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О. Экономическое развитие, инновации, технологические изменения и рост
O. Economic Development, Innovation, Technological Change, and Growth

ИССЛЕДОВАНИЕ ВЛИЯНИЯ ЗЕЛЕНЫХ ИНВЕСТИЦИЙ НА КАЧЕСТВО ЖИЗНИ: СРАВНИТЕЛЬНОЕ ИССЛЕДОВАНИЕ КИТАЯ И БЕЛАРУСИ С ТОЧКИ ЗРЕНИЯ ПЕРСПЕКТИВЫ ЭКОНОМИЧЕСКОГО РОСТА

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Аннотация. Исследуется влияние зеленых инвестиций на качество жизни с точки зрения экономического роста. В целях изучения данного процесса используются панельные данные и модели с фиксированными эффектами для 30 провинций Китая, а также для 6 регионов и столицы Беларуси за период с 2010 по 2020 г. Результаты показывают, что при сохранении других условий неизменными увеличение зеленых инвестиций на 1,0 % может ускорить экономический рост на 0,22 %. Проводится сравнительный анализ влияния зеленых инвестиций на экономический рост в Китае и Беларуси. Выявляются существенные различия в их воздействии. Утверждается, что экономический эффект от зеленых инвестиций в Беларуси примерно в три раза выше, чем в Китае. Эти выводы остаются актуальными в случае учета проблемы эндогенности и проведения серии проверок надежности. Для улучшения качества жизни и увеличения экономических выгод, получаемых от зеленых инвестиций, предлагаются соответствующие меры экономической политики.

Ключевые слова: зеленые инвестиции; качество жизни; экономический рост; Китай; Беларусь.

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EXPLORING THE IMPACT OF GREEN INVESTMENT ON QUALITY OF LIFE: COMPARATIVE STUDY OF CHINA AND BELARUS FROM THE PERSPECTIVE OF ECONOMIC GROWTH

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Abstract. The impact of green investment on quality of life from the perspective of economic growth is investigated. Panel data and fixed effects models for 30 provinces in China as well as 6 regions and the capital city of Belarus for the period from 2010 to 2020 are used to study this process. The results show that holding other conditions constant, a 1.0 % increase in green investment can accelerate economic growth by 0.22 %. A comparative analysis of the impact of green investment on economic growth in China and Belarus is carried out. Significant differences in their impact are identified. It is argued that the economic benefits of green investment in Belarus are about three times higher than in China. These findings remain valid if the endogeneity problem is taken into account and a series of robustness checks are conducted. Appropriate economic policy measures are proposed to improve the quality of life and increase the economic benefits of green investment.

Keywords: green investment; quality of life; economic growth; China; Belarus.

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Introduction

Global greenhouse gas emissions have been on a steady rise. In 2011–2020, compared to 1850–1900, global surface temperatures reached 1.1 °C, and as per projections they are more likely than not to reach 1.5 °C in the near term, even under the very low greenhouse gas emission scenario [1, p. 42]. This situation has garnered worldwide attention and given a strong push to green investment.

Green investment is a new type of investment model centred on the concept of sustainable development, taking into account the harmonious coexistence of the economy, society and environment. In 2022, global investment in renewable power and fuels reached a record high of 495.4 bln US dollars, a 17.2 % increase from 2021 [2, p. 32]. These data show some progress has been made in green investment which is important for the improvement of the quality of life.

People's quality of life, as the ultimate goal of economic and social development, has always been the concern of governments and scholars. Green investment can enhance the quality of life in dimensions such as environment, society and economy [3, p. 169]. On the one hand, green investment has the non-productive purpose of improving the quality of environment which can promote the development of environmental protection industries and reduce pollution emissions, thus enhancing the health of residents and their quality of life from an environmental perspective. This type of investment can also improve social infrastructure to increase people's quality of life from a social perspective. On the other hand, green investment has economic benefits. Moreover, this investment, especially productive, is able to contribute to economic development through channels such as financial guidance, improvement of industrial structure, optimisation of resource allocation and enhancement of innovation. In addition, awareness of environmental protection is growing, and increasingly stringent environmental standards are being adopted. Against this backdrop, green investment can enable corporations to better adapt to market demand, gain consumer value recognition and thus increase wealth accumulation.

