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Does the BRI contribute to poverty reduction in countries along the Belt and Road? A DID-based empirical test

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Most countries along the Belt and Road are developing countries that face pronounced challenges due to poverty. The Chinese government has committed to implementing the Belt and Road Initiative (BRI) to establish a 'Road to Poverty Reduction'. This study explores the impact of the BRI on poverty reduction in participating countries as well as the mechanisms underlying this impact. This research is of great significance to the continuing implementation of the BRI and global poverty governance. Based on a panel dataset extending from 2005 to 2019 and encompassing 151 countries, this article uses the difference-in-differences method to examine the Initiative's impact and conducts heterogeneity analysis to explore the mechanism underlying this impact in further detail. This approach results in four findings. First, joining the BRI can significantly reduce poverty rates in these countries. Second, the policy effect exhibits a time lag. In the long term, the poverty reduction effect becomes more significant. Third, the BRI can significantly reduce poverty in countries neighbouring China and in lower-middle-income countries. The Land Silk Road Economic Belt and the 21st-Century Maritime Silk Road distinctly reduce poverty. Fourth, the BRI contributes to poverty reduction in BRI countries by facilitating trade, enhancing financial and credit systems, increasing China's greenfield investment, and establishing digital infrastructure. Additionally, the BRI promotes poverty reduction through increased bilateral visits and technical cooperation, whereas knowledge sharing remains an area in need of further development. Through theoretical analysis and empirical tests, this article evaluates the policy effect of the BRI on poverty alleviation, tests the underlying mechanism, and responds to some concerns expressed by the international community. The findings of this article provide a feasible direction for improving the ability of the BRI to reduce poverty more effectively in the future and thus achieve the United Nations' sustainable development goals (SDGs).

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Introduction

According to the 2030 Agenda, poverty eradication in all forms and in all places is the most significant contemporary global challenge and an indispensable requirement for sustainable development (United Nations, 2015). Before the outbreak of the COVID-19 pandemic, many countries worldwide had made significant progress in reducing poverty. In particular, China adopted the 'Targeted Poverty Alleviation Strategy' (TPA) in 2013. Based on policy support for pro-poor economic growth, inclusive social development, and multi-dimensional TPA as well as coordinated promotion by government, market, and social forces, China completed the arduous task of eradicating extreme poverty by the end of 2020, thereby meeting the sustainable development goals (SDGs) pertaining to poverty reduction 10 years ahead of schedule (Wang and Zhang, 2021). Unfortunately, global poverty reduction has virtually stalled due to the COVID-19 pandemic. Climate change and local conflicts further hamper progress towards poverty alleviation. As detailed in the World Bank's *Poverty and Shared Prosperity Report 2022*, the global incidence of extreme poverty declined from 37.8% in 1990 to 8.4% in 2019. Although projections indicate a further reduction to 6.8% by 2030, this figure remains far below the expectations of the SDGs, which aim to eradicate extreme poverty by 2030. Global poverty governance remains a complex and intractable task. The topic of how to combine China's successful poverty reduction experience with the international platform established by the Belt and Road Initiative (BRI) to provide development opportunities for impoverished populations worldwide and thus supply a plausible solution to the challenge of achieving the 2030 SDGs is worth studying.

Alongside the country's economic and social development, China has also actively participated in global governance. In 2013, China proposed the BRI with the goal of fostering a community characterized by shared interests, a common destiny, and collective responsibility, which entails the cultivation of mutual political trust, economic integration, and cultural inclusivity through economic partnerships with BRI countries (Xinhua, 2017). The BRI has injected new vitality, drive, and competitiveness into the process of economic globalization (Jin, 2016). Within the framework of the BRI, China and BRI countries have engaged in international cooperation in critical areas such as policy consultation, trade promotion, infrastructure connectivity, financial cooperation, and people-to-people exchanges ('Five Cooperation Priorities') (Ministry of Foreign Affairs, 2017); furthermore, according to data released by the World Bank, in the 5 years following their participation in the initiative, BRI countries exhibited a combined GDP increase of 39.6%. At the Boao Forum for Asia in 2021, President Xi Jinping proposed developing the BRI into a pathway towards poverty alleviation (Xi, 2021). Most countries along the Belt and Road face the formidable task of poverty governance. BRI countries such as Ethiopia, Tanzania, Uganda, Zambia, Myanmar, Laos, and Cambodia are on the list of the 47 least-developed countries identified by the UN in 2015, which face an enduring struggle against long-term poverty[1]. India[2], Nigeria, and Bangladesh, which feature many impoverished people, are all BRI countries. According to statistics provided by the World Bank in 2019, the BRI covers a critical poverty-stricken region of the world, with 43.7% of moderately poor people and more than 1/3 of impoverished people living in BRI countries[3]. China actively seeks to align the essence and substance of the BRI with the SDGs to help BRI countries reduce poverty more effectively. A report by the World Bank proposed that by 2030, the BRI could lift 76 million individuals out of extreme poverty and 32 million people out of moderate poverty (World Bank, 2019)[4]. However, the question of whether the BRI can alleviate widespread poverty in countries

along the Belt and Road has not yet been the subject of detailed academic discussion.

Accordingly, this article focuses on 15-year continuous panel data drawn from 151 countries and attempts to explore the implications of the BRI for poverty reduction and the intrinsic mechanisms underlying this impact. Specifically, this article aims to answer the following questions: Can the BRI effectively contribute to poverty reduction in BRI countries? Does the BRI work differently in countries with different income groups or of different geographical types? If such a poverty reduction effect exists, how can the BRI benefit impoverished populations in countries along the route? This article makes several marginal contributions as follows. First, unlike the extant literature, which has focused on the economic effects of the BRI, this article evaluates the policy effect of the BRI from the perspective of social value and investigates whether the initiative can benefit people with low incomes in countries along the Belt and Road, thus contributing evidence from a different perspective to extant research on ways of evaluating the impact of the BRI. Second, this article establishes a framework for theoretical analysis of the poverty reduction effect of the BRI based on the foundational path towards poverty reduction alongside economic growth and social development, following which the article verifies this framework empirically. Third, this article explores in depth the role played by the 'Five Cooperation Priorities' in the implementation of the BRI. It distinguishes between the role of the world and that of China in the task of ensuring unimpeded trade and financial integration, emphasizes the importance of digital infrastructure in facilities connectivity, and regards people-to-people bonds and policy coordination as channels for knowledge sharing and technological exchange. The study provides practical guidance for improving the poverty reduction effect of the BRI and offers theoretical support for foreign cooperation in pursuit of poverty alleviation.

Literature review and theoretical analysis

Literature review. Since the inception of the BRI, a substantial body of literature has emerged on this topic, mainly in the fields of international relations, political science, and international business. The motivations underlying the implementation of the BRI are still vague. Various scholars have offered differing viewpoints on this topic. Some researchers have posited that the BRI serves as a vehicle through which China can exert soft power on the global stage, while others have contended that the initiative is driven by aspirations for expanded market access and heightened development opportunities (Blanchard, 2017; Wang, 2016). Investigations of the economic impacts of the BRI have primarily focused on three aspects: the Chinese, the participants, and the stakeholders involved in the initiative.

Many scholars have analysed the impact of the BRI on China's economy from the perspectives of industrial development and enterprise competition. Previous research has found that the BRI has significantly improved the average quality of the products exported by domestic enterprises along the Belt and Road, notably facilitating high-quality exports from Chinese enterprises. The implementation of the BRI significantly reduced the financing constraints faced by enterprises through the diversification of financing sources and the mitigation of operating costs (Xu Si et al., 2019). Additionally, the BRI has improved corporate productivity and reduced financing constraints, thus facilitating a process of industrial optimization and upgrading within China (Lu et al., 2021; G. Wang and Lu, 2019).

