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How popularising higher education affects economic growth and poverty alleviation: empirical evidence from 38 countries

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The popularisation of higher education supports UNESCO's aim of developing inclusive and equitable quality education to achieve the fourth Sustainable Development Goal. However, the effect of popularising higher education on economic growth and poverty alleviation remains unexplored. Therefore, this study investigated the effects of higher education and adult education within populations (popularisation of higher education) on economic growth (gross domestic product; GDP) and the poverty line using panel data from 38 countries. OLS and quantile regression were performed using data for the period 1995–2021 extracted from the OECD and World Bank databases. The results showed that the population segments with higher education had a significantly positive impact on GDP growth. Moreover, an increased proportion of the population with higher education, of working age, was found to be a contributing factor to GDP growth. Popularising higher education also played a positive role during the initial stage of social and economic development. This study also highlighted that popularising higher education play a key role to influence a country's educational development and scientific and technological innovation drives the deepening of a country's economy. It suggested that both national and local governments worldwide should pay much attention to the popularisation degree of higher education to greatly improve the innovative ability of talents and scientific and technological innovation in higher education for both the economic growth and poverty alleviation.

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Introduction

The popularisation of higher education critically contributes to UNESCO's efforts to realise the fourth Sustainable Development Goal of inclusive and equitable quality education (Ainscow, 2020; Bamberger and Kim, 2022).Popularisation of higher education expands the scale of higher education and its high growth rate introduces considerable challenges to the management structure of higher education, triggering a series of theoretical and practical concerns relating to the nature and function of higher education (Balestra and Ruiz, 2015; Brand, 2021). Given that education and social and economic development are mutually reinforcing, the expansion of higher education leads to an ascending spiral of development for individuals and/or economies. By contrast, a lack of education or early withdrawal from education leads to a downward spiral for them (Camilla, 2023). This relationship between education and development undergirds the model of poverty alleviation based on the return on education (Decancq, 2017). The previous studies emphasise the importance of the return on education as a multidimensional anti-poverty mechanism and thus a key factor in poverty alleviation (Fang et al., 2022; Chelli et al., 2022; Garritzmann, 2016). For example, return on education is the key factor enabling a transition from poverty alleviation through education to poverty alleviation through education (Gillian et al., 2021; Gong and Hong, 2021). Poverty alleviation is realised through an interlinking of these two processes and the promotion of the latter (Granata, 2022; Habibi and Zabardast, 2020). The educational resources can meet the needs of the poor mainly through the return on education at the levels of survival and life quality. In addition, the previous studies highlighted that, with a continuous expansion in the scale of higher education, its economic effect gradually appears to become marginal (Hoeller et al., 2014). The density of colleges and universities worldwide has increased considerably in recent years, but it is still inadequate to meet increasing demands resulting from the ongoing popularisation of higher education (Jericho, 2016). The increase in the number of colleges and universities has a positive effect in promoting economic development but with marginal benefits. (Julian, 2018).

Through reviewed the current relevant studies, it is found that there have limited studies that have simultaneously explored the effects of popularising higher education on economic growth and poverty alleviation. The previous research revealed that most studies have focused on the relations between popularisation of higher education and economic growth. However, a few empirical investigations have examined the effect of population segments with higher education and adult education (popularisation of higher education) on economic growth (GDP) and poverty reduction. Considering the scope and limitations of previous studies, it aimed to address the above research gap by investigating the effect of a population segment with high levels of higher education and adult education (popularisation of higher education) on economic growth (GDP) and the poverty line at a wide scale using panel data from 38 countries. The main research questions addressed in this study are as follows.

Q1: What is the effect of a population segment with higher education on GDP growth?

Q2: What is the effect of adult education on GDP growth?

Q3: What impact does a population segment with higher education have on reducing the proportion of those experiencing poverty?

Q4: What is the relation between an increased level of adult education and the proportion of the population experiencing poverty?

All these questions are relevant to an exploration of the effect of the population segment with higher education and adult education (popularisation of higher education) on economic

growth (GDP) and the poverty line. This study is divided into several sections: the first section concentrates on examining the effect of popularising higher education on economic growth and the poverty line, the relationship between popularisation of higher education and poverty alleviation, and the relationship between popularisation of higher education and poverty alleviation. In the second section of method, to address this research gap, this study performed OLS and quantile regressions using data extracted from the OECD and World Bank databases for the period 1995–2021. An OLS regression model and a panel quantile model were used to analyse the effect of a population segment with higher education and adult education (popularisation of higher education) on economic growth (GDP) and the poverty line within 38 OECD countries. The impact of the proportion of people aged 24–64 years and 25–34 years who had completed higher education in relation to their peers on GDP and the proportion of people living in poverty in 38 OECD countries have been measured and analysed. The results and discussion have been provided at the last.

Literature review

The effect of popularising higher education on economic growth. The population segment with higher education is regarded as an important contributor to economic growth, generating scientific knowledge and providing labour, which in turn increases human capital and productivity (Jungblut, 2017; Kalamova, 2020; Liu, 2017). As the scale of higher education expands, the emergence of knowledge power as a large-scale global phenomenon reflects the important role of an expanded educated labour force in the advancement of science and technology and the economy. For example, the relationship between higher education and economic development in European Union countries between 1997 and 2016 was analysed. Their findings revealed a statistically significant correlation between expanding higher education and economic growth in the selected countries. The one-way cause-and-effect relationship between education and economic development in these countries suggests that an increase in the proportion of the population enroled in higher education boosts economic performance. In addition, using a survey sample of 35 households, a retrospective study in Brazil, examined the role of educational expansion in reducing income inequality and poverty. Its findings suggest that it would take decades to reduce inequality and poverty in this country and that this outcome could only be achieved through a major expansion of the higher education sector. The growth needed to achieve this outcome would be considerable (Lamichhane et al., 2021). This reduction in inequality and poverty could only be achieved if optimistic assumptions about growth, matching job skills and the return on education do not fall short. In brief, education is not a panacea for reducing poverty and inequality. How three major stages of education contributed to the growth in labour productivity in 125 countries during the period 1999–2014 was also explored. They found that human capital is consistent with the educational returns of an average number of years of formal education at the levels of primary, secondary, and higher education. Their analysis showed that higher education had the greatest impact on labour productivity in the economies under study (Ledger et al., 2019). In addition, popularising higher education plays an important role in promoting economic growth, as the scale of higher education can guarantee the scale of human resources development by improving the quality of human resources and cultivating and distributing innovative scientific and technological talents. The scale of higher education guarantees the spread of science and technology and the popularisation of scientific and technological achievements (Mathias, 2023; Megyesiova and

Lieskovska, 2018). The expanded scale of higher education worldwide has a spatial spillover effect on economic growth, which is strengthened through international cooperation in the fields of science and technology.

