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EXAMINING THE ROLE OF EDUCATION SPENDING ON CHINA'S REGIONAL ECONOMY FROM THE STANDPOINTS OF HUMAN AND INTELLECTUAL CAPITAL

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Abstract: *This paper investigates the impact of local investments in education on the economic growth of different regions in China. It examines both the direct and indirect effects of financial investments in education. It analyzes the role of human capital and intellectual capital as mediators in the relationship between education and economic growth. The study utilizes a panel data model and a model of mediating effects to conduct an empirical analysis using data from China between 2000 and 2018. The findings indicate that local financial investment in education significantly impacts economic growth, although the magnitude of this effect varies across regions. Investing in education directly stimulates economic growth and indirectly promotes it by accumulating human and intellectual capital. Therefore, increasing investment in education and nurturing innovative, high-level talent are crucial steps towards achieving high-quality economic development in China. The literature review reveals that investment in education has been extensively studied concerning economic growth, with scholars emphasizing the role of human capital in the production process and the positive effects of education on worker productivity and income equality. However, educational investment's impact on economic growth has shown variations in different countries and regions. Some studies suggest that excessive development of higher education may hinder local economic development, while others highlight the positive impact of educational inputs on human capital quality and technological innovation. To examine the causal mechanism explicitly, this paper proposes a causal inference model based on mediating effects, considering both human capital and intellectual capital as mediating variables. The research methodology includes a baseline regression model and a model of mediating products, employing panel data techniques and instrumental variable estimation to address endogeneity issues. The results of the baseline regression analysis support the positive relationship between local financial investment in education and economic growth, controlling for other factors such as capital stock, labour force, urbanization rate, trade dependence, and population growth. Furthermore, the mediating effects model suggests that education investment indirectly influences economic growth by enhancing human capital and promoting technological innovation. These findings contribute to a better understanding of how education affects regional economies in China. In conclusion, this study highlights the significance of education in driving high-quality economic development in China. It emphasizes the importance of increasing investment in education and fostering the development of innovative and highly skilled individuals. The findings provide valuable insights for policymakers and stakeholders seeking to promote sustainable and inclusive economic growth through education reform and targeted investments in human capital.*
Keywords: causal inference, education investment, high-quality economic development, innovation, mediating effects, regional development.
JEL Classification: H52, I22, I28.

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Introduction. China has been reforming and opening up for more than 45 years. During this time, the socialist market economy system has been set up and is improving. China's economy has transitioned from high growth to a new normal characterised by high-quality development. In the past, however, economic growth was overly reliant on low-cost production factors and quantitative expansion, ignoring the character of economic development and investment in human capital. As supply-side structural reform advances, China's industrial structure needs transformation, and economic development necessitates introducing new dynamic energy. Therefore, at the start of the 14th Five-Year Plan, it is essential to transform the mode of economic growth further. Education is a one-hundred-year plan for a nation's development, and the future of every individual in the next generation is at stake. Talent is key to attaining high-quality economic growth, so it deserves special consideration. The government should increase its investment in education finance, finance education through various channels, and work to resolve the current issues of insufficient total investment in education resources and unreasonable regional allocation to achieve high-quality and sustainable development of the local economy.

This paper's research question is how local investments in education affect the economic growth of different parts of China and how this growth happens. The study tells the difference between the direct and indirect effects of local financial investments in education. Think of local investment in financial education as a factor of production and look at its immediate effect on economic growth in different areas. Look at how human and intellectual capital, which act as mediators, indirectly affect economic growth. This paper's primary objective is to investigate how education affects regional economies in China. This paper uses a panel data model and a model of mediating effects to conduct an empirical analysis of China's data between 2000 and 2018. This helps achieve the objective. The findings show that local financial investment in education has a significant positive impact on economic growth. The magnitude of this effect differs by region. Investing in education positively impacts the accumulation of human and intellectual capital, which indirectly promotes economic growth. This paper argues that increasing investment in education and cultivating innovative, high-level talent are two of the most essential steps to achieving high-quality economic development in China.