In terms of its impact on BRI countries, many scholars have argued that the BRI has significantly promoted the economic growth of BRI countries and expedited regional economic

integration and development between China and BRI countries (Han et al., 2015; Jin, 2016; Sun et al., 2017; Maliszewska and Van Der Mensbrugghe, 2019). The BRI could reduce trade costs between China and BRI countries through massive infrastructure investments. Approximately 30% of the effect of China's foreign direct investment (FDI) on fostering the economic growth of BRI countries can be attributed to infrastructure improvement (Sui et al., 2017). According to Chen et al. (2019), the BRI has contributed to urban development and poverty reduction in BRI countries. Zhang (2018) concluded that China's investment in BRI countries can promote employment growth in host countries and has significantly promoted the economic growth of BRI countries (Cao and Li, 2021). Considering the costs associated with the implementation of certain BRI projects, some scholars have also observed that the BRI has intensified competition among local enterprises and caused environmental pollution (Hughes, 2019).

Several scholars have focused on the initiative's impact on global welfare distribution. The connectivity facilitated by infrastructure development based on the BRI will offer benefits to other nations, including certain non-BRI countries in Europe (Fardella and Prodi, 2017). Zhai (2018) found that the development of regional infrastructure in BRI countries has positively impacted the expansion of global trade and enhanced overall welfare based on a global computable general equilibrium model. Additionally, the BRI has yielded remarkable results regarding promoting more equal opportunities in the division of labour in global value chains (Dai and Song, 2021).

Following the proposal of the BRI, a wealth of valuable findings emerged. The claims that the BRI has increased investment, promoted employment, facilitated urban development, and had other effects on economic development can hardly be rejected in light of such research. However, the impact of poverty on BRI countries requires further discussion. Economic growth and increased employment can bolster incomes among underprivileged populations, thereby mitigating poverty within countries along the Belt and Road (World Bank, 2019; Dollar and Kraay, 2002), while increased competition and environmental degradation can have negative impacts. Although some scholars have linked the BRI with the UN Sustainable Development Goals (SDGs), assuming that the implementation of the BRI is conducive to the achievement of SDGs such as SDG1, which focuses on eradicating poverty (Lewis et al., 2021), and although the World Bank noted that the BRI can help eliminate moderate poverty (a poverty headcount ratio based on $3.2 per person per day in terms of 2011 purchasing power parity (PPP)) (Maliszewska and Van Der Mensbrugghe, 2019), the question of whether a causal relationship exists between the BRI and poverty reduction has not yet been answered, and the internal mechanism underlying this impact has not been fully explicated.

Accordingly, this article attempts to extend the scope of the literature by exploring the causal relationship between BRI and poverty alleviation. What is unique about the BRI compared to international aid and other kinds of regional cooperation that primarily aim to eradicate poverty? This article attempts to answer this question based on the theories of neoclassical economics and development economics alongside the 'Five Cooperation Priorities' associated with the implementation of the BRI.

Theoretical analysis of BRI's poverty reduction effect. Poverty is among the most difficult problems facing the current global development process. According to open data released by the World Bank, in 2019, 6.5% of the population in BRI countries faced extreme poverty, while a more substantial portion of this population, approximately 29.3%, experienced moderate poverty; these rates were higher than the global average. In 2020, BRI countries accounted for a substantial 43.9% of the global population, but their contribution to the world's GDP amounted to only 16.3%. This disparity highlights the challenge of achieving the goal of eradicating poverty in 2030 solely through the efforts of BRI countries[5]. Nations have pledged to accomplish the SDGs by 2030, and extensive international anti-poverty cooperation measures have been implemented globally, primarily through multilateral international development cooperation led by organizations such as the UN, the International Monetary Fund (IMF), and the World Bank as well as bilateral or multilateral development cooperation efforts among different countries. According to development economics, a deficiency in capital formation could evolve from a lack of material capital to a lack of human and social capital, thus leading to a 'vicious circle of poverty'. However, external aid and investments from the international community can alleviate this situation (Nurkse, 1961). Since the 1990s, an alternative perspective has gained prominence, positing that nations can slip into poverty due to the absence of good and effective governance. Consequently, institutions such as the International Monetary Fund (IMF) and the World Bank have actively assisted the least-developed countries in the production of Poverty Reduction Strategy Papers (PRSPs). However, PRSPs that have promoted a participatory process involving civil society and development partners have played only a limited role.

In its attempt to eradicate extreme poverty, China has adopted a distinctive path towards poverty reduction that is characterized by certain unique attributes. The three pillar public policies—pro-poor economic growth, inclusive social development, and multi-dimensional targeted poverty alleviation—have not only been tested in practice but also embody universal values (Wang and Zhang, 2021). China's imbalanced development is primarily evident in the developmental disparities between the eastern and western regions of the country, which are caused by geographical, policy-related and historical factors. As early as 1996, China established an institutionalized collective action mechanism known as 'East–West collaboration in poverty alleviation' to address the imbalanced development of China's more developed eastern and less developed western provinces, especially regarding the problem of poverty in the West. In 1996, the 'Fujian-Ningxia collaboration' pioneered the adoption of a framework based on principles of 'Joint Promotion, Pairing Assistance, Industry Driving, Mutual Learning and Help, and Social Participation', thereby providing a reference for the overall implementation of East–West collaboration (Wang and Xie, 2022).

Similarly, the BRI aims to assist BRI countries with poverty governance in line with the 'Five Cooperation Priorities' pertaining to imbalanced regional development. The initiative focuses on the innovation of local development knowledge in developing countries, especially regarding development experience drawn from China. The 'Five Cooperation Priorities' are intended to overcome the development bottleneck faced by BRI countries, thereby promoting smooth infrastructure development, facilitating investment and trade and strengthening co-building and mutual learning in the context of policy consensus, which can help BRI countries find a path towards poverty reduction that is in line with their distinct national circumstances. Based on China's experience in poverty governance, this article constructs a theoretical framework for poverty reduction within the context of the BRI (Fig. 1). The study proposes the following hypothesis:

H1: Joining the BRI can reduce the poverty headcount ratio of BRI countries.

Most BRI countries exhibit sluggish economic growth, lower per capita GDPs, higher birth and mortality rates, and deficient
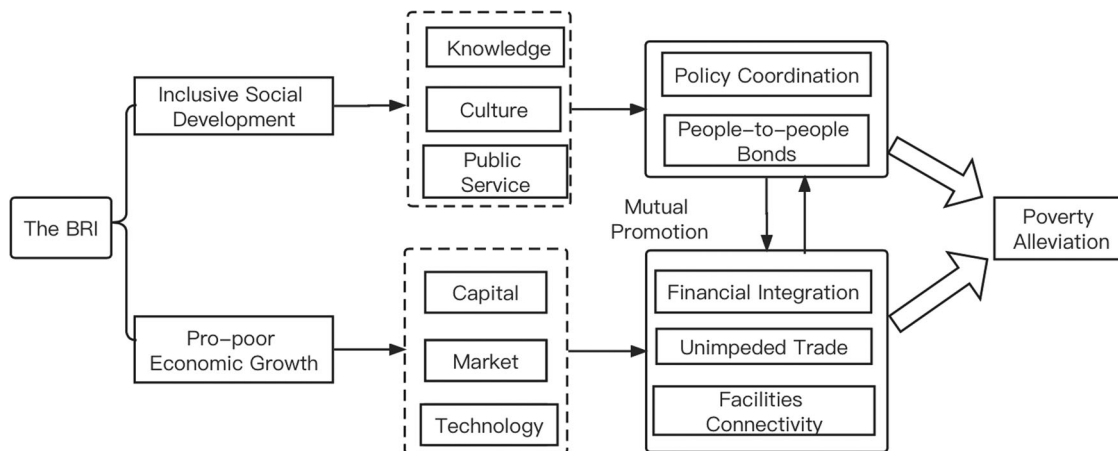
Fig. 1 Poverty reduction mechanism of the BRI. It presents a theoretical framework of the BRI for poverty reduction in countries along the routes.

public educational infrastructure when compared to developed nations. In addition, the economies of BRI countries are predominantly characterized by the manufacturing and export of primary and labour-intensive products. The primary task of poverty governance is to ensure sustainable economic growth. Nevertheless, economic growth does not invariably translate into improved conditions for the impoverished population, which requires the government to develop comprehensive and inclusive social policies to address this disparity. China leverages the 'Five Cooperation Priorities' to help BRI countries achieve the goal of poverty reduction through pro-poor economic growth and inclusive social development with the aim of extending the benefits of growth to all levels of society, particularly the impoverished population. To a certain extent, this process is based on the internationalization of China's economic development, and its purpose is to facilitate the joint exploration of a development path based on the establishment of a cooperation platform for the joint construction and sharing of the BRI.

