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Does dependence on natural resources promote human capital development in Africa?

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Abstract---This study examines the effects of natural resources on human capital in 25 natural resource-dependent African countries over the period 2000–2023. We estimate an empirical model using the double least squares method. The results indicate that total natural resource rents, as well as the ratio of natural resource exports to total exports, have a positive and significant effect on human capital. When considering different types of resource rents, the results show that oil and natural gas rents have positive and significant effects on human capital, while coal and forest rents have a negative and significant impact on human capital. These results hold up when using an alternative measure of human capital. These results underscore the need for these countries to sustain resource rents earmarked for financing human capital. These countries must also enhance transparency in the management of natural resource rents to stimulate human capital development.

Keywords---Natural resource rents, human capital, 2SLS, Africa.

JEL classification: O13, O15, O55

1. Introduction

Human capital is an important factor in determining a country's level of wealth. The work of Lucas (1988), Romer (1989), and Mankiw et al. (1992) argues that development gaps between countries are partly linked to differences in human capital. Human capital can be defined as the sum of investments in education, health, and training that enable an individual to be productive in the labor market (Becker, 1974). A high level of human capital facilitates the adoption of new technologies (Barro, 2001), promotes structural transformation (Gyimah-Brempong, 2011; AfDB, 2020), and contributes to the reduction of poverty and inequality (Shimeles and Verdier-Chouchane, 2016). It boosts economic productivity (Lucas, 1988), attracts foreign direct investment essential for

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economic transformation (Anyanwu, 2017), and contributes to the expansion of the industrial sector (Szirmai and Verspagen, 2015). The economic success of the Four Asian Tigers can be explained in part by the use of skilled human capital (Schultz, 1961; Becker, 1964; World Bank, 1993).

Given the role that human capital has played in the historical success of certain countries, it is included in the Sustainable Development Goals adopted by the United Nations in 2015. In Africa, the African Union's Agenda 2063 has made education a priority. However, the level of human capital in Africa remains low (World Bank, 2020). According to data from the United Nations Development Programme, in 2023, the average years of schooling was 9.09 in Africa, compared to 11.83 in the Americas, 11.18 in Asia and the Pacific, and 13.35 in Europe (UNDP, 2025).

Research on the determinants of human capital highlights the role of natural resources (Stijns, 2006; Blanco and Grier, 2012; Sun et al., 2017; Ouoba, 2020; Tian and Zhang, 2023; Debonheur et al., 2023). Hartwick's (1977) theory of weak sustainability argues that natural resource rents can be invested in the accumulation of human capital. Findings are mixed regarding the effect of natural resources on human capital. Some studies indicate that natural resources positively influence human capital (Kim and Lin, 2017; Ouoba, 2020; Dialga and Ouoba, 2022; Tian and Zhang, 2023). Others find a negative effect of natural resources on human capital (Blanco and Grier, 2012; Cockx and Francken, 2016; Sun et al., 2017; Debonheur et al., 2023).

For African countries, the debate over the role of natural resources in human capital accumulation is particularly relevant, as Africa is one of the regions with vast natural resources. In fact, revenues from natural resources accounted for 11.43% of Africa's gross domestic product in 2021, compared to 7.17% in East Asia and the Pacific, 4.66% in Latin America and the Caribbean, and 3.60% in Europe and Central Asia (World Bank, 2025). Furthermore, some countries are extremely dependent on natural resources. For example, the ratio of natural resource exports to total exports averaged 96.38% for Algeria, 96.17% for Angola, 90% for Nigeria, 72.14% for Gabon, and 71.86% for Zambia over the 2000–2023 period (WTO, 2025).

This study aims to analyze the effect of natural resources on human capital in Africa. This research makes several contributions to the literature. First, our study focuses on a sample of African countries with a high degree of dependence on natural resources. Second, we use several indicators to measure dependence on natural resources. These include different types of natural resource rents to capture differentiated effects and identify which type of natural resource rent most promotes human capital development in Africa. Furthermore, this study uses two measures of human capital, whereas previous studies have used a single indicator to measure human capital (Blanco and Grier, 2012; Ouoba, 2020; Tian and Zhang, 2023). Finally, we account for the endogeneity of natural resource dependence and apply the instrumental variables method.

