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Impacts of Reduced Inequalities on Quality Education: Examining the Relationship between Regional Sustainability and Higher Education

Tingting Liu [1], Xiaoxian Zhu [2,*] and Mengqiu Cao [3]

[1] School of Foreign Studies, China University of Mining and Technology, Xuzhou 221116, China
[2] Business School, Teesside University, Middlesbrough TS1 3BX, UK
[3] School of Architecture and Cities, University of Westminster, London NW1 5LS, UK
* Correspondence: x.zhu@tees.ac.uk

Abstract: Although the United Nations' Sustainable Development Goals (SDGs) advocate, through SDG 4 and SDG 10, equitable quality education and the reduction of inequalities within and between countries, respectively, few studies have examined how inequalities in regional sustainability influence higher education. Therefore, this study aims to examine the relationship between regional sustainability and higher education in China using fixed-effects panel modelling. A systematic force framework showing how regional sustainability drives higher education was constructed from economic, social, and environmental perspectives, and the endogeneity in the process of how regional sustainability affects higher education was explored by introducing one-year lagged values as instrumental variables. Our results show that regional sustainability has a significant impact on higher educational attainment in China, with differing effects in the eastern, central, and western regions, respectively. In central China, economic sustainability plays a significant positive role in higher educational attainment; in the western region, economic and social sustainability have stronger positive effects, while environmental sustainability has significantly negative effects. In terms of policy implications, our findings can be used to support regional development policies to promote regional higher education.

Keywords: regional sustainability; higher education; economic dynamics; urban development; China

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1. Introduction

In 2015, the United Nations proposed a series of Sustainable Development Goals (SDGs) relating to social, economic, and environmental aspects worldwide, with the aim that these goals be achieved by 2030. The SDGs comprise 17 goals and 169 targets, some of which are interlinked and interdependent [1]. Investigating the complex interactions between these goals and targets is of great significance for their successful implementation and can help different sectors to develop clear policies for their achievement [2]. Therefore, many studies have examined the interactions between these goals and targets, as well as the effects of their combination. However, few studies have explored the relationship between SDG 4 (concerning the provision of quality education for all) and SDG 10 (focusing on reducing inequalities within and between regions and ensuring sustainability in this regard).

Regional sustainability, which relates to the interactions between human society and the natural environment, has attracted considerable scholarly attention [3]. The concept of regional sustainability became popularised over two decades ago, and its aim is to meet current regional needs without damaging future generations' ability to meet their needs [4]. Regional sustainability can be categorised into economic, social, and environmental factors, respectively, and a sustainable environment, sustainable economic dynamics, technology, innovation, and higher education represent the core elements of this concept [5]. In the context of a complex socio-economic ecosystem, sustainable regional development attempts to promote harmonious development between human society and the natural world, in a specific region [6]. However, significant problems can result when there is a low uptake of regional higher education and a lack of effective collaboration and cooperation between regional industry and university research [7]. These issues negatively impact on regions' social progress and economic growth [8]. Thus, to integrate the development of regional higher education into the development of the economy, society, and the natural world, it is imperative that the impact of regional sustainability on higher education be assessed.

Many empirical studies have offered new insights into existing scientific knowledge concerning this topic [9]. Peer and Penker (2016) concluded that these new insights, including various models and paradigms, have shifted research priorities from 'what' to 'how' (for example, new models such as the triple-helix model (The triple-helix model was first advanced by Etzkowitz and Leydesdorff (1997) to explain the new relationship between university, business, and government in the era of the knowledge economy. Triple-helix theory uses a spiral innovation model to describe the multiple reciprocal relationship between different innovation institutions (public, private, and academic) at different stages of knowledge commercialisation)), presenting knowledge as being combined with and coproduced by science, society, and innovation [10]. However, although many studies have explored the role of education in urban development [11,12], individual health [13], and regional sustainability [14], these studies have the following shortcomings: (1) Few studies have used a comprehensive framework to systematically explored how regional sustainability impacts higher education. (2) Considerable effort has been expended on exploring the effects of higher education on regional development; however, higher education is also shaped by regional development and few studies have examined the endogeneity between regional sustainability and higher education. (3) Horizontally, there are huge spatial disparities between regions, and vertically, different administrative levels have different effects; however, most existing studies have focused on macro analyses at the national level, ignoring the differences between the national and regional levels.

