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The effect of human capital on economic growth: The case of Chad

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Abstract:

The purpose of this article is to study the impact of human capital on economic growth in Chad over the period (1990 to 2021). To do so, we used VAR modeling, the Granger causality test and impulse response function analysis.

The estimation results revealed that human capital in Chad contributes positively to economic growth through the "secondary education" variable. Considering the effect of human capital on growth, investment in education, particularly primary and higher education, will increase economic growth in the long term.

Keywords: human capital; economic growth; VAR Modeling; Chad.
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1. Introduction

Human capital has long played an important role in growth theory. Investment financed by savings has always been considered the engine of growth in traditional theories. In the new theories of growth, investment in human capital also has a very important role to play in explaining economic growth, not least because of the positive externalities that accompany its accumulation.

The study of the impact of human capital on economic growth is a preoccupation of developed countries, and is more important for developing African countries such as Chad, for several reasons: firstly, human capital has an important role to play in economic growth for countries whose development remains linked to the quantity and quality of these human resources. Secondly, the concept of human capital enhances the value of human beings through their knowledge, skills and competencies, which are a source of productive dynamism. The idea of competence encompasses not only the individual's knowledge, but also his "know-how": rationality, capacity for adaptation and innovation. Education is one of the determinants of human capital (Wold Bank, 1998).

Despite its considerable potential for socio-economic development, including mineral resources such as oil and gold, livestock breeding and arable land, Chad remains one of the poorest countries in the world. Efforts to achieve growth are often thwarted by the deterioration of the internal and external environment. Indeed, the incoherent economic policies of decades of corruption, political instability and security challenges relating to conflicts in neighboring countries, and the consequences of climate change, the arrival of refugees from border countries estimated at over 450,000 people, the Covid-19 pandemic and the war between Russia and Ukraine have, radically, altered Chad's macro-economic prospects.

With a GDP (Gross Domestic Product) per capita estimated at 686 USD in 2021, the country suffers from a shortage of skilled labor, an often-outdated administration and insufficient or degraded infrastructure. In 2021, according to the Human Development Index, the country ranked 190th out of 191 countries, behind Niger and ahead of South Sudan. This index was 0.394 (UNDP, 2022). The illiteracy rate was 78% in 2020. This rate reveals a facet of the disparities between men and women: it is 69% for men and 86% for women, with those living in rural areas more affected (92%).

Although the well-established theory of the role of human capital in economic growth, the majority of research has focused on developed countries or on mixed samples of developed and developing countries. However, empirical research on developing countries is still relatively small and deserves further consideration. This on the one hand, and on the other hand, as the success of economic policies in East Asian countries was due to efforts made in education and training, why not the same process will occur in African countries. Our research thus makes a contribution to the empirical literature on developing countries, hence the interest of devoting this article to the case of Chad.

The aim of this study is to examine the impact of human capital on economic growth, based on the Chadian education system at all levels (primary, secondary and higher education). The aim is to answer the following research question: "What is the impact of human capital on economic growth in Chad?" The hypothesis put forward to answer this question is the existence of a positive influence of human capital across the three levels of education on economic growth. To this end, the study first reviews the main theoretical and empirical works explaining the relationship between human capital and economic growth (Section 2). It then uses econometric analysis to test the existence of this relationship in the case of Chad. This will be demonstrated using a VAR model and a Granger causality test

(Section 3). The final section (section 4) is devoted to the economic interpretation of the results obtained.

2. Theoretical and empirical literature review

The role of human capital in economic growth has been the subject of theoretical and empirical debate. According to Adam Smith, the specialisation that results from the division of labour plays a crucial role in increasing the productive forces of labour and skills. He also put forward other ideas concerning the impact of education, specific knowledge, learning and experience on economic development. Subsequently, Mincer (1958) developed a model to explain income disparities between individuals, which are partly attributable to differences in investment in human capital. The idea was extended to the country level by Schultz (1961), who put forward the hypothesis that a large part of the increase in countries' productivity is attributable to the increase in human capital.

More recently, models have been developed suggesting various approaches to influencing productivity through human capital. The observation that a person's income increases with their level of education has led economists to consider education as capital. Human capital, like physical capital, is subject to an investment decision in order to generate a return in the future that manifests itself in higher individual incomes than those obtained without this education.

The notion of human capital became widespread around the 1960s, following the work of the American economists such as (Arrow, 1962) and (Becker, 1962). Other works were subsequently developed, demonstrating the existence of a robust link between human capital and economic growth. These include (Romer, 1990), (Mankiw, Romer, & Weil, 1992), and (Barro & Lee, 1993).

