THE ROLE OF HUMAN CAPITAL IN FINANCE-GROWTH NEXUS: PANEL DATA ANALYSIS OF AFRICAN COUNTRIES

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Abstract

While the individual role of human capital accumulation and financial sector development are well accounted for in both theoretical and empirical economic growth literature, there are not many studies that emphasize the joint significance of these two important economic growth covariates, especially within the African context. Bridging this knowledge gap is not just important for academic literature but also imperative for policy. This study relies on a novel broad-based composite indicator of financial development to tease-out the role of human capital in the finance-growth nexus using data for 44 African countries from 1991 to 2020. The study uses the Panel Smooth Transition Regression (PSTR) method as its main technique and systems GMM interaction specification for robustness test.

Our findings from the GMM show that human capital when interacted with financial institutions and market development, boosts economic growth. This effect is more pronounced when human capital is measured as life expectancy than when measured in secondary enrolment. Our results from the PSTR estimations show that an adequate level of human capital development is needed for financial development to promote economic growth in African countries, with a threshold value of 85 (35) for secondary enrolment (life expectancy) measures of human capital development. Therefore, African countries should increase access to education and improve life expectancy of population to catalyze the impact of financial development on economic growth. The outcome of this study should, therefore, reignite the recognition of the complementary role of human capital and finance in the economic growth

Keywords: Financial development, economic growth, non-linearity, Africa, human capital, panel smooth transition regression.

1. Introduction

Long-term economic growth depends increasingly on advancement in human capital, as a better-trained and educated healthy workforce improves labor productivity. According to the Global Human Capital Report 2017, 'a nation's human capital endowment — the knowledge and skills embodied in individuals that enable them to create economic value — can be a more important determinant of its long-term success than virtually any other resource'. Gruzina, Firsova & Strielkowski, in an essay on Human Capital, considers education, training and medical treatment (good health) as the important determinants of human capital (Gruzina, Firsova, & Strielkowski, 2021). It is against this backdrop that Sustainable Development Goals (SGD) 4 (quality education) and 3 (Good health and well-being) recognised the important role that human capital plays in the long-term development of economies and societies. Similarly, goals 2 and 3 of the Agenda 2063 (long-term Vision for Africa) recognized education and health respectively as critical for a prosperous Africa.

Similarly, financial sector development – another critical long-term determinant of economic growth – is crucial for the achievement of Africa's vision of Agenda 2063. The Agenda 2063 envisions a financial system in Africa that is inclusive, innovative, digitalised, dynamic and integrated that can substantively contribute to the realisation of the goals. Likewise, the financing for development (Addis Ababa Action Agenda) recognised 'the role that well-functioning national and regional development banks can play in financing sustainable development, particularly in credit market segments in which commercial banks are not fully engaged and where large financing gaps exist. It is therefore clear that the importance of human capital and financial development in the global and Africa's long-term development aspirations is that African countries continue to experience impressive growth performance despite the many global shocks and headwinds. According to Africa Development Bank (2023), Africa's pre-COVID-19 top five performing economies are projected to grow by more than 5.5% on average in 2023-2024. These

countries are Rwanda (7.9%), Côte d'Ivoire (7.1%), Benin (6.4%), Ethiopia (6.0%), and Tanzania (5.6%).

Therefore, in the context of these dynamics in economic growth, financial and human capital development in Africa, one is poised to ask the empirical question: does human capital development mediate finance-growth nexus in Africa? In other words, does human capital, beyond directly impacting growth, moderate the financial development impact on growth? While Evans et al., 2002 examine the role of both human and financial capital in growth using a translog production function, De Gregorio, 1996 examined how credit constraint affects both human capital and growth. Other studies about the mechanism of how finance affects growth (Berthelemy, 1996; Philippe Aghion, Peter Howitt, 2005) focused on the role of initial economic development and convergence. This study is about how human capital enhances the finance-growth nexus for a sample of African countries.

Using a new broad-based composite financial development indicator, this study examines the importance of human capital development for finance-growth relationships for Africa. In other words, does better human capital development promote economic growth in Africa by not only enhancing growth but also through intensifying finance growth promoting effect? There is no doubt that Africa is home to the world's largest proportion of low-income countries, and therefore the need for economic growth and development is paramount.