On the one hand, through its influence on crucial aspects such as capital, market dynamics, and technological advancement in BRI countries, the BRI contributes to their economic growth and poverty reduction. Capital accumulation is the main element of growth (Chenery and Watanabe, 1958). Economies that feature limited capital resources often focus on industries that rely on labour-intensive or resource-intensive production. According to the theory of comparative advantage, this focus leads less developed countries to export primary products in international trade, consequently hindering their capacity to pursue upward shifts in industrial upgrading. On the macro level, investment is the driving force underlying the sustained growth of the national economy, which can not only overcome the bottleneck caused by inadequate capital formation but also enhance the efficacy of capital allocation. On the micro level, investment also entails a technology spillover effect (MacDougall, 1975), which yields additional societal advantages such as increased domestic employment opportunities (Koizumi and Kopecky, 1980). Constrained by limitations pertaining to self-owned funds and access to financing, some BRI countries experience prolonged periods of delayed development. Financial integration represents the foundation of the smooth development of the BRI. China provides financial support to BRI countries mainly through investments and the establishment of a platform for multilateral financing cooperation. From 2013 to 2018, China allocated a total of $41.4 billion to foreign aid, which was divided into three categories: grants (47.3%), concessional loans (48.5%), and interest-free loans (4.2%)[6]. China has also used platforms such as the World Bank, the Asian Infrastructure Investment Bank

(AIIB), and the Asian Development Bank (ADB) to expedite the processes of information exchange, project endorsement, and capability enhancement, thus accumulating more capital dividends for the construction of the BRI. In 2021, Chinese firms made direct nonfinancial investments of $20.3 billion in 57 BRI countries, which was up to 14.1% year on year[7] and accounted for 17.9% of the total in the same period. In addition, Chinese firms signed 6257 new contracts pertaining to foreign contracted projects in 60 BRI countries, amounting to $134.0 billion. Chinese engineering technology has been applied and distributed through projects based on such foreign contracts in BRI countries.

Second, narrow domestic markets hinder economic development (Nurkse, 1961), whereas international trade can effectively broaden market horizons, thus stimulating the vitality of the development of domestic economies. Using yearly data for Chinese provinces from 1996 to 2005, Guo and Luo (2008) found that trade could alleviate poverty through economic growth. Regarding unimpeded trade, the World Bank estimates that trade will increase at a rate between 2.8 and 9.7% for corridor economies and at a rate between 1.7 and 6.2% worldwide (World Bank, 2019). According to the World Input–Output Database (WIOD), the trade volume between China and BRI countries reached $1.8 trillion in 2021, up 32.4% year on year. The growth of trade in goods and services between China and BRI nations has driven the development of related industries and provided opportunities for employment and poverty reduction. In addition, the interactions among trade, investment, financing, and aid activities in the relationships between China and BRI countries can promote technological progress to a certain extent, which may enhance the technical proficiency of BRI participants.

Finally, a nation's production possibility frontier is intricately shaped by the intricate interactions between capital and technology, which may be affected by infrastructure improvement. For BRI countries, infrastructure deficiency and policy disparities impede the seamless flow of trade and foreign investment activities. Infrastructure represents the foundation of connectivity and guarantees other forms of cooperation. While reducing transport costs and establishing favourable conditions for investment and trade, infrastructure can directly promote the economic development of BRI countries. In the collaborations facilitated by the BRI, China has played a pivotal role in assisting BRI nations in the task of establishing essential transport infrastructure such as railways and vessels, thus laying a foundation for cross-border transportation services. Many Chinese firms have implemented FDI mainly in the form of infrastructure construction. In 2021, China-Europe freight trains made 15,183 trips, up 22% year on year, transporting 1.46 million

twenty-foot equivalent units (TEU) containers, up 29% year on year[8]. Economic collaboration between China and the countries involved in the BRI has intensified, leading to the cultivation of reciprocal advantages and mutual developmental progress.

On the other hand, while capital, trade, and infrastructure represent tangible support for economic advancement and poverty alleviation, policy coordination and the establishment of people-to-people bonds serve as intangible yet vital elements of support. Another aspect that distinguishes the BRI from the aid provided by international organizations is the extensive cultural exchange, knowledge acquisition, and technology-sharing features, which are associated with policy coordination and people-to-people bonds. By benefiting from distinctive late-mover advantages during development, BRI countries can efficiently bridge technological gaps by emulating and proficiently mastering advanced technologies drawn from both developed and developing nations. Sen (1999) defined poverty in terms of a lack of capabilities. Poverty encompasses more than merely a deficiency in income; it also includes various objective indicators of deprivation, such as clean drinking water, road infrastructure, sanitation facilities, and subjective feelings of welfare (Sen, 1999; Wang and Alkire, 2009). The BRI implements many projects aimed at addressing deficiencies in essential public services, including initiatives related to housing, medical care, and education; enhancing people-to-people interactions, including the establishment of the Chinese Government Scholarship-Silk Road Programme, which streamlines visa procedures for tourists from BRI countries, and its tendency to send young volunteers to deepen people-to-people exchanges with other nations; and leveraging advanced technologies such as digital technology to continue strengthening these cultural exchanges. For example, China launched the programme 'Access to Satellite TV for 10,000 African Villages' in more than 20 African countries[9]. China has also established scientific research institutions such as joint laboratories and international technology transfer centres in partnership with BRI countries to promote scientific and technological research. By cultivating people-to-people bonds, the BRI offers assistance in terms of personnel, projects, and financial resources with the goal of elevating the educational and healthcare standards of participating countries, which is conducive to enhancing the self-development ability of impoverished populations.

In addition, in the attempt to transform the BRI into a path towards poverty alleviation, it is necessary to focus on institutional development and governance ability while stimulating economic growth and enhancing the self-development ability of people experiencing poverty. Acemoglu and Robinson (2012) argued that inclusive economic and political institutions represent the keystone of a nation's prosperity. Tebaldi and Mohan (2010) found that an effective government and stable political system create important conditions for poverty reduction based on a comparison of eight systems. Hannan (2014) emphasized the importance of cooperative governance and poverty reduction in developing countries. By offering a comprehensive strategic blueprint for economic and trade collaboration alongside vigorous policy coordination and the exchange of developmental insights between China and the BRI countries, the participating nations can foster a consensus regarding development. By incorporating China's invaluable experience in poverty eradication and steadfastly adhering to a development philosophy based on the well-being of people, the BRI has the potential to offer viable solutions to the challenge of poverty reduction. By the end of March 2022, China had forged more than 200 agreements with 149 countries and 32 international entities to construct the BRI jointly, including domains such as connectivity, investment, trade, and finance. China has also offered more than 4,000

training programs for officials from BRI countries and has dispatched a substantial number of experts and consultants to facilitate reciprocal knowledge exchange[10]. Accordingly, the following hypothesis is proposed:

H2: The BRI can contribute to poverty reduction in BRI countries through policy coordination, facility connectivity, unimpeded trade, financial integration, and people-to-people bonds.