Literature Review. In recent decades, investment in education has been increasingly recognized as a key factor in promoting technological progress and economic development. According to the theory of human capital, education can enhance individual workers' human capital, increasing labour productivity and promoting economic growth. The new view of economic growth demonstrates that the economy can accomplish sustained growth without relying on external forces and that endogenous technological progress based on human capital is a key factor in ensuring sustained economic growth. Linking human capital with technological progress and economic growth, Romer and Lucas, along with others, argue that human capital affects the capacity to innovate knowledge and the capacity to imitate, absorb, and apply new technologies, which in turn can influence technological progress in production and thus promote economic growth, elaborating on the role of human capital in economic growth. Nelson and Phelps argue that education and adopting new technologies are tightly intertwined and that a well-educated workforce can implement new technologies more quickly (Lucas et al., 1995; Nelson et al., 1966; Rosen, 1990). Other studies indicate that innovation is a more significant economic development driver. The study by Grossman and Helpman demonstrates that the skill composition of the workforce is correlated with the level of innovation in the economy, and they conclude that an increase in skilled workers promotes growth. In contrast, an increase in unskilled workers inhibits development. Innovation and imitation are two sources of productivity growth (Grossman and Helpman, 1991), according to Acemoglu et al., 2006. In a similar vein, Vandenbusche, Agueio, and Meghir contend that technological progress has a dual source and that economic growth results from learning and imitating extant technologies and innovation, particularly in technologically advanced economies. Like other types of investment, investment in human capital through the development of education also has an opportunity cost, i.e., more workers receiving higher levels of education leave fewer workers involved in productive activities in the short run, and from this perspective, an increase in the scale of education may have a retarding effect on short-term economic growth (Acemoglu et al., 2006; Vandenbussche et al., 2006). In the long run, the quantity of human capital that the level of education represents will support economic development, whereas, in the short run, it might not have much of an impact.

Investment in education has been extensively examined in relation to economic growth. Early articles (Solow et al.,1956) did not assign human capital a special function because they believed that the supply of productive labour and technological progress were exogenously determined. Schultz and others proposed the theory of human capital in the 1960s (Schultz et al., 1961), which argued that human factors (especially human quality) play a crucial role in the production process and that human capital consists of the expenditures on

human education and training as well as the opportunity costs arising from these expenditures. However, the disparity in regional population growth rates has not been deemed a consequence of technological and economic progress. According to human capital, development significantly contributes to economic growth (Aghion et al.,1998). Particularly, educational inputs can increase worker productivity and decrease income disparity, thereby fostering economic expansion. Human quality has a significant impact on the production process, and investing in human and intellectual capital can promote the growth of knowledge assets, increase innovation, and boost total factor productivity, thereby accelerating economic growth.

Besides the quantity of human capital, the quality of human capital can also contribute to economic growth. Undoubtedly, workers with higher human capital will contribute more to economic growth, and education quality directly affects human capital. Among the numerous factors that influence the quality of education, teacher resources are frequently among the most significant. Teacher factors considerably impact educational efficacy and student development (Zhang et al., 2012). In addition, the impact of the mechanism through which teacher resources are invested to enhance the quality of human capital is similarly long-lasting. In addition to being an investment in human capital, the consumption characteristics of education can also contribute directly to economic growth (Min et. al, 2021). Keynesian fiscal spending theory proposes that governments should increase budgetary spending by implementing expansionary fiscal policies, thereby increasing aggregate social demand, stimulating consumption, and accelerating economic growth. And education finance is an essential component of public finance, with China's education expenditures ranking first in the field of public finance. According to Keynesian economic theory, government spending on education can boost economic development by increasing demand and consumption.

Some international studies have concluded that government expenditure on private consumption has crowding-out and complementing effects (Chen et al., 2013). Due to the various stages of economic development in China, however, some studies have found a positive correlation between government expenditure and resident consumption (Liu and Ma, 2001). The effect of the state's active fiscal policy on the consumption of urban residents is more pronounced (Li, 2005). Government expenditures on agricultural support significantly impact rural residents' consumption (Chu and Yan, 2009). From a structural point of view, government consumption expenditure items crowd out residents' consumption, while government investment expenditure crowd in residents' consumption (Hong and Xiao, 2009). According to Keynesian fiscal expenditure theory, education expenditures can increase social demand. On the one hand, the education expenditure used to organize schools, which itself constitutes a part of social consumption, directly increases domestic consumption demand; on the other hand, according to Keynesian absolute income theory, the salary paid to teachers will be used as teachers' income, which affects teachers' consumption and thus forms residents' personal consumption. Moreover, our government's expenditures on education may demonstrate a positive correlation with resident consumption, indicating a crowding-in effect.

Studies show that investing in education promotes economic development in developed nations but not developing ones. Most of the money for higher education comes from central transfer payments, and the Western region doesn't put much money into education because it doesn't have much money to invest and because the way investments are set up isn't fair. Studies have also revealed that the overdevelopment of higher education hinders local economic development and that the productivity of college students in China has not yet reached its maximum potential. While some nations have discovered no significant effects, others have found significant ones. According to studies, educational investment positively impacts the economies of countries underperforming in academic development, especially in countries with high levels of educational development.