While empirical work on finance-growth nexus is not anything new, unlike previous studies, this study uses a novel data set and econometric technique; and emphasizes the role of human capital to add to the evidence on finance-growth nexus for Africa. The study makes significant contributions to the existing literature on finance–growth nexus by empirically examining how different measures of human capital and finance shape the finance–economic growth nexus. In addition, this study is able to bring a different perspective to the literature by highlighting the role of countries' human capital stock in mediating the impact of financial deepening on economic growth. Also, the study makes a more systematic attempt to evaluate the relative importance of finance and human capital in the growth process while controlling for other variables.

2. Theoretical Framework

Theoretical work on the role of financial development and economic growth dates to the works of

early researchers (Schumpeter, 1912; Gurley & Shaw 1955, Goldsmith, 1969; McKinnon, 1973). Levine, 2005 carves out a functional approach to the finance-growth nexus, which focuses on the role of the financial system in ameliorating information, transaction and contract enforcement costs to enhance resource allocation, thereby promoting growth. Accordingly, financial systems exist to produce information ex-ante about possible investments and allocate capital; monitor investments and exert corporate governance after providing finance; facilitate the trading, diversification, and management of risk; and mobilize and pool savings (Levine, 2005).

Financial institutions connect profitable investments and capital through collecting and processing information thereby promoting resource allocation and accelerate economic growth. Similarly, by specializing in information collection and processing, financial institutions can promote long-run growth by identifying the best production technologies and those entrepreneurs suitable for successfully applying the new technologies in creating new products and production processes (King & Levine, 1993b).

Since effective corporate governance improves resource allocation and enhances economic growth, financial arrangements that ensure managers maximize firm value will boost savings and channel capital to profitable investments (Stiglitz and Weiss, 1983).

Financial contracts, markets and intermediaries are able to ameliorate risk in the face of information and transaction costs through hedging, trading, and pooling, which has positive ramifications on resource allocation and growth. Because high return projects are the riskier ones, financial contracts, markets and intermediaries that allow agents to diversify their portfolio increase their preference for high expected return projects and growth (Gurley and Shaw, 1955; Patrick, 1966). In the presence of capital scarcity, high return, risky indivisible projects, financial systems that promulgate risk diversification promote savings mobilization towards the high return projects (Acemoglu and Zilibotti, 1997), and encourage innovative activity (King and Levine, 1993b).

There are two costs to pooling savings from disaggregated individuals to form a pool that can be accessed by investors for capital formation; and both costs are effectively reduced under different sets of financial arrangements. These are the information cost of acquiring the confidence of the savers, and the transaction cost of gathering the pool from different individuals (Levine, 2005).

Pooling under bilateral contract arrangements like joint stock companies is potent in reducing transaction costs (Levine, 2005). By pooling savings, the financial system diversifies portfolios toward high return risky projects, promoting growth (Acemoglu and Zilibotti, 1997).

Finally, theoretical models that explain non-linear financial development and growth show that financial development and growth relationships exhibit multiple equilibria. Berthélemy and Varoudakis (1995, 1996), and Aghion et al. (2004) provide evidence for multiple equilibria in the finance-growth nexus explained in terms of reciprocal externalities between the real and financial sectors.

3. Review of Empirical Literature

The empirical literature on human capital, financial development and economic growth is not nascent. Sehrawat, M., & Giri, (2017) also studied an empirical relationship between financial development indicators and human capital in some selected Asian countries using the annual data from 1984-2013. The estimation was done using the panel dynamic ordinary least squares and fully modified ordinary least squares techniques are used. The short-term and long-run causality is examined by panel Granger causality. The study revealed that both financial development indicators and economic growth variables act as an important driver for the increase in human capital. The results of panel Granger causality indicate that causality runs from indicators of financial development, economic growth and public spending on education to human capital. Nuryani, Satrawan, Gorda, & Martini, (2018) conducted a study to determine the influence of human capital, social capital, and economic capital on LPD financial performance in Buleleng regency as well as their influence of financial performance on corporate social responsibility using primary and secondary data. They found a positive but insignificant relationship between Human capital and financial performance.

Within the African context, Elfaki, Handoyo and Ibrahim (2021) investigated the effects of human capital on manufacturing sectors and economic growth in Sub-Saharan African (SSA) countries from 1990 to 2015. The findings suggested that quality human capital is an accelerator in driving economic growth through the manufacturing sector. Oyinlola, Adedeji and Onitekun (2021) examined the relationship between human capital, innovation, and inclusive growth in 17 sub-Saharan African countries between 1998 and 2014. The study found that human capital and

innovation measures positively with inclusive growth and the quality measurements of the human capital index and total factor productivity had the most significant impact. Shobowale, Olopade and Oladeji (2021) also investigated the direct impact of human capital development on economic growth in selected Sub-Saharan African Countries during the period 1981-2020 using the panel least square method. The result shows that while human capital development alone cannot produce the required economic growth, however, it has a positive influence on growth. This study is consistent with the study by Saka and Olanipekun (2021).

