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# SUSTAINABLE DEVELOPMENT IN CHINA'S MAJOR CITIES: THE IMPACT OF LOGISTICS ON THE ECONOMY UNDER THE BELT AND ROAD INITIATIVE

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# Sustainable development in China's major cities: the impact of logistics on the economy under the Belt and Road Initiative

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## Abstract

Previous studies have shown that the direction of government policies can have a significant impact on economic development. The Belt and Road Initiative (B&R) has considerably benefitted the regions it includes. A quantified and in-depth analysis of the Initiative's actual benefits has not yet been carried out, however. This study attempts to fill this gap and examines the impact of the government's economic development policy from a coordination perspective. The B&R is said to have significantly contributed to economic growth, but no quantified analysis of its positive impacts and its effects on sustainable economic development is available. This study analyses the Initiative's influence on the logistics performance and economic development of a select number of major cities in China. Our study concludes that (1) the Initiative is positively correlated with the economic development of the major cities examined; (2) it reinforces logistics development, which in turn promotes economic development and fosters economic integration in the global economy; and (3) our findings guide investment planning and policy making to promote the sustainable development of cities. The model proposed in our study can be used by cities to improve sustainability and to monitor the progress made in logistics, which is directly correlated with economic development.

**Keywords**: economic development of major cities; sustainable development; sustainability of logistics in major cities; Belt and Road Initiative

# 1 Introduction

Cities are increasingly using emerging information technologies to build new urban forms that simultaneously foster multiple goals such as prosperity, efficiency and competitiveness, and comprehensive development by balancing the three dimensions of sustainable growth, namely the economic, social and environmental dimensions. This is particularly the case in municipalities, provincial capitals and cities that show potential for growth, that have an important political status, a large economy, etc., and are often referred to as 'major cities' (Jong et al., 2015; Whiteman et al., 2010). Major cities have the capacity to achieve exceptional performance by improving resource utilization efficiency, optimizing urban management and operational services, and enhancing citizens' quality of life (Hills and Man, 1998; Ismagilova et al., 2019).

The logistics industry plays a crucial role in urban production systems. In the context of major cities with their large population size and economies, logistics is deeply integrated in information technologies, including big data and cloud computing, to meet the cities' demands in a timely manner (Kumar et al., 2016; Bag et al., 2020). Next-generation logistics involves efficient transport systems, smart warehousing, intelligent delivery, route tracking, precision supply chains, green logistics and many other aspects to provide smart, efficient and sustainable logistics services (Wen et al., 2018; Lan and Zhong, 2018). Logistics plays an important role in promoting economic development as a pillar industry of the national economy (Whiteman et al., 2010; Yang et al., 2019). A highly developed logistics system may attract investments and promote the allocation of different production factors, thus contributing to a rise in the region's economic efficiency and sustainability. Economic growth increases the demand for logistics which in turn promotes further economic growth through feedback effects (Hills and Man, 1998; Reza, 2013). Yet excessive investments in the development of regional logistics might also be a waste of resources. Thus, coordination is key for sustainable development. In other words, regional logistics and the economy should be coordinated if sustainable development is to be achieved. The quantified analysis we carry out to determine whether the level of development and the scope of logistics capabilities matches the regional economy can be an extremely useful tool.

The Belt and Road (B&R) Initiative introduced by China in 2013 was built on the existing multilateral mechanisms of China and the countries it has developed active economic partnerships with based on existing cooperation platforms, with the aim of establishing a community of shared interests and responsibilities grounded in mutual trust, economic integration and cultural inclusion (Cui and Song, 2019；Tian et al., 2019). UN Secretary-General Antonio Guterres has stated that the five pillars of the Belt and Road Initiative, namely policy coordination, facilities connectivity,

unimpeded trade, financial integration and people-to-people exchange, are closely linked to the 17 Sustainable Development Goals (SDGs). In this regard, the UN General Assembly adopted a Resolution to support the alignment of B&R with the SDGs. Over 150 countries and international organizations, including UNIDO, have to date signed the B&R cooperation framework with China, making the Initiative the largest international cooperation platform in the world and an important channel for all partners to reach consensus and promote cooperation.

To conduct a comprehensive analysis of the contribution and impact of the B&R on the construction of infrastructure of global value chains (GVCs), the National Development and Reform Commission (NDRC) of China and the United Nations Industrial Development Organization (UNIDO) agreed to produce the research report "Promoting Development of Global Value Chains through the Belt and Road Initiative" from 2018 to 2019, as part of the MoU on Jointly Promoting the Development of B&R signed between NDRC and UNIDO. The report highlights the positive role of infrastructure connectivity in promoting the development of GVCs.

The Initiative has also played an important role in increasing the level of trade within the region, strengthening national relations, and promoting economic development in underdeveloped regions (Huang, 2016). It is furthermore expected to strengthen economic growth in China as well as in other participating countries. The question, however, is how these economic benefits can be quantified and how the Initiative's support mechanism can be substantiated.