To bridge these research gaps, this study aims to quantitatively investigate the impacts of regional sustainability on higher education and to specifically address the following research questions: (1) Do the impacts of regional sustainability on higher education differ at national and regional levels? (2) How can we address endogeneity issues in the mechanism for measuring the effects of regional sustainability on higher education? Our study is pioneering, firstly because it contributes to existing literature by focusing on China's national and sub-national levels. We construct a theoretical framework, laying the foundation for the selection of variables for an empirical model that explores the relationship between regional sustainability and higher education. Second, we explore endogeneity with regard to the effects of regional sustainability on higher education by introducing one-year lagged values as instrumental variables. Finally, we aim to identify the association between regional sustainability and higher education in a more careful and tangible way by focusing on the effects at both national and regional levels. Higher education development occurs in specific regions and its development is affected and supported by economic growth within these regions. This paper provides suggestions for regional development policies concerning the promotion of regional higher education and a new perspective for improving higher education in China.

2. Literature Review

2.1. Links between Regional Development and Higher Education

Studies have reported that regional development has a strong interactive relationship with higher education and that the development of higher education is significantly affected by regional growth [15–17]. The evolution of cities' economies can offer distinct benefits regarding conceptualising the developmental role of higher education; this is a result of the latter's emphasis on education, work, innovation, social capital, the environment, and production [18]. He (2001) found that regional urbanisation is the primary factor influencing the development of higher education within a region. Meanwhile, focusing on the effects of per-capita gross domestic product (GDP) on higher education development, Ma (2002) showed that a region's economic development determines its higher education needs and that inequalities in regional growth are linked to higher education development [19]. Thus, regional development dramatically impacts higher education [20]. Kelly (2020) found that educational attainment has a significant impact on reducing carbon intensity, arguing from an ecological modernisation perspective [21]. The analytical results of this study emphasised the importance of education and highlighted how the effects differed between regions. The assessment of regional sustainability has become increasingly important in recent years. Using network big data, Zhao et al. (2018) assessed sustainable urban communities and identified that education, as an important public service, plays a vital role in achieving sustainable communities and cities [22]. Consequently, there is a need for more emphasis to be placed on providing dedicated support for designing sustainable cities, communities, and regions, particularly in the case of developing countries, suggesting that education is a key aspect of, and helps to drive, regional sustainability.

More specifically, it has been observed that higher education acts as a driving force for stimulating regional sustainability. Januskaite and Uziene (2018) concluded that the development of the media has led to better social and environmental policies and a greater awareness of the need for sustainable cities, communities, and regions through education [23]. Educating people about sustainability should be encouraged, because intellectual capital including innovation, smart specialisation, and public–private collaboration is directly linked to regional intellectual capital and the development of regional sustainability. Januskaite and Uziene's (2018) research confirmed the mutual relationship between regional sustainability and educational attainment. Esteban et al.'s (2019) review integrated sustainable transport models and identified the relationships between sustainable transportation and education [24]. In line with Esteban et al.'s (2019) research [24], Zu et al. (2021) explored the impacts of regional sustainability on higher educational attainment through a panel analysis and showed that an increase in sustainable transport has induced growth in higher education [25].

2.2. How Regional Sustainability Affects Higher Education from Economic, Social, and Environmental Perspectives

This study examines how regional sustainability affects higher education levels. The theoretical framework used is illustrated in Figure 1.

Zhou and Luo (2018) tested the relationship between higher education, technological innovation, and economic growth, and concluded that there is an interaction mechanism that operates between them involving dynamic circulation and that higher education and economic development mutually affect and reinforce each other [26]. Economic dynamics provide the material basis and underlying conditions for higher education development. Economic demand can drive higher education development by increasing social demand for human capital [27]. Meanwhile, technological advancements, including the ability to pursue green innovation, patents, and so on, and higher education also mutually influence each other [28].

The social aspect of this issue has been widely studied [29]. Among a variety of social factors, transportation is the primary element. As the distance between a person's place of study and their family's residence is a negative determinant of academic performance, it is important to reduce the distance between residence location and higher education facilities by adopting a spatial organisation approach [30]. Improving transport planning offers a means of reducing the travel distance, thereby contributing to city and higher education development [31]. Specifically, transport sustainability plays a significant and crucial role in promoting campus sustainability [32], as it is not only conducive to the transformation of transport modes in colleges and universities, and even entire cities, but also helps to improve awareness of sustainable development in colleges and universities. Additionally, regional competition is closely related to inclusive urbanisation [33]. Since 1999, there has been rapid expansion in China's higher education sector, with gross enrolment rates increasing from 10.5% in 1999 to 40% in 2015. The expansion of higher education has improved the educational levels of migrant workers while bringing more competition into the labour market, especially in regions with large populations [34].

Finally, environmental aspects should also be considered. Environmental sustainability is mainly connected with universities' goals and daily activities. An increasing number of universities are aiming to achieve sustainability goals, including higher education sustainability (In this study, higher education primarily refers to undergraduate level). Regional sustainability can encourage higher education institutions to recognise the importance of sustainability within higher education [32,35]. From the perspective of scientific research, it has been argued that coordinated efforts between teaching staff engaged in sustainable activities on university campuses can be a very effective way of promoting environmental sustainability. Thus, sustainability impacts higher education faculty and pedagogical goals.