However, evidence suggests that the financial development and growth nexus is nonlinear. Jobarteh and Kaya (2019) examined the conditioning role of the overall level of financial development, financial institutions development and financial markets development in the finance-growth nexus for African countries using the panel smooth transition regression approach (PSTR). The study found that an adequate level of the overall financial development is needed for finance to be growth enhancing in African countries, while a robust non-linear finance-growth nexus cannot be established when the finance-growth nexus is conditioned on financial institutions' development or financial markets development.

Beyond financial development, human capital has been investigated to promote the effect of financial development on economic growth in Africa. Muazo Ibrahim (2018) also did an analysis on the interactive effect of human capital in financial development–economic growth nexus in 29 sub-Saharan African (SSA) countries over the period 1980–2014. The analyses were conducted using the system generalised method of moments within the endogenous growth framework while controlling for country-specific and time effects. The study found that, while both human capital and financial development unconditionally promote growth in both the short and long run, results from the interactive terms suggest that, irrespective of the measure of finance, financial sector development largely spurs growth on the back of quality human capital. Similarly, Oyinlola and Adedeji (2019) examined the roles of financial development in human capital development and its impact on inclusive growth in nineteen different Sub-Saharan African nations using the system generalized method of moments (GMM) estimation technique. The study found that financial development promotes the extent to which human capital can facilitate inclusive growth, but the choice of measurement of human capital and financial development is important in examining their complemental influence on inclusive growth. Abubakar et al (2015) interacted with financial

development and human capital in a growth regression for ECOWAS (Economic Community of West African States) using a panel unit root and co-integration approach. Their finding, however, shows that financial development does not enhance growth directly and indirectly through human capital accumulation.

The literature therefore indicates that (1) human capital has a direct impact on economic growth within the context of Africa; (2) there is evidence for a non-linear finance-growth nexus for Africa that depends on financial development; and (3) there is mixed evidence that human capital development promotes finance-growth nexus for African countries. This study seeks to add to the available evidence on the role of human capital on the finance-growth nexus for Africa and differs from the extant literature in (1) uses advanced econometric techniques that allow for testing for non-linearity and modelling it and (2) uses a novel data of financial development that decomposes financial development into financial institutions and markets development; hence allowing for policy specific recommendation for financial institutions and financial markets.

4. Methodology

4.1 Data

This study uses a secondary data set for all variables that are sourced from several sources, especially the key variables. Our variables in the growth equation include initial GDP per capita (from the convergence hypothesis), human capital, investment, trade openness, financial development. Investment is measured as gross fixed capital formation as a percentage of GDP, trade openness is measured as the sum of imports and exports as the ratio of GDP. Financial development is measured using a composite index of financial institutions development, financial markets development and the overall financial sector development that was constructed by (Svirydzenka, 2016), which assesses three main dimensions: depth, access and efficiency. Since this is a recent dataset, we intend to augment the traditional measures with this index. Human capital is measured in terms of school enrollment, which captures how accessible education services are in a country, and life expectancy. All data, except financial development, are sourced from the World Development Indicators and transform into logarithmic form.

In this paper, the focus is to explore the influence of the different measures of human capital development in terms of access and quality, in financial development-enhancing economic growth. It is argued that an efficient human capital will be productive thereby leading to more growth through its making the financial sector more growth enhancing and inclusive.

4.2 Econometric Model and the Estimation Technique

This study employs an array of econometric methods to answer the questions and to test the hypotheses that human capital matters for the finance-growth nexus. The empirical model to estimate is a standard growth regression (King & Levine, 1993; Levine, Loayza, & Beck, 2000).

$$growth_{it} = \alpha_0 + \alpha_1 Fd_{it} + \alpha_2 sch_{it} + \alpha_3 (Fd * HC)_{it} + A_4 X_{it} + \varepsilon_{it} \quad (1)$$

In this empirical model, Fd refers to one of the financial development indexes, HC is school enrolment representing human capital, and X is the control variables or other growth covariates like trade openness and gross fixed capital formation. The last term refers to the idiosyncratic error term, assumed to be normally distributed with a constant variance-covariance matrix. Our coefficient of interest is the α_3, which shows the nature of interaction between human capital and financial sector development in the growth process.