Model and data description

Model design. This article explores the poverty reduction effect of the BRI on participating countries. Unlike regression models such as the ordinary least squares method (OLS) and the fixed effects model (FE), the difference-in-differences (DID) model was established based on a randomized experiment and can effectively evaluate a policy by calculating the changes in the dependent variables between the treatment group and the control group across two different periods and then comparing the differences between these groups to obtain the average treatment effect (based on the assumption that the two groups exhibited the same development trend before the policy was implemented). The DID method has been widely used in policy impact evaluation. The literature on evaluating the impact of the BRI has also used this method extensively (Du and Zhang, 2018; Mao et al., 2019). Based on previous research and data availability, this article uses the DID method to test the effect of the BRI's policies on poverty reduction in BRI countries. In particular, the year 2013, when China implemented the BRI, is viewed as a pivotal policy juncture, and BRI countries constitute the treatment group. The model is established as follows:

$$Pov_{it} = \alpha_0 + \alpha_1 DID_{it} + \alpha_2 BRI_i + \alpha_3 Time_t + \beta_i \sum Control_{it} + \mu_i + \sigma_t + \varepsilon_{it} \tag{1}$$

In this context, Pov_{it} indicates the poverty of country i in year t as measured by the poverty headcount ratio based on a threshold of \$3.2 per person per day (in terms of 2011 PPP); BRI_i and $Time_t$ are both binary variables; BRI_i is the policy variable, which receives a value of 1 if country i is a BRI country and otherwise receives a value of 0; $Time_t$ is the time variable, which receives a value of 1 if t is greater than or equal to 2013 and otherwise receives a value of 0; and DID_{it} is a policy-influenced interaction item whose value is equal to the product of the two variables BRI_i and $Time_t$. This item takes a value of 1 if and only if the observed variable belongs to countries along the Belt and Road and the time is after 2013, i.e., when $BRI_i = 1$ and $Time_t = 1$ simultaneously. At this time, the coefficient α_1 of DID_{it} represents the policy effect of joining the BRI. $Control_{it}$ represents a series of control variables; μ_i is the country fixed effect; σ_t is the yearly fixed effect; and ε_{it} is the random error term.

Data source and variable selection. Most of the data used in this analysis were taken from the WDI (World Development Indicators), the World Integrated Trade Solution (WITS) database, and PovcalNet of the World Bank as well as from the websites of the UN and China's Belt and Road Portal, China Global Investment Tracker (CGIT) and statistics drawn from the websites of the Confucius Institute and the Chinese Ministry of Foreign Affairs.

Measurement of poverty variable. One way to discuss poverty in a country or region is to use a single economic indicator such as income, consumption, or the income poverty line. With regard to poverty alleviation strategies, most countries determine their national income poverty thresholds based on the specific developmental conditions that are obtained within their territories.

Comparing income-related poverty criteria across different countries poses inherent challenges. To discuss global poverty dynamics more effectively, the international poverty threshold established by the World Bank serves as a widely adopted benchmark and was derived from globally aggregated poverty data adjusted for constant prices; this benchmark has gained broad acceptance for both academic research and practical applications. Another approach is based on the multidimensional poverty indicators associated with capability theory, such as the United Nations Development Programme's Human Development Index (HDI), the University of Oxford's Multidimensional Poverty Index (MPI), or robust methods of analysing multi-dimensional poverty using the first order dominance (FOD) approach (Arndt et al., 2012).

This article uses the moderate poverty line of $3.2 per person per day (in terms of 2011 PPP; this measure was released by the World Bank) to measure the poverty level in the dependent variable for the following reasons. First, the World Bank has long tracked poverty in countries worldwide, providing a comprehensive view of global, regional, and country-level trends for more than 160 economies. Many studies on country-level poverty have used the World Bank's national poverty incidence rate (Agénor, 2004; Azam et al., 2016; Brown, 2017). Some scholars have chosen the Multidimensional Poverty Index (MPI) based on competency-building theory to discuss poverty. However, the sample size and period of the MPI cannot be used for the panel data analysis of countries worldwide conducted in this article since its measurement began in 2010. Second, as only two BRI countries in the sample selected in this article represent 'low-income countries' (as classified by the World Bank), the effect of the initiative cannot be captured if the extreme poverty line (i.e., $1.9 per person per day according to the World Bank) is adopted. In other words, as most BRI countries are middle-income economies, utilizing the extreme poverty line might lead to an underestimation of the situation of poverty in these nations due to its relatively low threshold. Additionally, the incidence of poverty in many countries along the Belt and Road is above 10% at the $3.2 poverty line, which is prominent and worthy of attention. In conclusion, this article measured poverty using a moderate poverty headcount ratio based on the $3.2 poverty line. The data were drawn from PovcalNet, a reliable and globally recognized database that has consistently monitored poverty levels since 1981.

Control variables. This article incorporated control variables spanning three dimensions that could influence a nation's poverty situation.

First, a set of variables in the economic domain was chosen, including economic scale, economic growth rate, physical capital, natural resource endowment, and the proportion of agricultural output value. Dollar and Kraay (2002) found that economic growth can benefit all and improve poverty through the 'trickle-down effect'. Wang et al. (2014) argued that China's significant reduction in poverty since 1978 can be attributed to its consistently high economic growth. The economic scale and growth rate measure a country's economic strength and development speed. The former reflects the present state of economic development, whereas the latter indicates the potential for future economic growth. This article chooses per capita GDP to measure economic scale and GDP growth to measure economic development (Dollar and Kraay, 2002). Per capita GDP refers to the average economic output per citizen, and a higher per capita GDP generally corresponds to higher disposable income, consequently reducing the likelihood of absolute poverty, while a high growth rate implies a rapid expansion of the economy, resulting in the creation of more job opportunities and potentially leading to a reduction in poverty. The logarithm of GDP per capita is included in the model to reduce heteroscedasticity.

Physical capital, natural resource endowment, and the proportion of agricultural output value partly reflect the structure and quality of economic development, which affects the extent to which economic growth can benefit people with low incomes. The proportion of total fixed capital formation to GDP (%) measures physical capital (Ghali and Ahmed, 1999), which is usually considered in the form of the 'capital formation rate'. This factor is also called the 'investment rate' in GDP accounting. The higher the indicator is, the higher the country's level of economic development. The proportion of natural resource rent to GDP (%) endowment measures natural resources. The higher the proportion is, the more strongly development depends on resource endowment (Stijns, 2006). The agricultural output value (%) calculation is derived from the ratio of agricultural added value to GDP. A higher proportion indicates that a country's economic growth relies more heavily on the primary industry, which corresponds to a relative underdevelopment status quo for the country (Chandio et al., 2016).

Second, the urbanization level, labour force participation rate, population density, and dependency ratio were selected for social development. Urbanization can improve production efficiency and drive economic growth (Bertinelli and Black, 2004). On the one hand, this process stimulates the demand for a rural labour force for nonagricultural employment, which substantially enhances the overall income of rural households (Hu et al., 2006); on the other hand, it can narrow the income gap and offer the rural population better social security, both of which contribute to poverty alleviation. The labour force participation rate, population density, and dependency ratio reflect a country's demographic characteristics. Poverty is significantly connected to the labour market (Odhiambo and Manda, 2003). The labour force participation rate is a dynamic indicator of a country's labour market vitality, which offers valuable insights into diverse consumer market potentials across various nations. Increased labour participation can help lift families out of poverty (Mooney, 1967). Population density is not solely linked to poverty (Tinsley and Bishop, 2006); it is also correlated with other variables influencing poverty, such as economic growth (Quigley, 1998), innovation and the availability of employment opportunities (Carlino et al., 2007). A high dependency ratio in a family or developing country can lead to lower productivity on the part of such a labour force (Ferriss, 2006). The dependency ratio is also a crucial factor that significantly influences household welfare (Akerele and Adewuyi, 2011).