This study assesses the impact of the B&R Initiative on logistics and economic development as well as the trajectory of the logistics industry and the support mechanism for sustainable development in major cities. According to evaluations of urban indicators published by the China National Standardization Administration Committee (Lombardi et al., 2012), 35 representative major cities (with a large population size and economy) are selected, using the entropy method and a correlation analysis based on China's city tier system, a hierarchical classification of Chinese cities. Among these, 12 major cities are covered by the B&R Initiative. The biggest difficulty in evaluating the impact of policies lies in how to rule out the influence of other factors. This study therefore applies an improved difference in difference in difference (DIDID) model (Chen et al., 2018). By comparing the relevant parameters of both the experimental and the control group, we can eliminate the influence of unrelated factors. Moreover, considering the possible time lag of the B&R Initiative due to the extensive range of regions covered and the prolonged period before its impacts can be measured (Wei et al., 2019), this paper introduces a dynamic difference in difference (DID) measurement system to more accurately track the effects of the B&R Initiative (Wang et al., 2017).

This study makes four theoretical contributions, which are summarized below:

(1) It carries out an empirical analysis of the B&R Initiative's influence from the perspective of how logistics contribute to cities' sustainable economic development. It takes the time delay that may arise into consideration, closely traces the dynamic impact of the Initiative on the relevant regions, and determines that the advantages become evident in the third and fourth year following the launch of the Initiative.

(2) This study empirically analyses how the Initiative promotes regional economic development from the perspective of sustainability and coordination between regional logistics and the economy. The implementation of the B&R can alter cities' economic structure and improve the development and level of coordination between the economy and the logistics industry, intensifying sustainable economic development.

(3) This study also demonstrates that the B&R Initiative increases demand for logistics, improves the construction of logistics infrastructure, and enhances efficiency of the movement of goods, thereby further boosting sustainable economic development. This finding has policy implications, namely that the Initiative strengthens the national economy, which is of relevance for future policy making in major cities.

(4) It furthermore proposes a path for sustainable development, i.e., it advocates coordinated development between the logistics industry and the economy, as the development of logistics can lead to reductions in the cost of transport and curb cities' operational and maintenance costs. At the same time, this study provides guidance for future policies that should be tailored to the local conditions to improve cities structures and to receive full-circle feedback (Saba et al., 2020).

The remainder of this paper is structured as follows. Section 2 reviews existing studies on logistics in major cities, on economic and sustainable growth and the B&R Initiative. Section 3 presents the empirical analysis in detail, including the data sources used, a description of the main models and methods and the regression analysis. Section 4 summarizes the conclusions and implications of this study.

## 2. Literature review

### (1) The logistics industry's effects on the economic development of major cities

In previous studies, urban planning of major cities is presented from the perspective of emerging information technologies used to build urban infrastructure, including hardware, software and data (Zheng et al., 2014; Hashem et al., 2016; Mirza and Ahsan, 2019). Huovila et al. (2019) focus on a series of activities and cities' knowledge management processes as well as their overall development. They assert that from a process perspective, major cities have adopted a new city form to achieve prosperity, efficiency and competitiveness. Neirotti et al. (2014) identify the key factors in urban planning of major cities. One of the main objectives in terms of transport, for example, is optimizing the urban logistics system to make it more sustainable and environmentally friendly.

Today, we have shifted from a narrow to a broad perspective when we look at major cities, and no longer focus exclusively on technology, but take the city's comprehensive and sustainable development into consideration. For instance, Qi et al. (2019) highlight the importance of operations management in urban planning of major cities, asserting that opportunities arise when different systems and business models are integrated. The majority of studies reviewed conclude that measures related to material infrastructure, equipment and governance must be continuously improved to ensure sustainable urban development (Russo et al., 2016; Tseng et al., 2018; Wei et al., 2019).

### (2) The impact of logistics development on the economy

Logistics is of major economic significance in every country. Historically, the volume of freight movement and economic growth have always been deemed to be highly correlated (Dolati et al., 2019; Ferrell et al., 2020). Previous studies have investigated the interdependent relationship between logistics and the economy in terms of quantification (Van den Heuvel et al., 2013). For instance, Lean et al. (2014), using China's most recent logistics and economics data, apply the dynamic structure model to study the relationship between logistics development and economic growth in terms of total output, total demand and their decomposition. Using exploratory cluster mapping, a network content analysis and a Delphi analysis, Bolumole et al. (2015) explore how logistics assets can best be taken advantage of in a given region to enhance economic growth.

Based on select economic and logistics indicators, Čulková et al. (2015) conduct an economic assessment of the transport and logistics industries, which can contribute to improving the economy by reducing the costs, enhancing the quality and enhancing the efficiency of logistics

and consequently increasing productivity. Li et al. (2018), by developing an error correction model with panel data from 2003 and 2014 under the Belt and Road Initiative, confirm that the logistics infrastructure has positively contributed to economic growth and conclude that telecommunications and air transport are the most influential industries and should thus be prioritized to promote economic development and reduce inter-regional economic inequalities.

Lan et al. (2017) apply the entropy method and granger causality test to develop the urban logistics and economic evaluation index system. The evaluation system analyses the relationship between urban logistics and the economy, and further corroborates the role urban logistics play in promoting economic growth. Hylton & Ross (2018) find that the aggregation of the logistics industry and economic development in a given region mutually reinforce each other based on an empirical study of the postal service. D'Aleo & Sergi (2017) find a strong mutual reinforcement between the development of the logistics industry and some key components of a country's global competitiveness, including infrastructure, the human factor and institutions, all of which are of major significance for economic growth.