Popularising higher education also plays a direct role in cultivating and transporting scientific and technological talents to promote international scientific and technological cooperation (Mitic, 2018; Özdoğan Özbal, 2021; OECD, 2022; Pinheiro and Pillay, 2016). The scale of postgraduate education inhibited the total number of scientific and technological innovation achievements, indicating that there may be a trade-off between 'quantity expansion' and 'quality upgrading' of scientific and technological innovation achievements. Nevertheless, the positive effect on the number of high-tech innovation outcomes is significant, indicating that the supporting effect of graduate education on scientific and technological innovation is mainly concentrated in the high-tech fields (Pinheiro and Pillay, 2016; Rowe, 2019; Sahnoun and Abdennadher, 2022). The 'talent increment' of regional expansion and the 'resource stock' of graduate education have a combined promoting effect on high-tech innovation. There are differences in the effect of graduate education supporting high-tech innovation among provinces with different characteristics relating to the development of graduate education. The incremental expansion of high-quality talent is essential for enhancing the efficiency of material capital and stabilising the advantage of resource stocks. Using education statistics from OECD countries, Russia, and several other countries that participate in OECD education research, comparative and correlational analysis methods were applied to analyse how the scale of growth in young people's participation in higher education is reflected in changes in their employment and economic activity. The results of their analysis showed that the growth in economic activity involving young graduates with a master's degree exceeded that of college graduates after the 2009 financial crisis, and graduates fared better in the 2020 crisis, which was triggered by the COVID-19 pandemic.

The effect of popularisation of higher education on poverty alleviation. Popularisation of higher education is regarded as an essential factor contributing to poverty alleviation (Samo, 2022; Adams, 2013; Zapp, 2022). The higher education's role in promoting economic growth can only be fully realised through the cultivation of talents suitable for the actual development situation of the country. Countries with food shortages, for example in Africa, also need to procure and train the right agricultural talent. Key drivers of sustainable agricultural production include access to improved technologies, sustainable growth of human, biological and natural resource capital, improvements in institutional performance and a favourable economic policy environment. Higher education graduates with the necessary 'soft skills and business skills constitute an important pillar. Chakeredza (2008), who explored the effect of popularising higher education on poverty alleviation, suggested that the number of hungry people in Africa will continue to increase. Higher education in agriculture must be transformed, and efforts must focus on retaining faculty and on reviewing and redesigning institutional management systems, curriculum content and education delivery.

There are many reasons for poverty, with a lack of education being an important one. Insufficient quality education leads to educational poverty. Using PISA data, Agasisti et al. (2021) investigated the extent of educational poverty in European countries, considering its incidence, breadth, depth and severity. For this study, they adopted an additive multidimensional poverty measure proposed by Alkirew and Foster. Their findings indicated that between 2006 and 2015, the depth and severity of poverty decreased in most of the countries under study. Moreover, the incidence of educational poverty in many European countries was related mainly to student characteristics and school factors. The expansion of higher education has a positive effect on economic development and poverty reduction by improving work skills within the labour force. Increased enrolment in higher education encourages individuals born in families with low education levels to avail of higher education opportunities. Evidently, the expanded scale of higher education in the process of promoting economic growth has enhanced the equity effect of intergenerational social mobility. The expansion of higher education improves total factor productivity, thus promoting economic transformation and advancement globally (Samo, 2022; Adams, 2013; Zapp, 2022). Furthermore, the previous studies have shown that the structure of higher education talent training has a significant impact on economic development. Therefore, government departments need to make constant efforts to improve relevant systems and promote the optimisation and upgrading of the structure of higher education talent training to meet the needs of future economic development.

Theoretical underpinnings. The relationship between education and economic growth is a classic issue in the study of educational economics. For example, in Solow's view, the growth of per capita output comes from per capita capital stock and technological progress, but capital investment has the problem of diminishing marginal returns, and the long-term sustainable development of the economy depends on technological progress (Solow, 1957). The emphasis on technological progress is a very important point in Solow's growth theory. It was Schultz who systematically analyzed the contribution of education to economic growth. Influenced by the progress of economic growth theory and national accounting methods, Schulz proposed human capital theory in the process of explaining Solow residuals (Schultz, 1961). believes that once human capital is included in economic growth, it will solve the paradoxes and puzzles faced in economic growth research. Starting with the difference in income of different types of workers in the labour market, he found that education and health factors are the main reasons for the income difference, and further clarified that the reason for the income difference is the difference in labor productivity (Schultz, 1961). Schultz (1961) believes that human resources include the quantity and quality of labor, and he mainly focuses on the skills and knowledge of people who can improve labor productivity. As for how to measure human capital investment, Schulz believes that the cost of human capital can be measured in the same way as physical capital. Lucas (1988) focuses on the mechanism of human capital accumulation and why human capital does not show diminishing marginal returns like physical capital. Lucas divides the effect of human capital into internal effect and external effect. Romer (1990) internalised technological progress, revealed the relationship between human capital and technological progress, and proposed that the stock of human capital determines the economic growth rate, and it is human capital rather than population that determines economic growth. Romer starts with three hypotheses: first, technological progress is central to long-term economic growth; Second, technological progress is formed by people's response to market incentives, and market incentives determine technological progress. Third, technology is a special kind of product, and once the cost of the initial input is produced, the technology can be reproduced indefinitely at no cost or very low cost.

In other words, higher education is more about improving students' ability and productivity, thereby increasing students'

Table 1 Descriptions of the study variables.

Variable type	Variable dimension	Variable indictor	Variable interpretation	Mean	Standard deviation
Independent Variable	Population with higher education	Ratio of completion of higher education to total number of eligible workers	Percentage of 25–64-year old's who have completed higher education (%)	36%	12.9%
	Popularisation of higher education development (Adult education level)	Number of young people completing higher education as a proportion of their peers	Number of 25–34-year old's who have completed higher education as a percentage of their peers (%)	29.8%	11.2%
Dependent Variable	Level of economic and social development	GDP	Total annual domestic economic production (USD)	106.9 billion	255 billion
	Fairness in economic and social development	Poverty line	The share of the population living on less than $2.15 a day	0.98	2.34

income, and promoting economic growth. Higher education mainly affects economic growth through two aspects: one is the same as Schulz's improvement of individual ability, and the internal effect of human capital, which directly affects the production process (Schultz, 1961). Second, Lucas emphasised the external effect of human capital, and the comprehensive effect of human capital on the whole society, which has the characteristics of increasing marginal benefit (Lucas, 1988). It emphasises that the human capital invested in technological innovation and the existing knowledge and technology stock of the whole society jointly determine technological innovation.