Third, institutional quality was selected based on the political environment, which is provided by the WDI and is mainly used to measure a country's governance level. Poverty governance involves multiple parties, such as the government, the market, and social organizations, who engage in a process of continuous investment, negotiation and coordination to address poverty. It also indicates a country's governance effectiveness (Feiock, 2013), and the quality of governance and the prevailing system within a country can significantly impact its investment and trade activities (Table 1).

Descriptive statistics. This article selected the period from 2005 to 2019 for analysis. Due to data limitations in some countries, 151 countries were included in the observational sample[11], including 53 BRI countries and 98 non-BRI countries. Descriptive statistics of the samples are shown in the following Table 2.

Analysis of empirical results
Benchmark regression results. According to the model constructed previously, the regression results are shown in Table 3

Table 1 Description of variables.

	Variable name	Variable code	Definition
Economic dimension	Economic scale	*gdp_per*	GDP per capita (US$)
	Economic growth rate	*gdp grow*	GDP growth ratio (%)
	Physical capital	*physicalcapital*	Proportion of total fixed capital formation to GDP (%)
	Natural resource endowment	*nature source*	Proportion of natural resource rent to GDP (%)
	Proportion of agricultural output value	*agriculture*	Proportion of agricultural added value to GDP (%)
Social dimension	Urbanization level	*urbanization*	Proportion of urban population to total population (%)
	Labour force participation rate	*labour*	Proportion of total labour force to total population aged 15–64 (%)
	Population density	*density*	Number of inhabitants per square kilometre
	Dependency ratio	*dependency*	Age dependency ratio, working-age population/non-working-age population (%)
Political dimension	Institutional quality	*inst_qual*	Average of the total scores for freedoms of speech, legal capture, supervision quality, political stability, corruption control and government effectiveness. Each estimate ranges from −2.5 to 2.5.

Source: World Bank WDI (World Development Indicators) database, World Bank World Integrated Trade Solution (WITS) database, PovcalNet, UN database, Belt and Road Portal, China Global Investment Tracker (CGIT), Collation performed by the author using Stata software. The same points hold below.

Table 2 Descriptive statistics of the variables.

Variable	Sample size	Mean value	Standard deviation	Minimum value	Maximum value
Moderate poverty headcount ratio (%)	2161	25.5	29.27	0	98.46
Economic scale (US$)	2161	13000	19800	151.7	155000
Economic growth rate (%)	2161	3.776	4.079	−46.08	34.5
Physical capital (%)	2161	23.59	7.858	0.502	81.18
Agricultural output value (%)	2161	11.59	10.92	0.214	60.61
Natural resource endowment (%)	2161	6.699	10.08	0	81.95
Urbanization level (%)	2161	57.11	21.31	9.375	98.04
Labour force participation rate (%)	2161	60.5	9.501	32.03	88.35
Population density	2161	132.8	202.3	1.626	1770
Dependency ratio (%)	2161	60.93	17.69	16.07	111.9
Institutional quality	2161	−0.0683	0.886	−1.902	1.894

Columns (1) and (2) report the effects of BRI participation on poverty reduction in BRI countries. All regressions control for fixed time and country effects. The results show that the coefficient of DID is consistently and significantly negative regardless of the inclusion of control variables, which is consistent with the expected direction of action, indicating that the BRI can help BRI countries reduce the poverty headcount ratio. The coefficient of DID after adding control variables changed to −3.42, implying that in comparison to non-BRI countries (the control group), participation in BRI is associated with an average decrease of 3.42% points in the poverty headcount ratio in BRI countries (the treatment group) while accounting for political, economic, and social factors that may affect the incidence of poverty.

According to the regression results regarding the control variables, the coefficients of both economic scale and economic growth rate are significantly negative. Specifically, a 1% point increase in economic scale is associated with an average decrease of 1.79% points in the poverty headcount ratio, showing that economic development is crucial for poverty reduction in BRI countries. The findings shown in Table 3 Column (2), indicate a negative correlation between physical capital and a country's poverty headcount ratio. The coefficient of the agricultural output value (%) shown in the table is positive, indicating that for every 1% point increase in the share of agricultural output, the incidence of poverty in the country increases by 0.35% on average. To alleviate poverty among farmers, it is imperative to accelerate the transformation and upgrading of primary industry, enhance the value added to agriculture, and achieve holistic development that encompasses the primary, secondary, and tertiary sectors.

In the social dimension, for every 1% point increase in urbanization, the poverty rate has an average reduction of 0.65% points. Conversely, every 1% point rise in the dependency ratio leads to an average increase of 0.45% points in poverty incidence. The positive coefficients associated with the labour participation rate in column (2) engender outcomes that stimulate contemplation. One possible reason is that a significant portion of the rise in labour force participation originates from low-paying or precarious employment. Kolev (2005) found that the poverty reduction effect of employment was related to the quality of work—workers in informal employment actually experienced an increase in poverty. Even with engagement in the labour market, individuals may find it challenging to overcome poverty due to insufficient wages. The coefficient of institutional quality is negative, indicating that the poverty headcount ratio decreases by 5.12% points on average for every unit of improvement in a country's governance level. For countries with serious poverty problems, it is very important to improve their institutional environment.

Heterogeneity analysis. Does the poverty reduction effect of the BRI exhibit varying impacts across different categories of countries? If so, in which countries is this effect more pronounced? In addition, the BRI can be divided into the Land Silk Road Economic Belt and the 21st-Century Maritime Silk Road. Which type of BRI is more effective? To address these inquiries, this part of the article discusses the heterogeneity of this effect in terms of three aspects: geographical distance, income classification, and BRI type.

Table 3 Benchmark regression model of the poverty reduction effect of the BRI on BRI countries.

Variable	(1) Poverty	(2) Poverty
DID	−2.01***	−3.42***
	(−4.44)	(−8.75)
lngdp_per		−1.79***
		(−4.67)
gdp_growth		−0.05*
		(−1.70)
physicalcapital		−0.18***
		(−8.76)
agri_value		0.35***
		(7.17)
natural_rents		0.04
		(1.56)
pop_urban		−0.65***
		(−8.93)
labour		0.56***
		(9.37)
age_dependency		0.45***
		(13.47)
pop_dens		−0.00
		(−0.27)
inst_qual		−5.12***
		(−6.34)
Constant	31.51***	18.07***
	(74.56)	(2.62)
County fixed effect	YES	YES
Year fixed effect	YES	YES
Observations	2161	2161
R-squared	0.30	0.53
F	56.66	88.14

Note: values in parentheses are *t*-statistics. *** and * indicate statistical significance at the 1% and 10% levels, respectively.

Grouping by geographical distance. The BRI is associated with the 'Five Cooperation Priorities', while the relative geographical locations of BRI countries and China influence the nuanced implementation of these priorities, consequently resulting in variations in their impact. Bordering countries are grouped into neighbouring countries and non-neighbouring countries based on whether they feature a land border with China. Participation in the BRI has a noteworthy impact on poverty alleviation, which is evident in both neighbouring and non-neighbouring countries, as shown in Table 4 Columns (1) and (2). Remarkably, the coefficient associated with neighbouring countries exhibits a more substantial magnitude than that associated with non-neighbouring countries. As shown in the regression results regarding the interactive terms presented in Column (3), the BRI has a poverty reduction effect on neighbouring countries that is 8.31 higher than its effect on non-neighbouring countries. In addition, considering the geographical distance between China and BRI countries, the interaction terms between the distance from the capital and the distance from major cities were constructed using DID variables. The regression results are shown in Columns (4) and (5). The significance of the poverty reduction effect of the BRI remains apparent, yet its role gradually decreases as the distance between the two countries increases. This result can be reasonably explained. When countries are geographically closer, it becomes more feasible for them to engage in collaborative efforts involving infrastructure, trade, and related domains. This enhanced proximity facilitates greater factor mobility, spurs economic advancement, enhances employment prospects, and ultimately contributes to poverty alleviation.