According to (Becker, 1962, p. 9), human capital can be defined as: "*the stock of productive resources embodied in the individuals themselves, made up of elements as diverse as level of education, training and work experience, state of health or knowledge of the*

economic system". In other words, any form of activity that can contribute to economic growth and human development. His seminal work, "Human Capital and Theoretical and Empirical Analysis", published in 1964, was the precursor of human capital theory. The basic idea behind Becker's analysis is that wage differentials result from productivity differentials between workers. This differential in wages and productivity is explained by unequal holdings of human capital.

Theoretical work on the relationship between human capital and growth can be divided into two categories. The first is based on the Solow model developed in 1956 and extends the framework for analysing exogenous growth. This approach is illustrated by the study of (Mankiw, Romer, & Weil, 1992). The second is endogenous growth theory, of which Romer's model is the main representative. In the exogenous growth model, economic growth is governed by external factors, such as technological advances, savings and population growth. These variables are independent of the economic model and do not depend on individual or internal economic decisions. Technical progress is considered as an exogenous factor by exogenous growth models, such as the Solow model. In contrast, in the endogenous growth model like Lucas and Barro (Lucas, 1988), (Barro R. , 1990), economic growth is assumed to be influenced by internal factors, such as individual choices and economic decisions. The endogenous growth model integrates individual decisions into the economic development process, for example Barro's model, which focuses on education, i.e. the accumulation of human capital as a factor in economic growth. Individuals' investment in their education influences their productivity and their contribution to economic growth.

The measurement of human capital is presented in the form of a factor of production. It often appears in the form of an investment flow (measured by an enrolment rate) or a stock (number of years of education accumulated by the working population). It is similar either to "learning and doing" and refers to the years spent by individuals in

educational institutions, or to "learning by doing" and refers to apprenticeship. Nonetheless, its influence in the form of externalities tends to take a broader view, considering individuals' ability to adopt new technologies, their adaptation to the system and their communication skills.

As noted above, the externalities of education are reflected at the macroeconomic level. This observation has given rise to a multitude of empirical studies aimed at identifying the role of human capital in economic growth, as well as confirming it and assessing its econometric consequences.

Recent empirical studies on human capital and growth are fraught with controversy, especially as regards the effect of human capital accumulation on growth. New growth theories have taken two routes to explain technical progress: human capital accumulation and Research & Development (R&D). Models based on capital accumulation place greater emphasis on social inequalities between individuals, or on the influence of growth on these social inequalities. Other factors have been put forward by the international financial institutions. Indeed, the IMF and the World Bank consider that sustainable development can only be achieved by implementing the following commitments: access to primary education for all children, reduction in gender inequalities, reduction in poverty, reduction in infant mortality and better access to health services.

In a study of around one hundred countries, including both developed and developing countries, (Barro R. , 1997) concluded that secondary and higher education play an essential role in economic growth. The authors argue that secondary education offers technical and vocational programmes aimed at acquiring skills that facilitate the integration of young people into working life. However, research conducted by Oukaci & al. (Oukaci, Bouznit, Abderrahmani, & Ferfara, 2015) on the case of Algeria shows that secondary education does not promote economic growth. The lack of a link suggests that it

is probably vocational training that could have an impact on economic growth.

In another study, (Berthélemy, Varoudakis, & Dessus, 1997) in their work entitled "Human capital and economic growth: the role of the trade regime", confirm the positive role of trade openness in the contribution of human capital to economic growth. The argument put forward is that, by opening up its trade regime, a country benefits from innovations produced in the rest of the world, enabling it in turn to engage in innovative and efficient activities.

Using a panel data model, the study by (Sadi & Rezine, 2021) on the impact of different levels of education and vocational training on growth for Algeria, Tunisia, Morocco, Egypt, Iran and Jordan concluded that primary and secondary education have a positive impact on growth, while higher education has a negative effect on economic growth. Similarly, in her study of the case of Algeria, (Lenba, 2022, p. 1047) shows that investment in human capital through education can have a negative impact on economic growth. In fact, a 1% increase in education spending leads to a 0.05% drop in GDP per capita. To maximize the contribution of human capital to the economy, the author suggests increasing spending on education, improving the quality of teaching and the professional integration of graduates.

Recent research conducted in Africa, examines how human capital influences economic growth in 48 African countries from 2000 to 2019. The results show that human capital indicators, namely the human capital index and life expectancy, have a strong influence on economic growth (Wirajing , Nchofoung, & Etape , 2023).

3. Statistical data and methodology

This work is inspired by Barro's model and Lucas's endogenous growth model, which emphasise the role of education as a driver of economic growth. It examines the internal factors that affect growth,

such as investment in education. The advantage of this model is that it enables us to understand how economic and political decisions can stimulate economic growth and thus design more effective policies. Another particularity of this model is its flexibility in that it can explain phenomena of economic convergence or divergence between variables.