The rest of the article is organized as follows: Section 2 provides a brief review of the literature. Section 3 presents the methodological approach. Section 4 presents and discusses the results. Section 5 concludes.

2. Literature Review

The analysis of the effect of natural resources on human capital falls within the framework of the theory of weak sustainability. According to the theory of weak sustainability (Hartwick, 1977), it is possible to substitute natural capital—that is, natural resources—with human capital in order to support the consumption needs of future generations. The idea is to maintain the total stock of capital constant from the perspective of intergenerational equity (Solow, 1974; Hartwick, 1977). Indeed, the Hartwick-Solow rule stipulates that reinvesting rents derived from natural resources allows future generations to benefit from productive capacities in terms of knowledge and skills.

However, rising natural resource rents reduce incentives to invest in human capital formation (Badeeb et al., 2017). Thus, the mechanism through which a negative relationship exists between natural resource rents and human capital is the lack of pressure on governments to invest in educational infrastructure, as well as the use of natural resource rents by the ruling elite to finance political programs aimed at maintaining their hold on power (Auty, 2001).

From an empirical perspective, several studies have examined the effects of natural resources on human development. For example, Debonheur et al. (2023) analyzed the effects of natural resource rents on human development in 41 African countries over the period 1996–2019. They used quantile regression and the generalized method of moments and concluded that total natural resource rents negatively influence human development in Africa. This result is consistent with that of Pérez and Claveria (2020), who found a negative influence of mining rents on human development in African countries between 2007 and 2016.

However, several authors have found that natural resources promote human development (Sinha and Sengupta, 2019; Nchofoung et al., 2021; Dialga and Ouoba, 2022). Indeed, Dialga and Ouoba (2022) examined a sample of 42 countries covering the period from 2009 to 2015. Their results showed that extractive rents positively influence human development. Similarly, Nchofoung et al. (2021), in a comparative analysis using IV Tobit regression, found that natural resources have a positive effect on human development in 107 developing countries. Furthermore, Sinha and Sengupta (2019) studied the impact of natural resources on human development in 30 countries in Asia and the Pacific over the period 1996–2016. They used quantile regression and found that various resource rents have a positive effect on the Human Development Index.

Another group of authors has examined the effect of natural resources on human capital. Indeed, Tian and Zhang (2023) use fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS) and find that, over the 1990–2021 period, coal, oil, and mining rents have a positive and significant effect on human capital. Ouoba (2020), using a panel of 23 natural resource-rich countries, concluded that natural resource rents promote human capital

development over the 2000–2014 period. Shao and Yang (2014) also found that natural resource wealth has positive effects on human capital. However, Blanco and Grier (2012) found that dependence on natural resources had a significant negative effect on human capital in 17 Latin American countries over the period 1975–2004. Similarly, Sun et al. (2018) present evidence of a negative effect of dependence on natural resources on human capital.

Cockx and Francken (2016) analyzed the impact of the resource curse on education spending in 140 countries over the period 1995–2009. They demonstrated that dependence on natural resources reduces public spending on education. In contrast, the study by Kim and Lin (2017) argues that dependence on natural resources improves education.

Research shows that institutional quality is a factor in human capital development. In this context, Ouedraogo et al. (2021), using a sample of 49 African countries over the period 1996–2018 and applying the generalized system of moments method, found that institutional quality has a positive effect on education. Furthermore, Dianda et al. (2025) indicate that economic freedom promotes human capital development.

3. Methodological Approach

3.1 Empirical Model

To analyze the effects of natural resources on human capital in Africa, the empirical model adopted draws on the work of Dialga and Ouoba (2022) and Debonheur et al. (2023) for the variable of interest, and on Tian and Zhang (2023) for the measurement of human capital. Furthermore, based on the literature, we include a number of control variables. Thus, the econometric model is as follows:

$$HC_{it} = \alpha_0 + \alpha_1 NRR_{it} + \beta X_{it} + \varepsilon_{it}$$

In the equation above, HC_{it} is the dependent variable representing the human capital of country i at time t , and ε_{it} denotes the error term. In this study, we use two measures of human capital. These measures are commonly used in the literature to approximate human capital (Ouoba, 2020; Diallo and Ouoba, 2024; Somé and Nikiema, 2026). The first measure is the human capital index by Feenstra et al. (2015), which captures the duration of schooling and the returns to education. The second measure is the average years of schooling among adults. NRR_{it} represents natural resources. Total resource rents are used in line with the literature on natural resource dependence (Cockx and Francken, 2016; Kim and Lin, 2017; Ouoba, 2020). The vector X_{it} represents the control variables commonly used in the literature, namely: financial development, measured as domestic credit extended to the private sector as a percentage of GDP; and foreign direct investment, measured as net foreign direct investment flows as a percentage of GDP. Institutional quality, which is the arithmetic mean of the World Bank's six governance indicators: control of corruption, government effectiveness, political stability, regulatory quality, rule of law, and voice and accountability. Education expenditure, which is public spending on education as a percentage of GDP.

3.2. Data

Our study focuses on a sample of 25 African countries dependent on natural resources. The sample size and the analysis period are determined by the availability of human capital data. Table A1 in the appendix lists the countries. Human capital data are drawn from two sources: The first measure comes from the Penn World Table 10 database. The second measure comes from the United Nations Development Programme (UNDP) database. Data on natural resource rents and control variables are provided by the World Bank through the World Development Indicators. Data on natural resource exports come from the World Trade Organization (WTO) database. Table A2 in the appendix provides a description of the variables used. Furthermore, the descriptive statistics in Table A3 in the appendix reveal low data dispersion. This indicates convergence of results. The correlation matrix presented in Table A4 in the appendix shows that the coefficients between the independent variables are generally weak. This confirms that there is no multicollinearity issue among the model's variables.

3.3. Estimation method

Studies examining the effect of natural resources on development indicators (Brunnschweiler and Bulte, 2008; Van der Ploeg and Poelhekke, 2010; Ouoba, 2016; Bayili and Maiga, 2025) have indicated that dependence on natural resources is endogenous. Indeed, the resource curse observed in many African countries shows that rents derived from natural resources fuel corruption and conflict, which hinders human capital development due to insufficient financial resources. Conversely, well-educated and healthy citizens can demand transparent management of resource revenues and contribute to the creation of added value. Thus, to address this issue of endogeneity, this study employed the instrumental variables method of least squares (IV-2SLS). Endogeneity arises from two-way causality, from the omission of an important variable in the model, and from measurement error in a variable (Murshed, 2020). This dual causality implies that natural resources can affect human capital and vice versa (Nkurunziza et al., 2017). Indeed, a low level of human capital implies limited skills, a lack of know-how, and a shortage of technology—all of which are essential for economic diversification and reducing dependence on natural resources. Conversely, revenues from the exploitation of natural resources can stimulate human capital development by investing in training and educational infrastructure (Kim and Lin, 2018; Mejía, 2020).

One of the requirements of this method is to identify the appropriate instrument for natural resources. Thus, based on the economic literature, both endogenous and exogenous instruments can be used. For endogenous instruments, these include three-period lags of natural resource rents (Bayili and Maiga, 2025) and natural resource exports. Regarding external instruments, this study uses terms of trade as in Amiri et al. (2018) and Bayili and Maiga (2025). Terms of trade are obtained by calculating the ratio of export prices to import prices. The terms of trade are a useful instrument in that natural resource-dependent countries suffer from a deterioration in the terms of trade due to falling prices of natural resource exports, as argued by Prebisch (1950) and Singer (1950). Consequently, the terms of trade are correlated with natural resources.

The validity and robustness of the instruments are tested using the Kleibergen-Paap rk LM statistic, the Cragg-Donald Wald F statistic, and the Hansen J statistic.

4. Results and Discussion

4.1. Effects of Natural Resources on Human Capital

The results presented in Table 1 are those obtained using the human capital measure from the UNDP database. Thus, Table 1 presents the effects of natural resources on human capital in Africa from 2000 to 2023. Three diagnostic tests validate our results. First, the instruments are relevant because the p-values associated with the Kleibergen-Paap statistic are less than 5%. Second, the instruments are not weak because the Cragg-Donald statistics exceed the critical values of Stock and Yogo. Finally, the Hasen tests indicate that the internal and external instruments used are valid because the p-values associated with these statistics are greater than 10%.