Methods

Research hypotheses and analytical model. In this study, an OLS regression model and a panel quantile model were used to analyse the effect of a population segment with higher education and adult education (popularisation of higher education) on economic growth (GDP) and the poverty line within 38 OECD countries. The study's hypotheses were as follows:

Hypothesis 1: The effect of a population segment with higher education has a positive impact on GDP growth.

Hypothesis 2: Some level of adult education has a positive impact on GDP growth.

Hypothesis 3: A population segment with higher education has a positive impact by reducing the proportion of the population experiencing poverty.

Hypothesis 4: An increase in the level of adult education has a positive impact by reducing the proportion of the population experiencing poverty.

The widely used Mankiw-Romer-Weil model was applied in this study. The overall level of development of higher education and the popularisation of higher education were considered core elements that independently promote economic development and alleviate poverty. The following model was constructed by incorporating the variable of quality higher education into the Solow model:

$$Ln(Y_{it}) = \theta_0 + \alpha \ln(Q_{it}) + \beta \ln(P_{it}) + \mu_{it},$$

where Y_{it} refers to the output of i country in t year. The independent variables Q_{it} and P_{it} respectively represent the scale of development and the degree of popularisation of higher education in i country in t year. The following specific model was constructed:

$$Ln(C_{it}) = \alpha \ln(A_{it}) + \beta \ln(B_{it})$$

$$Ln(D_{it}) = \alpha \ln(A_{it}) + \beta \ln(B_{it}).$$

The independent variables were the proportion of people aged 25–64 years with higher education (A) and the proportion of people aged 25–34 years with higher education within the same age group (B). The first variable reflects the population segment that has completed higher education and can work in the corresponding age group. The second reflects the degree of popularisation of higher education. The proportion of those who have completed higher education in relation to their peers is in the normal state, which can reflect the enrolment rate for the previous process of higher education, thus indicating the degree of popularisation of higher education.

The dependent variables were GDP and the poverty line (D). GDP is a measure the overall level of a country's economic and social development. The poverty line refers to the proportion of people living on less than US$1.25 a day as a percentage of the country's total population or the proportion of people living in poverty. Thus, it reflects the level of equity in social development. The figure of US$2.15 is used in the World Bank's index and is based on the purchasing power parity in 2017 (see Table 1).

Data sources and selection of variables. This study measured the impact of the proportion of people aged 24–64 years and 25–34 years who had completed higher education in relation to their peers on GDP and the proportion of people living in poverty in 28 OECD countries. Specifically, this study assessed the impact of the overall level of development of higher education and the degree of its popularisation (the breadth of development of higher education) on GDP (the height of development of economic and social development) and the poverty line (the breadth of development of economic and social development). Data were sourced from the OECD database and the World Bank website covering the period 1995–2021. This study selected 38 OECD countries for this study: the United States, UK, France, Germany, Italy, Canada, Ireland, the Netherlands, Belgium, Luxembourg, Austria, Switzerland, Norway, Iceland, Denmark, Sweden, Spain, Portugal, Greece, Turkey, Japan, Finland, Australia, New Zealand, Mexico, the Czech Republic, Hungary, Poland, South Korea, Slovakia, Chile, Slovenia, Estonia, Israel, Latvia, Lithuania Colombia and Costa Rica. Figure 1 shows the distribution of the 38 OECD countries. Of these countries, 20 were founding members of the OECD when it was established in 1961, while the remaining 18 subsequently became members. After 1994, OECD membership expanded rapidly. Five new members were added within three years. OECD then entered a period of accelerated development, and its operations and advancement reached an optimal stage. Therefore, this study selected data from the OECD database and the World Bank website covering the period 1995–2021 to explore the relationship between higher education and economic and social development in OECD member countries.

Results

The impact of the population segment with higher education on GDP growth. This study explored the impact of the population segment with higher education on GDP, taking the
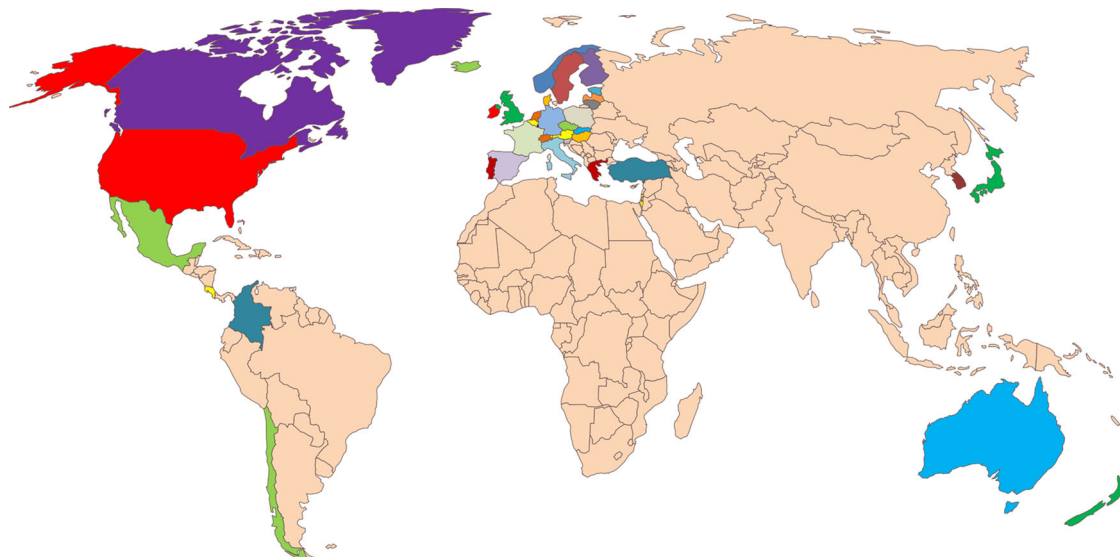
Fig. 1 The geographical distribution of the 38 selected OECD countries. It expresses the geographical relations of the Atlantic region and simplifies the latitude and longitude lines and country symbols, highlighting the geographical distribution by highlighting OECD countries in color and other countries in apricot color.

proportion of people aged 25–34 years who had completed higher education (B) and the proportion of people aged 25–64 years who had completed higher education (A) as the independent variables for the OLS regression. The square value of model R was 0.097, indicating that the two independent variables could explain 9.73% of the change in GDP. The model passed an F test ($F = 46.137$, $p = 0.000 < 0.05$), indicating that at least one of the two independent variables impacted the GDP regression coefficient (C). The following formula was used:

$$C = -4.763 - 0.813*B + 1.553*A$$

The final analysis revealed that the regression coefficient value of A was 1.553 and the significance level was 0.01 ($t = 7.141$, $p = 0.000 < 0.01$). Therefore, A had a significantly positive influence on C. Accordingly, the proportion of the population aged 25–64 years who had completed higher education, that is, the overall level of development of higher education was found to have a positive impact on GDP. The influence coefficient value was 1.533, indicating that an increase in the proportion of the population with completed higher education led to an increase in GDP.