**(3) The impact of the B&R Initiative on logistics**

Huang (2016) asserts that the B&R Initiative is an international economic endeavour with the aim of stimulating economic development in regions extending to the Asian, European and African continents, accounting for 64 per cent of the world's population and 30 per cent of global GDP. The Initiative is considered to be a new economic growth pole for the countries it includes. Yang et al. (2017) find that the Initiative is conducive to the reconstruction of the shipping service network between Asia and Europe. They conclude that the B&R could optimize the reconstruction of the entire Eurasian transport network system.

According to Herrero et al. (2017), the Initiative could improve cross-border infrastructure and reduce transport costs between China and Europe. Zeng et al. (2018) apply the entropy maximization principle to develop an improved gravitational prediction model to calculate changes in transport volume. Other studies reveal that the opening of the "Maritime Silk Road" has influenced the volume of cargo in the Strait of Malacca, has affected the market share of transshipment between ports and diversified the shipping network system. Liu et al. (2018) review the coordination of the B&R Initiative's logistics supply chain and include logistics providers and integrators in their logistics supply model. The results show that the various cost allocation methods play an important role in each participant's key decisions.

## 3. Empirical study

### 3.1 Evaluation Indicator System

**(1) Major indicators**

| Dimension | Logistics indicator | Economic indicator |
|---|---|---|
| 1 | number of logistics employees | value added of the tertiary industry |
| 2 | civilian truck holdings | GDP per capita |
| 3 | total fixed asset investments in logistics | total investments in fixed assets |
| 4 | total postal business volume | total retail sales of consumer goods |
| 5 | road freight turnover | total resident population |
| 6 | | household consumption level |
| 7 | | public finance revenue |

**(2) Value**

The weight of these seven economic indicators and five logistics indicators are calculated using the entropy method. The scores of the economic and logistics level in different cities are calculated by multiplying the weights and the standardized indicators. The detailed calculation is presented in Section 3.4, Equations (1)-(4).

**(3) Descriptive analysis**

This study collected the logistics and economic data of 35 major cities from 2006 to 2017. The data covers all provincial capital cities, four municipalities and Hangzhou, Ningbo and Shenzhen, which deliver substantial economic growth in mainland China. The data were obtained from the Wind database. The description of the variables is provided in Table 1.

Table 1 shows that the gap between the economic development indicators of cities included in and those excluded from the B&R Initiative has narrowed considerably since the launch of the Initiative. Many of the cities included in the B&R Initiative are located in the central and western regions of China, which are less developed, i.e. the average economic indicators of the cities included in the Initiative were lower than those of the cities excluded from the B&R, with a difference of approximately 20 per cent. Following the implementation of the Initiative, this gap

decreased to around 10 per cent. This confirms that the Initiative has contributed to the economic development of the cities included. The gap between the logistics indicators of the cities included in and those excluded from the B&R has also been significantly reduced since the introduction of the Initiative.

**Table 1: Comparison of economic and logistics data before and after the launch of the B&R Initiative**

| **variables** | **Prior to the launch of the Initiative (2005-2012)** | | | | | **After the launch of the Initiative (2013-2017)** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | N | min | max | mean | sd | N | min | max | mean | sd |
| | Cities excluded from the Initiative | | | | | | | | | |
| **economy** | 176 | 0.074 | 0.932 | 0.315 | 0.206 | 110 | 0.084 | 0.861 | 0.326 | 0.200 |
| **logistics** | 176 | 0.052 | 0.923 | 0.272 | 0.210 | 110 | 0.036 | 0.789 | 0.231 | 0.180 |
| | Cities included in the Initiative | | | | | | | | | |
| **economy** | 104 | 0.067 | 0.581 | 0.252 | 0.142 | 65 | 0.092 | 0.613 | 0.294 | 0.156 |
| **logistics** | 104 | 0.026 | 0.684 | 0.252 | 0.176 | 65 | 0.025 | 0.846 | 0.240 | 0.189 |
| | Entire sample | | | | | | | | | |
| **economy** | 280 | 0.067 | 0.932 | 0.292 | 0.187 | 175 | 0.084 | 0.861 | 0.314 | 0.185 |
| **logistics** | 280 | 0.026 | 0.923 | 0.265 | 0.198 | 175 | 0.025 | 0.846 | 0.234 | 0.183 |