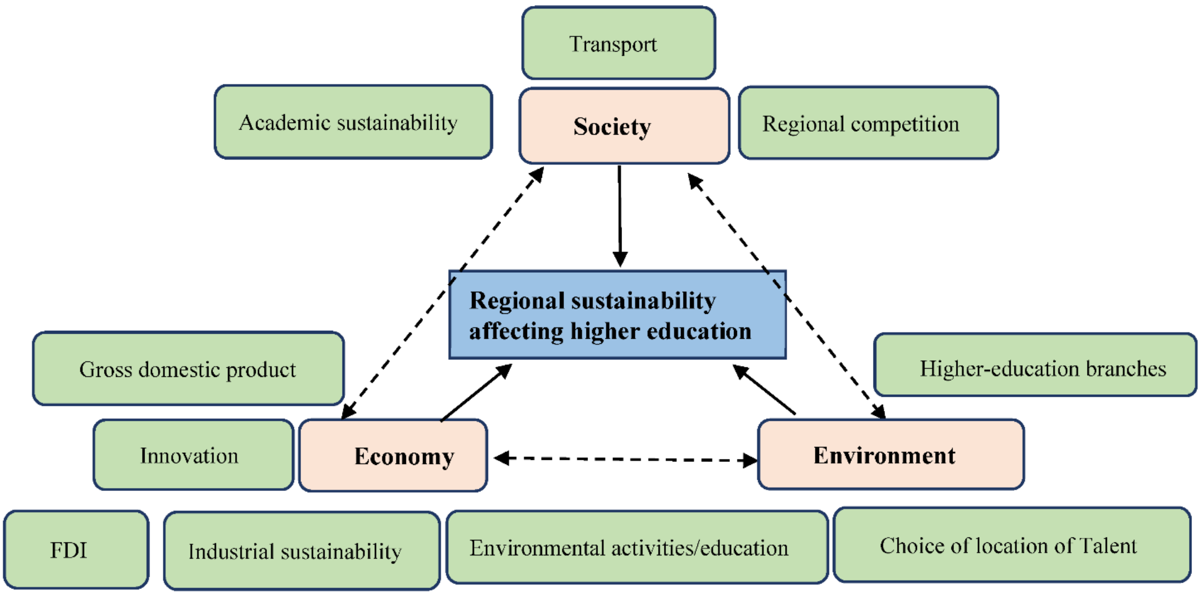

Figure 1. Framework for the impact of regional sustainability on higher education.

3. Data and Methods

To examine, the effect of regional sustainability on higher education in mainland China (focusing on 23 provinces, 5 autonomous regions, and 4 municipalities), from 2000 to 2017, we used data from China's Statistics Yearbooks (2000–2017) and from the yearly National Statistics Gazette of Educational Development (2000–2017), and applied a fixed-effects panel model. Stata16 was used to conduct the data analysis in this study.

The fixed effects model and random effects model are both able to solve the problems of heteroscedasticity that cannot be directly captured by the commonly used regression models. Because panel data contain rich information, we can identify potential differences between individuals or groups in the data [36]. From the perspective of model construction, both fixed effects and random effects are developed from error component models. Although the fixed effects model is not directly observable, unlike the random effects model, it is still controllable [36]. Because they use model estimation, fixed effect models have obvious advantages in terms of convenience. Even if they cover a long time period, such models can be estimated quickly and easily, using two-step estimation (Frisch–Waugh–Lovell (FWL) theorem). However, the estimation of random effects is very complicated, because it usually only provides a feasible generalised least squares estimator (FGLS). It should be noted that the generalised least squares (GLS) method is effective and that FGLS can only approximate the GLS estimator when the covariance matrix asymptotically converges. Therefore, we decided to use the fixed effects model, rather than the random effects model, because it is a more robust method. Additionally, this method tends to be more consistent for model estimations and can reduce the potential endogeneity caused by missing variables, to an extent [37]. Gao (2004) employed the same method for analysing regional industrial growth and trade development and found the method to be effective for measuring data at national and/or regional levels [38]. Moreover, Choy and Li (2017) used a similar model to explore the impact of higher education on China's inclusive regionalisation policy and demonstrated that the model can also be applied to regional education [11]. Based on consideration of the literature discussed above, the basic econometric model used for the current research was as follows:

$$\text{HigherEducation}_{it} = \beta_0 + \sum\nolimits_k \beta_k \text{RegionalSustainability}_{kit} + \nu_i + \varepsilon_{it}, \tag{1}$$

where i and t refer to a city and time, respectively; RegionalSustainability denotes a set of k independent variables; vi represents regional fixed effects that do not change over time; and εit represents random interferences. Although this model can help us answer our research questions, it is relatively weak in terms of investigating regional sustainability, neither can it completely explain endogeneity issues (Roberts and Goh 2011). To avoid endogeneity, therefore, we employed two-stage least-squares (2SLS) regressions to assess our estimates from the fixed-effects panel model.