The regression coefficient value of B was −0.813 at a 0.01 level of significance ($t = -4.300$, $p = 0.000 < 0.01$), indicating that B had a significantly negative influence on C. The proportion of the population aged 25–34 years who had completed higher education, that is, the degree of popularisation of higher education had a negative effect on GDP, and the influence coefficient value was −0.813.

The negative impact on economic and social development caused by an increase in the popularity of higher education and the proportion of young people's higher education experience may be attributed to the excess capacity of higher education. The development of higher education should be adapted to the national context. An excess of higher education and a lack of investment lead to a rise in the social cost of education and a decline in social outputs, which hinder social and economic development. At the same time, young people aged between 25 and 34 years occupy the position of' export' in the education process. With the increasing popularity of higher education, the supply of talents in the labour market generated through the recruitment of former higher education exceeds the demand for graduates with higher education within recruiting organisations. Consequently, issues such as wasted educational resources and knowledge, unemployment, excessive education, excess talents, an imbalance in the structure of higher education, excessive expansion and decreasing compatibility undermine economic operations and hinder GDP growth.

In this study, the variance decomposition and Pearson coefficient based on covariance calculation were analyzed. The variable of the number of 25–34-year-old who have completed higher education as a percentage of their peers explains 50.74% of the change in GDP. The variable of the proportion of 25–64-year-old who have completed higher education explains 49.26% of the change in GDP. The variable of 25- to 34-year-olds who completed higher education as a percentage of their peers explained 45.88% of the change in poverty line. The variable of the proportion of people aged 25–64 who have completed higher education explains 54.12% of the change in GDP (See Table 2).

The proportion of people aged 25–34 who have completed higher education in their peers and the proportion of people aged 25–64 who have completed higher education in their peers, GDP and poverty line showed significant correlation coefficients. The correlation between the proportion of people who have completed higher education at the age of 25–34 and the proportion of people who have completed higher education at the age of 25–64 is 0.931, and shows a significance of 0.01, which indicates that there is a significant positive correlation between the proportion of people who have completed higher education at the age of 25–34 and the proportion of people who have completed higher education at the age of 25–64. The correlation between the proportion of the number of people who have completed higher education at the age of 25–34 and the GDP is 0.209, and the significance is 0.01, which indicates that there is a significant positive correlation between the number of people who have completed higher education at the age of 25–34 and the GDP. The correlation between the number of people who have completed higher education and the poverty line at the age of 25–34 is −0.365, with a significance of 0.01, indicating a significant negative correlation between the number of people who have completed higher education and the poverty line at the age of 25–34 (See Table 2).

Table 2 Covariance test.

Items	Covariance	Variance decomposition value	Percent%
Divide_25-64_gdp	7652.762	0.493	49.26%
Divide_25-34_gdp	7882.662	0.507	50.74%
Divide_25-64_Poverty line	31263.199	0.459	45.88%
Divide_25-34_Poverty line	36883.255	0.541	54.12%
In total	-	1	100%

Var value = 15535.424 for GDP.
Var value = 68146.454 for poverty line.

Table 3 Pearson correlation.

	Mena	Standard deviation	25-34	25-64	GDP	Poverty line
25-34	36.001	12.902	1			
25-64	29.814	11.222	0.931**	1		
GDP	10.694	25.502	0.209**	0.279**	1	
Poverty line	0.979	2.345	−0.365**	−0.329**	−0.048	1

**$p < 0.01$.

White test and BP test were used in this study. The test null hypothesis is that the model has no heteroscedasticity. The table above shows that both tests reject the null hypothesis ($p < 0.05$), indicating that the model does have heteroscedasticity. When there is a heteroscedasticity problem, Robust and robust standard false regression is used (See Table 3).

The impact of a population segment with higher education on the poverty line. This study also explored the impact of a population segment with higher education on the poverty line. Specifically, this study performed an OLS regression in which the proportion of people aged 25–34 years who had completed higher education (B) and the proportion of those aged 25–64 years who had completed higher education (A) were the independent variables. As Table 2 shows, the R squared value was 0.134. This means that variables A and B could explain 13.37% of the change in the poverty line (D). The model passed the F test ($F = 48.771$, $p = 0.000 < 0.05$), which means that at least one variable (A or B) had an impact on the poverty line. The formula for the change in the poverty line was expressed as follows:

$$D = 2.284 − 0.048*B + 0.005*A$$

The final analysis revealed that the regression coefficient value of the proportion of people aged 25–64 years who had completed higher education (A) was 0.005 but with no significance ($t = 0.428$, $p = 0.669 > 0.05$), indicating that the population segment with higher education did not have an impact on the poverty line.

The regression coefficient value of the proportion of people aged 25–34 years who had completed higher education (B) was −0.048 at a significance level of 0.01 ($t = −4.305$, $p = 0.000 < 0.01$), which means that in relation to their peers, the proportion of people aged 25–34 years who had completed higher education had a significantly negative impact on the proportion of poor people. A higher proportion of people aged 25–34-years who had completed higher education corresponded to a higher penetration rate of higher education and a lower proportion of those living in poverty. This phenomenon can be attributed to OECD's support for the development of higher education in various countries. When the development of higher education reaches a certain level, the reduction of the proportion

Table 4 A comparison of the results of the OLS regression.