Grouping by income type. Based on the World Bank's income classification, the 151 countries were categorized into four groups: 'low-income countries, lower-middle-income countries, upper-middle-income countries, and 'high-income countries'. Given the relatively low poverty headcount ratio in high-income countries, their inclusion in the analysis of the poverty reduction effect of participation in the BRI may not lead to substantial insights. Consequently, this article focused solely on countries belonging to the first three income categories. Additionally, due to the limited number of low-income countries included in the treatment group, these countries were combined with 'lower-middle-income countries' to form the 'Lower-middle-income' category for analytical purposes. The results are shown in Table 5 Column (1). Furthermore, the results after the combination of lower-middle-income countries with upper-middle-income countries to form the middle-income group are shown in Column (2). Both results indicate that the poverty reduction effect of the BRI remains significant. Notably, when a country belongs to an upper-middle-income country and then the income variable is set at 1, this study performs a regression involving an interaction term. The coefficient of the interaction term suggests that the BRI tends to have a more pronounced effect on poverty alleviation in lower-income and middle-income countries. Lower-middle-income countries stand to obtain greater incremental benefits through participation in the BRI.

Grouping by BRI Type. This article then divided the sample into the *Land Silk Road Economic Belt group* and *the 21st-Century Maritime Silk Road group*, and the results are shown in Table 5 Columns (3)–(5). Column 3 shows that joining the BRI can significantly reduce the moderate poverty headcount ratio in countries along the Land Silk Road by 1.85% points, while Column 4 shows that it can reduce the moderate poverty headcount ratio in countries along the Maritime Silk Road by 5.99% points. Comparing the coefficients of the two interaction terms in Column 6, the poverty reduction effect of the Maritime Silk Road is more pronounced. A possible reason for this difference is that sea transport is the most important mode of international trade.

Further discussion

Based on the analysis presented above, participation in the BRI leads to a substantial decrease in the poverty headcount ratio within BRI countries, although these impacts vary across different countries. However, the empirical results reported above fail to answer the question of how this impact is achieved. Based on the theoretical and practical framework for policy, this article attempts to discuss the poverty reduction mechanism of the BRI in terms of the 'Five Cooperation Priorities'. According to the practice suggested by Wen et al. (2004), this article used the stepwise regression method and the Sobel test to test the mechanism; the specific model used was as follows:

$$Pov_{it} = \alpha_0 + \alpha_1 BRI_{it} + \beta_i \sum Control_{it} + \mu_i + \sigma_t + \varepsilon_{it} \quad (2)$$

$$Mediater_{it} = \theta_0 + \theta_1 BRI_{it} + \theta_i \sum Control_{it} + \mu_i + \sigma_t + \varepsilon_{it} \quad (3)$$

$$Pov_{it} = \psi_0 + \psi_1 BRI_{it} + \psi_2 Mediater_{it} + \psi_i \sum Control_{it} + \mu_i + \sigma_t + \varepsilon_{it} \quad (4)$$

In this context, $Mediater_{it}$ is the mediating variable (namely, 'Five Cooperation Priorities'); α_1 measures the total effect of joining the BRI on poverty reduction, and θ_1 measures the relationship between joining the BRI and the mediating variable M. If α_1, θ_1 and ψ_2 are significant, then a mediating effect is present; otherwise, the Sobel test must be performed.

Table 4 Grouped regression by geographical distance.

Variable	(1) Neighbouring countries	(2) Nonneighbouring countries	(3) Comparison of neighbouring countries	(4) Distance to the capital	(5) Distance to major cities
	Poverty	*Poverty*	*Poverty*	*Poverty*	*Poverty*
DID	−9.50**	−0.87**	−1.63***	−14.47***	−14.33***
	(−2.20)	(−2.40)	(−3.84)	(−13.52)	(−13.47)
did_contig			−8.31***		
			(−11.49)		
did_distcap				0.002***	
				−10.771	
did_dist					0.002***
					−10.713
Control variable	YES	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES
Constant	63.01	92.92***	32.03***	24.91***	24.92***
	(1.63)	(12.76)	(4.69)	(3.68)	(3.68)
Observations	178	1913	2 091	2 091	2 091
R-squared	0.836	0.539	0.568	0.564	0.564
F	30.15	82.22	96.91	95.58	95.47

Note: values in parentheses are *t*-statistics. *** and ** indicate statistical significance at the 1% and 5% levels respectively.

Table 5 Grouping by income type and BRI type.

Variable	(1) *Lower-middle-income*	(2) *Middle-income*	(3) Comparison of income groups	(4) *The Maritime Silk Road*	(5) *The Land Silk Road*	(6) Comparison of BRI types
	Poverty	*Poverty*	*Poverty*	*Poverty*	*Poverty*	*Poverty*
DID	−9.24***	−3.21***	−5.81***	−5.99***	−1.85***	
	(−12.33)	(−5.54)	(−12.91)	(−9.41)	(−4.99)	
*did*income*			6.09***			
			(10.02)			
*did*briMaritime*						−6.19***
						(−9.83)
*did*briland*						−2.30***
						(−5.26)
Control variable	YES	YES	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES	YES
Observations	952	1314	2161	1588	1954	2161
R-squared	0.64	0.57	0.55	0.52	0.57	0.53
F	59.80	62.56	92.85	63.09	96.78	87.24

Note: values in parentheses are *t*-statistics. *** indicate statistical significance at the 1% levels.

Unimpeded trade. The BRI serves as a substantial platform for fostering regional collaboration. Participation in the BRI not only facilitates enhanced trade relations with China but also fosters expanded trade partnerships both among BRI nations and with other potential countries. This article measured *unimpeded trade* by reference to multilateral trade volume (*multitrade*) and bilateral trade volume with China (*bitrade*) and collected relevant data from the WITS database provided by the World Bank. The estimated coefficients shown in Table 6 Columns (1) and (3), are significantly positive, indicating that joining the BRI has a substantial and positive influence on enhancing the trade performance of countries. The results shown in Columns (2) and (4) indicate that the BRI promotes poverty reduction by fostering an improvement in the multilateral trade level at the global level and enhancing bilateral trade volume specifically with China. This article further selected the variable of trade partners (*trade_partner*) for analysis. The results in shown in Columns (5) and (6), indicate that BRI countries have achieved poverty reduction through enhanced international collaboration with a broader array of trading partners, which is mutually confirmed by the results shown in Columns (1) and (2).

Financial integration. China has been strengthening financial cooperation with BRI countries with the goal of providing them with credit support. According to statistics provided by the China Banking and Insurance Regulatory Commission (CBIRC), by the end of June 2023, a total of 13 Chinese banks had established 145 tier-one branches in 50 BRI countries[12]. By reference to Lyu et al. (2009), the branches of commercial banks (*bank_n*) were used as a proxy variable for the financial environment of BRI countries regarding financial integration, and the data were drawn from the World Bank. The estimated coefficients shown in Table 7 Columns (1) and (2), are significant, indicating that the BRI has significantly increased the number of branches of commercial banks in BRI countries, subsequently contributing to poverty alleviation. To explore the investment opportunities offered by joining the BRI, FDI (*fdi_inflows*) and the number of greenfield investment projects (*green investment*) in China were selected as

Table 6 Mediating effect test of trade.

