

The Impact of the Belt and Road Initiative on the Economic Development of the Countries Participating in the Initiative

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Abstract. In the context of globalization, common development has become an important goal pursued by all countries. This article aims to evaluate the impact of the “Belt and Road Initiative” (B&R) on the economic development of countries along the route, as economic cooperation between countries continues to strengthen and common prosperity becomes an increasingly important issue. This paper selects panel data from several relevant countries from 2004 to 2022 and uses the difference-in-differences method (DID) to compare the economic development between countries participating in the “B&R” Initiative and those that are not. The empirical results indicate the “B&R” Initiative has a promoting effect on the income per capita level and Industrial structure optimization of participating countries. Moreover, countries with a higher level of economic development are affected by the “B&R” Initiative, and their Income per capita growth effects are more obvious, while the increase in the proportion of secondary industry in less economically developed countries is more obvious. This paper finally puts forward relevant policy recommendations based on empirical results.

Keywords: B&R, income per capita, industrial structure.

1. Introduction

At the beginning of the 21st century, the global economy experienced a notable slowdown [1]. Simultaneously, the rise of various emerging industries (such as the Internet of Things (IoT), Electric and New Energy Vehicles Industry, Digital Economy Industry etc.) has led to significant changes in economic structures [2]. Consequently, nations are now confronted with more complex, diversified challenges and risks. In particular, the long-term impact of the financial crisis has underscored the limitations of the existing global governance structure in maintaining the world economic order. Against this background, China's “B&R” Initiative emerges as an innovative international cooperation model, aiming to bolster connections and cooperation among countries along the route. By promoting infrastructure construction and economic integration, it seeks to foster shared development opportunities and advance common prosperity. Therefore, examining the impact of the “B&R” Initiative the economic development of participating countries is essential. An in-depth analysis of its effects on industrial structure, national income levels, and other economic indicators is crucial to understanding the initiative's developmental significance for these countries. Such research will provide a scientific basis for future governmental decision-making and international cooperation strategies.

Since the proposal of the “B&R” Initiative in 2013, numerous scholars have analyzed its impact on the economic development of countries along the routes from various perspectives. Zheng Lei et al. focused on predicting the patterns of China's foreign investment while Liao Hongwei et al. examined the interactive relationship between outward foreign direct investment (OFDI), industrial structure upgrading, and economic growth using empirical analysis [3, 4]. Jiang et al. used a propensity score matching difference-in-differences (PSM-DID) model to investigate the “B&R” Initiative's effects on and mechanisms for promoting economic growth in participating countries [5]. Furthermore, Zhang Hui et al. utilized the deviation-share method's analytical framework to

demonstrate that the trade cooperation network established by the “B&R” Initiative has significantly reduced production costs and increased product demand in various countries, thereby enhancing their trade exports [6].

Reviewing the existing literature reveals that while scholars commonly assess the “B&R” Initiative's impact on participating countries through specific economic indicators, comprehensive empirical analyses of overall economic development levels remain scarce. Given the direct involvement of these countries in the globalized economy, a macro perspective is essential for an integrated assessment of their economic progress. Therefore, this study uses the difference-in-differences (DID) method to compare the economic development differences between “B&R” Initiative participating countries and non-participating countries before and after the initiative's launch. By controlling for extraneous variables, this study provides a deeper and more accurate understanding of the long-term impact of the “B&R” Initiative on the economic path of participating countries and inform future policy formulation.

2. Mechanism Analysis

According to existing literature and economic principles, the impact of the “B&R” Initiative on national economic development can be categorized as either promotive or neutral. Figure 1 below illustrates the mechanisms of action in both scenarios.