	Dependent variable: C.GDP Regression coefficient	Dependent variable: D. Regression coefficient of poverty line
Constant	−4.763 (−1.801)	2.284** (13.628)
B.25–34	−0.813** (−4.300)	−0.048** (−4.305)
A.25–64	1.553** (7.141)	0.005 (0.428)
Sample size	859	635
R^2	0.097	0.134
Adjusted R^2	0.095	0.131
F value	$F_{(2,856)} = 46.137$, $p = 0.000$	$F_{(2,632)} = 48.771$, $p = 0.000$
D-W value	0.024	0.327

**$p < 0.01$ t-value in parentheses.

of the population segment experiencing poverty will no longer be affected by a simple expansion of the scale of extended higher education and the superposition of the total number of highly educated human resources. It will be influenced more by the reasonable distribution of educational resources and educational equity within higher education and its popularisation, that is, the increase in the proportion of the school-aged population aged 25–34 years based on the increase of the previous enrolment rate (see Table 4).

The effect of adult education on GDP growth. For quantile regression analysis, a total of nine models (with decimal points ranging from 0.10 to 0.90 and at intervals of 0.10) were estimated in this analysis, which aimed to explore the impact of the independent variables A and B on the dependent variable, GDP (C). When the quantile value was between 0.1 and 0.3, the proportion of the population aged 25–64 years who had completed higher education (A) had no significant positive impact on GDP growth, indicating that the development of higher education did not significantly affect economic and social development in poorer OECD countries. When the quantile value was between 0.4 and 0.6, the level of development of higher education had a significantly negative impact on economic and social development. Thus, for a country that had developed over a period, the

Table 5 A comparison of the results of the quantile regression analysis.

	Quantile 0.10	Quantile 0.20	Quantile 0.30	Quantile 0.40	Quantile 0.50	Quantile 0.60	Quantile 0.70	Quantile 0.80	Quantile 0.90
Dependent variable: C.GDP									
B.25–34	0.041 (1.688)	0.105** (3.912)	0.125** (4.236)	0.231** (6.994)	0.278** (7.538)	0.313** (6.589)	0.114 (1.353)	−0.647** (−3.519)	−1.357** (−5.481)
A.25–64	−0.038 (−1.539)	−0.057 (−1.898)	−0.048 (−1.421)	−0.138** (−3.601)	−0.160** (−3.786)	−0.157** (−2.919)	0.198* (2.051)	1.248** (5.964)	2.906** (9.790)
Dependent variable: D. Poverty line									
B.25–34	0.000 (0.000)	0.006* (2.255)	0.000 (0.000)	0.000 (0.000)	−0.011* (−2.218)	−0.020** (−3.330)	−0.025** (−3.010)	−0.040** (−3.879)	−0.051* (−2.254)
A.25–64	0.000 (0.000)	−0.004 (−1.409)	−0.000 (−0.000)	−0.000 (−0.000)	0.002 (0.441)	0.007 (1.108)	0.000 (0.008)	−0.000 (−0.026)	−0.021 (−0.977)

*$p < 0.05$ **$p < 0.01$ t-value in parentheses.

advancement of higher education required multiple inputs, such as capital, material, and human resources.

During the early stage of the development of higher education, such inputs may, however, have a negative and weakening impact on social and economic development. The added cost of education and the lag between the output of educational achievements and the input of talents puts increased pressure on economic and social development during a certain period. When the quantile value was 0.7 or higher, the improvement of the overall level of higher education had a significantly positive impact on GDP growth, indicating the realisation of the talent training outcomes of higher education. Teaching and research outcomes were thus transformed into socially productive resources and power, with talents with higher education contributing to economic and social development.

When the quantile value was 0.1, the proportion of people aged 25–34 years who had completed higher education in relation to their peers (variable B), indicating the popularisation of higher education, had no significant impact on GDP growth. Thus, in extremely backward countries, the popularisation of higher education had little effect on economic and social development. When the quantile value ranged between 0.2 and 0.6, the popularisation of higher education had a significantly positive effect on GDP growth, indicating its contribution to economic growth.

When the quantile value was 0.7, the influence of variable B on variable C was no longer significant, indicating that social development would soon face the problem of overcapacity in higher education. When it exceeded 0.7, the ratio of eligible people aged 25–34 years who had completed higher education in relation to their peers had a significantly negative impact on GDP growth, revealing that with the development of the economy, society and education, higher education had become over-expanded. Thus, the cost of investing in education exceeded the social benefits, leading to overcapacity whereby the supply of higher education talents exceeded the demand. This situation led to wasted educational resources and excessive competition of talents, hindering economic growth (See Table 5).