The methods are numerous, varied and sometimes complex. For our part, inspired by some empirical work, devoted to the study of the link between human capital and economic growth for the case of developing countries, such as that of (Oukaci, Bouznit, Abderrahmani, & Ferfara, 2015), (Melloul & Amara, 2016) and (Chadlia, 2023), we have chosen the VAR method. This approach is used to analyse empirically the contribution of human capital to economic growth in Chad during the period 1990-2021. The VAR model is an econometric method for symmetrically detecting links between several time series, where each variable is explained by its own past values and those of the other variables. The advantage of using the VAR model is that it is possible to capture the dynamic interactions between human capital and economic growth.

The aim of this section is to carry out an empirical analysis of education as a determinant of growth in Chad. First, we present data on the educational and economic spheres in Chad, then we visualize the evolution of economic growth in Chad and finally, we will present the results of the VAR model estimation as well as those of causality, and we will conclude with an impulsive analysis (shock analysis).

3.1. Presentation of data

Based on the theoretical and empirical literature on the impact of human capital on economic growth, and taking into account data availability, we selected the following variables:

- Real GDP growth rate measuring economic growth (rgdp);
- Variables relating to the three levels of education (primary: Prim, secondary: secd and higher education: high), as well as expenditure on

education (spend): Primary education promotes the acquisition of basic human capital, which is crucial for economic development. It contributes to improving the population's literacy and basic knowledge, which in turn fosters productivity and sustainable growth. Secondary education plays an essential role in acquiring the skills needed to adapt to economic change. Higher education promotes the advancement of scientific knowledge and the training of skilled workers, which increases human capital and productivity.

- Gross Fixed Capital Formation (gfcf): Economic growth is influenced by investment in fixed assets. When companies invest in new infrastructure, machinery and equipment, this leads to an increase in production, which in turn boosts the productive capacity of the whole economy.

- Working population (work): The choice of this variable is justified by the fact that demographic growth, particularly the increase in the educated and skilled working population, plays an essential role in economic growth through the rise in labour productivity, which contributes to the increase in the production of goods and services. In addition, more skilled workers make more efficient use of physical capital such as machinery. This leads to increased production and higher GDP.

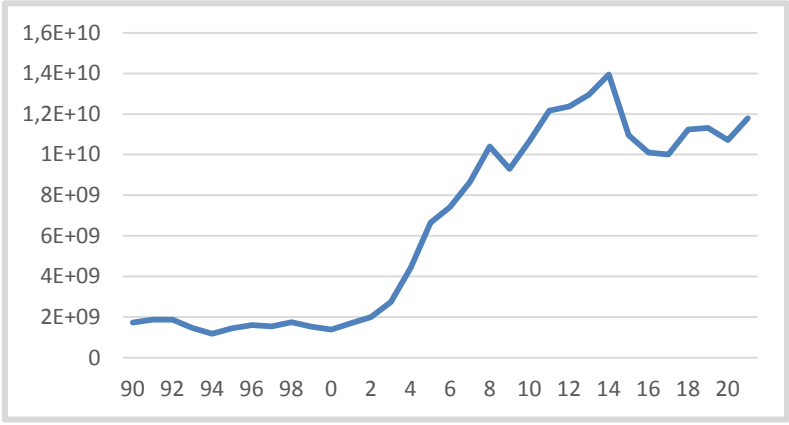
- Trade openness (open): the contribution of trade openness to the explanation of the link between human capital and growth can be explained by the fact that open economies can specialise and focus on areas in which they have a competitive advantage, which leads to an increase in productivity and human capital. Similarly, openness makes it easier to access foreign knowledge and technologies, which is conducive to the acquisition of human capital.

As a data source, we used school directories from the ministry of higher education, UNDP’s human development reports and human capital data provided by the world bank. Our study covers the period (1990-2021).

3.2 Evolution of economic growth in Chad

In Chad, the real GDP growth rate follows a very irregular pattern, as shown in figure 1. The graph shows that the trend in the real GDP variable declined over the period from 1990 to 2001. A trend of increase ensued, spanning from 2002 to 2013. Between 2014 and 2017, there was still another declining trend, which was followed by a decrease in 2020 and a modest recovery in 2021.