Nevertheless, the effect of fiscal and educational investment on GDP growth is frequently region-specific. On the transmission path of education investment to economic growth, a growing body of research concludes that financial education investment improves the character of the labour force or promotes technological innovation, increasing national income levels. Studies have also found that higher growth rates of fiscal education expenditures and labour force education levels contribute substantially to economic expansion. Additionally, increased total financial investment in higher education and per capita financial investment is associated with an increase in the region's human capital. According to the works (Yao et al., 2017; Cai, 2020), it has been determined that an increase in education level in each province of China promotes science and technology innovation.

The amount and stock of human capital greatly affect the economy's growth. Early foreign researchers (Baron et al.,1986; Krueger and Lindahl, 2001) discovered that human capital accumulation had negligible effects on economic growth but contributed considerably. Some ideas argue that both the process and current

stock of intellectual capital significantly contribute to the growth of the national income level, that intellectual capital drives economic growth by promoting the increase of TFP, and that economic growth is crucial for innovative development (Hong, 2013). Using the DEA method, (Yan and Wang, 2004) measured the technological progress index and TFP and argued that technological progress promotes the change of economic growth mode, which in turn supports economic growth. Studies have shown that educational investment can promote economic growth, but the impact varies in different regions. Some scholars believe that excessive development of higher education will hinder local economic development. In contrast, others believe that educational inputs can improve the quality of human capital and promote technological innovation. Foreign scholars have different views on the effects of academic inputs, with some arguing that some countries do not affect economic growth and others claiming that they can contribute significantly to economic growth in developed countries.

Few empirical studies on the relationship between education and economic growth have examined the causal mechanism explicitly. Typically, correlation analysis is conducted using a single factor, and no unified framework exists. This paper will attempt to construct a causal inference model based on mediating effects from the dual perspective of human capital and intellectual capital to identify the transmission mechanism of educational input on economic growth and make a small contribution to the existing body of knowledge. Based on the past studies that economists have published, they can draw generalizations. Human capital is an important factor of production that is widely involved in production activities in all sectors of society and contributes to economic growth. Second, human capital accumulation promotes technological innovation and imitation, resulting in technological progress (represented by an increase in intellectual capital), which is the growth engine of a nation. On the other hand, human capital accumulation encourages technological innovation and imitation, resulting in technological progress (in the form of increased intellectual capital), which is the propelling force behind a nation's long-term economic development. Second, education investment is also consumption-oriented and can stimulate demand-side economic growth in the immediate term; therefore, it can formulate two hypotheses:

H1: Educational inputs will directly stimulate economic growth.

H2: Educational investment will promote the level of human and intellectual capital, which will indirectly affect economic growth.

Methodology and research methods. Design model of baseline regression: It is presumed that China's economic expansion follows a C-D production function. The local financial education input is regarded as a production factor added to the model by the C-D production function concept. The following production function containing financial education inputs is postulated in this paper:

$$Y = AK\alpha L\beta Xc \quad (1)$$

where Y is the total economic output of the region, X is the capital stock, and L is the number of labourers, and use the resident population of each province as a proxy; X denotes the local financial education input of each region; A denotes the technology level, which is typically considered constant; α and β and c represent the elasticities of physical capital input, labour force input, and financial education input, respectively.

Logarithmically linearize both sides of the equation to determine how much each factor contributes to economic growth. It helps reduce the sample's heteroskedasticity, lower the change in the variables, and make it easier to understand the estimated coefficients as elasticities. Then, look at each individual fixed effect and add a set of control variables. This gives us the following regression equation:

$$lnYit = lnA + \alpha linKit + \beta lnLit + clnXit + \gamma \times conrtolit + \mu i + \varepsilon it \quad (2)$$

Design model of intermediate effect: When considering the mediating impact from the perspectives of intellectual capital and human capital, technological level A is no longer a constant but becomes the mediating variable, intellectual capital Ait, which is measured by the number of patents for inventions in each province Patent; the other mediating variable is human capital H, which is measured by the number of years of education per capita Hit. Following this, model the mediating effects of the dual mediating variables.

$$Ait = aXit + b \times conrtolit + jAi, t-1 + \mu i + e1 \quad (3)$$
$$Hit = fXit + h \times conrtolit + kHi, t-1 + \mu i + e2 \quad (4)$$

$$lnYit = \varphi + c`lnXit + \alpha linKit + \beta lnLit + d1Ait + d2Hit + g \times conrtolit + \mu i + e3 \quad (5)$$