The increased level of adult education and the proportion of the population experiencing poverty. Using the same model, this study explored the influence of the independent variables, A and B, on the poverty line (dependent variable D). The proportion of the population aged 25–64 years who had completed higher education (independent variable A) had no significant influence on the proportion of the population living in poverty, indicating that popularisation of education and economic and social development have been achieved to a certain extent in OECD countries, and improvements targeting the population experiencing poverty could no longer be achieved simply by increasing the volume and quantity of higher education. When the quantile value was 0.1, the proportion of people aged 25–34 years who had completed higher education in relation to their peers (independent variable B) had no significant effect on the proportion of the population experiencing poverty (dependent variable D). Therefore, the strategy of increasing higher education enrolment and the ratio of the eligible population through the fair allocation of educational resources, and thus the popularisation of education, would not be effective for a small population segment experiencing poverty. In other words, the population segment experiencing poverty in highly developed countries is less receptive to the popularisation of higher education. When the quantile value was 0.2, the independent variable, B, had a significantly positive impact on the dependent variable D, that is, an increase in the popularity of higher education led to an increase
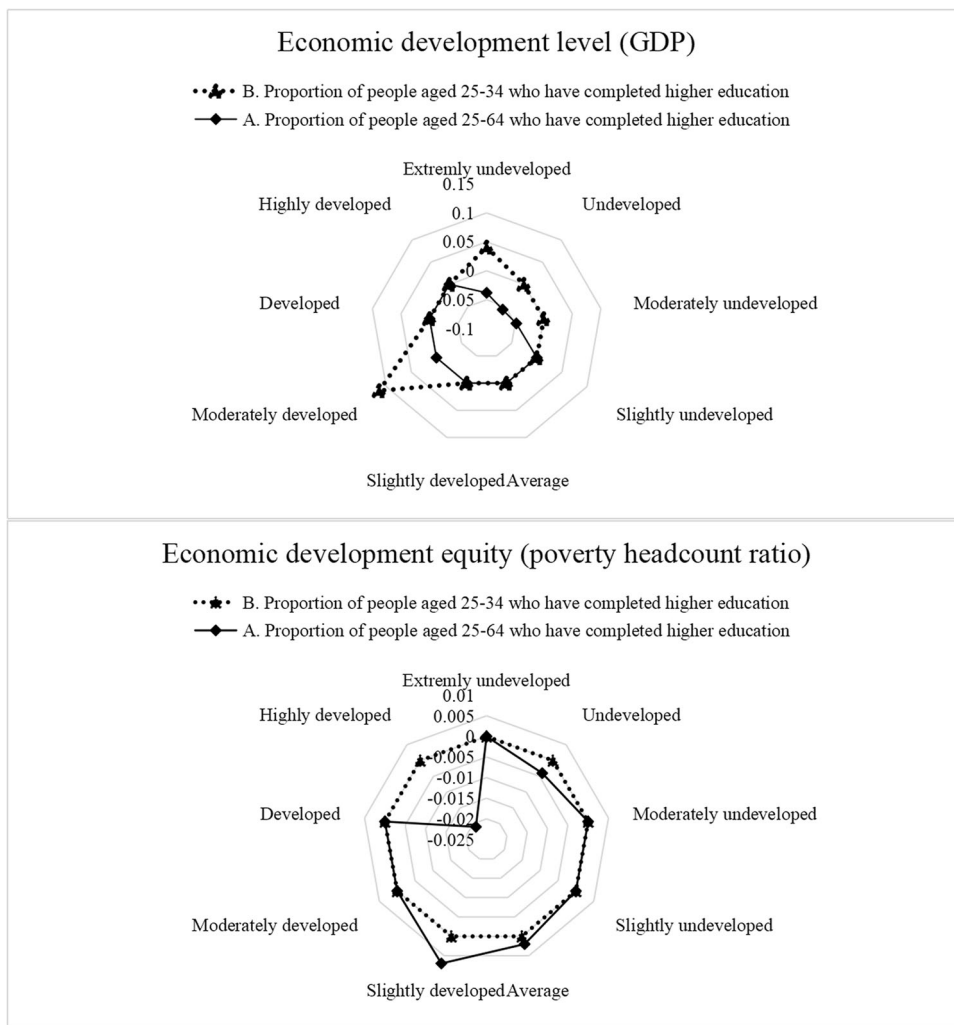
Fig. 2 Countries with sub-loci 0.1–0.9 are defined as extremely undeveloped, undeveloped, moderately undeveloped, slightly undeveloped, average, slightly developed, moderately developed, developed, highly developed. The dashed line represents the proportion of people aged 25–34 years who have completed higher education. The solid line represents the proportion of people aged 25–64 years who have completed higher education, the impact of the overall level of higher education.

in the population segment experiencing poverty. This phenomenon can be interpreted as reflecting the inherent disadvantages of the welfare state in the field of education. A rise in the number of eligible young people aged 25–34 years who have completed higher education reflects the development trend of higher education towards fairness and popularisation following the redistribution of higher education resources.

The fair distribution of higher education resources leads to a lack of competition in the areas of teaching and career development. To a certain extent, reducing students' willingness and enthusiasm to work may lead to poverty caused by the failure to achieve teaching results. When the quantile value was between 0.3 and 0.4, the independent variable, B, had no significant influence on the dependent variable D. In relatively poor countries, the popularisation of higher education contributes little to reducing the degree of poverty, so it may be necessary to explore ways of alleviating poverty from the perspective of improving the overall level and expanding the scale of basic higher education. When the quantile value was 0.5 or above, the independent variable B had a significantly negative impact on the dependent variable D, indicating that for countries with a relatively high proportion of their population experiencing poverty, the following strategy would be more effective.

Considering the quantile data, this study deemed that the degree of sensitivity of countries at different stages of economic development to the level of development and popularisation of higher education could be more intuitively evaluated using a radar map (see Fig. 2). Countries with sub-points 0.1–0.9 were defined along a spectrum as extremely backward, backward, moderately backward, slightly backward, moderate, preliminarily developed, moderately developed, developed, and highly developed. From the perspective of economic development, increasing the proportion of young people who complete higher education and popularising higher education had an obvious positive effect in backward and medium-developed countries, whereas the effect in highly developed countries was not obvious. Overall, the sensitivity of OECD countries to the high level of education penetration was found to be higher than the level of development of higher education. From the perspective of equitable economic development, the overall level of development of higher education had no significant impact on the poverty link in OECD countries, whereas OECD countries with differing economic development backgrounds and at varying stages of development evidenced relatively significant and stable sensitivity to the proportion of young and middle-aged people who completed higher education and the popularisation of higher education.

Discussion

Our findings indicated that population segments with higher education had a significantly positive impact on GDP growth in 38 OECD countries. An increase in the proportion of the population segment of working age who completed higher education was found to contribute to GDP growth. Moreover, an improvement in the popularity of higher education played a positive role during the initial stage of economic and social development.

At the same time, oversupply and overcapacity may result from a continuous improvement of higher education. A very large number of young people who have completed higher education can lead to excessive competition and wasted academic qualifications (Mathias, 2023; Megyesiova and Lieskovska, 2018). In turn, higher education knowledge unemployment, over-investment, a structural imbalance, disorderly expansion and wasted resources can occur, which have detrimental impacts on economic operations.

Some studies have shown that strengthening the quality of higher education helps to improve cognitive abilities within the labour force, thereby enhancing the growth of the knowledge economy (Ainscow, 2020; Bamberger and Kim, 2022). Other studies have reported regional heterogeneity relating to the marginal effect of improving the quality of higher education on economic growth. Some scholars have analysed the influence of the quality of higher education on economic development from the perspective of human capital investment theory. Their findings indicate that the quality of higher education determines the composition and growth trend of social human capital. Because of differences in the degrees of development of different economies, the quality of higher education has a phased influence on economic growth (Balestra and Ruiz, 2015; Brand, 2021). Case studies of African developing countries by international scholars have revealed that quality factors are key to realising the economic development function of higher education. From the perspectives of both efficient financial investments by states in education poverty alleviation and the effects of economic, time and emotional investments of poor families and individuals in education poverty alleviation, it is necessary to take the return on education into consideration. Moreover, it is important to respond to reasonable concerns regarding the return on education for poor people and to strengthen their cognitive capacities to rationalise as well as their expectations regarding returns on education (Li et al., 2023). In this way, the intention to participate and behaviour of anti-poverty education will be generated, and the strategic upgrading of poverty alleviation combined with the promotion of aspirations and cognitive capacities will be emphasised.