Variable	(1) multitrade	(2) Poverty	(3) bitrade	(4) Poverty	(5) trade_partner	(6) Poverty
DID	6.24***	−2.09***	0.57**	−1.98***	0.78**	−1.46***
	(3.81)	(−4.73)	−2.8	(−3.61)	−2.94	(−5.39)
mutlitrade		−0.04***				
		(−3.87)				
bitrade				−0.20***		
				(−3.16)		
trade_partner						−0.11*
						(−1.79)
Constant	172.91***	24.92	33.59***	−7.26	34.76***	3.27
	(7.51)	(1.47)	(9.89)	(−0.56)	−5.05	−0.26
Observations	1920	1920	1590	1590	1508	1508
R-squared	0.91	0.98	0.86	0.99	0.91	0.99
F	38.51	2724	32.48	668.9	785.0	1301

Note: values in parentheses are t-statistics. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 7 Mediating effect test of trade.

Variable	(1) bank_n	(2) Poverty	(3) fdi_inflows	(4) green investment	(5) Poverty
DID	0.73**	−2.97***	−0.01	0.18*	−3.18***
	(2.37)	(−4.39)	(−0.23)	(1.93)	(−5.09)
bank_n		−0.09***			
		(−3.71)			
green investment					−0.96**
					(−2.47)
Control variable	YES	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES
Constant	4.08	−2.21	20.42***	−1.86***	9.28
	(0.52)	(−0.39)	(16.57)	(−3.45)	(1.12)
Observations	2068	2068	2008	2294	1957
R-squared	0.95	0.98	0.90	0.39	0.98
F	814.8	1257	1574	16.16	11497

Note: values in parentheses are t-statistics. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

measurement indicators, in which context the data were drawn from the World Bank and China Global Investment Tracker (CGIT), respectively. The results shown in Table 7 Column (3), indicate that the BRI has not exerted a significant influence on poverty reduction in BRI countries through FDI, while the results shown in Columns (4) and (5) indicate that the BRI has helped BRI countries achieve poverty reduction by increasing China's greenfield investment projects.

Facilities connectivity. Some BRI countries feature under-developed transportation and digital infrastructure. By 2030, the infrastructure investment requirements of these BRI nations are expected to amount to $649.9 billion (World Bank, 2019). China contributes to the enhancement of the infrastructure standards of BRI countries through a substantial variety of collaborative infrastructure initiatives. Based on the availability of data, mobile subscription (mobile) and internet utilization (internet) were selected to measure the level of facility connectivity. The estimated results shown in Table 8 Columns (1) and (3), indicate that the BRI has significantly increased the digital infrastructure level of BRI countries; that is, the number of mobile subscriptions and internet utilization has markedly increased. Furthermore, the results shown in Columns (2) and (4) indicate that the BRI drives

poverty reduction by increasing the number of mobile subscriptions in BRI countries, while its effect on internet utilization is not obvious.

People-to-people bonds. Referring to the practice suggested by Dai and Song (2021), this article selected the number of Confucius schools (kschool_n) as a proxy variable for people-to-people bonds. The estimated coefficients in Table 9 Column (1) are significantly positive, indicating that BRI is linked to an increase in the number of Confucius Institutes established in BRI countries. However, the coefficient in Column (2) is not statistically significant, suggesting that Confucius Institutes may not have a significant impact on poverty alleviation, which may be because education is a long-term investment, which entails costs in the short term; furthermore, the process of achieving poverty reduction through knowledge takes a long time.

Policy coordination. Referring to Zhang and Jiang (2012), this article measured policy coordination based on the number of official visits (visit_n) and collected corresponding data from China Diplomatic Yearbooks. To verify the knowledge sharing and technical learning that occurred between China and BRI countries in the context of policy coordination, this article also

selected the indicator of technical cooperation exchanges (*tech_coop*), sourced from the World Bank. The estimated coefficients in Table 9 Columns (3) and (5) are significant, indicating that joining the BRI significantly increased the number of bilateral visits and technical cooperation exchanges with China. Therefore, the BRI has enhanced China's level of policy coordination with BRI countries. Columns (4) and (6) indicate that the BRI has reduced the poverty headcount ratio of BRI countries through technology learning.

Conclusions and discussion

Conclusions. Since the implementation of the BRI, academic research on this topic has increased rapidly. Numerous scholars have explored various dimensions of the BRI, including its economic, social, political, and environmental aspects. Few scholars have empirically tested the impact of this initiative on poverty in countries along the Belt and Road. In the context of the United Nations 2030 SDGs, this article constructed a DID method to examine the impact of the BRI on poverty alleviation by using

data drawn from 151 countries over 15 years. This article reveals several findings.

First, compared with non-BRI countries, joining the BRI promotes the poverty governance of BRI countries, leading to a substantial reduction in their moderate poverty headcount ratio when compared to countries that do not participate in the initiative. Second, the impact of the BRI on poverty reduction varies across different countries. Specifically, the poverty reduction effect of the BRI is more pronounced in lower-middle-income countries than in high-income countries. The geographical distance between the participating countries and China influences the effectiveness of poverty reduction. Third, according to the mechanism test, the BRI can help BRI countries reduce their poverty headcount ratio through unimpeded trade, financial integration, facility connectivity, and policy coordination. Regarding unimpeded trade, the BRI has significantly elevated the trade activity of BRI countries both multilaterally and bilaterally. Notably, BRI countries can further alleviate their poverty headcount ratios by engaging in international trade activities with a broader range of partners through the BRI, which acts as a regional platform for economic cooperation. In terms of financial integration, the BRI has established more branches of domestic commercial banks, thus contributing to the establishment of a robust and comprehensive financial service system. Moreover, the BRI has also substantially increased China's greenfield investment projects in BRI countries. thereby helping them achieve the goal of poverty reduction. Concerning facilities connectivity, the BRI has improved the digital infrastructure of BRI countries, thus laying a foundation for them to implement cross-border e-commerce, mobile payment, and other activities. Regarding people-to-people bonds, the opening of Confucius schools in BRI countries contributes to their cultural exchanges with China while the effect on poverty reduction needs further observation.

Through the establishment of people-to-people bonds and policy coordination, China imparts practical insights into poverty reduction to BRI countries by exchanging knowledge and technical expertise with them. In essence, the BRI serves the common good of the world. Through the BRI, countries along the route can foster diverse levels of policy alignment, improved infrastructure connectivity, enhanced trade relations, financial integration, and strengthened people-to-people ties with many nations. These collaborative efforts collectively contribute to the

Table 8 The mediating effect of facilities connectivity.

Variable	(1) internet	(2) Poverty	(3) mobile	(4) Poverty
DID	5.43***	−3.05***	2.01**	−3.21***
	(6.40)	(−5.17)	(2.23)	(−4.72)
internet		0.01		
		(0.61)		
mobile				-0.07***
				(-12.92)
Control variable	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES
Constant	1.20	19.87	66.27	16.02**
	(0.17)	(1.71)	(1.43)	(2.18)
Observations	1859	1859	1951	1951
R-squared	0.96	0.98	0.88	0.98
F	99.61	1451	195.8	1243

Note: values in parentheses are *t*-statistics. *** and ** indicate statistical significance at the 1% and 5% levels, respectively.

Table 9 The mediating effect of people-to-people bonds and policy coordination.