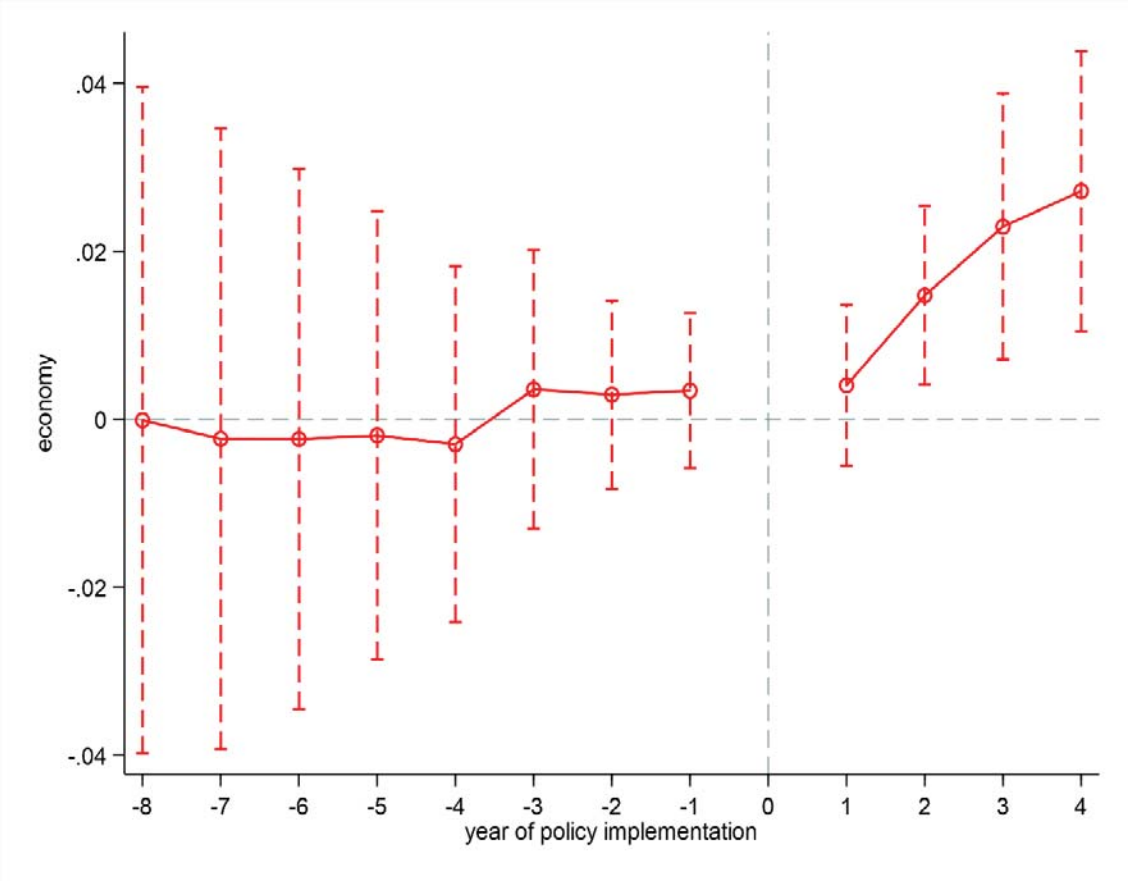
### 3.2 The influence of the B&R Initiative on the economy using the dynamic DID test

We use a dynamic DID test to examine the Initiative's dynamic effect on the economy and introduce a series of time dummy variables to trace its impact on economic development in the years following its implementation. The model is as follows:

$$economy_{i,t} = \alpha_{\mathrm{i}} + \beta_1 * did^{-8} + \beta_2 * did^{-7} + \cdots + \beta_{12} * did^{+3} + \beta_{13} * did^{+4} + \beta_{14} * logistic_{i,t} + \sum C_{\mathrm{i}} * year_t + \sum C_{\mathrm{i}} * city_i + \mathrm{B} * X + \varepsilon. \quad (1)$$

The model is based on the year of implementation, i.e., 2013. $did^{-8}$ for the cities included in 2005 is 1, and is otherwise 0. This method applies to the other variables as well. To avoid multicollinearity, the model does not include $did$ in 2013. The explanatory variable logistics and the control variables are added to the model and are represented by X. Figure 1 illustrates the regression results of the coefficient. The dots in the figure denote the coefficient estimation, and the dotted lines are the confidence interval of the coefficient estimation. The reliability of a DID model builds on the parallel trend assumption. Accordingly, any change in the dependent variables between the control group and the experimental group indicates a parallel trend prior to the occurrence of a given event. Thus, the later difference in the trends of the two groups' dependent variables can be fully attributed to this given event. In our research, the parallel trend test is included in the dynamic DID model. As Figure 1 shows, the coefficients of DID prior to and including 2013 are close to 0, and their confidence intervals are 0. This indicates that the economic development of the control group and of the experimental group did not differ significantly, regardless of any differences in independent variables, fixed effects or random errors. This validates the parallel trend assumption, that is, the two groups' samples are comparable in the DID model. We find that the implementation of the Initiative boosted the economic development of the regions included in Figure 1 considerably. We observe a long-term growth, which is particularly noticeable in the third and fourth year following the Initiative's implementation. Table 2 presents the estimated regression results of the coefficients. The coefficient estimation value of $did^{+3}$ and $did^{+4}$ is significantly positive at the 5 per cent significance level, which implies that the implementation of the Initiative had a significant positive influence on the economy of the cities included after the third year.

**Figure 1** **Dynamic effects of the B&R Initiative on the economic development in the regions included**




Based on these results, we find that, the economic indicators for the third year following the launch of the B&R Initiative are 0.016 higher in quantitative terms for the cities covered by the Initiative than those for the first year of implementation (2013). The economic values in the fourth year are 0.02 higher than in 2013. This result confirms that the B&R Initiative has a positive long-term influence on the economic development of the cities included at the 5 per cent significance level.