It should be noted that there are relatively few studies on green investment and quality of life, especially empirical. One of the reasons is the uncertainty of the concept of quality of life, despite more than half a century of academic research on the subject. Taken together, common methods of measurement this phenomenon include economic growth, life satisfaction, health, happiness, etc. [4, p. 1]. Among them, economic growth is the basis and condition for improving the quality of life and is one of the key factors in its measurement.

Therefore, constrained by data availability, this article utilises data for China and Belarus to explore the impact of green investment on quality of life from the perspective of economic growth. Furthermore, a comparative study is conducted to explore the commonalities and differences of the economic benefits of green investment among these countries.

The selection of China and Belarus for comparative study is due to several reasons. Firstly, Belarus pays great attention to ecology and a relatively well-developed legal system and institutional mechanisms for environmental

protection [5, p. 89]. China is working on these aspects. Hence, exploring the differences in the benefits of green investment through comparative analysis may provide practical recommendations for policymakers. Secondly, the relationship between China and Belarus is getting closer in terms of trade, economics, etc. It includes the identification of the all-weather comprehensive strategic partnership, the promotion of the Belt and Road initiative, etc. China has become the second largest trading partner for Belarus. Therefore, the comparative analysis can provide a reference for the governments, intergovernmental organisations and corporations of both countries to further cooperate and trade directions, especially the related cooperation for sustainable development of the Belt and Road initiative.

Model, variables and data

Model, variable description and data sources. This paper examines the impact of green investment on economic growth by constructing an econometric model

$$\ln \mathrm{GDP}_{it} = \lambda_0 + \lambda_1 \ln \mathrm{GI}_{it} + \sum_{j=2}^{6} \lambda_j \mathrm{Control}_{it} + \varepsilon_{it}, \quad (1)$$

where i is the province; t is the year; GDP is the economic growth (dependent variable, measured by the gross domestic product); GI is the green investment (core independent variable, measured by expenditure for energy conservation and environment protection); λ_0, λ_1 and λ_j are the estimated coefficients of the corresponding terms; Control is the control variable; ε is the random error term. This method is the commonly used method of measurement in article [6, p. 568].

Previous studies have shown that innovation capacity (IC) can improve the efficiency of economic growth [7]. The number of research and experimental personnel is used to measure this variable taking into account that talent is a core element of innovation [8, p. 8]. The demand structure (DS) is an internal requirement for sustained economic growth and is measured using total retail sales of consumer goods as a share of GDP [9]. The degree of openness (OD) is crucial for economic growth, especially in developing countries [10, p. 479; 11, p. 290]. The foreign trade dependence degree (the share of total amount of import and export trade in GDP) is used to measure it. The unemployment rate (UR) is one of the key indicators of the success or failure of socio-economic policies and has a significant negative impact on economic growth [12, p. 10]. This variable is measured using the registered unemployment rate. Moreover, as the topic of global warming has gained more attention in recent years, many scholars have confirmed that environmental pollution level (PL) significantly affects economic growth [13]. It is measured using the volume of effluent discharged. Thus, in this article, the above variables are selected as control variables.

The research data were obtained from several sources. The main sources include the following: «China statistical yearbook», «China statistical yearbook on science and technology», «China population & employment statistical yearbook», «Statistical yearbook of the Republic of Belarus, 2022» and «Regions of the Republic of Belarus socio-economic indicators in 2016».

It seems important to note that based on the existing literature it is known that there is no consensus on the conclusion of whether economic growth can influence green investment [14, p. 100; 15, p. 126]. Some scholars' empirical findings indicate that economic growth has a driving effect on green investment [15, p. 126]. Accordingly, in order to avoid the endogeneity problem, that may result from the bidirectional causality between green investment and economic growth, this paper further employs the instrumental variable approach (IV regression, or two-stage least squares regressions) to conduct the endogeneity test. Green investment with a lag of 1 year is selected as an instrumental variable in our work [16, p. 72]. The instrumental variable is selected for the several reasons. On the one hand, green investment with a lag of 1 year is closely related to green investment in the current period which fulfills the condition of being highly correlated with endogenous explanatory variables. On the other hand, green investment with a lag of 1 year cannot directly affect economic growth, satisfying the exogeneity condition of instrumental variables.