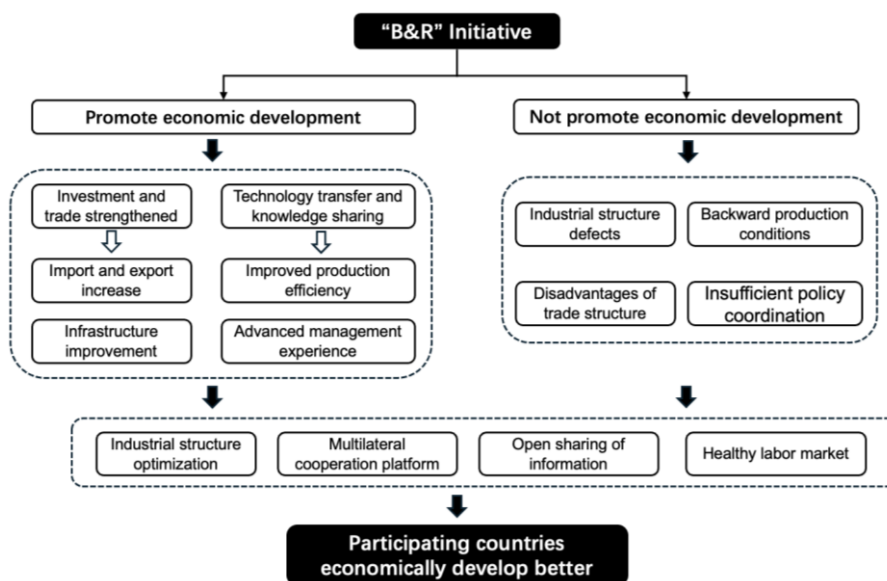


Figure 1. B&R Initiative policy effect ((Picture credit: Original))

The "B&R" Initiative has strengthened the economic vitality of countries along the route by attracting investment and promoting trade [7]. It has addressed the funding gap for infrastructure and energy projects, and by lowering trade barriers and expanding markets, it has opened more avenues for these countries to enter the international market [8]. This not only stimulate local industry development but also boosts export capabilities. Furthermore, the Initiative facilitates the transnational transfer of technology and knowledge [9]. Chinese companies' overseas investments and project collaborations equip local industries with advanced technology and management expertise, thereby elevating production efficiency and innovation capacity. In turn, encourages the shift from labor-intensive to capital and technology-intensive industries, which leads to industrial structural adjustment that benefits long-term economic growth and labor productivity enhancement. Ultimately, these changes are expected to underpin the sustained and robust development of the economy [1].

However, attributing the post-initiative economic growth directly as the primary driving force of economic development warrants careful consideration for several reasons: Firstly, the economic foundations of most developing countries are relatively weak. According to the principle of diminishing marginal utility, the initial stages of increased consumption can lead to a significant rise

in both marginal utility and the rate of economic growth [10]. Secondly, the rapid economic growth in these countries could also stem from a combination of factors such as investment, education, and technological advancement. Therefore, in assessing the impact of the initiative, it is crucial to consider a variety of factors and deeply analyze its mechanisms and long-term effects within the specific economic contexts of different countries and regions [11-12].

Based on the above analysis, this study proposes the following hypotheses:

Hypothesis 1: The "B&R" Initiative has a promoting effect on the Income per capita level and Industrial structure optimization of participating countries.

Hypothesis 2: Countries with a higher level of economic development are affected by the "B&R" Initiative, and their Income per capita growth effects are more obvious, while the increase in the proportion of secondary industry in less economically developed countries is more obvious.

The rest of this article is organized as follows: Section 2 details the development context of the "B&R" Initiative and proposes theoretical hypotheses. Section 3 describes the model framework, analysis methods, and key variables employed in this study. Section four presents empirical testing, including basic results, robustness checks, and heterogeneity analyses. Finally, section 5 draws conclusions and offers recommendations.

3. Empirical Analysis

3.1. Data

This paper focuses on 16 countries in four categories, based on the economic development of the "B&R" Initiative, and collects data from the World Bank database, World Education Database, and United Nations Statistics Division during the period of 2004-2022. The classification of sample countries is shown in Table 1.