The results of the estimates indicate that the coefficients associated with measures of natural resources are positive and statistically significant at the 1% level (estimates 1 and 2). These results can be explained by the fact that the exploitation of natural resources generally generates significant revenues for incumbent governments, enabling them to finance human capital development. These results are consistent with the theory of weak sustainability (Solow, 1974; Hartwick, 1977), which states that revenues from natural resources can be transformed into human capital. These results also confirm previous studies that have shown that dependence on natural resources promotes human capital development (Kim and Lin, 2018; Ouoba, 2020).

The coefficient associated with the institutional quality variable is positive and significant at the 1% level, suggesting that countries with high-quality institutions have public policies that promote access to education, training, and learning and, consequently, have a high level of human capital. This finding is consistent with the work of Ouedraogo et al. (2021) and Debonheur et al. (2023).

Financial development, as measured by credit extended to the private sector, is positively and significantly associated with human capital at the 1% significance level. This result suggests that improved access to credit contributes to the growth of human capital. Indeed, in countries where economic agents have greater access to financing, they have more income to invest in training, education, and learning, which translates into a high level of human capital. This result confirms that found by Tian and Zhang (2023).

The results of Estimations 1 and 2 show that foreign direct investment contributes to human capital development in African countries dependent on natural resources. The coefficients obtained are positive and significant at the 1% level. These results are consistent with those obtained by Ouoba (2020) and Liu (2024). Indeed, foreign direct investment (FDI) improves human capital through the funding received by the host country, which is invested in educational and health infrastructure. Furthermore, FDI incentivizes skilled workers through wage premiums, which encourages others to improve their skill levels (Liu, 2024).

Public spending on education has a positive and statistically significant effect at the 1% significance level (estimates 1 and 2). Thus, this result shows that improving access to education through tuition subsidies, increasing scholarship quotas for students, and providing school supplies to the most vulnerable groups enhances human capital. This result confirms that obtained by Ouedraogo et al. (2021), who show that a well-targeted public spending program stimulates the development of human capital.

Table 1: Effects of Natural Resources on Human Capital

Dependent variable: human capital (UNDP)		
Estimation method: Two-stage least squares (IV-2SLS)		
Variables	(1)	(2)
Total natural resources rents (% of GDP)	0.0532*** (0.0140)	
Natural resource exports (% of total exports)		0.0248*** (0.00348)
Institutional quality	0.613*** (0.211)	0.460** (0.199)
Financial Development	0.0473*** (0.0129)	0.0545*** (0.0130)
FDI net inflows (% of GDP)	0.00418*** (0.000779)	0.00380*** (0.000731)
Government expenditure on education	0.188*** (0.0670)	0.272*** (0.0537)
Constant	6.370*** (0.423)	5.514*** (0.451)
Number of countries	25	25
Observations	525	525
R-squared	0.132	0.265
Kleibergen-Paap rk LM statistic P-value	0.0000	0.0000
Cragg-Donald Wald F statistic	415.603	1266.865
Stock-Yogo CV (10%)	19.93	19.93
Hansen J statistic P-value	0.1950	0.7482

Source: Author

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4.2. The impact of different types of natural resource rents on human capital

We break down natural resource revenues into their various components, namely: oil revenues, mining revenues, forestry revenues, natural gas revenues, and coal revenues.

The results in Table 2 show that oil and natural gas rents have a positive and statistically significant effect on human capital at the 1% significance level. Indeed, the positive effect of oil rents on human capital is consistent with that found by Tian and Zhang (2023) and can be explained by the fact that oil resources generate sufficient revenue, which is used by the government to finance

educational programs and health infrastructure, thereby contributing to the improvement of human capital. This result confirms that of Blanco and Grier (2012).

The positive and significant coefficient associated with natural gas revenues suggests that revenues from natural gas are likely to promote human capital development. These resources help increase national income, thereby enabling countries to finance investments in human capital accumulation. This result is consistent with those obtained by Sinha and Sengupta (2019) and Debonheur et al. (2023).