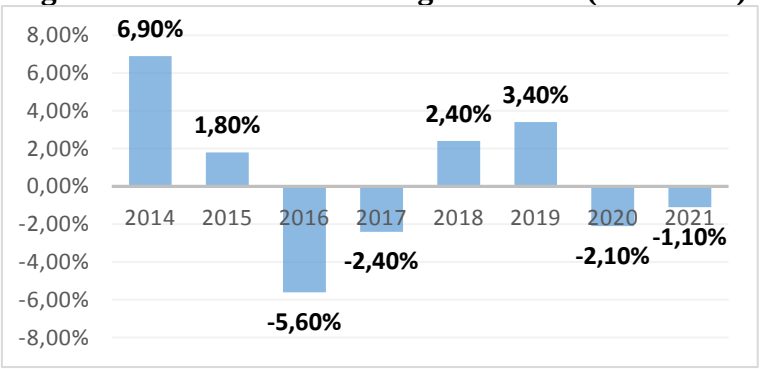
Fig 1: Evolution of real GDP (1990-2021)



Source: Generated based on WB data (World Bank, 2023)**.**

The Chadian economy is largely dependent on oil production, which began in 2003 and enabled the country to enjoy a period of rapid growth until 2014 (average annual growth rate of 13.7%). In recent years, the Chadian economy has suffered a double exogenous shock: rising insecurity in neighboring countries and the commodities crisis in 2014. After two years of sharp recession in 2016 and 2017, triggered by the oil price shock of 2014 and 2015, Chad returned to positive growth in 2018 (+2.4%) thanks to the recovery in prices, but the covid-19 pandemic and the subsequent fall in oil prices affected the country, distancing it from its growth trajectory. The Chadian economy went into recession between 2020 and 2021, with real GDP growth rates of (-2.1%) and (-1.1%) respectively.

Fig. 2. Evolution of real GDP growth rate (2014-2021)



Source: Generated by the authors based on IMF data (IMF, 2021).

3.3 VAR model estimation

VAR modeling is based on the assumption that the evolution of the economy is well approximated by the description of the dynamic behavior of a vector of "n" variables linearly dependent on the past. Since Sims' initial work (1980), econometric techniques based on VAR models have undergone numerous developments. Here, we seek to model GDP as a function of its determinants in standard VAR form; we test the hypothesis of causality in the Granger sense for the variables. Then, we use impulse analysis to see the consequences of the various shocks exerted on the variables.

Before estimating the model, we first study the stochastic characteristics of the different series. For this, we use the augmented Dickey-Fuller unit root test (ADF test). Table 1 shows the results for the different series: with the exception of higher education, the others series are not stationary at level. However, they become stationary with the first differentiation and the second differentiation for both series (work, secd).

Table 1. Results of unit root test (ADF)

Variables	Models (1) (2) (3)	Calculated ADF	Tabulated ADF	Ordre of integration
logrgdp	1	-3,05	-1.95	I(1)
loggfcf	1	-3,29	-1.95	I(1)
logwork	1	-7,30	-1,95	I(2)
logprim	1	-3,08	-1.95	I(1)
logsecd	1	-2,51	-1,95	I(2)
loghigh	3	-5.39	-3.56	I(0)
logspend	1	-5,58	-1.95	I(1)
logopen	1	-7,55	-1.95	I(1)

Source: Generated by the authors using Eviews10.

The second step is to determine the optimal lag order or the order of the VAR. The table below shows that it equals one (1) according to the FPE, SC and HQ criteria (we choose the line with the most stars on the values).

Table 2. Determination of the number of lags in the VAR model

Lag	LogL	LR	FPE	AIC	SC	HQ
1	246.1615	NA	3.52e-16*****	-13.01153	-9.966493*****	-12.08063*****
2	320.0276	63.31384	5.33e-16	-13.71626*	-7.626179	-11.85446

Source: Generated by the authors using Eviews10.

Table 3. Estimation of VAR model (1)