Table 1. Classification of sample countries

Groups	Categorization	Countries
Processing group	East and South-East Asia	Singapore; Thailand
	Central and South Asia	Kazakhstan; Sri Lanka
	Africa	Morocco; Egypt
	Europe	Poland; Russia
Control group	East and South-East Asia	Japan; Korea
	Central and South Asia	India; Bhutan
	Africa	Mauritius; Swaziland
	Europe	England; France

3.2. Variable Selection

Based on the "B&R" Initiative, Table 2 shows the specific variable definitions. In order to measure the level of national economic development, this paper adopts income per capita and Industrial structure as explained variables. Except for explanatory variables, control variables are also included: (1) fixed asset investment: some research has shown the fixed asset investment will grow as the city expand [13]. Therefore, this paper will use the ratio of total investment to GDP to illustrate. (2) human capital level: as the growth of Years of schooling per capita, human capital level will gradually accumulate [14]. A positive correlation was found between education and the level of regional economic development. Thus, using the Number of secondary school students receiving general education to demonstrate the Human capital level. (3) level of technological development: advanced science and technology on the one hand can bring about progress in products, services and production methods, on the other hand, can improve productivity and competitiveness through automation and intelligence, and the industrial structure will be adjusted and upgraded at the same time as science and technology advances, thus promoting economic growth in many ways. Referring to Acemoglu, this paper will apply R&D expenditure as a share of GDP to present Level of technological

development [15]. (4) openness of economic development: an open economy can promote economic growth in many ways, such as resources, technology, talent mobility. Accordingly, ratio of total exports and imports to regional GDP for each country can suggest Openness of economic development.

Table 2. Description of variables

variable dimension	Variable Name	Variable Meaning	Symbol
explained variables	Income per capita	Income per capita	income
	Industrial structure	Share of secondary industry in gdp	structure
explanatory variables	post	0 before 2013, 1 after 2013	post
	treat	1 for countries participating in the Belt and Road Initiative, 0 otherwise	treat
control variables	fixed asset investment	Total investment in GDP ratio	investment
	Human capital level	Number of secondary school students receiving general education	education
	Level of technological development	R&D expenditure as a share of gdp	tech
	Openness of economic development	Total exports and imports of countries/Regional GDP	econ

3.3. Model Design

To evaluate the impact of the “B&R” Initiative on the economic development of the countries along the route, this paper will employ DID to analysis, the models of this study are as follows:

$$income_{it} = \beta_0 + \beta_1 D_t + \beta_2 D_p + \gamma D_t * D_p + \sum X_{it} + \varepsilon_i \tag{1}$$

$$structure_{it} = \beta_0 + \beta_1 D_t + \beta_2 D_p + \gamma D_t * D_p + \sum X_{it} + \varepsilon_i \tag{2}$$

Where $income_{it}$ and $structure_{it}$ represents the country i in year t ; D_p is time dummy variable, before 2013 when the year of the “B&R” initiative started ,is given a value of 0, while after is 1; D_t is Inter-group dummy variables, the participating countries are given a value of 1, the non-participating countries are given a value of 0; $\sum X_{it}$ is a group of control variables, including fixed asset investment, Human capital level, Level of technological development and Openness of economic development; ε_i is random interference term (RIT).

3.4. Empirical Analysis

3.4.1 Descriptive statistics

According to Table 3, income and structure are employed as explained variables. Processing group and control group are distinguished by treat, while post stands for time, which means the enact time of the “B&R” Initiative is in 2013 and after. It can be seen that Income is 9.074, and standard deviation is 1.204, indicating a significant fluctuation comparing to overall.

Table 3. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Income	304	9.074	1.204	6.436	11.324
Structure (%)	304	29.751	7.063	16.2	45.4
post	304	0.526	0.5	0	1
treat	304	0.438	0.497	0	1
investment	304	26.37	8.935	11.825	69.418
education	304	5659533.4	19561936	0	1.30E+08
tech	304	1.026	1.183	0	4.93
econ	304	0.007	0.006	0.002	0.034

3.4.2 Correlation analysis and multicollinearity test

Through correlation analysis and multicollinearity test, statistics show there are no sign of multicollinearity. Therefore, regression analysis can be performed.

3.4.3 DID regression

Table 4 indicates that both income and structure has influenced by the “B&R” Initiative. It can be seen from model (1) that the “B&R” Initiative has a considerable positive impact on the income of participating countries, while a negative result has presented on the industrial structure of those participants in model (2). Considering that participating in the “B&R” Initiative may promote the optimization of industrial structure, which results in economic diversification, along with the development of services and high-tech industries, and eventually leads to the reduction in the proportion of the secondary industry.