To measure higher education, we used data on higher educational attainment (HEA), which comprise the percentage of adults among the working population who have at least an undergraduate degree. Choy and Li (2017) argued that HEA can reflect the influence of skilled workers on a region's or a city's growth and population [11]. Furthermore, other studies have suggested that HEA can have a strong, positive impact on human capital [39,40]. Thus, it was chosen as a proxy for higher education in this study.

To measure regional sustainability, we selected GDP, FDI, and industrial upgrading (CLP), which were used as independent variables. Regarding economic sustainability, GDP can directly reflect the total economic output produced by a region from a macro perspective. It provides an important basis for the formulation of higher education development strategies and macroeconomic policies for higher education. Pastor et al. (2018) found that higher education promoted an 11% increase in per-capita GDP in European countries [41]; an increased GDP can in turn result in more policy support for human capital when those individuals possess higher education qualifications [42]. Technology spill-over through FDI can contribute to innovation and sustainable development and FDI plays an important role in higher education [43]. In the case of technology-intensive industries, FDI can improve the quality of human capital (labour); however, with regard to labour-intensive industries, cheap labour is more important. CLP was selected to represent industrial sustainability. As the main channel for cultivating specialised human capital, higher education plays an important role in promoting scientific and technological progress and accelerating the adjustment and upgrading of the industrial infrastructure (Wang and Yu 2016). Industrial upgrades help to optimise the structure of higher education and improve the spatial distribution of labour [44]. In our study, the formula used to measure industrial upgrades was as follows:

$$\text{CLP}_{it} = \ln\left(\frac{A_{it}}{L_{it}}\right) - \ln\left(\frac{A_t}{L_t}\right), \tag{2}$$

where L is labour in region i in year t and A represents total assets. Li and He (2017) highlighted that negative results indicate that industrial development in the region is labour-driven, while positive results indicate that industrial development is capital-driven [37]; therefore, a change from negative to positive means there has been a change from labour-driven to capital-driven industrial development, indicating that CLP has been achieved.

We measured social sustainability by considering access to transportation, academic development, and urbanisation level. For the sustainability of transport development variable, we chose the ratio of highway length to higher education population in each region. The transportation infrastructure affects the geospatial planning of higher education institutes. More highly developed regional transportation promotes the decentralised development of cities and facilitates the division of labour in cities based on geographical criteria, thereby causing an agglomeration effect [45]. The establishment of universities requires large areas of land resources; in contemporary China, it is difficult to build new universities in the metropolises, as such land has become a high-value resource [46]. Consequently, regions with more developed transportation networks have transportation links that extend to remote regional areas, in which land prices are relatively low [47], which makes the creation of new higher education facilities in these areas more likely. Transportation also has strong positive externalities [48], promoting employment and industrial development. In order to measure the academic sustainability of a region, we selected the percentage of research and development (R&D) investment in higher education in terms of GDP. The academic quality of higher education is closely related to government funding, especially R&D investment [49]. Moreover, increasing R&D cooperation between universities and industries can incentivise university researchers and improve the quality of labour working in local industries [50]. Finally, urbanisation level was selected as a variable to test the effect of regional population on higher education. By examining exogenous population growth and pre-assuming endogenous economic growth, Black and Henderson (1999) found that human capital accumulation increases regional populations. In China, increasing educational attainment leads to more rapid regionalisation, as it can contribute to removing barriers between rural and regional areas where higher-education resources are limited [11].