(2) and (5) have an endogeneity problem that needs to be fixed through IV estimations. In (3) and (4), use dynamic panels to regress A and H as mediating variables (3) and (4). It is because Romer (1990) argues in his endogenous growth theory that the production of the research sector, i.e., technological innovation, depends on the level of technology in the previous period; similarly, since human capital may have a similar agglomeration effect, a region with abundant human capital may attract more human capital. This is consistent with the way human capital grows in Lucas' endogenous growth model, and it will enhance the model's explanatory power. Introducing one-period lags for A and H leads to the endogeneity problem when the regression coefficients obtained even with the within-group estimator (FE) are biased. Arellano et al. (1991) proposed successive differential GMM and horizontal GMM methods address this issue. Blundell et al. (1998) proposed a GMM system with higher efficiency by combining the two approaches. Using the system GMM method, estimate (3) and (4).

Selection of variables for the benchmark regression model:

– The dependent variable Y represents the total economic output, measured by GDP (in billions of yuan).

– The main explanatory variable X represents the education input, measured by local fiscal education expenditure (in billions of yuan).

– The other explanatory variables include capital stock K (in billions of yuan) and labour force L (in ten thousand people).

– The control variables include urbanization rate (urban), degree of economic dependence on foreign trade (trade), and natural population growth rate (pop). These variables are selected to account for the factors that affect economic production.

– Selection of variables for the mediation effect model

– The dependent variable Y and the explanatory variable X are the same as in the benchmark model: GDP and local fiscal education expenditure Xp.

– The mediating variable human capital is measured by the average years of education H (in years).

– The mediating variable, knowledge capital, is measured by the number of domestic invention patents granted (in pieces).

– The instrumental variable used in the IV estimation is the dummy variable (sunwage), which is 0 for 2000–2007 when sunwage is not implemented and 1 for 2008 onwards when sunwage is implemented.

The provincial macroeconomic data used in this article includes China's GDP, GDP growth index, per capita GDP, local fiscal education expenditure (2008–2018), total fixed asset investment, central fiscal education expenditure, resident population, domestic invention patent application authorization volume, total import and export of domestic destinations and sources of goods, natural population growth rate, etc. from 2000 to 2018. These data come from the National Bureau of Statistics website.

Results. Use formula (2) to perform mixed regression, fixed-effects regression, and random-effects regression on the panel model, respectively. The results are in Table 1.

Table 1. Mixed regression, fixed effects regression and random effects regression

VARIABLES	1 POLS	2 FE	3 RE
	InY	InY	InY
lnXp	0.3430***	0.4749***	0.4749***
	(-0.0114)	(-0.0114)	(-0.0114)
lnK	0.5130***	0.3089***	0.3089***
	(-0.0189)	(-0.0178)	(-0.0178)
lnL	0.3090***	0.3916***	0.3916***
	(-0.0137)	(-0.0202)	(-0.0202)
urban	0.6876***	0.6203***	0.6203***
	(-0.0614)	(-0.0569)	(-0.0569)
trade	0.1844***	0.1758	0.1758***
	(-0.0216)	(-0.0337)	(-0.0337)
Pop	-0.0101***	-0.0100***	-0.0100***
	(-0.0022)	(-0.0028)	(-0.0028)
Consiant	-0.4199***	0.0893	0.0893
	(-0.0842)	(-0.1543)	(-0.1543)

Continued Table 1

	1	2	3
	POLS	**FE**	**RE**
Observations	589	589	589
Individual fixed effects	No	Yes	Yes
Time fixed effects	No	Yes	Yes
R2	0.9907	0.9909	0.9905
F test	10320.36***	10009.36***	/
Wald test	/	/	57778.93***
Hausman test	/	36.61***	/

*****p<0.01, ∑**p<0.05, ∑*p<0.1*

Sources: developed by the authors.

The mixed regression in Table 1 shows that controlling for other variables, the coefficient of the main explanatory variable lnXp is 0.3430 and is significant at the 1% significance level, initially showing that fiscal education investment significantly promotes regional economic growth. However, mixed regression is not suitable for panel data, so perform fixed-effects or random-effects panel regression analysis. The Hausman test statistic value is 36.61 and is significant at the 1% level, indicating that fixed-effects regression should be used. According to the results of fixed-effects regression, controlling for other variables, the coefficients of the explanatory variables lnXp, lnK, and lnL are 0.4749, 0.3089, and 0.3916, respectively, and are all significant at the 1% level of significance. That is to say, when education investment, capital investment, and labour input increase by 1%, economic output increases by 0.4749%, 0.3089%, and 0.3916%, respectively. This shows that local fiscal education investment, capital investment, and labour input all significantly promote economic growth, with the former having the greatest effect. In addition, the urbanization rate and economic dependence on foreign countries also have a significant positive impact on economic growth, while the natural growth rate of the population has no significant effect on economic growth. The goodness-of-fit R2 value is 0.9909, indicating that the model fits well. To further investigate how local fiscal education investment influences regional economic development, use the mediation effect model to examine the mechanism of the impact of local fiscal education investment on economic growth from the perspective of human capital and knowledge capital. Run regressions on the mediating effects model and analyse the results. In the first step, the total impact of factors such as Xp, the local financial input to education, on economic output Y is examined without considering the mediating variables. Regressing equation (2) using the 2SLS approach, where the instrumental variable IV is Sunwage, the 2SLS regression results show in Table 2.