Table 4. DID regression

	(1) income	(2) structure
treat_post	0.171*** (4.56)	-1.060* (-1.87)
investment	-0.004 (-1.21)	0.110* (1.77)
education	-0.000 (-0.24)	-0.000 (-0.59)
tech	0.013 (0.53)	-0.145 (-0.26)
econ	-30.385*** (-4.08)	294.358*** (2.87)
_cons	9.337*** (100.98)	25.168*** (14.14)
N	303.000	304.000
r2	0.984	0.904
F	9.320	4.733
id	YES	YES
year	YES	YES

Note: *t* statistics in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

3.4.4 Parallel trend test

The main purpose to carry out a parallel trend test is to verify whether there is a trend difference between the processing group and control group before the implementation of the policy. In comparative research, cause-effect inference can be more reliably if the trends in different groups or processes are parallel. In the graph below, the horizontal coordinate represents the year and the vertical coordinate represents the magnitude of the policy impact coefficient. If the confidence intervals for the values of the coefficients represented by the points fall outside of the blue horizontal line in the graph, this means that the coefficients are significantly different from 0, violating the original hypothesis that the coefficients on the policy are 0, so that the policies have a significant effect. Furthermore, if the confidence intervals of the coefficients before the implementation of the policy all contain zero, this indicates that the parallel trend test is passed. Figure 2 demonstrates that the result of income is significant after the policy enacted, and none of the points are on the blue line, whereas Figure 3 indicates a notable outcome from before to current, and all of which are above the blue line. Thus, both income and structure have passed the parallel trend test.

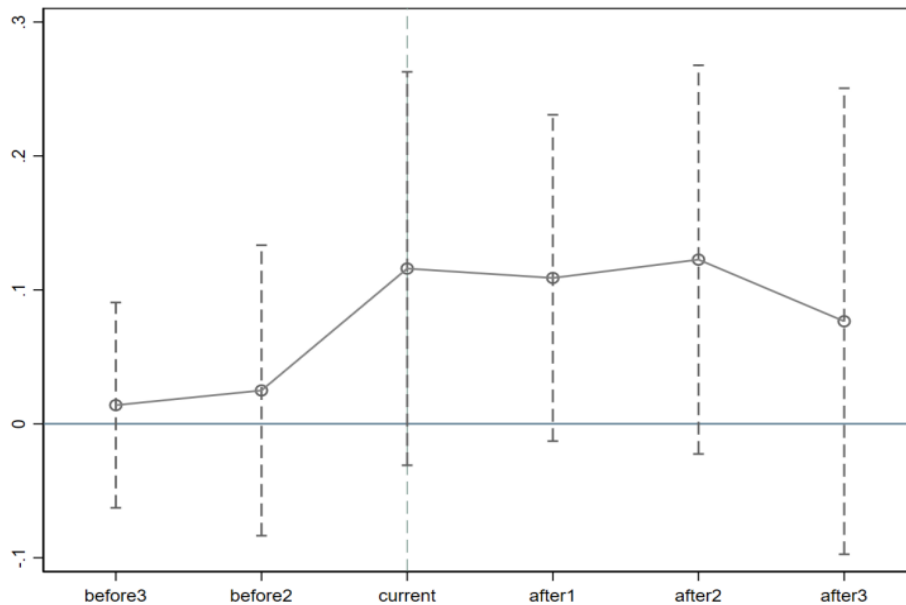


Figure 2. Parallel trend in income (Picture credit: Original)