	dlogrgdp	dloggfcf	ddlogwork	dlogprim	ddlogsecd	loghigh	dlogopen	dlogspend
dlogrgdp(-1)	0.667522	0.248742	0.017970	0.050882	-0.071515	-0.165594	-0.063131	0.434969
	(0.18036)	(0.26132)	(0.02214)	(0.08425)	(0.11571)	(0.13228)	(0.23422)	(0.61869)
	[**3.70098**]	[0.95186]	[0.81150]	[0.60391]	[-0.61803]	[-1.25186]	[-0.26954]	[0.70304]
dloggfcf(-1)	0.030377	0.122269	0.018787	0.081873	0.042198	0.039059	0.144515	-0.394975
	(0.14206)	(0.20582)	(0.01744)	(0.06636)	(0.09114)	(0.10419)	(0.18447)	(0.48730)
	[0.21384]	[0.59405]	[1.07720]	[1.23376]	[0.46300]	[0.37489]	[0.78339]	[-0.81054]
Ddlogwork(-1)	-4.549301	-5.035692	-0.516538	-0.693365	-0.216174	1.709213	2.315953	-0.256689
	(1.58037)	(2.28974)	(0.19403)	(0.73825)	(1.01391)	(1.15905)	(2.05223)	(5.42111)
	[2.87862]	[-2.19925]	[-2.66221]	[-0.93920]	[-0.21321]	[1.47467]	[1.12851]	[-0.04735]
dlogprim(-1)	-0.442625	-0.750094	-0.024497	0.031689	-0.306646	0.369268	-0.533510	1.653593
	(0.48091)	(0.69678)	(0.05904)	(0.22465)	(0.30854)	(0.35270)	(0.62450)	(1.64966)
	[-0.92038]	[-1.07652]	[-0.41490]	[0.14106]	[-0.99387]	[1.04697]	[-0.85430]	[1.00238]
ddlogsecd(-1)	1.013164	1.340879	-0.025630	0.120554	-0.372309	-0.764166	0.648238	-0.669499
	(0.33512)	(0.48555)	(0.04114)	(0.15655)	(0.21500)	(0.24578)	(0.43518)	(1.14957)
	[3.02325]	[2.76158]	[-0.62293]	[0.77007]	[-1.73164]	[-3.10914]	[1.48957]	[-0.58239]
loghigh(-1)	-0.001080	-0.077703	-0.002661	-0.003228	0.008334	0.967809	-0.050514	-0.215181
	(0.02964)	(0.04294)	(0.00364)	(0.01385)	(0.01902)	(0.02174)	(0.03849)	(0.10167)
	[-0.03645]	[-1.80946]	[-0.73135]	[-0.23317]	[0.43827]	[44.5229]	[-1.31244]	[-2.11647]
dlogopen(-1)	0.275946	0.541623	-0.002759	-0.043380	0.025531	-0.274066	-0.415609	-0.010692
	(0.15437)	(0.22366)	(0.01895)	(0.07211)	(0.09904)	(0.11322)	(0.20046)	(0.52954)
	[1.78754]	[2.42160]	[-0.14555]	[-0.60156]	[0.25778]	[-2.42072]	[-2.07323]	[-0.02019]
dlogspend(-1)	0.088367	0.126197	-0.024815	-0.009215	-0.034076	-0.055353	-0.103559	-0.239359
	(0.07221)	(0.10462)	(0.00887)	(0.03373)	(0.04633)	(0.05296)	(0.09377)	(0.24770)
	[1.22376]	[1.20624]	[-2.79916]	[-0.27319]	[-0.73555]	[-1.04523]	[-1.10441]	[-0.96634]
C	0.037903	0.835086	0.024402	0.074065	-0.055177	0.439823	0.539535	2.013561
	(0.28999)	(0.42015)	(0.03560)	(0.13546)	(0.18605)	(0.21268)	(0.37657)	(0.99474)
	[0.13071]	[1.98759]	[0.68541]	[0.54675]	[-0.29658]	[2.06803]	[1.43276]	[2.02421]
R-squared	0.539838	0.505838	0.611682	0.207263	0.290193	0.992882	0.418545	0.264083
Adj. R-squared	0.355773	0.308173	0.456354	-0.109832	0.006271	0.990035	0.185963	-0.030283

Source: Generated by the authors using Eviews10.

Observing the VAR estimate results shows that the coefficients of the variables: logrgdp, logwork and logsecd are significant, because

the associated student statistics are higher than the statistics tabulated at the 5% threshold (1.96). Similarly, the coefficient of the logopen variable is significant at the 10% threshold because the associated student statistics are higher than the statistics tabulated at the 10% (1.64). However, the coefficients of the other variables differ from zero but are insufficient. The determination coefficient R^2 is equal to 53% so the adjustment quality is good.

According to the VAR estimates, we can see that a 1% increase in secondary education and the opening rate will result in an increase of 1.01% and 0.27% of real GDP, respectively, while a 1% rise in the working population will lead to a 4.54% decrease in GDP. Indeed, the GDP equation shows that real GDP is positively dependent on the secondary schooling rate and the opening rate. Nevertheless, the working population explains GDP negatively.

3.3.1 VAR model validation

To validate a VAR model, three tests need to be carried out. These are the autocorrelation test, the heteroskedasticity test and the error normality test.