Table 2. 2SLS regression of the total effect of educational inputs

VARIABLES	Phase 1	Phase 2
	InXp	**InY**
InXp		0.4852***
		(0.0211)
LnK	0.8978***	0.2975***
	(0.0306)	(0.0275)
InL	1.4189 ***	0.3988***
	(0.1872)	(0.0821)
urban	1.2012	0.5744***
	(0.1793)	(0.0680)
trade		0.0900**
		(0.0399)
POP		-0.0045
		(0.0031)
sunwage	0.4966***	
	(0.0316)	
Observations	589	558
Number of id	31	31
R^2	/	0.9907
Instrumental variable F-test	242.2***	/
Weak instrumental variable test		240.2

*****p<0.01, ∑**p<0.05, ∑*p<0.1*

Sources: developed by the authors.

The regression of the endogenous variable on IV in the first stage of 2SLS shows that the regression coefficient of the endogenous variable (*Xp*) on the instrumental variable (*sunwage*), controlling for other variables, is 0.4966 with a positive coefficient and is significant at the 1 % level of significance. This indicates that the instrumental variable is highly correlated with the endogenous variables. The F-test statistic for the exogenous instrumental variable is 242.2, which is significant at the 1% level, also indicating that the exogenous instrumental variable meets the correlation requirement. The regression results from the second stage of the 2SLS show that the coefficient of the main explanatory variable (*InXp*), controlling for other variables, is 0.4852 and is significant at the 1% level. This indicates that, at the national level, increased local financial expenditure on education significantly contributes to regional GDP growth. The other control variables such as capital stock (*K*), labour force *(L*), urbanisation rate (*urban*) and natural population growth rate (*pop*) also have a significant positive relationship with regional GDP F with an R^2 of 0.9907, indicating that the model fits well and has sufficient explanatory power. Table 2 shows that the value of F is 240.2, which means a significant rejection of the sunwage policy (*sunwage)* is a weak instrumental variable, and therefore *sunwage* meets the correlation requirement. We can therefore consider *sunwage* as an ideal instrumental variable. Therefore, the coefficient c of the endogenous variable estimated using this instrumental variable is unbiased, i.e. can more accurately estimate the magnitude of the impact of local financial expenditure on education on economic output. Perform a systematic GMM regression of (2) and (3). The regression results are shown in Table 3.

Table 3. Regression of overall mediating variables on explanatory variables

VARIABLES	(2)	(3)
	patent	H
L.H	/	0.5244***
		(0.0918)
Xp	1.0528**	0.0011***
	(0.4152)	(0.0003)
L.patent	1.0816***	/
	(0.0281)	
Controls	YES	YES
Observations	556	558
Number of id	31	31
GMM	YES	YES

****p<0.01, ∑**p<0.05, ∑*p<0.1*

Sources: developed by the authors.

Table 2 shows that the regression coefficients of the main explanatory variable education on the mediating variables knowledge capital (*P*) and human capital (*H*) are 1.053 and 0.0011, respectively, positive and significant at the 1% significance level. Therefore, it can be concluded that local fiscal education investment in various regions has significantly increased local knowledge capital and human capital. Considering the unit issue, since the unit of the explanatory variable local fiscal education investment is 100 million yuan, the unit of knowledge capital, i.e., the number of invention patents, pieces, and the unit of human capital, i.e., years of education, is years, so the larger coefficient of the former explanatory variable *Xp* and the smaller coefficient of the latter *Xp* can also be reasonably explained. And from the table, it can be seen that the mediating variables *P* and *H* are very significant in their regression on their lag one period, respectively, which also verifies the previous hypothesis that the creation of knowledge capital depends on existing technology level and human capital also has an agglomeration effect. Considering both direct and indirect effects, a 2SLS regression of equation (), with IV still sunwage, was performed, and the regression results are shown in Table 4. In the first stage of the 2SLS, the regression of the endogenous variable ` on the independent variable *IV* reveals a significant coefficient of 0.46 for sunwage at the 1% significance level. The exogenous instrumental variable's F-statistic value of 250.25 indicates that this instrumental variable and the endogenous variables are significantly correlated, satisfying the correlation requirement for instrumental variables. From the 2SLS second-stage regression, observe that the coefficient of *InXp*, c', is 0.4715, a positive coefficient statistically significant at the 1% level, indicating that local financial investment in education has a significant direct effect on regional economic growth. Also, after controlling for other variables, observe that the coefficients of the intellectual capital variable are statistically significant at the 1% level.