The instrumental variable approach is implemented in several stages. The specific stages are as follows.

Stage 1. Regression of green investment on green investment with a lag of 1 year.

The equation of this regression is as follows:

$$\ln \mathrm{GI}_{it} = \beta_0 + \beta_1 \ln \mathrm{GI}_{it-1} + \sum_{j=2}^{6} \beta_j \mathrm{Control}_{it} + u_{it}, \quad (2)$$

where GI_{it-1} is the instrumental variable (green investment with a lag of 1 year); β_0, β_1 and β_j are the estimated coefficients of the corresponding terms; u is the random error term. From this regression equation, it is also possible to obtain the fitted value of the explanatory variable GI′.

Stage 2. Regression analysis.

The equation of this regression is as follows:

$$\ln GDP_{it} = \gamma_0 + \gamma_1 \ln GI'_{it} + \sum_{j=2}^{6} \gamma_j Control_{it} + \theta_{it}, \quad (3)$$

where γ_0, γ_1 and γ_j are the estimated coefficients of the corresponding terms; θ is the random error term. The fitted value GI′ obtained in the first stage is used to replace GI in the benchmark regression equation (1).

Data processing and descriptive statistics. In this article, 30 provinces of China (excluding Hong Kong, Macao, Taiwan and Tibet), 6 regions and the capital city of Belarus from 2010 to 2020 are selected as the research sample. The raw data were processed as follows.

All value variables were deflated using 2010 as the base period in order to exclude the effect of price factors. Units of green investment and economic growth convert to US dollar units on the average official exchange rates of the yuan or Belarusian ruble against the US dollar. Data on exchange rates are taken from the source «China statistical yearbook» for 2011–2021 and the official site of the National Bank of the Republic of Belarus. In order to eliminate heteroskedasticity, logarithmic transformations perform for economic growth, green investment, innovation capacity and pollution level. The data processing and subsequent empirical analysis are done by using the econometric software *Stata 14.0*. The results of descriptive statistics for the variables are shown in table 1.

Table 1

Descriptive statistics

Variable (unit)	Observations	Mean value	Standard deviation	Minimum value	Maximum value
GDP (mln US dollars)	407	276 901.30	273 680.50	3084.33	1 356 678.0
GI (mln US dollars)	407	1606.46	1346.47	24.61	9261.21
IC (pers.)	407	103 953	139 624	326	872 238
DS (%)	407	38.73	7.94	14.83	59.06
OD (%)	407	42.79	45.83	0.76	250.08
UR (%)	407	2.77	1.22	0.10	4.60
PL (mln m^3)	407	1284.07	1337.10	95.0	8307.50

The average value of green investment in both China and Belarus has been rising steadily, from 957.877 mln US dollars in 2010 to 1973.645 mln US dollars in 2020. Nevertheless, the data in table 1 show that the share of green investment in GDP is relatively small, with its mean share being only 0.58 %. It can be seen that green investment needs to be further enhanced. It is worth noting that during the sample period the average value of the share of green investment in GDP in Belarus is 1.15 %, and the average value of the share of green investment in GDP in China is 0.77 %. This situation shows that Belarus is better than China in terms of green development.

Results and discussion

Unit root test. In order to avoid the occurrence of pseudo-regression, this paper carried out the unit root test. The selected panel data has a short time dimension and a large cross section dimension. Therefore, the methods of Harris – Tzavalis unit root test and Im – Pesaran – Shin unit root test are chosen to test for the presence of unit root in this panel data. Specific results are shown in table 2.

Table 2

Unit root tests

Variable	Results of levels		Results of 1st difference	
	Harris – Tzavalis test	Im – Pesaran – Shin test	Harris – Tzavalis test	Im – Pesaran – Shin test
GDP	0.866	–0.799	0.035**	–2.622**
GI	0.766	–0.136	–0.415**	–4.178**
IC	0.832	–1.417	0.003**	–2.836**
DS	0.806	–1.026	–0.151**	–3.228**
OD	0.673*	–1.423	0.041**	–2.470**
UR	0.728	–1.086	0.062**	–2.599**
PL	0.802	–1.159	–0.151**	–3.234**

Notes: 1. Symbol * and symbol ** indicate the rejections of the null hypothesis of the unit root test at the 5 and 1 % significance levels respectively. 2. The null hypothesis of the unit root test is that there is the presence of a unit root.