Implications. Our use of panel data from 38 countries to deepen understanding of the effect of popularising higher education on economic growth and poverty reduction also has practical implications. The economic, social, and higher education undertakings in OECD countries evidence a certain level of development. The population segment with higher education has no significant impact on reducing the proportion of the population segment experiencing poverty. Simply increasing the proportion of people who complete higher education and expanding the scale of higher education will not effectively reduce poverty (Li and Xue, 2021). Providing more educational opportunities to poor people through the slanting of educational resources can help to reduce the proportion of poor people (Ainscow, 2020; Bamberger and Kim, 2022). For example, popularising higher education plays a key role to influence a country's development level and scientific and technological innovation drives the deepening of a country's economy (Bamberger and Kim, 2022). Technological progress is the core of economic growth, scientific and technological innovation brings

technological change and development in all aspects, human capital promotes economic growth, and higher education trains talents and improves the capital attribute of human (Camilla, 2023). For endogenous economic growth theory, the economy does not rely on external forces to achieve sustained growth, and endogenous technological progress determines sustained economic growth. Popularising higher education worldwide brings the accumulation of human capital, improves the quality of workers, and scientific and technological innovation makes technological progress and high-quality economic development, practically. Human capital accumulation is also the process of continuous input of labour force, which covers the accumulation of human capital by labour force factors in formal education, training, and other learning processes. From the perspective of human capital, popularising higher education is the most direct and efficient way to promote the accumulation of human capital and improve the quality of labour force (Balestra and Ruiz, 2015; Brand, 2021). The popularisation degree of higher education is one of the important indicators to measure the development level of a country's economic, and it is also the common trend of the development of higher education in all countries after World War II. In this transitional era, how to continue the achievements of higher education in the popular era and solve the existing problems as soon as possible is the heavy responsibility of our times. Therefore, at the initial stage of popularisation of higher education, it is necessary to re-examine the process of higher education popularisation globally and explore the internal logics between the popularisation of higher education and Sustainable Development Goal of inclusive and equitable quality education (Ainscow, 2020; Bamberger and Kim, 2022).

For policy suggestions, this study suggests that both national and local governments worldwide should pay much attention to the popularisation degree of higher education to greatly improve the innovative ability of talents and scientific and technological innovation in higher education. For example, they could promote scientific and technological innovation in an organised manner to serve national and regional economic and social development. Faced with the current situation in which global higher education has entered a stage of popularisation and new challenges and problems in serving regional economic and social development, national governments should continue to optimise the distribution and structure of higher education resources to support different regions, focusing on the major strategy of enhancing national competitiveness, serving economic and social development, and promoting common prosperity.

Contributions. This study novelty contributes on examining how popularising higher education affects economic growth and poverty alleviation, conceptually, methodologically, and practically. For instance, this study focuses on epitomising the conceptual and analytical model to explore the effects of higher education and adult education within populations (popularisation of higher education) on economic growth (gross domestic product; GDP) and the poverty line. In addition, this study novelty combines both Mankiw-Romer-Weil model Solow model to investigate the effects of higher education and adult education within populations on economic growth and the poverty through OLS regression model and quantile model. For the practical aspect, this study practically uncovers the implicit significance of the popularisation of higher education for advocating UNESCO's aim of developing inclusive and equitable quality education to achieve the fourth Sustainable Development Goal.

Limitations. This study had some limitations. Data could have been collected from a larger sample of OECD countries to explore the effect of population segments with higher education and adult

education (popularisation of higher education) on economic growth (GDP) and the poverty line. In addition, a qualitative component could be included in future studies to uncover the cultural and historical contexts of the effect of popularising higher education on economic growth and poverty reduction at the local level. Future studies should also investigate the causal relationship between the popularisation of higher education and economic growth. Additional empirical data and advanced research methods can be used to enable a shift from correlation to causality.

Conclusion

In conclusion, this study examined the effect of the population segment with higher education and adult education (popularisation of higher education) on economic growth (GDP) and the poverty line using panel data from 38 countries. The population segment with higher education was found to have a significant positive impact on promoting GDP growth. An increase in the proportion of the working-age population segment that had completed higher education was evidently conducive to GDP growth. Popularisation of higher education was also found to play a positive role in the initial stage of economic and social development.

Data availability

The data of OECD country GDP is retrieved from https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=1W, The data of OECD country poverty line is retrieved from https://data.worldbank.org/indicator/SI.POV.DDAY?locations=1W&start=1984&view=chart, The data of OECD country Population with tertiary education 25–34-year-old is retrieved from https://data.oecd.org/eduatt/population-with-tertiary-education.htm#indicator-chart, The data of OECD country Percentage of 25–64-year old's who have completed higher education (%) is retrieved from https://data.oecd.org/eduatt/adult-education-level.htm#indicator-chart,
The datasets generated during and/or analysed during the current study are available in Harvard Dataverse https://doi.org/10.7910/DVN/TP43QS.

References

Adams, R (2013). Education: poverty and inequality blamed as UK sinks in adult literacy league: OECD survey flags up big problems for England: Post-16 education blamed for failure to address issue. *The Guardian*. (2013, October 9). London, England

Agasisti T, Longobardi S, Prete V, Russo F (2021) The relevance of educational poverty in europe: determinants and remedies. J Policy Model 43(3):692–709. https://doi.org/10.1016/j.jpolmod.2020.03.015

Ainscow M (2020) Promoting inclusion and equity in education: lessons from international experiences. Nord J Stud Educ Policy 6(1):7–16

Balestra C, Ruiz N (2015) Scale-invariant measurement of inequality and welfare in ordinal achievements: an application to subjective well-being and education in OECD Countries. Soc Indic Res 123(2):479–500. https://doi.org/10.1007/s11205-014-0751-2

Bamberger, A, & Kim, MJ (2022) The OECD's influence on national higher education policies: internationalisation in Israel and South Korea. Comp Educ 18. https://doi.org/10.1080/03050068.2022.2147635

Brand M (2021) The OECD poverty rate: lessons from the russian case. Glob Soc Policy 21(1):144–147

Camilla S. (2023) The design of upper secondary education across OECD countries: Managing choice, coherence and specialisation. OECD Education Working Papers. https://doi.org/10.1787/158101f0-en

Chakeredza S, Temu A, Saka J, Munthali D, Muir-Leresche K, Akinnifesi F, Ajayi O, Sileshi G (2008) Tailoring Tertiary Agricultural Education for Sustainable Development in Sub-Saharan Africa: Opportunities and Challenges. J Sci Res Essay 3(8):326–332

Chelli F, Ciommi M, Mariani F, Polinesi G, Recchioni MC, Lamonica GR, Salvati L (2022) A story of strengths and weaknesses in tertiary education: evaluating "Mobility" and "Opportunities" in OECD countries with composite indicators. Sustainability 14(24):16463. https://doi.org/10.3390/su142416463