Table 4. Equation (4) 2SLS regression considering direct and indirect effects

VARIABLES	Phase 1 InXp	Phase 2 InY
InXp	/	0.4715***
		(0.0226)
Inpatient	0.0753***	0.0186*
	(0.0197)	(0.0095)
H	03082***	0.0581***
	(0.0327)	(0.0135)
InK	0.6160***	0.2524***
	(0.0375)	(0.0252)
InL	0.6656***	0.2551***
	(0.1511)	(0.0688)
urban	0.7829***	0.4726***
	(0.1626)	(0.0670)
trade	0.4628***	0.0735***
	(0.0949)	(0.0350)
pop	-0.0296***	-0.0036
	(0.0073)	(0.0031)
sunwage	0.465***	
	(0.0294)	
Observations	588	588
Number of id	31	31
R^2	/	0.9913
Instrumental variable F-test	250.25***	
Weak instrumental variable test		273.7

*****p<0.01, ∑**p<0.05, ∑*p<0.1*

Sources: developed by the authors.

The intellectual and human capital *H* coefficients are 0.0186 and 0.0581, respectively, which are significant at the 10% and 1% significance levels, indicating that intellectual and human capital also substantially contribute to regional economic growth (although intellectual capital contributes less). The insufficient instrument variable test Kleibergen-park wald The F value of 273.7 *rejects* sunwage *as* a weak instrumental variable, so *sunwage* is considered to satisfy the correlation requirement. Finally, compare the regression results for equations (1) and (4), as shown in Table 5.

Table 5. (1) (4) Comparison of regression results

VARIABLES	(1)InY	(4)InY
InXp	0.4852***	0.4715***
	(0.0211)	(0.0226)
InK	0.2975***	0.2524***
	(0.0275)	(0.0252)
InL	0.3988***	0.2551***
	(0.0821)	(0.0688)
urban	0.5744***	0.4726***
	(0.0680)	(0.0670)
trade	0.0900**	0.0735**
	(0.0399)	(0.0350)
pop	-0.0045	-0.0036
	(0.0031)	(0.0031))
Inpatient		0.0186*
		(0.0095)
H		0.0581***
		(0.0135
Observations	558	557
Number of id	31	31
R^2	0.9907	0.9913
Weak instrumental variable test	240.2	273.7

*****p<0.01, ∑**p<0.05, ∑*p<0.1*

Sources: developed by the authors.

In (2) and (5), the coefficients of the primary explanatory variables In*Xp* are positive at 0.4852 and 0.4715, respectively, and both are statistically significant at the 1% level of significance (Table 5). Thus, the total effect coefficient c of *InXp* is 0.4852, while the direct effect coefficient c' is 0.4715, indicating that local financial expenditures on education have a substantial direct impact on economic growth. And the coefficients of the mediating variables (*Inpatien*t) in equation (4) are 0.0186 and 0.0581, which are both significant at the 10% and 1% significance levels, i.e., both d_1 and d_2 are significantly positive. In the second step of regression of mediating variables on explanatory variables, the coefficients of regression of financial investment in education (*Xp*) on mediating variables intellectual capital (*patent*) and human capital *H* are 1.0530 and 0.0011, respectively, and both are significant at the 1% significance level, i.e., both a and b are highly significant and positive. Consequently, c-c' is greater than 0, and $ad_1 + bd_2$ is also notably greater than 0. Therefore, unloading local government's financial investment in education effectively promotes the growth of regional intellectual and human capital (a and b are significantly greater than 0). The increase in human capital and intellectual capital promotes regional economic growth (d_1 and d_2), so the indirect contribution of local financial investment in education to economic growth is also significant. Since local financial expenditure on education substantially directly affects regional economic development and indirectly through mediating variables, regional financial expenditure on education promotes economic growth through partial mediating effects.

Conclusions. The study demonstrates that financial investment in education considerably contributes to China's regional economic growth. Moreover, the study indicates that financial investment in education not only contributes directly to economic development but also indirectly by fostering the accumulation of human and intellectual capital throughout the nation. Using a model of mediating effects, this paper analyzes the transmission path of financial investment in education to economic growth and observes significant disparities in the transmission of effects across regions.