As seen in table 2, all variables fail the above tests except for the variable of degree of openness. However, variables, after being processed by the first differences, all pass tests which are stationary series.

Cointegration test. Although the test results after the first differences of the variables are stationary series, the economic implications of the regression results of the differenced series differ from those of the original series. Therefore, this paper further examines the long run equilibrium relationship between all the variables using the Westerlund test so as to explore the possibility of conducting regression analysis using the original series.

Table 3

Westerlund test and Hausman test

Type of test	Statistical significance indicator	Country		
		China	Belarus	China and Belarus
Westerlund	Variance ratio	9.02*	3.55*	9.67*
Hausman	Chi2	23.59	55.45	112.41
	p-Value	0	0	0

Note. Symbol * indicates the rejection of the hypothesis that there is no long run equilibrium relationship between the variables at the 1 % significance level.

The results in table 3 show that there is a long run equilibrium relationship between all the variables which means the original series is suitable for regression analysis. Hence, the original series is used for the following empirical analysis.

Hausman test. The results of the Hausman test reveal that China, Belarus and the mixed sample of these countries passed the significance test (according to table 3 $p = 0$ in all cases). Thus, so the fixed effects model should be selected.

Benchmark regression. In order to study the impact of green investment on economic growth and its differences across countries, this paper utilises fixed effects models and performs regressions using the data from China, Belarus and the mixed sample of these countries as samples. The regression results for the economic growth variable are presented in table 4.

Table 4

Benchmark regression

Variables	Country		
	China	Belarus	China and Belarus
GI	0.13* (3.17)	0.43* (8.01)	0.22* (5.54)
Constant	5.34* (11.83)	8.87* (9.04)	5.49* (11.15)
Control variables	+	+	+
Individual fixed effect	+	+	+
R^2	0.83	0.74	0.79
N	330	77	407

Notes: 1. In 2nd–3rd rows of the table numbers are regression coefficients and numbers in parentheses indicate the corresponding *t*-values. 2. The *t*-values in parentheses are calculated using in clustering robust standard errors. 3. Symbol * stands for $p < 0.01$. 4. Sign + means that all control variables and individual fixed effects are controlled for this regression.

According to table 4, green investment can significantly increase economic growth. In the mixted sample, a 1.0 % change in green investment can lead to an average change in economic growth of 0.22 %, while controlling for other variables being constant. In comparison, the change in economic growth driven by green investment in Belarus amounted to 0.43 % which is more than three times the change in economic growth driven by green investment in China (0.13 %). It can be seen that keeping all other things constant the economic effects that can be produced by green investment in Belarus are significantly higher than those in China.

This situation has arisen for several reasons. On the one hand, the early economic development (agriculture) of Belarus was dependent on the ecological environment which has contributed to the fact that the population of Belarus has always had a strong sense of ecological protection [17, p. 409]. In contrast, there were practical problems such as economic and technological backwardness, material scarcity and population pressure for a longer

period of time after the founding of China. This has led to the deepening of the concept of rapid economic development which has also caused the environmental awareness of Chinese residents to be extremely weak. Although the environmental awareness of Chinese residents has greatly improved, it is still far from meeting the requirements of the green development goals.

On the other hand, Belarus has established relatively well-developed institutional mechanisms for green development. Belarus has a number of laws and regulations dealing with ecological aspects such as climate, water resources, special protected areas and licensing systems. Moreover, Belarus had incorporated the principles of the green economy into its national strategy for sustainable social and economic development. Compared to Belarus, China still has a lot of space for progress in developing institutional mechanisms as well as in law enforcement and regulation for the green economy [17, p. 409].