From equation 1, this study employs the PSTR model of (Gonzalez et al., 2005a) and those robustness tests using interaction terms in a systems GMM. On a methodological front, PSTR has the advantage of not just assuming that human capital accumulation affects finance-growth nexus but is able to analytically test for such a relationship. It is also able to model the nature of the relationship between human capital accumulation and finance's effect on growth. Specifically, it can tell the speed at which the finance-growth nexus changes as human capital improves.

The rest of this section explains the PSTR methodology.

The panel smooth transition regression method allows the researcher to both model endogeneity and heterogeneity in the data while allowing the researcher to control for individual country fixed effects. Following (Gonzalez et al., 2005a) a PSTR model specification of equation 1 is as follows.

$$growth_{it} = \mu_i + \beta_0 FD_{it} + \beta_1 FD_{it}\, g(HC_{it};\, \gamma, c) + \beta_2\, X_{it} + u_{it}$$

For $i = 1, 2, \ldots . . N$ and $t = 1, 2, \ldots . . T$, where N and T represent the countries in the region and the years respectively. $growth_{it}$ is the dependent variable representing the GDP growth rate for country i for year t. X_{it} represents the vector of control variables including human capital measured by secondary enrollment and life expectancy, trade openness and gross fixed capital formation. For values of $\gamma > 0$ and $c_1 < c_2 < \cdots < c_m$, $g(HC_{it}; \gamma, c)$ is a continuous logistic transition function of the form:

$$g(HC_{it}; \gamma, c) = [1 + \exp\left(-\gamma \prod_{j=1}^{m} (HC_{it} - c_j)\right)]^{-1}$$

The transition variable is normalized to take values from 0 to 1. The number of thresholds (m) according to (Gonzalez et al., 2005a) $m = 2$ is sufficient. However, $m = 1$ gives two regimes for which if $(\ldots) = 0$, the regression parameter in is β_0' describing the first regime, and if $g(\ldots) = 1$ the regression parameter becomes $\beta_0' + nonlinearity$ the second regime. Testing for non nonlinearity model amounts to testing for $H_0 : \gamma = 0$ or $H_0' : \beta_0 = \beta_1$, but because the model contains unidentified nuisance parameters this test is a non-standard test. Gonzalez et al., 2005a followed (Luukkonen, Saikkonen, & TerÄsvirta, 1988) to replace the $g(\ldots)$ with its first order Taylor expansion around the transition parameter set to zero ($\gamma = 0$) in an auxiliary equation of the form:

$$y_{it} = \mu_i + \beta_0^* FD_{it} + \beta_1^* FD_{it}\, HC_{it}^1 + \beta_2^* FD_{it}\, HC_{it}^2 + \cdots . + \beta_m^* FD_{it}\, HC_{it}^m + u_{it}{}'$$

Finally, based on LM test (either Wald or Fisher version) or Likelihood Ratio (LR), the linearity test can be done via testing the following hypothesis $H_0 : \beta_0^{*\prime} = \beta_1^{*\prime} = . . = \beta_m^{*'} = 0$ against at least one threshold. This test is done sequentially so that if linearity is rejected, the next stage will involve a null of one threshold against two, and this procedure continues until the null of no more non-linearity cannot be rejected (Gonzalez et al., 2005a). However, Gonzalez et al., 2005a discounts the significant level by a constant discounting factor between zero and unity to avoid excessively large models. Note that the model reduces to Hansen, 1999 panel transition regression model (PTR) as $\gamma \sim \infty$, and a linear fixed effect model as $\gamma \sim 0$ as described above.

Panel smooth transition regression model may be suited for modelling testing and modelling non-linearities, but it does not take care of endogeneity in the best of ways. This is why researchers instead fed in the lag values of the endogenous variables to avoid estimating the contemporaneous

effect, which may be associated with the errors. The other way to control endogeneity is to estimate a dynamic panel with interaction terms as in a robustness check. We intend to follow the PSTR model with a Systems GMM result for robustness check.

5. Empirical Results and Discussion

5.1 Descriptive statistics

To do a preliminary analysis, we have collected data on GDP per capita income at constant 2015 purchasing power parity US$, secondary school enrollment rate and life expectancy as a measure of human capital, gross capital formation as a measure of investment, and trade openness from World Development Indicators. Also, financial development as a composite index, financial institutions and financial market as a measure of the financial system in Africa from the International Monetary Fund. The sample comprises 44 African countries from 1991-2020.