Science and technology are the first productive forces, but humans are primarily responsible for creating and utilizing science and technology. Therefore, the government should continue to adhere to the national strategy of bolstering the nation with talent, increasing its financial investment in education without letting up, and effectively using financial leverage to finance education via multiple channels. Ensure that everyone has access to the education they deserve, enhance the human capital of the entire society, achieve economic growth, and advance social justice.

First, increasing education expenditures benefits economic growth. Should make effective use of education investments and concentrate on resolving the prevailing issue of education's limited supply. To address the issue of students dropping out of school due to poverty, the government should, on the one hand, collaborate with schools to set up scholarships and grants for poor students and subsidize them by offering part-time jobs to assist students, reducing school fees and living subsidies, etc. Second, it should strengthen cooperation with commercial banks and other financial institutions to promote interest-free and low-interest student loans appropriate for students receiving financial aid. The government can leverage financial leverage to provide credit guarantees for poor students by establishing guarantee funds, establishing a personal credit system for needy students, and enhancing the credit collection system to reduce the difficulty of approval and the incidence of bad loans so that more poor students can benefit. Third, in order to address the issues of inadequate educational infrastructure and talent deficiency, it is necessary to make effective use of financial support and social influence while depending on financial resources. Establish education investment funds, loosen restrictions on financing, and encourage social capital to invest in education and participate in funding and donation activities. Fourth, to make up for the current lack of educational resources, there should be increased investment in and treatment of teachers through initiatives like government-society joint ventures to run schools. We can only foster scientific and technological innovation and economic growth by increasing investments in education, bolstering talent development, and enhancing population quality.

This paper's novel contribution is using the instrumental variables (IV) estimation approach for the mediated effects model, which is currently underutilized in economics due to the endogeneity of the model. This research makes a substantial effort to identify a causal relationship linking educational expenditures and economic expansion. It is hoped that future researchers on this topic will seek further, more diverse, and precise causal inference methods to verify or refute the theories presented here. The results of this paper suggest that increasing educational expenditures can have positive spillover effects on economic expansion through various channels, such as human capital accumulation, innovation, and institutional quality. However, these findings are subject to some caveats, such as the validity of the IVs used, the potential heterogeneity of the effects across countries and periods, and the possibility of omitted variable bias. Future research on this topic could explore alternative causal inference methods, such as randomized controlled trials, natural

experiments, or structural models, to test the robustness and generalizability of the IV approach. Moreover, future research could examine more closely the mechanisms through which educational expenditures affect economic expansion, such as by disaggregating the effects by level and quality of education, the sectoral composition of output, and institutional context.

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References

Acemoglu, D., Aghion, P., & Zilibotti, F. (2006). Distance to frontier, selection, and economic growth. *Journal of the European Economic Association*, *4*(1), 37–74. [Google Scholar] [CrossRef]

Aghion, P., & Howitt, P. (1998). Market structure and the growth process. *Review of Economic Dynamics*, 1(1), 276–305. [Google Scholar] [CrossRef]

Arellano, M., & Bond, S. (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *The Review of Economic Studies*, *2*, 277. [Google Scholar] [CrossRef]

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, *1*, 115–143. [Google Scholar] [CrossRef]

Cai, F. (2020). Research on the relationship between science and technology innovation activities and economic development in colleges and universities--Statistical analysis based on R&D activities in colleges and universities. *Journal of Higher Education* (07), 40-42.

Chen, P. L., Lu, S. N., & Hou, J. H. (2013). Analysis of the crowding-out effect of government education spending. *Education and Economics*, (4), 16-20. [Google Scholar]

Chu, D. Y., & Yan, W. (2009). Local government expenditure and rural residents' consumption demand: An empirical analysis based on provincial panel data from 1998-2007. *Statistical Research*, 26(8), 38-44.

Grossman, G., & Helpman, E. (1991). In *Innovation and growth in the global economy* (pp. 56–58). essay, The MIT Press. [Google Scholar]

Hong, Y. X., (2013). On innovation-driven economic development strategies. *The Economist* (01), 5-11. [Google Scholar]

Hong, Y., & Xiao, H. (2009). The impact of government consumer spending on residents' consumption: A perspective on Chinese residents' consumption behavior. *Research in Finance and Trade*, (4), 69-76. Retrieved from [Link]

Krueger, A. B., & Lindahl, M. (2001). Education for growth: Why and for whom? *Journal of Economic Literature*, 39(4), 1101–1136. [Google Scholar] [CrossRef]

Li, G. Z., (2005). Government spending and consumption: Substitution or complementarity. *World Economy*, 28(5), 38-45. [Link]

Liu, S. C., & Ma, S. Y. (2001). An empirical analysis of the relationship between deficits, national debt and economic growth: A review of the crowding-out effect of active fiscal policy. *Economic Research*, (2), 13-19. [Link]

Lucas, R. E. (1988). On the mechanics of Economic Development. *Journal of Monetary Economics*, 22(1), 3–42. [Google Scholar] [CrossRef]

Min, W. F., Yu, J., & Wu, J. Q. (2021). The role of education in expanding domestic demand to drive economic growth. *Educational Research*, (5),12—22.