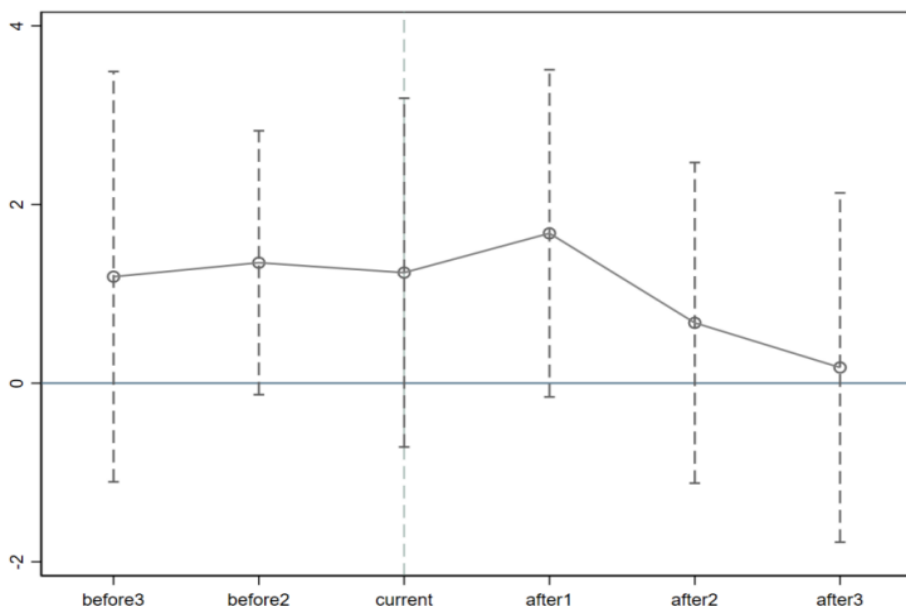


Figure 3. Parallel trends in structure (Picture credit: Original)

3.4.5 Heterogeneity test

In order to run heterogeneity test, the processing and control groups were differentiated according to the median national income per capita of each country (income). Countries with national income per capita in the top 50% are considered as higher economically developed countries, while the others are considered as less economically developed countries.

It is evident in model (1) from Table 5 that comparing to less economically developed countries, higher economically developed countries have shown more effective income growth after participating in the “B&R” Initiative. This means that they are likely to have more complete economic infrastructures, industrial systems and market mechanisms, so that they can take better usage of the chances that the “B&R” Initiative has brought. In model (2), a positively significant result has shown in development of the secondary industry of less economically developed countries, with the value of the regression coefficient is 1.725. However, the value of the regression coefficient of higher economically developed countries is -5.157, and is negatively considerable at 1% level. Perhaps the primary reason is that less economically developed countries tend to develop traditional secondary industry after participating in the “B&R” Initiative, as these countries may need to develop their

economies first through industrialization. On the contrary, higher economically developed countries may have completed the process of industrialization, therefore focusing more on the services and high-tech industries, which leads to the decline of the proportion of secondary industry.

Table 5. Heterogeneity analysis

	Income		structure	
	higher economically developed countries	less economically developed countries	higher economically developed countries	less economically developed countries
treat_post	0.105** (2.13)	0.070 (1.19)	-5.157*** (-5.04)	1.725* (1.85)
investment	-0.011* (-1.89)	0.001 (0.47)	-0.008 (-0.07)	0.046 (0.76)
education	-0.000 (-1.64)	0.000 (0.55)	0.000 (1.07)	-0.000** (-2.08)
tech	0.063** (1.98)	-0.020 (-0.31)	-0.249 (-0.45)	0.581 (0.46)
econ	-38.251*** (-6.44)	-45.235 (-1.44)	73.695 (0.62)	483.619** (2.12)
_cons	10.562*** (62.78)	8.266*** (37.19)	27.144*** (7.96)	28.082*** (12.38)
N	152.000	151.000	152.000	152.000
r2	0.975	0.938	0.928	0.900
F	18.448	0.980	12.500	3.770
id	YES	YES	YES	YES
year	YES	YES	YES	YES

Note: *t* statistics in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

3.4.6 Endogeneity test

The purpose of the endogeneity test is to determine whether there will be endogeneity problems in the model, with several main causes including two-way causality, omitted-variable bias and measurement error. As for less developed countries, participation in the “B&R” may boost the regional economic growth. Therefore, endogeneity issues arising from two-way causality can be eliminated through lagged data tests. Additionally, by controlling time and individual fixed effects in the modeling session, the endogeneity problems caused by omitted-variable bias has already been tackled. Unfortunately, due to the inaccessibility of data, the experiment to verify measurement error was not performed.