Table 4. VAR model validation tests

Tests	Statistic test	P-value
Serial correlation LM test	69.00877	0.4976
Heteroskedasticity test	75.35140	0.5402
Normality test	19.35103	0.2509

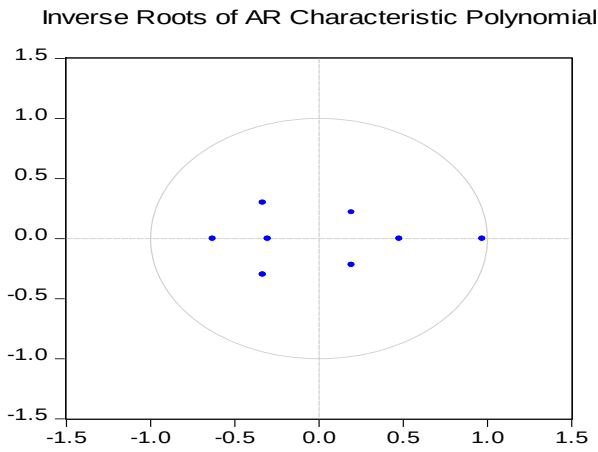
Source: Generated by the authors using Eviews10.

The results showed the absence of autocorrelation between the errors. The errors are homoscedastic and normally distributed. Given that the probability of all three tests is greater than 5%, we can say that the VAR model is validated.

3.3.2 VAR model stability test

We find that all the points (the inverses of the characteristic polynomial roots) are all inside the unit circle. In this way, the model respects the stability conditions.

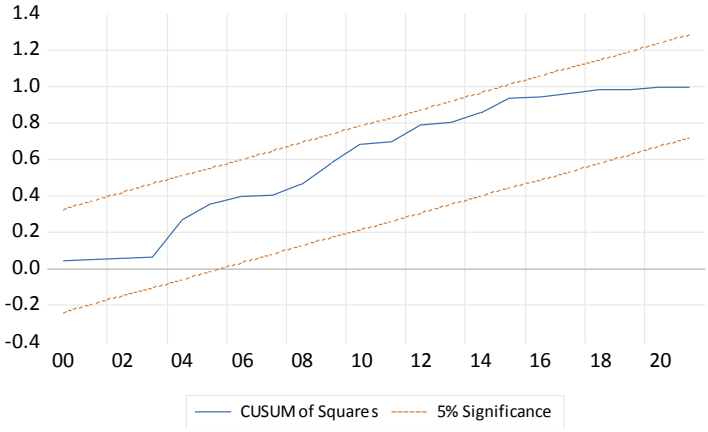
Fig 3. Model stability



Source: Generated by the authors using Eviews10.

Another test to validate the model is the CUSUM test, which is extremely useful for confirming the stability of the coefficients of a regression model throughout the study period and identifying any structural changes. The result of our test, presented in Figure 4, shows a curve contained within a corridor. Consequently, our model is stable.

Fig 4. CUSUM test



Source: Generated by the authors using Eviews10.

3.4 Granger causality test

The purpose of the Granger causality test is to examine the causal relationships between the different variables of the model. In Granger's sense, variable X causes variable Y if knowledge of X's past improves prediction of Y. The basic idea of this test is to accept or reject the null hypothesis "H0" that variable X does not cause variable Y in the Granger sense. The H0 hypothesis is accepted if the probability is greater than 5%. Otherwise, we accept the alternative hypothesis (Charpentier, 2013).

The results obtained, presented in table 5, show the existence of a single causal relationship. Indeed, only the "secondary education" variable causes GDP and this at 10%, where the probability of the test is equal to 0.08. Furthermore, to go a step further, it is preferable to complete this study with impulse analysis.

Table 5. Results of Granger causality test

Null Hypothesis:	Obs	F-Statistic	Prob.
Dloggfcf does not granger cause dlogrgdp	30	0.19684	0.6608
Dlogrgdp does not granger cause dloggfcf		0.36226	0.5523
Ddlogwork does not granger cause dlogrgdp	29	2.67203	0.1142
dlogrgdp does not granger cause ddlogwork		1.20936	0.2815
dlogprim does not granger cause dlogrgdp	30	0.03424	0.8546
Dlogrgdp does not granger cause dlogprim		0.62662	0.4355
ddlogsecd does not granger cause dlogrgdp	29	3.21150	**0.0848**
dlogrgdp does not granger cause ddlogsecd		1.47510	0.2355
loghigh does not granger cause dlogrgdp	30	0.03450	0.8540
dlogrgdp does not granger cause loghigh		0.00024	0.9878
dlogopen does not granger cause dlogrgdp	30	0.97582	0.3320
dlogrgdp does not granger cause dlogopen		0.10323	0.7505
Dlogspend does not granger cause dlogrgdp	30	0.33365	0.5683
dlogrgdp does not granger cause dlogspend		0.95690	0.3367

Source: Generated using Eviews10.

