet). The model is extended as:

$$lnufi_{it} = \alpha + \beta pol_{it} * Econo + \gamma Control_{it} + v_t + \mu_t + \varepsilon_{it} \quad (7)$$

where $Econo_i$ is a set of dummies for developed, developing, and less-developed provinces, and the interaction term captures how the policy effect varies with development level.

Table 8 presents the results. After adding control variables, the interaction

coefficient for developed provinces is around –0.119 and statistically significant at the 5% level, suggesting that the NWLSC may slightly crowd out or dampen coordinated linkage growth in these regions. For developing provinces, the estimated coefficient (approximately 0.0515) is positive but statistically insignificant, implying no clear effect in this group. By contrast, for less-developed provinces, the interaction term is about 0.233 and significant at the 1% level, indicating that the NWLSC generates substantial improvements in economic linkages for historically lagging regions.

These results are in line with theories of market access and diminishing marginal returns to infrastructure. Less-developed provinces often suffer from poor connectivity, limited market access, and restricted participation in national and global value chains. Corridor construction relaxes these constraints by expanding transport capacity, reducing trade and logistics costs, and connecting peripheral regions to core markets. Together with targeted policy support and financial resources, this creates new opportunities for industrial upgrading, export expansion, and integration into regional production networks, leading to disproportionally large gains in their outward functional roles and interprovincial linkages.

For developed provinces, which already have relatively complete transport systems and strong industrial bases, the marginal benefit of the NWLSC is more limited. In addition, the corridor may reallocate traffic, investment, and policy attention toward newly connected less-developed regions, potentially intensifying competition and reducing the net growth of their own linkage index. Developing provinces lie between these two extremes: they benefit from improved connectivity but may face competition both from more advanced regions and from newly favored less-developed areas, resulting in statistically insignificant net effects in the short run.

In summary, the heterogeneity analysis shows that the NWLSC is particularly effective in strengthening economic linkages in less-developed regions and southern coastal provinces, while its impact is weaker or even negative for developed provinces and northern inland areas. This has important implications for policy design: to fully realize the corridor's potential for balanced regional development, differentiated and region-specific supporting policies are needed to help central and northern inland regions, as well as more developed provinces, better integrate into the evolving corridor network.

Table 8: Economic Development Level Heterogeneity Regression Results

Variables	(1) Developed lnufi	(2) Developed lnufi	(3) Developing lnufi	(4) Developing Lnufi	(5) Less Developed lnufi	(6) Less Developed lnufi
Pol_Econo	-0.0877* (0.0475)	-0.119** (0.0548)	0.0489 (0.0663)	0.0515 (0.0702)	0.150** (0.0575)	0.233*** (0.0618)
Gov		-0.245 (0.0618)		-0.234 (0.57)		0.17 (0.564)

Lninv		0.198** (0.0898)		0.182** (0.0885)		0.321*** (0.0975)
Ind		0.373 (0.698)		0.472 (0.71)		0.475 (0.614)
Lncon		-0.0795 (0.123)		-0.101 (0.125)		-0.108 (0.118)
Tran		0.0485 (0.0698)		0.00783 (0.0612)		0.0866 (0.0965)
Trade		-0.197 (0.377)		-0.297 (0.38)		0.11 (0.311)
Constant	7.407*** (0.0172)	6.149*** (1.242)	7.396*** (0.018)	6.471*** (1.244)	7.370*** (0.0224)	4.912*** (1.088)
Observations	162	162	162	162	162	162
R-Squared	0.961	0.963	0.961	0.962	0.963	0.965

6. Conclusions and Policy Suggestions

This study contributes to the international literature on infrastructure-led regional integration by providing causal evidence from the New Western Land–Sea Corridor (NWLSC), a major multimodal transport initiative in western China. Using provincial panel data from 2014–2022 and a multi-period DID framework, we show that the NWLSC significantly strengthens interprovincial economic linkages. The estimated effect remains highly robust across event-study tests, placebo exercises, alternative functional linkage measures, and lagged specifications, underscoring the credibility of the causal estimates. These results add to global empirical evidence demonstrating that large-scale transport corridors can reshape economic connectivity, reduce logistical frictions, and influence the spatial configuration of regional development.

The dynamic analysis indicates that the NWLSC's impact grows progressively over time, consistent with the cumulative nature of corridor development observed in other regions such as the Greater Mekong Subregion, Sub-Saharan Africa, and the Trans-European Transport Network. However, the effects are not spatially uniform. Southern coastal provinces—characterized by better port accessibility and more developed logistics ecosystems—experience the greatest increases in functional linkages. Less-developed inland regions also exhibit substantial gains, reflecting the transformative role of improved connectivity in overcoming historical market access constraints. By contrast, central and northern inland provinces show limited or insignificant responses, highlighting persistent structural barriers that inhibit their ability to fully leverage corridor-related opportunities.

These findings carry broader implications for transport corridor planning in China and in other developing and emerging economies. First, the results highlight the importance of sustained institutional coordination. Successful corridor development requires not only physical infrastructure but also supportive

governance frameworks that facilitate multimodal integration, reduce administrative fragmentation, and harmonize standards—lessons consistent with corridor experiences in Southeast Asia and Africa. Strengthening cross-regional cooperation mechanisms and improving logistics governance are therefore essential for maximizing corridor-wide benefits.

Second, the heterogeneous effects observed across provinces underscore the need to strategically leverage the spillover potential of major hub cities. International research shows that well-connected metropolitan centers often act as growth poles that transmit productivity, technology, and logistics advantages to surrounding regions. Strengthening functional linkages between core hubs such as Chongqing and Chengdu and neighboring inland provinces could help generate broader spatial spillovers and reduce regional disparities.

Third, targeted complementary investments are critical for regions with weak initial conditions. The evidence from both China and other developing regions indicates that improvements in "last-mile" connectivity, feeder transport networks, and logistics service capacity are essential for enabling lagging areas to participate in corridor-related economic flows. Tailored interventions—such as incentivizing logistics firms, supporting multimodal transport operators, and encouraging industrial clustering around inland hubs—can help amplify corridor benefits and prevent the reproduction of spatial inequality.

Finally, the study demonstrates that transport corridors can function as platforms for long-term, balanced regional development when embedded within broader national and regional strategies. For countries implementing similar initiatives—whether in Asia, Africa, or Latin America—our findings highlight the importance of aligning corridor construction with regional planning, industrial policy, and cross-jurisdictional governance. When properly coordinated, transport corridors can evolve beyond logistics channels into integrative mechanisms that reshape economic geography, foster regional cohesion, and support sustainable growth.

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