The following variables were used to measure environmental sustainability. Environmental development (Environ) can be used as an indicator of the effect of a region's competitiveness landscape on HEA. Lannelongue et al. (2017) concluded that environmental management has a positive influence on human capital in organisations with low capital intensity, but found that the effect becomes negative for organisations with a high capital intensity [51]. However, by considering environmental externalities, Mazzanti and Zoboli (2009) highlighted that there is a positive relationship between environmental efficiency and labour productivity [52]. This indicates that environmental development can increase HEA by promoting labour productivity, but also that the relationship may vary across different organisations. Renewable energy utilisation (REI) can constitute a measure of energy sustainability. Renewable energy technologies promote higher education reform and accelerate environmental education [53]. According to Friman (2017), environmental education "designs, builds, and establishes an Ecological Garden. It helps to understand that one person alone can't handle the expected crisis on Earth as a result of air pollution and greenhouse gas emissions into the atmosphere. There is a need for understanding and cooperation from the general population to treat this crisis". The development of renewable energy requires high-quality human capital and, consequently, increases educational attainment. The authorisation of green patents (This study follows the definition of green patents used in Fabrizi, Guarini, and Meliciani's (2018) study, namely that they are "based, for a large part, on the International Patent Classification (IPC) system, developed at the World Intellectual Property Organisation, which is a hierarchical system classifying inventions into more than 70,000 technological groups and subgroups. It allows identifying technologies relevant to environmental management (as human and ecosystem health), water-related adaptation, and climate change mitigation.") (GPs) reflects a region's innovation sustainability. Shelton and Loet (2012) suggested that patenting can increase HEA, especially for government-funded universities [54]. However, Saad et al. (2015) argued that, as a result of institutional diversity, higher education has an adverse impact on patent production [55]. Saad et al. (2015) further specified that the capacity of the higher education sector and support for university students are positively correlated with the level of national innovation and knowledge production [55]. The output of patents by universities, and especially GPs, which can promote social and economic sustainability, is conducive to fostering skilled workers and improving cooperation between industry academia and research [56]. Table 1 summarises the independent variables.

Table 1. Summary of variables (2000–2017).

	Independent Variables		Definition	Sources
Economic sustainability	Economic growth	GDP	Regions' GDP (trillions of yuan).	Provinces' statistical yearbooks
	Technology absorptive capacity	FDI	Percentage of FDI to GDP at province level (millions of yuan).	Provinces' statistical yearbooks
	Industrial sustainability	CLP		China's and provinces' statistical yearbooks; China's Industrial Statistics Yearbook
Social sustainability	Transport development	Traff	Percentage of highway length to population with higher education in each region (km).	Provinces' statistical yearbooks
	Academic sustainability	R&D	Percentage of R&D investment in higher education to GDP at province level.	Provinces' statistical yearbooks
	Urbanisation level	Urban	Percentage of regional population to total population at province level.	Provinces' statistical yearbooks
Environmental sustainability	Environmental development	Environ	Percentage of landscaping area to total land area at province level (hectares).	Provinces' statistical yearbooks
	Renewable energy utilisation	REI	Percentage of output value of new energy industry to GDP at province level (millions of yuan).	Industrial and commercial bureau database
	Green patent authorisation	GP	Proportion of GP authorisation by higher education to the total number of authorised patents.	State Intellectual Property Office database; Provinces' statistical yearbooks

CLP: industrial upgrading; Environ: environmental development; FDI: foreign direct investment; GDP; gross domestic product; GP: green patent; R&D: research and development; REI: renewable energy utilisation; Traff: transport development; Urban: urbanisation level.

The basic econometric model used to measure regional sustainability and higher education can be specified as follows:

$$\text{HEA}_{it} = \beta_0 + \beta_1\text{GP}_{it} + \beta_2\text{Traff}_{it} + \beta_3\text{GDP}_{it} + \beta_4\text{RD}_{it} + \beta_5\text{Urban}_{it} + \beta_6\text{Environ}_{it} + \beta_7\text{REI}_{it} + \beta_8\text{FDI}_{it} + \beta_9\text{CLP}_{it} + \nu_i + \varepsilon_{it} \quad (3)$$

First, we ran the fixed-effects model to test the impacts of regional sustainability on higher education. Our model was estimated using region-fixed effects rather than time-fixed effects. Second, to avoid potential endogeneity issues concerning regional sustainability and higher education, 2SLS was used. The presence of endogenous variables can result in biased estimates [57]. Our analysis indicated that regional sustainability has a strong correlation with higher education; thus, regional sustainability was treated as endogenous. The null hypothesis, that there are consistent and unbiased estimates in the ordinary least squares (OLS) estimator for regional sustainability, was rejected by the Durbin–Wu–Hausman (DWH) test. Therefore, we employed 2SLS to address this problem. Following Ciccone's method (2002), we used the natural log of the regional land area as the instrumental variable [58]. This instrumental variable is geographically objective and can scientifically manage endogeneity issues.