The descriptive statistics of the variables employed for this study are presented in Table 1 and it can be seen from the results that all the series have positive mean values; this means that all variables have increasing trends. The average real per capita GDP of $1,982 reveals the low-income status of the countries under the study as per the World Bank income grouping. The standard deviation of the financial institution's indicator reveals wide dispersion compared to the financial market indicator. Financial development as a composite index is relatively stable. Intuitively, the relative volatility of financial institutions performance has implications for the role of the financial system. This may be associated with the performance of agents, brokers, and intermediaries in financial transactions which hinders growth inclusiveness. Furthermore, among the human capital indicators, life expectancy is stable compared to secondary school enrolment. The summary statistics also show that trade is volatile compared to gross capital formation.

Table 1: Variables descriptive statistics

Variable	Observation	Mean	Standard Deviation	Min	Max
GDP per capita	1157	1982.077	2747.11	190.333	16747.34
Financial Development	1320	0.126	0.0981037	0	0.592

Financial markets development	1320	0.049	0.090	0	0.533
Financial institutions development	1320	0.199	0.126	0	0.713
Secondary enrolment	1003	95.153	25.375	21.708	156.404
Life expectancy	1320	56.023	7.781	14.098	76.593
Gross fixed capital formation	1022	95.153	9.258	-2.424	81.021
Trade openness	1036	65.461	33.064	19.684	222.082

Source: Authors' computation using data from the World Bank (2022) and International Monetary Fund (2022).

4.2 Linear and Non-Linear panel data results

In this section, we use systems GMM (Arellano and Bover, 1995; Blundell and Bond, 1998) to uncover the independent unbiased effect of human capital on the finance-growth nexus in Africa and the results are presented in Table 2. Columns I, III, and V present the result for the linear specification with the three financial development indicators, one for each column, and columns II, IV and VI present the result for non-linear specification with financial indicators for each column.

We conduct panel estimations of the finance–economic growth nexus in 44 African countries controlling for initial values of real GDP per capita, financial development indicators (financial development, financial institutions and financial market), human capital (secondary enrollment ratio and life expectancy), trade openness and gross capital fixed formation. These control variables are consistent with standard literature. We include in our estimation time and country effect to purge time-related shocks and country-level heterogeneity in the growth process. We estimate twelve models by sequentially introducing the different indicators of finance and human capital and its interaction to examine the robustness of the estimates to model specification. The findings from these exercises are presented in Tables 2 and 3.

We begin by discussing the adequacy of the models estimated. For all the models estimated, the p-values (0.0000) of the Wald $\chi 2$ statistic affirm joint significance in each model. The tests for over-identifying restriction reveal the validity of the instruments used given our failure to reject the null hypotheses for Sagan's tests. Serial correlation of the first degree is bound to be present

in dynamic models. However, model diagnostics show that serial correlation of second degree is not a problem in all specifications in Tables 2 and 3 (P-values > 0.05). Model over identification restrictions tests of Hansen show that the validity of the over-identification restrictions cannot be rejected in all specifications. These findings by and large reassure the coherence and consistency of our estimates.

In all cases financial development is positively and significantly related to growth, however, the magnitude is higher for financial institutions than financial markets. This is not surprising given that financial institutions are more developed (mean of 0.199) than financial markets (mean of 0.049). Combined, the overall financial sector development exerts an even more effect on growth. Trade openness which measures the extent to which a country is receptive to foreign businesses as a growth covariate is also examined and the results show that trade are significant determinant of growth when life expectancy is introduced in the model, but not significant when education is introduced in the model. However, the coefficients are economically insignificant.

Table 2: Effect of education (schooling) on finance-growth nexus

VARIABLES	**Linear specifications**			**Non-linear specifications**		
	Overall	Institutions	Markets	Overall	Institutions	Markets
L.lngdppc	0.884***	0.711***	0.888***	0.889***	0.500**	0.779***
	(0.0439)	(0.131)	(0.0703)	(0.0439)	(0.215)	(0.119)
Lnsch	0.0557	0.224*	0.092	0.230**	0.836**	0.522**
	(0.0398)	(0.121)	(0.0616)	(0.106)	(0.41)	(0.238)
Lntrade	0.0418	0.108	0.0483	0.0457*	0.2	0.132
	(0.0383)	(0.0768)	(0.0434)	(0.0267)	(0.154)	(0.0853)
Lngfcf	0.0236	0.0439	0.046	0.0425**	0.0928	0.109*
	(0.0153)	(0.0352)	(0.0272)	(0.0179)	(0.1)	(0.0612)
Lnfd	0.125**			0.239		
	(0.0502)			(0.148)		
Lnfdsch				0.0866*		
				(0.0434)		
Lnfi		0.105*			0.894	
		(0.0532)			(0.56)	
Lnfisch					0.281*	
					(0.16)	
Lnfm			0.00471			0.314**
			(0.00302)			(0.149)
Lnfmsch						0.0871**