Decancq, K (2017) Measuring multidimensional inequality in the OECD member countries with a distribution-sensitive better life index. Soc Indic Res 131(3):1057–1086. https://doi.org/10.1007/s11205-016-1289-2

Fang W, Farooq U, Liu Z, Lan J, Iram R (2022) Measuring energy efficiency financing: a way forward for reducing energy poverty through financial inclusion in OECD. Environ Sci Pollut Res 29(47):71923. https://doi.org/10.1007/s11356-022-20139-8

Garritzmann, JL (2016) The political economy of higher education finance: the politics of tuition fees and subsidies in OECD Countries, 1945–2015. Garritzmann. Germany, Berlin: Springer International Publishing

Gillian G, Lisa T, & Thomas W (2021) How are higher education systems in OECD countries resourced?: Evidence from an OECD Policy Survey.OCDE. https://doi.org/10.1787/0ac1fbad-en

Gong HJ, Hong JE (2021) Does postsecondary education attainment matter in community service engagement? Evidence from Across 18 OECD Countries. Educ Sci 11(3):1–17. https://doi.org/10.3390/educsci11030096

Granata, M (2022) The OECD and technical education in post-war Mediterranean Europe. Labor History. https://doi.org/10.1080/0023656X.2022.2057459

Habibi, F & Zabardast, MA (2020) Digitalization, education and economic growth: a comparative analysis of Middle East and OECD countries. Technol Soc 63. https://doi.org/10.1016/j.techsoc.2020.101370

Hoeller P, Joumard I, Koske I (2014) Reducing income inequality while boosting economic growth: can it be done? Evidence from OECD Countries. Singap Econ Rev 59(1):1–22

Jericho, G (2016) Australia didn't have a 'great recession'? Tell that to young people; an OECD report has found a rise in youth not in employment, education or training (Neets) since 2008. While historically the rate isn't high, benefits are so low that youth are now more likely to be living in poverty. Guardian. London, England. https://link.gale.com/apps/doc/A463552813/AONE?u=unimelb&sid=bookmark-AONE&xid=701996a9

Julian LG (2018) The political economy of higher education finance. the politics of tuition fees and subsidies in OECD Countries, 1945–2015. Czech Sociol Rev 54(3):479–482

Jungblut J (2017) The political economy of higher education finance. The politics of tuition fees and subsidies in OECD countries, 1945–2015. Eur J High Educ 7(1):96–99. https://doi.org/10.1080/21568235.2017.1265789

Kalamova, M (2020) Resourcing higher education: challenges, choices and consequences. Higher Education Policy Team. Paris: OECD Publishing

Lamichhane, S, Egilmez, G, Gedik, R, Bhutta, MKS, & Erenay, B (2021) Benchmarking OECD countries' sustainable development performance: a goal-specific principal component analysis approach. J Clea Prod 287. https://doi.org/10.1016/j.jclepro.2020.125040

Ledger, S, Thier, M, Bailey, L, & Pitts, C (2019) OECD's approach to measuring global competency: powerful voices shaping education. Teachers College Record, 121(8):1–40

Li, J & Xue. E (2021) Returnee faculty responses to internationalizing "Academic Ecology" for Creating World-class Universities in China' Elite Universities. Higher Education. 81(5), 1063–1078

Li, J, & Xue. E, Liu, C, Li, X (2023) Integrated macro and micro analyses of student burden reduction policies in China: call for a collaborative "family–school–society" model. Humanities & Social Sciences Communications. 10, 184 (2023). https://doi.org/10.1057/s41599-023-01695-x

Liu, L (2017) Exploring the relationship between education economy and individual civic attitudes: a cross-national analysis in England, Spain, Sweden, Poland and Chinese Taipei

Lucas R (1988) On the mechanics of economic development. J. Monetary Econ 22(1):342

Mathias B (2023). The assessment of students' creative and critical thinking skills in higher education across OECD countries: a review of policies and related practices. OECD Education Working Papers. https://doi.org/10.1787/35dbd439-en

Megyesiova, S, & Lieskovska, V (2018) Analysis of the sustainable development indicators in the OECD Countries. Sustainability 10(12). https://doi.org/10.3390/su10124554

Mitic RR (2018) The political economy of higher education finance: the politics of tuition fees and subsidies in OECD Countries, 1945-2015. Rev High Educ 41(3):484–487

OECD (2022) Education at a Glance 2022: OECD Indicators, OECD Publishing, Paris, https://doi.org/10.1787/3197152b-en

Özdoğan Özbal E (2021) Dynamic effects of higher education expenditures on human capital and economic growth: an evaluation of OECD countries. Policy Rev High Educ 5(2):174–196. https://doi.org/10.1080/23322969.2021.1893125

Pinheiro R, Pillay P (2016) Higher education and economic development in the OECD: policy lessons for other countries and regions. J High Educ Policy Manag 38(2):150

Romer M (1990) Endogenous technological change. J Political Econ 98(5):S71–S102

Rowe E (2019) Capitalism without capital: the intangible economy of education reform. Discourse 40(2):271

Sahnoun M, Abdennadher C (2022) Returns to investment in education in the OECD Countries: does governance quality matter? J Knowldege Econ 13(3):1819–1842. https://doi.org/10.1007/s13132-021-00783-0

Samo V. (2022). A snapshot of equity and inclusion in OECD education systems: findings from the Strength through Diversity Policy Survey. OECD Education Working Papers. https://doi.org/10.1787/801dd29b-en

Schultz (1961) Investment in human capital. Am Econ Rev 51(1):1–17

Solow RM (1957) Technical change and the aggregate production function. Rev Econ Stat 39(3):312–320

Zapp M (2022) Revisiting the global knowledge economy: the worldwide expansion of research and development personnel, 1980–2015. Minerva 60(2):181–208. https://doi.org/10.1007/s11024-021-09455-4

Author contributions

Substantial contributions to the conception or design of the work: Jian Li and Eryong Xue; the acquisition, analysis, or interpretation of data for the work: Jian Li and Eryong Xue; drafting the work or revising it critically for important intellectual content: Eryong Xue, Jian Li, Yukai Wei, and Yunshu He; final approval of the version to be published: Eryong Xue and Jian Li.

Competing interests

The authors declare no competing interests.

Ethical approval

Ethical approval was not required as the study did not involve human participants. It was not required as this article used published data.

Informed consent

This article does not contain any studies with human participants performed by any of the authors.

Additional information

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