4. Results and Discussion

4.1. Fixed-Effects Model Results

Table 2 presents the results of the fixed-effects model. First, among the factors relating to economic sustainability, GDP has significantly positive effects on HEA both in China as a whole and in each region, and economic dynamics are always intertwined with HEA [59]. China's central and western provinces are relatively under-developed regions, and their GDP has clear positive effects on HEA because cities in these regions have a greater capacity for development and a high demand for talent [60]. FDI also has a strong positive effect on HEA [28,61]. However, the strength of its effects differs across the three regions, with the eastern region showing the highest effect, the central region showing an intermediate effect, and the western region showing the lowest effect. The differing effects of FDI across the regions reflect the unevenness of FDI in the three regions. The eastern coastal region has the largest proportion of FDI. FDI brings technological advances and innovation [62], thus improving technological and innovative progress in higher education. Along with its effects on HEA, most scholars believe that FDI increases the stringency of environmental policies [63], which indicates a potential multicollinearity issue, because this may affect other independent variables in our model. However, the Pearson's correlation coefficient for our model suggested that multicollinearity did not significantly affect our model. The final economic sustainability indicator is CLP, which shows significant positive effects at the national level, proving that industrial sustainability significantly affects HEA. CLP contributes to major industrial upgrades and social change and China is currently pursuing innovation-driven development [64]. The analytical process is illustrated in Figure 2.

Table 2. Fixed-effects model results for different regional levels.

	Constant	Economic Sustainability			Social Sustainability			Environmental Sustainability			Adjusted R^2
		GDP	FDI	CLP	Traff	R&D	Urban	Environ	REI	GP	
National level	−3.524 **	0.402 **	0.992	4.360 ***	0.094 **	0.177	0.058	0.027 **	0.794 **	−0.84	0.657
Eastern China	−3.074 *	0.536 *	1.480 **	0.363 **	0.100 ***	0.175 ***	1.305 ***	0.744 ***	−0.576	−0.129 *	0.713
Middle China	1.928	5.084 ***	0.145 *	0.761 **	−0.186	−0.327 *	−5.333	0.174 *	0.424 *	0.219 ***	0.612
Western China	3.9 **	0.186 **	0.046 ***	5.115	0.743 ***	8.527 **	0.088 *	0.542 ***	−5.807	−3.962 **	0.589

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. CLP: industrial upgrading; Environ: environmental development; FDI: foreign direct investment; GDP; gross domestic product; GP: green patent; R&D: research and development; REI: renewable energy utilisation; Traff: transport development; Urban: urbanisation level.

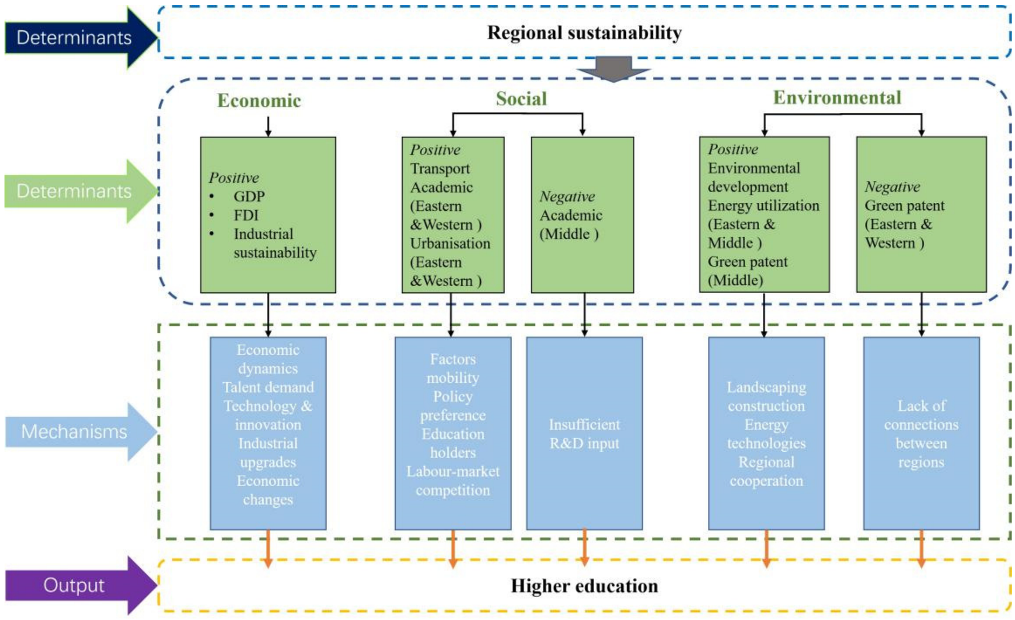

Figure 2. Mechanisms of regional sustainability affecting higher education. Note: Urbanisation and renewable use in the middle region as well as green patents in the western region are insignificant.