**Table 2: Estimated regression results of the coefficients**

| | (9) |
|---|---|
| logistic | 0.072* |
| | (0.038) |
| did+1 | -0.003 |
| | (0.005) |
| did+2 | 0.008 |
| | (0.005) |
| did+3 | 0.016** |
| | (0.008) |
| did+4 | 0.020** |
| | (0.008) |
| ln fiscal expenditure | 0.073** |
| | (0.031) |
| ln deposits of financial institutions | -0.005 |
| | (0.021) |
| ln volume of foreign trade | 0.003 |
| | (0.005) |
| ln per capita disposable income | 0.006 |
| | (0.037) |
| constant | -0.158 |
| | (0.310) |
| Fixes effect | √ |
| Year effect | √ |
| N | 455 |
| r2 | 0.8428 |

### 3.3 Improved DIDID regression of logistics development

We add the interaction term of logistics and the improved DIDID method to determine the Initiative's impact by examining the coefficient of the interaction term to pinpoint how the Initiative actually affects regional economic growth. The main model is as follows:

$$\begin{aligned} \text{economy}_{i,t} = \alpha + \beta_1 logistics_{i,t} + \beta_2 logistics_{i,t} \cdot concern_i + \beta_3 logistics_{i,t} \cdot post_t + \\ \beta_4 logistics_{i,t} \cdot did_{i,t} + \beta_5 did_{i,t} + B'_{i,t} X_{i,t} + \sum c_t \cdot year_t + \varepsilon_{i,t}. \end{aligned} \quad (2)$$

In Equation (2), $\text{economy}_{i,t}$ is the economic development indicator of City *i* in phase *t*; $logstic_{i,t}$ is the logistics development indicator of City *i* in phase *t*; $concern_i$ is a dummy variable for the cities included in the Initiative, where $concern_i = 0$ means that the city is excluded from the Initiative and $concern_i = 1$ means that the city is included in the Initiative. $post_t$ is the dummy variable of the Initiative's time sequence where $post_t = 0$ refers to the period prior to the Initiative's implementation (2006 to 2012), while $post_t = 1$ refers to the period following its implementation (2013 to 2017). $did_{i,t} = post_t * concern_i$ is the interaction term, which only denotes a value of 1 for cities included in the Initiative following its launch.

Additionally, $logstic_{i,t} * did_{i,t}$ is the interaction term of the dummy variables of the policy time sequence, the city included in the Initiative and logistics development; $X_{i,t}$ represents the controlled variables (Levine & Renelt 1992; Sokolov-Mladenović et al. 2016), including government fiscal expenditure, total deposit of financial institutions, total imports and exports and per capita disposable income. Considering the heterogeneity of cities and the different years, our main model includes both city fixed effects and time fixed effects (Dang et al., 2018). In addition, to avoid the linearity problem, this model does not include the dummy variable $concern_i$ of the cities included in the Initiative and the dummy variable of the policy's time sequence $post_t$.

As the implementation of the B&R Initiative encouraged the development of software and hardware in the logistics industry, thereby enhancing the role the development of regional logistics plays in boosting economic growth, we assume that the positive impact of logistics on economic development should be significantly higher for the cities included in the Initiative after its implementation; the cross-term coefficient $\beta_4$ of the logistics level and DIDID in the regression model should be significantly positive as well. The regression results support this inference. The regression results are presented in Table 3.

**Table 3: The level of economic and logistics development**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Logstic | 0.128*** | 0.063* | 0.047 | 0.048 |
| | (0.046) | (0.035) | (0.045) | (0.044) |
| concernlogstic | | | -0.018 | -0.046 |
| | | | (0.027) | (0.04) |
| didlogstic | | | 0.073** | 0.112* |
| | | | (0.036) | (0.06) |
| postlogstic | | | 0.017 | 0.005 |
| | | | (0.037) | (0.04) |
| Did | | | | -0.016 |
| | | | | (0.01) |
| ln fiscal expenditure | | 0.078** | 0.079*** | 0.083*** |
| | | (0.029) | (0.029) | (0.03) |
| ln deposits of financial institutions | | 0.004 | 0.002 | 0.006 |
| | | (0.025) | (0.021) | (0.02) |
| ln volume of foreign trade | | 0.006 | 0.002 | 0.003 |
| | | (0.006) | (0.004) | (0.004) |
| ln per capita disposable income | | 0.023 | 0.033 | 0.045 |
| | | (0.036) | (0.029) | (0.03) |
| constant | 0.226*** | -0.436 | -0.483* | -0.654** |
| | (0.011) | (0.302) | (0.260) | (0.306) |
| Fixes Effect | √ | √ | √ | √ |
| Year Effect | √ | √ | √ | √ |
| N | 455 | 455 | 455 | 455 |
| r2 | 0.6055 | 0.8754 | 0.8636 | 0.8692 |

Notes:

1. The standard error of the regression coefficient appears in parentheses.
2. *, ** and *** represent significance at the significance levels of 1%, 5% and 10%.