According to Table 6, in model (1), a dramatically positive effect is found in the lagged period of income, indicating that the “B&R” Initiative can not only influence participating countries in the short term, but it is also able to make a sustainable difference in the longer term. Furthermore, lagging effect implies the deeper impact of the “B&R” Initiative on the economic, social and industrial structures of the implementing countries, which will take some time to fully materialize and emerge. In model (2), one period lagged variable does not have a notable effect on the share of the secondary industry. However, there are positive impacts in fixed asset investment (investment) and openness of economic development (econ). This means that the impact of the “B&R” Initiative on the secondary industry may take some time to realize. Therefore, indicators such as investment and econ may be easier to observe the influence on the proportion of secondary industry in a short term.

Table 6. Endogeneity test

	(1) lagging one period behind income	(2) lagging one period behind structure
treat_post	0.179*** (4.63)	-0.605 (-1.12)
investment	-0.006* (-1.85)	0.096* (1.89)
education	-0.000 (-0.56)	-0.000 (-0.04)
tech	0.003 (0.15)	-0.264 (-0.52)
econ	-28.510*** (-3.54)	285.487*** (2.78)
_cons	9.372*** (98.05)	25.772*** (17.26)
N	288.000	288.000
r2	0.985	0.918
F	8.568	3.376
id	YES	YES
year	YES	YES

Note: *t* statistics in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4. Conclusion

This paper selected the panel data of 16 countries along the "B&R" from 2004 to 2022, and compared the differences in economic development between the countries along the "B&R" before and after joining the "B&R" initiative and those that not join or joined later, by using the method of DID, focusing on the impact of the "B&R" initiative on the economic development of the countries along the "B&R". It also predicts the different effects of various factors on the economic development of the countries along the route after the implementation of the initiative.

Through the analysis of the model, it is found that the "B&R" Initiative has a positive promoting effect on the per capita income level and the optimization of industrial structure of the countries along the route. The promoting effect is mainly through the optimization of labor, capital and technology, so that the conclusion is still verified in a series of rigorous robustness tests. Moreover, the heterogeneity test results show that, compared with higher economically developed countries, less economically developed countries, driven by the "B&R" Initiative, have a more significant effect on economic growth in the secondary industry due to the influence of "late-mover advantage", which promotes the process of industrialization.

Based on the above conclusions, this paper makes the following policy recommendations:

First, expand the "B&R" cooperation lineup and form synergies in the industrial chain. The "B&R" covers many higher economically developed countries and less economically developed countries, and their distinctive industrial structures complement each other, but in many aspects, countries are still in a state of incomplete information symmetry. More countries should be called upon to join the big family of the "B&R" Initiative, and optimize the allocation of resources and maximize economies of scale by deepening industrial chain integration and cross-border investment. At the same time, the formation of close links in the global value chain can also enhance the competitiveness of enterprises in the region and promote the transformation and upgrading of related industries to high value-added.

Second, formulate investment strategies tailored to local conditions to avoid "curse to the latecomer". Due to the differences in the investment environment and basic national conditions of the countries along the "B&R", countries need to formulate differentiated investment strategies according to local conditions. On the basis of scientific assessment, less economically developed countries

should increase their investment in infrastructure to narrow the economic gap with other countries along the "B&R". At the same time, the less economically developed countries should adjust their own development path in a timely manner, and should not only develop the secondary industry, but should develop the whole industry in a comprehensive way, enhance the ability of independent innovation, optimize the industrial structure, and avoid the problems caused by the extensive economic development due to the "curse to the latecomer".

Third, explore diversified ways of cooperation and strengthen scientific and technological exchanges. On the basis of the overall trend of improving the level of infrastructure in countries along the "B&R", countries should constantly promote scientific and technological exchanges. On the one hand, countries along the "B&R" should be encouraged to carry out international research, and accelerate the concentration of innovation resources in countries along the "B&R" through joint laboratory construction, science and technology park cooperation and technology transfer. On the other hand, from the social, economic and environmental impact of the "B&R" multi-dimensional driving mechanism, through advanced science and technology support to achieve the "B&R" regional and cross-country social, cultural, environmental and ecological sustainable coordinated development, give play to the advantages of innovation to provide scientific and technological support.

Authors contribution

All the authors contributed equally and their names were listed in alphabetical order.

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