This paper argues that it is the relatively well-developed institutional mechanisms for green development and the persistence of the ecological priorities concept in Belarus that have led to the economic benefits derived from green investment than in China for several reasons. Firstly, the well-developed institutional mechanism for green development provides the guarantee for green investment as well as reduces investment risks and costs. Secondly, explicit and strict laws, regulations and policy documents can provide precise guidance and scientific bases for green investment. Thirdly, well-developed institutional mechanisms and profound ecological priority concepts are able to incentivise green development which can effectively enhance green innovation and improve the industrial structure, thus promoting the economic benefits of green investment.

Robustness checking. In order to verify the reliability of the above findings, this paper conducts robustness tests by endogeneity testing when the control variables and the sample period are changed respectively. The detailes are as following.

This article utilises equations (2) and (3) for endogeneity testing based on the correlation between green investment and economic growth variables. The results are shown in table 5.

Table 5

Endogeneity testing

Variables	Country		
	China	Belarus	China and Belarus
Regression of the first stage			
GI_{it-1}	0.47* (4.69)	0.96* (5.48)	0.68* (9.73)
Constant	0.96 (1.29)	–4.91 (–1.40)	0.31 (0.66)
Control variables	+	+	+
Individual fixed effect	+	+	+
R^2	0.91	0.85	0.98
N	300	70	370
Regression of the second stage			
GI′	0.19* (4.56)	0.52* (9.38)	0.27* (10.84)
Constant	6.34* (18.10)	8.22* (9.54)	5.02* (20.58)
Control variables	+	+	+
Individual fixed effect	+	+	+
R^2	0.99	0.97	0.99
N	300	70	370
Weak identification test			
F-statistic (Cragg – Donald Wald test)	69.745	75.445	262.556
F-statistic (Kleibergen – Paap rk Wald test)	22.65	65.81	94.99
Critical values (<15 %) (Stock – Yogo test)	8.96	8.96	8.96

Notes: 1. In 3rd–4th rows of the table numbers are regression coefficients and numbers in parentheses indicate the corresponding t-values. 2. The t-values in parentheses are calculated using in clustering robust standard errors. 3. In 10th–11th rows of the table numbers are regression coefficients and numbers in parentheses indicate the corresponding z-values. 4. Symbol * stands for $p < 0.01$. 5. Sign + means that all control variables and individual fixed effects are controlled for this regression. 6. The critical values are obtained from [18].

As can be seen from the regression of the first stage, green investment with a lag of 1 year has a strong explanatory power for green investment in the current period (row 3 of the table 5). Both the Cragg – Donald Wald *F*-statistic and the Kleibergen – Paap rk Wald *F*-statistic are larger than the corresponding critical value of 8.69, indicating that the instrumental variable selected in this paper is not a weak instrumental variable. In summary, the selected instrumental variable is valid.

The results in table 5 indicate that green investment still contributes significantly to economic growth after the use of the instrumental variable, and this contribution is enhanced compared to the benchmark regression. Furthermore, the economic benefits realised by green investment in Belarus remain greater than in China.

This article conducts robustness tests by removing one control variable from the five control variables in turn using equation (1). The results are presented in table 6.

Table 6

Robustness checks (changing the control variables)[1]

Variables	GDP (excluding IC)	GDP (excluding DS)	GDP (excluding OD)	GDP (excluding UR)	GDP (excluding PL)
GI	0.27* (7.22)	0.24* (5.14)	0.23* (6.44)	0.23* (6.02)	0.23* (6.44)
Constant	6.84* (16.16)	5.19* (7.93)	5.32* (11.07)	4.52* (10.58)	5.99* (10.5)
Control variables	+	+	+	+	+
Individual fixed effect	+	+	+	+	+
R^2	0.74	0.75	0.78	0.76	0.77
N	407	407	407	407	407

Notes: 1. In 2nd–3rd rows of the table numbers are regression coefficients and numbers in parentheses indicate the corresponding *t*-values. 2. The *t*-values in parentheses are calculated using in clustering robust standard errors. 3. Symbol * stands for $p < 0.01$. 4. Sign + means that individual fixed effects are controlled for this regression.

Referring to the existing literature [19, p. 89] the sample period is changed to 2013–2020 for the robustness test in order to avoid policy interference affecting the results. The regression results for the economic growth variable are presented in table 7.