Column (1) in Table 3 is a preliminary exploration of the correlation between logistics and economic development, whose independent variable only includes the logistics level. We find that logistics development has a significant positive effect on economic growth, and this effect is also economically significant. This conclusion corroborates the findings in previous literature. In Column (2), key variables that affect regional economic development are controlled for, including regional fiscal expenditure, total deposits of financial institutions, total imports and exports and per capita disposable income. The influence coefficient of logistics development on economic development is slightly lower, but still significant after controlling for these variables, indicating that logistics has a strong stimulating effect on economic development. To further explore the Initiative's impact on logistics development and consequently on economic growth, Column (3) adds logistics development and the cities covered by the Initiative as dummy variables: concernlogistic, the level of logistics development and the policy time sequence dummy variable, postlogstic, and the interaction term of these two dummy variables, didlogstic. Given the integrity of the model, the cross terms of the two dummy variables are added in Column (4).

**Table 4: The impact of logistics on the economy under the B&R Initiative**

| | **Before** | **After** |
|---|---|---|
| **nonconcern** | concern=0; post=0; did=0<br>The impact of logistics equals the coefficient, which is 0.048. | concern=0; post=1; did=0<br>The impact of logistics equals the coefficient of logistics, plus the coefficient of postlogstic, which is 0.048+0.005=0.053 |
| **concern** | concern=1; post=0; did=0<br>The impact of logistics equals the coefficient of logistics, plus the coefficient of concernlogstic, which is 0.048-0.046=0.002. | concern=1; post=1; did=1<br>The impact of logistics equals the coefficient of logistics, plus the coefficient of postlogstic, plus the coefficient of concernlogstic, plus the coefficient of didlogistic, which is 0.048-0.046+0.005+0.112=0.119. |

After adding the controlled variables model in Column (4) of Table 3, we find that the coefficient of didlogistic is significantly positive at 0.112*. This indicates that logistics development can have a positive influence on the economy. Moreover, after the B&R Initiative was implemented in 2013, the level of urban logistics considerably boosted economic growth in the cities included. The coefficient of logistics development of the cities included in the Initiative is 0.119 (Column 5 of Table 4), which was higher between 2013 and 2017 than that for the cities excluded from the Initiative (0.053). We can therefore conclude that the development of the logistics industry is very significant for the economic growth of major cities under the Belt and Road Initiative.

In Columns (3) and (4) of Table 3, the coefficients of didlogstic are significantly positive, indicating that the B&R policy has a positive influence on the economy through logistics development. This further verifies our hypothesis, namely that the B&R Initiative stimulates economic growth through logistics development. This reinforces our previous assumptions.

We can therefore conclude that the implementation of the Initiative has significantly improved the economic development of the cities included, especially cities in central and western China. The government has comprehensively improved human resources, capital facilities and infrastructure, which in turn has had a positive effect on the regional logistics industry. The logistics development of the cities included in the Initiative has improved resource allocation and reduced transaction costs, thus intensifying the positive effect of the logistics industry on economic growth. The cities included in the B&R Initiative require more logistics support if they are to become actively involved in international trade. Hence, the B&R Initiative represents a new growth opportunity for regional economies.

### 3.4 Coordinated development model

The coordinated development model, first introduced by Shihong Yang, is applied to the calculation of the level of coordinated development between logistics and the economy. A quantified analysis of the level of coordinated development between logistics and the economy can be useful for defining sustainable development goals, especially in terms of improving regional logistics systems. Thus, following the model proposed by Yang, we develop a three-component approach.

**(1) Standardization of data**

$a_i$ and $b_i$ represent weightings, while $\overline{x_i}$ and $\overline{y_i}$ are the code value of $x_i$ and $y_i$.

The equation is as follows:

$$\overline{x_i} = \begin{cases} x_i / \lambda_{\max x_i} & x_i : positive\ index \\ \lambda_{\min x_i} / x_i & x_i : negative\ index \end{cases}, \overline{y_i} = \begin{cases} y_i / \lambda_{\max y_i} & y_i : positive\ index \\ \lambda_{\min y_i} / y_i & y_i : negative\ index \end{cases}, \quad (3)$$

where $\lambda_{max}$ and $\lambda_{\min}$ denote the standard value of the corresponding indicators. $x_i$ is the direct index (the higher the value, the better).

**(2) Measurement model**

$f(x)$ represents the major city's logistics development, while $g(y)$ represents the major city's economic development. The equation is as follows:

$$f(x) = \sum_{i=1}^{m} a_i \overline{x_i}, \quad g(y) = \sum_{i=1}^{m} b_i \overline{y_i}. \quad (4)$$

*T* denotes the comprehensive evaluation level of urban logistics and economic development:

$$T = \alpha * f(x) + \beta * g(y), \quad (5)$$

where weight α and β are determined by senior managers of logistics companies and experts in logistics management. A higher *T* value signifies a higher level of system coordination. In a market economy, demand stimulates supply. Therefore, the relative weightings of these two indicators, namely $\alpha = 0.4$, $\beta = 0.6$, are determined by the experts/senior managers.

$$C = \left\{ f(x) * g(y) / \left[ \frac{f(x) + g(y)}{2} \right]^2 \right\}^k. \quad (6)$$

In Equation (6), *C* reflects the level of coordination between supply and demand. The higher the value of *C*, the better coordinated they are. We prove that $0 \le C \le 1$. The measurement model that evaluates the level of coordinated development between logistics capability and the economy is as follows:

$$D = \sqrt{C * T}. \quad (7)$$

D represents the level of coordinated development of the urban economy and logistics. C represents the level of coordination between these two indicators. Indicator D measures the level of regional development from an integrated perspective, taking both the level of coordinated development and the level of development into consideration. In Equation (7), a higher D value denotes a higher level of coordinated development of the urban economy and logistics. D=1 indicates that coordination has reached an optimum level. The level of coordinated development is a relative value. We can only compare the level of coordinated development of different cities if their environments are similar.