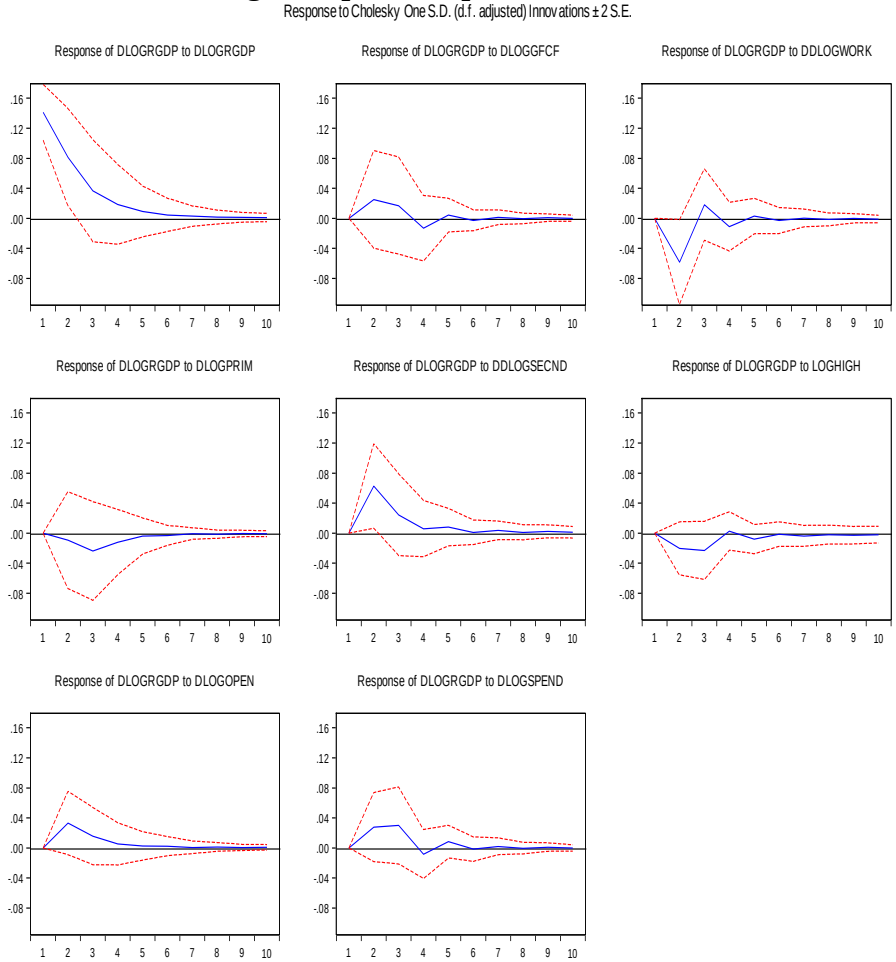
3.5 Impulse analysis of shocks

Shock analysis consists in examining how a shock to one variable at date "t", affects all the variables in the model for periods "t", "t+1", "t+2", etc. The results presented in the figure below show that the impact on real GDP varies from one variable to another. Indeed, shocks to the variables: secondary education rate, GFCF, trade openness rate and education expenditure have a positive influence on GDP from the second period. However, a shock to the primary and higher education variables has a negative impact on GDP, but these shocks are absorbed in the fifth and fourth periods respectively. Similarly, the working population has a negative impact, before it becomes positive, but this is transient in the third period, and is cancelled out in the fourth period.

Furthermore, we can observe that all the effects diminish over time, i.e. the response tends towards zero, which is consistent with the property of a stationary VAR process. For an overall view of these representations below, we note that the results of the impulse response

functions are consistent with those of the VAR estimation and causality test.

Fig 5. Impulse response Functions



Source: Generated by the authors using Eviews10.

4. Discussion of the results

As in all research work, interpreting the results requires a great deal of caution, and their selection represents a decisive challenge. In this section, we will try to provide the elements required to comment economically on the impact of each variable on economic growth in Chad.

4.1 Contribution of the education sector to economic growth

According to the estimation results, education in Chad has a positive influence on GDP through secondary education, which is in line with the hypothesis. This variable is more decisive than primary and higher education, which have a negative but insignificant influence on GDP.

With regard to the estimation result linked to the secondary education, an increase in this variable has a positive impact on GDP. This can be explained by the fact that pupil numbers have in turn improved since the late 1990s. This improvement is the result of the combined effect of an increase in public school provision, i.e. in access rates, and a net improvement in retention rates. In addition, this result can be explained by the effectiveness of the secondary education system in integrating young people with secondary education into economic activity.

As far as primary education is concerned, it leads to a reduction in GDP. This result contradicts Sadi and Rezine's study (Sadi & Rezine, 2021) of Algeria. In Chad, the deterioration in the quality of primary education has been evident since the early 1990s. The main reasons given for this are, on the one hand, that the state's supply capacity has been exceeded due to the meteoric growth in the school-age population. On the other hand, periods of economic recovery characterized by a reduction in public spending are bound to have negative effects on the education system. In response to this insufficiency in state services, a secondary school entrance examination was introduced. As a result, many children who have completed six years of schooling are repeating grades and dropping out en masse, leading to a return to illiteracy. Some of these pupils, rejected by the rigors of the sixth-form entrance exam, (the majority) have no command of reading nor how to solve operations.