The results show that the coefficients associated with coal and forestry rents are negative and significant. Indeed, Gylfason (2001) found that an increase in natural resources is negatively correlated with public spending on education. Furthermore, Badeeb et al. (2017) indicated that the higher the rents derived from natural resources, the less incentive governments have to invest in human capital. The negative effect of coal rent was observed by Debonheur et al. (2023). However, this result contradicts that of Tian and Zhang (2023), who found a positive relationship between coal rent and human capital.

Table 2: Effects of Different Types of Natural Resources on Human Capital

Dependent variable: human capital (UNDP)					
Estimation method: Two-stage least squares (IV-2SLS)					
Variables	1	2	3	4	5
Oil rents	0.0578*** (0.0124)				
Natural gas rents		0.824*** (0.0915)			
Coal rents			-0.234** (0.0955)		
Forest rents				-0.0864*** (0.0190)	
Mineral rents					-0.0314 (0.0276)
Institutional quality	0.462** (0.215)	0.592*** (0.217)	0.446** (0.225)	0.290 (0.225)	0.505** (0.225)
Financial Development	0.0419*** (0.0127)	0.0249** (0.0123)	0.0424*** (0.0117)	0.0200* (0.0118)	0.0414*** (0.0113)
FDI net inflows (% of GDP)	0.00369*** (0.000702)	0.00349*** (0.000656)	0.00324*** (0.000653)	0.00199*** (0.000753)	0.00335*** (0.000645)
Government expenditure on education	0.232*** (0.0590)	0.0687 (0.0520)	0.233*** (0.0668)	0.312*** (0.0627)	0.211*** (0.0670)
Constant	6.612*** (0.369)	7.622*** (0.349)	6.981*** (0.371)	7.489*** (0.355)	7.130*** (0.385)
Number of countries	25	25	25	25	25

Dependent variable: human capital (UNDP)					
Estimation method: Two-stage least squares (IV-2SLS)					
Variables	1	2	3	4	5
Observations	525	500	524	500	525
R-squared	0.204	0.269	0.134	0.196	0.127
Kleibergen-Paap rk LM statistic P-value	0.0000	0.0000	0.0013	0.0000	0.0001
Cragg-Donald Wald F statistic	1189.697	893.527	366.062	1009.537	220.228
Stock-Yogo CV (10%)	19.93	19.93	19.93	19.93	19.93
Hansen J statistic P-value	0.4824	0.1650	0.1576	0.1107	0.1079

Source: Author

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4.3. Alternative Measure of Human Capital

In this section, we use an alternative measure of human capital. This is the human capital index, which combines the average years of schooling from Barro and Lee (2013) with the return on education. This measure is used in line with previous research (Ouoba, 2020; Tian and Zhang, 2023; Diallo and Ouoba, 2024). Table 3 presents the estimation results obtained using the double least squares method, the human capital index provided by Penn World Table 10.0, total natural resource rents, and the ratio of natural resource exports to total exports. Thus, the results show that natural resources improve human capital (estimates 1 and 2). Indeed, the coefficients associated with total natural resource rents and natural resource exports are positive and statistically significant. Furthermore, variables such as institutional quality, financial development, and foreign direct investment have a positive and significant effect on human capital. Consequently, these additional results corroborate the conclusions of the baseline results in terms of signs and significance.

Table 3: Effects of Natural Resources on Human Capital

Dependent variable: human capital (PWT)		
Estimation method: Two-stage least squares (IV-2SLS)		
Variables	(1)	(2)
Total natural resources rents (% of GDP)	0.00819** (0.00349)	
Natural resource exports (% of total exports)		0.00357*** (0.000877)
Institutional quality	0.227*** (0.0672)	0.208*** (0.0632)
Financial Development	0.00686**	0.00807***

Dependent variable: human capital (PWT)		
Estimation method: Two-stage least squares (IV-2SLS)		
Variables	(1)	(2)
	(0.00319)	(0.00312)
FDI net inflows (% of GDP)	0.00216*** (0.000328)	0.00210*** (0.000305)
Government expenditure on education	-0.0170 (0.0173)	-0.00621 (0.0148)
Constant	1.784*** (0.106)	1.678*** (0.113)
Number of countries	25	25
Observations	525	525
R-squared	0.079	0.123
Kleibergen-Paap rk LM statistic P-value	0.0000	0.0000
Cragg-Donald Wald F statistic	415.603	1266.865
Stock-Yogo CV (10%)	19.93	19.93
Hansen J statistic P-value	0.6942	0.5416