**(3) The improved DIDID regression of the C and D values**

The economic and logistics coordination indicator C and the comprehensive evaluation indicator D of the level of coordinated economic and logistics development in 35 cities over the past 13 years are based on each city's annual logistics and economic score obtained in the previous section.

Table 5 reveals that the average level of coordination of the economy and logistics of the cities included in the Initiative was 0.904 prior to its implementation, which is approximately 1.5 per cent higher than the average level of coordination of the cities not participating in the Initiative. After the policy was introduced, this gap widened to approximately 4 per cent. This finding indicates that the Initiative has significantly increased the level of coordination (C value) of the cities included, and that the logistics systems and economies of the cities covered by the Initiative mutually benefit from each other's development and can thus realize sustainable development. The gap between the comprehensive evaluation indicator D also improved considerably – it was 7.6 per cent lower before the launch of the Initiative, which may imply that resources were wasted before the regions included in the Initiative reached a similar level to those cities excluded from the B&R. This finding substantiates that the Initiative has increased the level of coordinated development of both the economy and logistics in the cities included in the B&R.

**Table 5: Variable description: coordinated development indicators of logistics and the economy**

| Variable | Prior to the Initiative (2005-2012) | | After the Initiative (2013-2017) | |
|---|---|---|---|---|
| | C | D | C | D |
| | Cities excluded from the Initiative | | | |
| N | 176 | 176 | 110 | 110 |
| Min | 0.155 | 0.171 | 0.082 | 0.103 |
| max | 1.000 | 0.963 | 1.000 | 0.909 |
| mean | 0.891 | 0.493 | 0.756 | 0.441 |
| Sd | 0.155 | 0.177 | 0.286 | 0.186 |
| | Cities included in the Initiative | | | |
| N | 104 | 104 | 65 | 65 |
| Min | 0.283 | 0.131 | 0.108 | 0.111 |
| max | 1.000 | 0.775 | 1.000 | 0.791 |
| mean | 0.904 | 0.458 | 0.784 | 0.441 |
| Sd | 0.124 | 0.152 | 0.273 | 0.184 |
| | Full sample | | | |
| N | 280 | 280 | 175 | 175 |
| Min | 0.155 | 0.131 | 0.082 | 0.103 |
| max | 1.000 | 0.963 | 1.000 | 0.909 |
| mean | 0.896 | 0.480 | 0.767 | 0.441 |
| Sd | 0.144 | 0.169 | 0.281 | 0.185 |

In Section 3.2, we discuss that the impact of logistics on the economic growth of the cities included in the Initiative increased significantly following its implementation. The change in correlation is primarily the result of the change in the level of coordinated development between the economy and logistics, referred to as the D value. The improved DIDID model is applied to consider the fixed effects of the cities and of time to further explore the Initiative's effects on the level of coordinated development of the economy and logistics of the cities included. The model is as follows:

$$Index_{i,t} = \alpha_i + \beta_1 did_{i,t} + \sum \gamma_t \cdot year_t + \varepsilon_{i,t}, \quad (8)$$

where $\text{index}_{i,t} = \{C_{i,t}, D_{i,t}\}$ is the level of coordination development and the coordinated development values of the economy and logistics of City *i* in phase *t*.

**Table 6: The DID regression results of the level of coordination and the level of coordinated development of the economy and logistics under the Initiative**

| | (6) | (7) |
|---|---|---|
| | C | D |
| Did | 0.015 | 0.035*** |
| | (0.021) | (0.009) |
| _cons | 0.929*** | 0.470*** |
| | (0.018) | (0.008) |
| Fixed effect | √ | √ |
| Year effect | √ | √ |
| N | 455 | 455 |

Notes:
1. The standard error of the regression coefficient appears in parentheses.
2. *, ** and *** represent significance at the significance levels of 1%, 5% and 10%.

Column (7) of Table 6 reveals that the coefficient of DID is significantly positive, which indicates that following the implementation of the B&R Initiative, the level of coordinated development of the economy and logistics of the cities included improved significantly. This is attributable to the implementation of the Initiative, which has strengthened the role of trade, particularly international trade, and thus drives the economic development of the cities included in the Initiative. Incremental investments in the logistics infrastructure results in a better match with the local economic conditions and promotes sustainable development.