Nelson, R. R., & Phelps, E. S. (1966). Investment in Humans, Technological Diffusion, and Economic Growth. *The American Economic Review*, 56(1/2), 69–75. [Google Scholar]

Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of Political Economy*, *94*(5), 1002–1037. [Google Scholar] [CrossRef]

Romer, P. M. (1990). Endogenous Technological Change. *Journal of Political Economy*, *5(2)*, 71–102. [Google Scholar] [CrossRef]

Schultz, T. W. (1961). Investment in Human Capital. *The American Economic Review*, 51(1), 1–17. [Google Scholar]

Solow, R. M. (1956). A contribution to the theory of economic growth. T*he quarterly journal of economics*, 70(1), 65-94. [Google Scholar] [CrossRef]

Vandenbussche, J., Aghion, P., & Meghir, C. (2006). Growth, distance to frontier and composition of Human Capital. *Journal of Economic Growth*, *11*(2), 97–127. [Google Scholar] [CrossRef]

Yao, D. M., Ning, J., & Wei, Shi,Y. (2017). How Aging Affects Science and Technology Innovation. *World Economy*, (4), 105-128. Retrieved from [Link]

Yan, P., & Wang, B. (2004). Technical efficiency, technical progress and productivity growth:An empirical analysis based on DEA. *Economic Research*, (12),55-65. [Google Scholar]

Zhang, Y. M., Hao, Y., & Li, M. J. (2012). An empirical study of the effects of teacher factors and student factors on students' academic performance: A multilevel linear model analysis based on large-scale test data. Teacher Education Research, 24(4), 56-62. Retrieved from [Link]

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Роль витрат на освіту в регіональній економіці Китаю з точки зору людського та інтелектуального капіталу

Ця робота досліджує вплив місцевих інвестицій в освіту на економічне зростання різних регіонів Китаю. У статті досліджено як прямі, так і непрямі наслідки фінансових інвестицій в освіту. Обгрунтовано роль людського та інтелектуального капіталу як посередників у зв'язку між освітою та економічним зростанням. Огляд літератури показує, що інвестиції в освіту широко вивчалися в контексті економічного зростання, при цьому вчені підкреслювали роль людського капіталу у виробничому процесі та позитивний вплив освіти на продуктивність праці та рівність доходів. Однак, вплив інвестицій в освіту на економічне зростання в різних країнах і регіонах є різним. Деякі дослідження припускають, що надмірний розвиток вищої освіти може перешкоджати місцевому економічному розвитку, тоді як інші підкреслюють позитивний вплив інвестицій в освіту на якість людського капіталу та технологічні інновації. У дослідженні використано модель панельних даних та модель посередницьких ефектів для проведення емпіричного аналізу з на прикладі Китаю за період з 2000 по 2018 рр. Результати дослідження свідчать про те, що місцеві фінансові інвестиції в освіту суттєво впливають на економічне зростання, хоча величина цього ефекту варіюється залежно від регіону. Інвестиції в освіту безпосередньо стимулюють економічне зростання та опосередковано сприяють йому через накопичення людського та інтелектуального капіталу. Таким чином, збільшення інвестицій в освіту та розвиток інновацій є важливими кроками на шляху до досягнення якісного економічного розвитку Китаю. Ці висновки сприяють кращому розумінню того, як освіта впливає на регіональну економіку Китаю. Авторами емпірично обгрунтовано важливість освіти у забезпеченні якісного економічного розвитку Китаю. Воно підкреслює важливість збільшення інвестицій в освіту та сприяння розвитку інноваційних і висококваліфікованих фахівців. Висновки надають цінну інформацію для політиків та зацікавлених сторін, які прагнуть сприяти сталому та інклюзивному економічному зростанню через реформування освіти та цілеспрямовані інвестиції в людський капітал.

Ключові слова: причинно-наслідковий зв'язок, інвестиції в освіту, якісний економічний розвиток, інновації, посередницькі ефекти, регіональний розвиток.