Variable	(1) kschool_n	(2) Poverty	(3) visit_n	(4) Poverty	(5) tech_coop	(6) Poverty
DID	0.09***	−2.55***	0.09**	−4.00***	0.10**	−4.23***
	(8.03)	(−3.78)	(2.25)	(−3.84)	(2.5575)	(−4.7551)
kschool_n		0.59				
		(1.15)				
visit_n				−0.49		
				(−0.97)		
tech_coop						−0.85**
						(−2.36)
Constant	−0.84***	9.25*	1.44	−37.56***	19.66***	26.75**
	(−3.11)	(2.16)	(1.58)	(−3.78)	(54.01)	(2.74)
Control variable	YES	YES	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES	YES
Observations	1735	1735	1106	1106	1579	1579
R-squared	0.94	0.99	0.61	0.98	0.91	0.98
F	22.45	.	9.051	1256	82.49	290.5

Note: values in parentheses are *t*-statistics. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

advancement of poverty alleviation initiatives within the BRI framework.

Policy implications. Based on the conclusions of this article, the following policy suggestions are proposed for the subsequent deepening of cooperation within the BRI.

First, the BRI should continue to be pursued with the goal of expanding partnerships. The process of international poverty reduction has been greatly impeded by COVID-19 and regional conflicts. Since the poverty reduction effects of the BRI are more pronounced in the long term, sustained commitment and the continuity of initiatives are essential. China should leverage the international regional cooperation platform BRI to exert its own strength, disseminate its experience in poverty reduction, and help BRI countries achieve the SDGs. The BRI should strengthen cooperation with low- and middle-income countries.

Second, the roles of unimpeded trade, financial integration, and facility connectivity should be expanded to promote economic growth in BRI countries. The increase in multilateral trade is an essential mechanism by which the BRI can contribute to poverty reduction. China should expand the role of the BRI regional cooperation platform and provide more trade opportunities to BRI countries. In contrast, countries along the route should take full advantage of the platform to establish extensive trade partnerships and achieve poverty reduction by improving the overall regional trade level. Financial integration is a crucial form of support for the construction of the BRI. On the one hand, it is imperative for China to advance financial collaboration persistently, such as by fostering the establishment of a robust credit infrastructure and steadfast financial milieu within BRI countries. On the other hand, China should actively incentivize enterprises to channel investments into nations along the route, such as by providing financial support for firms to engage in production, operation, investment, and trade activities. In terms of facility connectivity, both China and BRI countries should continue to identify infrastructure construction as a critical area of cooperation, focusing on the development of digital infrastructure in BRI countries. Information and communication and mobile interconnection facilities are more profitable investments that can offer more information value to people with low incomes in a digital world.

Third, it is necessary to amplify the significance of interpersonal relationships and policy coordination to facilitate the dissemination of knowledge and the exchange of technical expertise. China is poised to fortify its policy coordination and facilitate the exchange of developmental insights with BRI partners. This process requires the country to harness the potential of cultural interactions, scholarly collaborations, and science and technology (S&T) partnerships involving Confucius Institutes, universities, and research establishments. Specifically, BRI countries are poised to inspire engagement on the part of various segments of society, including children, educators, women, and certain nongovernmental organizations (NGOs) as well as volunteers in the collaborative advancement of the BRI, which requires them to facilitate robust nonstate-driven exchange initiatives, thereby prioritizing the reciprocal enrichment of cultural insights, knowledge transfer, and skill development. China is positioned to broaden its collaboration to encompass governmental bodies, universities, and enterprises, such as by cultivating skilled individuals and imparting technical training to BRI nations, which may help empower these nations to harness late-mover advantages in advanced technological development. China should place a premium on the exchange of governance ideas. China should impart its valuable experience in policy coordination, tailoring these insights to the specific conditions of poverty that prevail within BRI nations.

Limitations and future recommendations. Although this article employed different methods to obtain a convincing result, there is room for further discussion of this topic to obtain a more accurate and detailed understanding of the poverty reduction effects of the BRI. First, this article adopts the standard DID model and identifies the policy cut-off point as 2013, whereas, in practice, countries along the Belt and Road joined several years after the initiative was proposed. The estimate of the effect would be more accurate if the time-varying DID method could be used based on the distinct entry times of each participating country. In addition, this article analyses data from 2005–2019. Since 2020, the ongoing COVID-19 pandemic and localized conflicts have had severe impacts on global poverty alleviation efforts. The impact of the BRI on poverty vulnerability and the resilience of countries along the route are issues worthy of further research.

Data availability

Notes

1 As no official list of participating countries exists, researchers generally use two methods to identify all BRI countries. The first aspect is the geographical location of the six overland economic corridors identified by China along the Silk Road Economic Belt and the countries along the 21st-Century Maritime Silk Road (this method is used by the World Bank). The second aspect is whether a country has signed an agreement with China to participate in the BRI. Based on these two approaches, the countries along the BRI in this article include 65 economies: Afghanistan, Albania, Armenia, Azerbaijan, Bahrain, Bangladesh, Belarus, Bhutan, Bosnia and Herzegovina, Brunei, Bulgaria, Cambodia, Croatia, Cyprus, Czech Republic, Egypt, Estonia, Georgia, Greece, Hungary, India, Indonesia, Iran, Iraq, Israel, Jordan, Kazakhstan, Kuwait, Kyrgyzstan, Laos, Latvia, Lebanon, Lithuania, Macedonia, Malaysia, Maldives, Moldova, Mongolia., Montenegro, Myanmar, Nepal, Oman, Pakistan, Palestine, Philippines, Poland, Qatar, Romania, Russia, Saudi Arabia, Serbia, Singapore, Slovakia, Slovenia, Sri Lanka, Syria, Tajikistan, Thailand, Turkey, Turkmenistan, Ukraine, United Arab Emirates, Uzbekistan, Vietnam, Yemen.

2 This article considers India as a BRI country for the following reasons: 1. Although India has not publicly declared its participation in BRI, its central geographical position makes it a major market and transportation channel for the BRI. 2. On China's official Belt and Road website(https://www.yidaiyilu.gov.cn/jcsjpc.htm), India is listed among the countries along the Belt and Road.3. Existing studies have regarded India as a BRI country, such as the classification of the World Bank (2019), Fan et al. (2016) and so on.

3 For lack of data, the number of poor people is calculated in 55 BRI countries, excluding ten countries, namely, Afghanistan, Bahrain, Brunei, Cambodia, Kuwait, Oman, Qatar, Saudi Arabia, Singapore and Palestine.

4 The extreme poverty line is set at $1.90 per person per day (in terms of 2011 purchasing power parity (PPP)), and the moderate poverty line is set at $3.2 per person per day (also in terms of 2011 purchasing power parity (PPP)).

5 Due to the lack of data, the total GDP is calculated by reference to 61 BRI countries, excluding Syria, Turkmenistan, Yemen and Palestine; the overall population is calculated by reference to 64 BRI countries, excluding Palestine.

6 http://www.xinhuanet.com/english/2021-01/10/c_139655510.htm.

7 All year on year increases mentioned in this article represent comparisons with the previous year.

8 https://www.ndrc.gov.cn/xxgk/jd/zctj/202201/t20220119_1312383.html?code=andstate=123.

9 http://en.people.cn/n3/2019/0409/c90000-9564916.html.

10 http://www.gov.cn/xinwen/2021-01/10/content_5578617.htm.

11 Based on 2019 data, the GDP corresponding to the sample represents 97.6% of the total global GDP, and the sample represents 98.3% of the global population.

12 https://www.yidaiyilu.gov.cn/p/0C00MUGP.html.

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Acknowledgements

Author contributions
NX: data analysis and writing; AC: data collection; XW (corresponding author): conceptualization, supervision; XZ (corresponding author): project administration, investigation. All authors substantially contributed to the article and accepted the published version of the manuscript.

Competing interests
The authors declare no competing interests.

Ethical approval
This article does not contain any studies featuring human participants performed by any of the authors.

Informed consent
This article does not contain any studies featuring human participants performed by any of the authors.

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