						(0.0412)
Constant	0.668**	0.885*	0.179	-0.201	-0.366	-1.192*
	(-0.256)	(-0.475)	(-0.203)	(-0.335)	(-0.974)	(-0.603)
AR(2)	-1.43	-0.89	-2.1	-1.02	0.19	0.35
Hansen Test	21.82	17.54	18.36	28.71	16.57	15.95
Observations	528	528	497	528	528	497
Number of id	34	34	30	34	34	30

Source: Author's computation using data from World Bank (2022) and International Monetary Fund (2022) Note: *** implies that statistically significant at 1%, ** implies that statistically significant at 5%, * implies that statistically significant at 10%.

The results show that the initial level of economic growth determines to a large extent, the level of economic growth in the economy as the coefficient on the lagged dependent term ranges between 0.50 and 0.88 and is statistically significant in all models at 1%. In the linear models, financial development is positively and significantly related to growth, however, the magnitude is higher for financial institutions than financial markets. This is not surprising given that financial institutions (mean of 0.22) are more developed compared to financial markets (mean of 0.06. Combined, the overall financial sector development exerts an even more effect on growth. Financial indicators have significant effects on growth except for financial markets which explains the low-level development of the financial markets in Africa.

The results show that the different measures of human capital have a positive impact on economic growth except in the linear models for overall financial development and financial markets development where secondary enrollment is used as a measure of human capital. This indicates the strong and significant role that human capital, both access to education and quality of life, plays in promoting economic growth in Africa. In other words, the direct impact of human capital on growth is observed in regressions. Trade openness is significant in the model where life expectancy is introduced and not education. However, the coefficient is economically insignificant. This implies that the extent to which activities that benefit from the openness of countries in Africa accrues to few populations. A greater number of people could have benefited if countries opened their economies to trade and had greater market access to the international market. The results also show that gross fixed capital formation is positively linked with economic growth although the growth elasticity is higher with the build-up of capital formation for most of the estimations but is not statistically significant.

The next discussion will focus on the report of the interactive terms between human capital and financial indicators referred to as the non-linear models. Tables 2 and 3 provide a summary of the results of the models with interaction terms aimed at probing if human capital enhances the impact of financial development on economic growth. We determine the interactive effect of human

capital in finance–growth nexus by introducing a multiplicative interactive term of human capital and finance into the growth equation to examine how the relationships vary. In addition, we alter the model specification when secondary enrollment is used as a proxy for human capital in Table 2, and when life expectancy is used as a proxy for human capital in Table 3. When we interact with secondary enrollment and financial development, the coefficient of the interactive term is positive and statistically significant at 10 per cent, just as when we replace financial development with a financial institution. Similarly, when enrollment is interacted with the financial market, the coefficient is significant at 5 per cent.

In Table 3, where life expectancy is interacted with financial development and financial institutions, the coefficient is positive and significant at 10 per cent. Also, when life expectancy is interacted with the financial market, the coefficient is positive and significant at 5 per cent. In both estimations, our finding shows that investment in human capital stock boosts economic growth by increasing the level of domestic financial development. However, given this finding, *further evidence suggests that a higher growth effect via finance is observed when human capital is measured with life expectancy relative to school enrollment*.

Table 3: Effect of human capital (life expectancy) on finance-growth nexus

Variables	**Linear specifications**			**Non-linear specifications**		
	Overall	Institutions	Markets	Overall	Institutions	Markets
L.lngdppc	0.852***	0.857**	0.882***	0.741***	0.716**	0.883***
	0.045	0.048	0.043	0.116	0.121	0.04
Le	0.314**	0.363***	0.504***	0.067*	2.903**	1.031***
	0.142	0.13	0.075	1.55	1.334	0.256
Lntrade	0.101*	0.109**	0.076	0.118	0.159	0.068
	0.056	0.054	0.057	0.107	0.101	0.062
Lngfcf	0.040*	0.038	0.018	0.079*	0.075*	0.038
	0.021	0.026	0.022	0.046	0.042	0.025
Lnfd	0.097**			-4.344		
	0.044			2.537		
lnfd_le				1.106*		
				0.643		
Lnfi		0.076*			-5.461	
		0.042			2.767	
lnfi_le					1.386*	
					0.702	
lnfm			0.010**			0.561**
			0.004			0.272
lnfm_le						0.140**
						0.067