We analysed the social factors of transport accessibility, R&D, and urbanisation level. Transport network development is an important factor in a city's development; it also occurs during higher education development [31]. According to the analytical results, transportation development plays a positive role in promoting HEA, especially in the western region. Unlike the eastern region, the western region does not have a high-quality transportation system. Good transportation networks can accelerate the flow of talent and knowledge [48], and thus are essential for promoting HEA in China. Academic sustainability was measured using R&D. R&D is always related to industrial development and energy efficiency [64] and it has direct and immediate effects on higher education development. The recent dramatic increase in China's higher education development is mainly due to high levels of investment in R&D [65]. Based on the analytical results, this study found that R&D plays a strong positive role in promoting HEA in the eastern and western regions, but has negative effects in the central region. The central region has been experiencing human capital flight over a long period [59]; thus, in this region, R&D investment alone is insufficient to attract more higher education candidates and talent. In contrast, the effects of R&D are dramatically positive in the western region. China's western region has lower levels of economic and educational development than the eastern and central regions and a relatively high demand for talent. The average development efficiency of high-end talent in the western region is low, while the central region plays an important role in the national and regional high-end talent-development system [66]; R&D investment can resolve the western region's urgent demand for higher education degree holders. Lastly, urbanisation level plays a positive role at the national level and in the eastern and western regions. In China, intensive urbanisation has resulted in a rapid expansion of the urban population and the expansion of higher education has contributed to the increasing number of higher education degree holders in cities. The increasing population in cities also intensifies labour market competition [34]. Consequently, intensive urbanisation encourages HEA.

Environmental variables, including environmental development and REI, were also analysed. Environmental development in a city usually refers to the percentage of landscaping area to total land [67]. The data showed that environmental development has positive effects, but that this effect was not as significant in the western region as in the eastern region, which may result from insufficient R&D investment in the western region. REI is another indicator of the effects of regional sustainability on HEA; it has positive effects on HEA at the national level. There are interactive relationships between REI, technology, and innovation [68], and the generalisation of REI encourages technological development and talent demand, which leads to an increase in HEA. However, the effects of REI on HEA in the western region are insignificant and negative. This can be explained by the uneven development of renewable energy sources. The western region has mainly introduced renewable energy technology developed in the eastern and central regions; thus, it does not have a high demand for local talent specialising in renewable energy [69]. GPs have negative effects on HEA in the eastern and western regions [70]. Although GPs are an important indicator of regional sustainability, they show a weak association with HEA. This may result from the low level of connection between GPs and participation in higher education.

4.2. Controlling for Endogeneity

The aforementioned results help to explain how regional sustainability affects HEA, but, as highlighted above, there are potential endogeneity problems. Economic, social, and environmental factors can affect higher education and, in turn, higher education can be a tool for developing economic growth, renewable energy technology, and urbanisation levels. This mutual influence can bias the results of the estimated fixed-effects model. For example, along with regional differences in R&D, FDI, and GDP, uneven development across regions may result in the uneven development of higher education and different talent needs; meanwhile, higher education is concurrently being emphasised in China as a means of reducing regional inequalities. Thus, the estimated fixed-effects economic coefficient may be biased.

Table 3 reports the 2SLS results. To conduct the 2SLS, we chose one-year lagged values as the instrumental variables; Ding (2013) previously used instrumental variables to test the endogeneity issue when assessing the effects of economic growth on urban transport [57]. The instrumentation method is regarded as a means of controlling for measurement errors. The DWH test rejected the null hypothesis that the regional sustainability variables are consistent and unbiased estimates in the OLS models. Thus, the 2SLS model provided greater support for addressing the endogeneity issue. Additionally, with respect to region-fixed effects, the 2SLS model was able to revise unobserved heterogeneities across regions as well as identify omitted variables [57].

Table 3. Two-stage least-squares regression results.

	Constant	Economic Sustainability			Social Sustainability			Environmental Sustainability		
		GDP	**FDI**	**CLP**	**Traff**	**R&D**	**Urban**	**Environ**	**REI**	**GP**
National level	−1.198 *	1.227 **	1.562 *	−0.39	0.314 ***	0.591 *	0.09 *	0.848 **	−0.928	−0.447
Eastern China	1.376 **	0.06 **	1.509 *	0.413 ***	2.407 *	0.736 ***	−1.91	0.803 ***	−0.296 *	−0.137* *
Middle China	2.148 *	0.622	1.558 **	0.579 **	−0.361 *	−0.765 *	−1.549 **	0.633 *	−0.324	0.288 ***
Western China	2.248 ***	0.459 **	0.948	0.331 *	1.116 ***	−0.102	0.524 **	0.653 ***	−0.059 *	0.662

Notes: *** Significant at the 1% level, ** at the 5% level, and * at the 10% level. CLP: industrial upgrading; Environ: environmental development; FDI: foreign direct investment; GDP; gross domestic product; GP: green patent; R&D: research and development; REI: renewable energy utilisation; Traff: transport development; Urban: urbanisation level.