As for the result for higher education, which shows a negative sign with GDP, it is consistent with the study by (Sadi & Rezine, 2021) which highlighted the important role of vocational training in

growth and employment. The negative impact of this variable on GDP in the case of Chad can be explained by the large number of university graduates, who are struggling to assert their skills in the labour market. For example, with an overall unemployment rate of 5.8% in 2017, 60% of the unemployed were university graduates. Other factors also play a part. The tertiary education enrolment rate is low, which means that few students have access to higher education. Similarly, the country lacks the funding to support higher education and improve access to programs focused on vital sectors (health, engineering, tourism, etc.). As a result, higher education does not support the Chadian economy.

The education spending does not make a significant contribution to economic growth, a result explained by the low proportion of public spending on education in GDP, which was only 2.91% in 2020 (Countryeconomy, 2023). This problem is partly related to the weakness of public income collection in the country. In addition, despite the increase in social spending since the exploitation of oil, spending on education remains insufficient and is still concentrated on salaries. This limited expenditures caused in low enrolment and attendance rates.

4.2 Contribution of GFCF to economic growth

In Chad, investment in infrastructure is extremely limited, amounting to no more than 10% of GDP. GFCF is also depreciating rapidly, which is not conducive to sustainable growth. In addition, the skills developed in the field of education are not adapted to current technology, which reduces the effect of investment in education on economic growth. Despite the significant flows of investment recorded in recent years, more needs to be done to make the business climate more favorable to this sector in order to achieve its full potential.

4.3. Contribution of the working population to economic growth

The working population in turn makes a negative contribution to GDP. This is due to the structure of the Chadian economy, inequalities, poverty and development challenges that limit the potential of the active population. The country also faces numerous social and development challenges, with a human development index among the lowest in the world. Problems of infrastructure, access to essential services and food security limit the productivity of the working population. What's more, only 50% of women are in the workforce, compared with 73% of men.

4.4. Contribution of trade openness to economic growth

The result of estimating the trade openness variable showed its positive contribution to economic growth. This result is in line with the study of (Berthélemy, Varoudakis, & Dessus, 1997) explaining the important role of trade openness in the contribution of education to economic growth.

This can be explained by the fact that the Chadian economy is largely dependent on oil production (20% of GDP and more than 80% of goods exports in 2019), which began in 2003 and enabled the country to experience a period of rapid growth until 2014 (average annual growth rate of 13.7%).

In view of these results, human capital measured by the education variables shows a close link with GDP, a result, which suggests that education is not playing its full role in Chad's economic growth process.

5. Conclusion

The objective of this paper is to analyze the contribution of human capital to economic growth in Chad based on time series, for the period (1990-2021) using the VAR model.

The results of the model estimation revealed that human capital contributes to economic growth through secondary education. This result is in line with the World Bank's statement in its report "Building Knowledge Societies" (World Bank, 2003) that education is one of the pillars of teaching that provides students with the tools, concepts and modes of reference that result from advances in science and the paradigms of the time. This education stimulates innovation, strengthens institutions and promotes long-term economic growth. These effects are manifested within society. At the individual level, education has a positive impact on employment, improved income and human health. It also contributes to poverty reduction and promotes equity and inclusion.

However, primary education, higher education and education spending do not play a significant role in explaining economic growth. Although higher education is an essential pillar of human development, and despite its support for basic and secondary education (World Bank, 2003), higher education in Chad does not contribute to economic growth. This result can be explained by the fact that the qualifications of university graduates do not meet the needs of the labor market, with the result that most graduates are potentially unemployed.

In view of these empirical results attesting to the low contribution of education to economic growth in Chad, the urgent need seems to be to improve its effectiveness. At primary level, educational reforms should focus on improving the level and quality of teaching. At secondary level, reforms must focus on adapting training programs to the needs of growth-generating and job-creating sectors (agriculture and industry). As for higher education, it is vital to set up programs based on a truly national system that is perfectly suited to the country's needs and to the priorities of economic development. Undertaking these reforms will enable the sector to compete with other universities in neighboring countries. In addition, public education resources must be used efficiently, ensuring that the

resources available are distributed fairly and effectively between the different levels of education.

In addition, economic policies need to be adapted, in particular by diversifying exports and improving the global economic environment by strengthening international openness, which is a determining factor in both the long and short term, by enabling the acquisition of new technologies that human capital can adapt.

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