Constant	-0.52	-0.874	-1.5	-10.447*	-10.375**	-3.699***
		0.534	-6.02		4.882	1.039
AR(2)	-1.01	-1.24	-1.63	-1.73*	-1.75	-1.29
Hansen Test	23.42	24.34	24.4	24.9	23.45	21.06
Observations	969	969	836	969	969	836
Number of id	37	37	32	37	37	32

Source: Author's computation using data from World Bank (2022) and International Monetary Fund (2022) Note: *** implies that statistically significant at 1%,** implies that statistically significant at 5%, * implies that statistically significant at 10%

4.3 Panel smooth transition regression approach results

Advances in econometric techniques allow for testing non-linear relationships between variables and model the heterogeneous economic relationships between variables. In the literature, some researchers' have questioned the notion that there is a linear relationship between finance and growth, hence the recent surge in nonlinear finance-growth studies (Mhadhbi & Terzi, 2022; Carré & L'œillet, 2018 and Ibrahim & Alagidede, 2017). Extant literature studied the existence of non-linearity as well as study the conditioning variables that moderate such nonlinearity (Jobarteh & Kaya, 2019). In this section, we estimate a panel smooth transition regression model of the finance-growth nexus where the finance-growth nexus is conditioned on the level of human capital development for African countries.

The results of the PSTR are shown in Tables 4 and 5 which include the linearity test, test of no remaining heterogeneity and the PSTR estimation. Table 4 shows the results when human capital, the conditioning variable is measured as the secondary school enrollment. Table 5 shows the results for life expectancy as a measure of human capital.

The first section indicates that the finance-growth nexus is non-linear by all three statistics when we condition the nexus on the secondary school enrollment. In all the specifications the Likelihood Ratio statistic, the Fisher and Wald statistics significantly reject linearity 1%.

Also, we test for the appropriate number of thresholds in each model using the Fisher, Wald and LR test statistics. The results in the second section of Table 5 highlight that the null of only one

threshold/two regimes cannot be rejected in all three models at a 10% level of significance, indicating that usually, one threshold is sufficient to capture all non-linearities in economic relationships (Gonzalez et al., 2005 and Jobarteh & Kaya, 2019). The results of the PSTR estimation output for finance-growth nexus are presented in the final section of Table 4.

Table 4: Linearity, non-linearity tests and PSTR estimation results when school enrollment is a threshold

	Overall		**Institutions**		**Markets**	
Linearity Test	Stat.	P value	Stat.	P value	Stat.	P value
Likelihood Ratio	6.584	0.086	4.764	0.053	5.389	0.0743
Wald	6.514	0.086	4.548	0.050	5.563	0.0784
Fisher	1.880	0.013	1.340	0.012	1.456	0.0124
Test of no linearity	T stat.	P value	T stat.	P value	T stat.	P value
Likelihold Ratio	-2.212	0.530	-2.843	0.620	-2.365	0.556
Wald	2.204	0.531	2.643	0.634	2.794	0.74
Fisher	0.613	0.607	0.754	0.708	0.76	0.763
PSTR Coefficient Estimates						
Gamma	5.55		5.55		5.55	
C	84.57		84.57		84.57	
	Regime 1	Regime 2	Regime 1	Regime 2	Regime 1	Regime 2
Coefficient	-0.303 (-0.76)	1.065 (1.90)	-0.132 (-0.53)	1.13 (2.02)	-0.278 (-0.641)	1.65 (2.34)

Source: Author's computation using data from World Bank (2022) and International Monetary Fund (2022) Note: ***, **, and * imply that statistically significant at 1%, 5%, and 10%, respectively.

Table 4 indicates that when we measure human capital by the secondary enrollment ratio, which indicates the percentage of students enrolled in secondary schools regardless of age as a portion of the total secondary school-aged population, the model shows that the finance-growth nexus is non-linear. The linearity test is rejected by all three statistics (Likelihood, Wald, Fisher) indicating the presence of non-linearities in the relationship. To model the non-linearity, we test for the number of thresholds (regimes), and the results indicate that one threshold, two regimes is sufficient to model the nonlinearity. Finally, we estimate the relationship which shows that an approximate secondary enrollment ratio of 85 is the cut-off below which finance does not promote growth, and above which finance significantly promotes economic growth. The threshold value does not change with either the overall financial development, financial institutions development, or financial markets.