According to the adjusted R^2 values shown in Table 4, compared with the fixed-effects results, the models performed better when the instrumental variables (one-year lagged values) were added. The estimated elasticity and significance of educational attainment with respect to regional sustainability increased dramatically. In order to test for endogeneity issues, we conducted a Sargan test. The Sargan test is used to assess the validity of instrumental variables for testing the over-identification restrictions, and thus enables the problem of over-identification to be excluded [71]. Several high-quality studies on sustainability issues have used the Sargan Test to test for endogeneity problems [72–74]. The Wu–Hausman test, also called the Hausman specification test, is designed to detect endogenous regressors in regression analysis [75] and has been widely used for testing endogeneity issues. From the test results produced by the Sargan test and the Wu-Hausmann test shown in Table 4, we found that the endogeneity issue did not affect our research results. Thus, the results of the 2SLS models strongly supported the aforementioned results produced by the fixed-effects panel model. Although the results are strongly supportive of the regional sustainability variables, the 2SLS estimator can contain biases in small samples [76]; thus, the 2SLS results should be treated with caution although, on asymptotic grounds, they are preferable to the results obtained from the fixed-effects model.

Table 4. Significance tests.

	Adjusted R^2	Sargan's Test	Significance in First Stage	Wu–Hausman Test
National level	0.675	1	0.000 ***	0.005 ***
Eastern China	0.725	1	0.002 **	0.012 ***
Central China	0.699	1	0.011 **	0.007 ***
Western China	0.701	1	0.000 ***	0.013 **

Notes: *** $p < 0.01$; ** $p < 0.05$.

5. Conclusions, Limitations, and Implications

Building on the systematic force framework that shows how regional sustainability drives higher education from the perspectives of the economy, society, and the environment, we adopted a fixed-effects panel model to determine the impact of variations in regional sustainability on HEA. In the analytical process, we found a potential endogeneity problem; our methodological approach enabled us to investigate whether endogeneity has a significant impact using the 2SLS model. Moreover, differences between the national and regional level, as well as between regions, were also examined. We found that, at the national level, transportation, environmental development, REI, industrial sustainability, and GDP have significant positive effects on HEA. In eastern China, transportation, R&D, urbanisation, environmental development, FDI, industrial sustainability, and GDP have significantly positive effects on HEA. In central China, GPs, environmental development, REI, FDI, industrial sustainability, and GDP all have significantly positive impacts on HEA, while R&D has negative effects. Finally, in western China, in contrast to central and eastern China, GPs play a negative role with regard to HEA. The developmental differences in the three regions clarify the divergences in relation to HEA depending on levels of regional sustainability.

This study highlights the differing effects of regional sustainability on HEA in different regions. The findings regarding this uneven development can help to clarify regions' differing needs regarding talent and HEA. Although the western region has a relatively low level of economic growth, HEA in the region is significantly impacted by transportation, R&D, FDI, and GDP; thus, economic dynamics play a more significant role in this region. The eastern region shares few similarities with the western region. The eastern region has a high level of economic growth, and FDI, environmental development, urbanisation, and industrial sustainability all have significant positive impacts. This shows that HEA in the eastern region is affected by a range of factors. The analytical results indicated that the social, economic, and environmental factors identified are unevenly distributed throughout China. This uneven distribution causes spatial differences in terms of regional sustainability and higher educational attainment. Emphasis should thus be placed on these regional differences when studying higher education development in different regions of China. Therefore, HE policymakers should be aware of these varying dimensions of regional sustainability in different regions when promoting local HE development.

Although this study was conducted in China, we argue that the analytical results can be generalised to other regions of the world. As the world's largest developing country, China has been experiencing uneven regional development patterns. Regional sustainability in different regions is also affected by various factors. In the case of other countries or regions, the different characteristics of individual regions should be investigated in regional sustainability studies. There may be situations that are specific to certain regions, thus future studies should review the most significant factors affecting regional sustainability and, in turn, implement the most suitable policies for addressing them. Increasing educational attainment in China has led to more rapid regionalisation, which can be used as an example for studying the relationship between city development and higher educational attainment. More importantly, the relationship between regional sustainability and higher educational attainment varies between countries and regions, thus a suitable specific indicator system should be established for assessing other countries and regions of the world beyond China.

Additionally, the findings question existing assumptions regarding the interactive relationships between regional sustainability and HEA. According to existing literature, HEA plays an important role in a city's development and sustainability. Thus, we found a strong potential endogeneity problem between the dependent and independent variables. To resolve this problem, we tested it using a 2SLS model. The outcomes obtained using the 2SLS model showed that the results of the fixed-effects model were valid and credible. However, although we found consistency in our model, endogeneity must still be treated with caution. It also represents a limitation of this research, because the model used has weak explanatory power with regard to endogeneity issues. Therefore, in future research, endogeneity should be further discussed and tested. More importantly, spatial aspects should also be considered, because of the finding that social, economic, and environmental factors are unevenly distributed throughout China.

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