We further explore how the Initiative affects economic development. Based on our previous findings, we control for the level of coordination C and the level of coordinated development D in Columns (9) and (10) of Table 7. If the change in C or D values leads to a change in the relationship between logistics and the economy, we assume—after controlling for the indicators C and D—that the coefficient of the interaction term of logistics and DID decreases, and that the significance level of the coefficient also decreases. The comparison of the regression results is presented in Table 7. Specifically, we report the estimated coefficients using the following regression equation:

$$\begin{aligned} economy_{i,t} = \alpha + \beta_1 logistics_{i,t} + \beta_2 logistics_{i,t} \cdot concern_i + \beta_3 logistics_{i,t} \cdot post_t + \\ \beta_4 logistics_{i,t} \cdot did_{i,t} + \beta_5 did_{i,t} + \beta_6 C_{i,t} + \beta_7 D_{i,t} + B'_{i,t} X_{i,t} + \sum c_i \cdot year_t + \varepsilon_{i,t} \end{aligned} \quad (9)$$

**Table 7: Model estimates of the impacts of C and D on economic development, including DIDID concern**

| | (8) | (9) | (10) |
|---|---|---|---|
| Logistics | 0.047 | 0.058 | -0.017 |
| | (0.045) | (0.05) | (0.08) |
| concernlogstic | -0.018 | -0.025 | 0.007 |
| | (0.027) | (0.03) | (0.04) |
| Didlogstic | 0.073** | 0.074** | 0.072* |
| | (0.036) | (0.04) | (0.04) |
| Postlogstic | 0.017 | 0.019 | 0.011 |
| | (0.037) | (0.04) | (0.03) |
| C | | -0.016 | |
| | | (0.01) | |
| D | | | 0.099* |
| | | | (0.06) |
| ln fiscal expenditure | 0.083*** | 0.079*** | 0.074** |
| | (0.03) | (0.03) | (0.03) |
| ln deposits of financial institutions | 0.005 | 0.002 | -0.001 |
| | (0.02) | (0.02) | (0.02) |
| ln volume of foreign trade | 0.003 | 0.002 | 0.002 |
| | (0.004) | (0.004) | (0.004) |
| ln per capita disposable income | 0.045 | 0.031 | 0.031 |
| | (0.03) | (0.03) | (0.03) |
| Constant | -0.654** | -0.464* | -0.450 |
| | (0.31) | (0.26) | (0.27) |
| Fixes effect | √ | √ | √ |
| Year effect | √ | √ | √ |
| N | 455 | 455 | 455 |
| r2 | 0.8692 | 0.8681 | 0.8581 |

Notes:
1. The standard error of the regression coefficient appears in parentheses.
2. Asterisks represent the significance of the regression (***P < 0.001, **P < 0.01, *P < 0.05).

Table 7 includes several dependent variables. Column (9) shows that the relationship between logistics and the economy has not changed significantly after controlling for level of coordination C. The coefficient of the interaction term of logistics and DID has slightly changed to 0.074, which nonetheless remains significant at the 5 per cent level. This implies that the change in indicator C prior to and following the Initiative's implementation does not fully explain the changes in the relationship between logistics and the economy.

Column (10) in Table 7 takes D into consideration. The coefficient of D is statistically significant at the 10 per cent level with a value of 0.099*, which implies a positive relationship between D and local economic development. In addition, compared with Column (8), the coefficient of the interaction term of DID and logistics in Column (10) decreases slightly to 0.01, but becomes significant at the 10 per cent level. This indicates that the D value explains part of the impact of logistics on the economy. In combination with the results presented in Table 3, we can put forward that the B&R has a positive impact on economic development by changing the level of coordinated development of the economy and logistics, thus expanding the contribution of the logistics industry to economic growth. The C value, however, is not positively correlated with the economy, indicating that the C value cannot explain the correlation of the economy and logistics with respect to D.

## 4. Conclusion

This study supports the findings of previous studies that logistics contributes to economic growth in the cities included in the B&R Initiative. This study complements the current research by shedding light on the support mechanism of the B&R Initiative, namely the coordinated development between the economy and logistics to improve the efficiency of urban transport and to reduce operational costs. This leads to sustainable development in major cities. We summarize our conclusions as follows:

- The B&R Initiative promotes economic growth and stimulates the economic development potential of the cities it includes. This effect becomes statistically significant both in the third and fourth year following the Initiative's implementation. The reasons for this time-lag are that the cities included needed time to improve their hardware, to attract human resources and to adjust their economic structure to foster economic efficiency and sustainable development.

- The Initiative's effect in terms of stimulating economic growth partly draws on the fact that it strengthens the level of coordinated development of the economy and logistics. That is, the Initiative improves the coordination between regional logistics and the

economy, which reinforces the mutual promotion effect between the two to realize the goal of sustainable development.

- The B&R Initiative has also contributed to the improvement of the logistics industry of the cities it includes. Following the Initiative's implementation, the negative gap between the logistics development of the cities included and those excluded from the Initiative also gradually narrowed. Infrastructure development has enhanced the hardware of the logistics industry and the integration of international logistics in ecological structures. The increase in the volume of international trade furthermore provides continuous impetus for the development of the logistics industry.

- The B&R Initiative has strengthened the role of the urban logistics industry in promoting economic development. Judging from the available human resources, capital facilities and infrastructure, the Initiative's implementation has significantly improved the logistics development of the cities it includes. This, in turn, has increased the efficiency of the urban logistics industry, thus intensifying its positive impact on economic growth.

- Lastly, the B&R has generated a higher volume of international trade among the cities included, which has enhanced the status and role of the logistics industry as an important driver of international trade and economic development. Improvements in logistics will further reduce cities' operational costs and accelerate their sustainable development.

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