Source: Author

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

5. Conclusion and policy implications

This study examined the effects of natural resources on human capital in 25 natural resource-dependent African countries. The empirical model was estimated using the two-stage least squares method over the period 2000–2023. The contribution of this study lies, on the one hand, in the relevance of the measures of human capital and, on the other hand, in the relevance of the measures of natural resources (taking into account the different types of natural resource rents as well as the ratio of natural resource exports to total exports). The results show that total resource rents as well as the ratio of natural resource exports to total exports improve human capital, as their associated coefficients are positive and significant. Furthermore, when natural resource rents are disaggregated, the positive and significant effects hold for oil and gas rents. In contrast, coal and forest rents have negative and significant effects.

These findings suggest that the governments of African countries dependent on natural resources should allocate a significant and stable portion of their natural resource revenues to the development of the education, health, and vocational training sectors. Furthermore, to mitigate the effects of commodity price volatility, these countries must develop and implement strategies for the sustainable financing of human capital. Finally, diversifying these countries' economic structures remains a priority for reducing their vulnerability to external shocks.

Declarations

Competing interests

The author has no relevant financial or non-financial interests to disclose.

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Appendix

Table A 1: List of countries in the sample

Algeria	Congo, Rep.	Mauritania	Togo
Angola	Egypt, Arab Republic	Mozambique	Ugandan
Burkina Faso	Ethiopia	Niger	Zambia
Burundi	Gabon	Nigeria	Zimbabwe
Cameroon	Ghana	Rwanda	
Central African Republic	Madagascar	Sierra Leone	
Congo, Demo. Rep.	Mali	Sudan	

Source: Author

Table A2: Variables, definitions, and sources

Variables	Definitions	Sources
Human capital	The mean years of schooling	United Nations Development Programme (UNDP)
Total resource rents (%GDP)	Total natural resource rents are the sum of oil, natural gas, coal, minerals, and forestry rents	World Development Indicators (WDI)
Natural resource exports (% of total exports)	Natural resource exports (% of total exports)	World Trade Organization (WTO)
Institutional Quality		Author's calculations
Foreign direct investment	Foreign direct investment net inflow (% GDP)	WDI
Domestic credit	Domestic credit to private sector (% GDP)	WDI
Government expenditure on education	Government expenditure on education, total (% of GDP)	WDI

Source: Author

Table A3: Descriptive statistics of variables

Variables	Obs	Mean	Std. Dev.	Min	Max
Human capital	600	7.786	2.003	2.261	12.91
Total resource rents (%GDP)	600	14.386	10.427	2.439	59.684
Natural resource exports (% of total exports)	600	43.167	32.366	0.188	99.662
Institutional Quality	600	-0.838	0.428	-1.854	0.102
Foreign direct investment net inflow (% GDP)	600	3.662	5.476	-17.292	38.943
Domestic credit to private sector (% GDP)	600	14.865	9.133	0.491	84.813
Government expenditure on education,	600	3.393	1.659	0.319	9.125

Variables	Obs	Mean	Std. Dev.	Min	Max
total (% of GDP)					
Coal rents (% GDP)	599	0.204	0.769	0	6.440
Forest rents (% of GDP)	600	6.265	5.905	0	40.408
Mineral rents (% of GDP)	600	1.764	3.880	0	28.813
Natural gas rents (% of GDP)	600	0.384	1.028	0	7.996
Oil rents (% of GDP)	600	5.769	11.120	0	57.514

Source: Author

Table A4: Correlation matrix

	1	2	3	4	5	6	7
1. Human capital	1						
2. Total resource rents	0,125	1					
3. Natural resource exports	0,299	0,46	1				
4. Institutional Quality	0,137	-0,163	-0,105	1			
5. Foreign direct investment	-0,005	0,084	0,110	0,130	1		
6. Domestic credit	0,269	-0,095	-0,185	0,137	0,039	1	
7. Government expenditure on education	0,312	0,052	-0,121	0,276	0,059	0,392	1

Source: Author