Table 7

Robustness checks (adjustment of sample period)

Variables	Country		
	China	Belarus	China and Belarus
GI	0.08* (2.24)	0.37** (5.12)	0.16** (4.42)
Constant	7.35** (13.47)	8.72** (7.01)	7.45** (12.92)
Control variables	+	+	+
Individual fixed effect	+	+	+
R^2	0.75	0.82	0.67
N	240	56	296

Notes: 1. In 2nd–3rd rows of the table numbers are regression coefficients and numbers in parentheses indicate the corresponding *t*-values. 2. The *t*-values in parentheses are calculated using in clustering robust standard errors. 3. Symbol * stands for $p < 0.05$ and symbol ** stands for $p < 0.01$. 4. Sign + means that all control variables and individual fixed effects are controlled for this regression.

In summary, compared with the results of the benchmark regression the correlation coefficients of green investment have the same sign, and the coefficient values and significance change only slightly. This demonstrates that the benchmark regression conclusions are robust.

[1]This paper only shows the regression results for mixed samples here because of page limitations. The results of the Chinese or Belarusian samples can be requested from the authors.

Conclusions

Based on panel data for 30 provinces in China as well as six regions and the capital city of Belarus from 2010 to 2020, the impact of green investment on economic growth is investigated and comparative analysis is carried out to examine the contribution of green investment to the improvement of quality of life from the perspective of economic growth. The findings of the study show that holding other conditions constant, a 1.0 % increase in green investment can accelerate economic growth by 0.22 %. The economic benefits of green investment in Belarus are about three times higher than in China. Possible reasons to be that Belarus has more developed institutional mechanisms for green development as well as a deep ecological priority philosophy compared to China, are considered. This provides a solid basis and a reliable guarantee for green investment in Belarus to realise its economic benefits. Moreover, the conclusions remain valid after a series of robustness tests.

Accordingly, in order to improve people's quality of life and enhance the driving effect of green investment on economic growth, this paper puts forward the following policy recommendations.

1. China and Belarus should increase green investment. It is advised to increase green investment at the governmental level, thereby guiding and incentivising the flow of social investment into green projects. It is recommended that relevant environmental protection preferential policies, such as environmental protection subsidies, be introduced so as to establish incentive mechanisms to encourage green investment and environmental protection behaviours among corporations and residents and to create a more favourable living environment for residents.

2. There is an urgent need for China to emphasise and develop the concept of environmental protection, and Belarus should continue to promote the concept of ecological priorities. Environmental education and practical activities should be carried out so as to enhance people's awareness of environmental protection and raise the level of public attention to eco-friendly lifestyle. In addition, it is suggested that the government and corporations take the initiative to publicise environmental information and establish efficient communication mechanisms. In this way, it allows the public to understand and provide feedback on environmental issues, increase participation in environmental protection and work together to maintain good living environments, thus contributing to the improvement of the quality of life of residents.

3. China should draw on the valuable experiences of Belarus and other countries to further strengthen the construction of institutional mechanisms related to the green economy, improve the management of green investment, so as to fully unleash its benefits in promoting economic growth and improving people's quality of life. Belarus should further develop its institutional mechanisms. Based on the objectives of the Paris agreement, it is recommended that the top-level design should be further optimised and the relevant laws and regulations should be improved. It is also advisable to strengthen the regulation of the green investment market and promote its healthy development, with a view to continuously consolidating the fruits of green development and guaranteeing the sustainable development of people's high quality of life.

4. China and Belarus should actively promote the construction of sustainable development of the Belt and Road initiative and provide platforms for foreign cooperation and communications in the field of green economy, in order to expand market opportunities for green economy. China should focus on increasing cooperation with Belarus on the sustainable development of the Belt and Road initiative and actively learn from the mature mechanisms of Belarus in regional ecological cooperation. It is proposed to further promote the development of bilateral trade between China and Belarus on the basis of the principle of ecological integration, with the Great Stone Industrial Park as the centrepiece, in order to cultivate new points of economic growth, increase sources of income for the population and thus to improve the quality of life of the population in a sustained manner.

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