Table 5: Linearity, non-linearity tests and PSTR estimation results when life expectancy is the threshold

	Overall		**Institutions**		**Markets**	
Linearity Test	Stat.	P value	Stat.	P value	Stat.	P value
Likelihood Ratio	6.584	0.086	4.764	0.053	5.389	0.0743
Wald	6.514	0.086	4.548	0.050	5.563	0.0784
Fisher	1.880	0.013	1.340	0.012	1.456	0.0124
Test of no linearity	T stat.	P value	T stat.	P value	T stat.	P value
Likelihood Ratio	-2.212	0.530	-2.843	0.620	-2.365	0.556
Wald	2.204	0.531	2.643	0.634	2.794	0.74
Fisher	0.613	0.607	0.754	0.708	0.76	0.763
PSTR Coefficient Estimates						
Gamma	3.50		3.50		3.50	
C	34.65		34.65		34.65	
	Regime 1	Regime 2	Regime 1	Regime 2	Regime 1	Regime 2

Coefficient	-0.303 (-0.76)	1.065 (1.90)	-0.132 (-0.53)	1.13 (2.02)	-0.278 (-0.641)	1.65 (2.34)

We present the results of the PSTR with life expectancy as the threshold variable in Table 5, and our findings show that for financial development to significantly promote economic growth an average person should live **approximately 35 years.** This indicates that a young population that lacks experience might not be able to harness the opportunities that the financial sector presents for economic growth and prosperity, hence the insignificance of finance-growth nexus below 35 years. However, in a population with higher life expectancy more experienced people are able to use the financial sector to grow businesses and the economy. These findings thus confirm the theory and evidence emphasizing the important link between investment in human capital accumulation and long-run economic growth (Barro and Sala-i-Martin, 1995; Evans, Green & Murinde, 2002; Oyinlola, Adedeji & Onitekun, 2021)

5.0 Conclusion and Recommendations

Using a new broad-based measure of financial development, this study attempts to investigate the role of human capital in the finance-growth nexus for a sample of forty-four African countries for the period 1992-2021, taking a five-year average of variables to smooth out business cycle effects. The analysis was in two stages, where the first stage studies the linear finance-growth nexus as found in the earlier finance-growth literature. The findings from this analysis show that the overall financial development, financial institutions development and financial markets development significantly enhance economic growth, even after controlling for other significant growth covariates in the setup of a dynamic panel regression method. It also showed that human capital significantly moderates the impact of financial development on economic growth with a significant interactive financial development-human capital term in all six specifications of the model. Whether we measure human capital by educational participation or quality of life, our results do not differ. Our results hold for financial institutions as well as for financial markets, and both combined.

In the second stage of the analysis, we rely on the endogenous threshold model of panel smooth transition regression (PSTR) introduced by (Fok et al., 2005; Gonzalez et al., 2005) to further investigate non-linearity in financial development and growth relationship. In this stage, we have formally tested and modelled the non-linearity in the finance-growth nexus to depend on human capital. In both models (secondary enrollment and life expectancy), we found that a threshold value of 85 (35) for secondary education (life expectancy) is the value above which financial development (institutions, markets and both) impacts growth positively. These results collaborated with other findings elsewhere.

Based on the findings in this paper, policymakers in African countries should further pursue financial development from a broad perspective, focusing not just on financial institutions, which dominate the financial sector of African countries, or financial markets, which are nascent in some countries, but keeping an eye on the trajectory of the overall financial sector development to allow growth enhancing financial development. Moreover, given that the financial development index is multidimensional, our findings call for policymakers to not just focus on financial deepening but also on access and efficiency aspects of the African financial superstructure. Furthermore, the results indicate a positive impact of human capital measured with education and life expectancy promote economic growth with a significant interactive financial development-human capital term in all six specifications of the model. Based on these findings, policymakers should design policies and frameworks that will improve human capital development by strengthening and safeguarding health systems and education through innovative finance which in turn promotes growth. The financial system should also be improved to deliver its catalytic role of improving human capacity development. This study is silent on the disaggregated effect of individual sub-dimensions of financial institution development and financial markets development and is a case for further research.

The list of countries under study includes Angola, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Congo Republic, Congo, Democratic Republic, Cote d'Ivoire, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, South Africa, South Sudan, Tanzania, Togo, Uganda, Zambia and Zimbabwe.

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